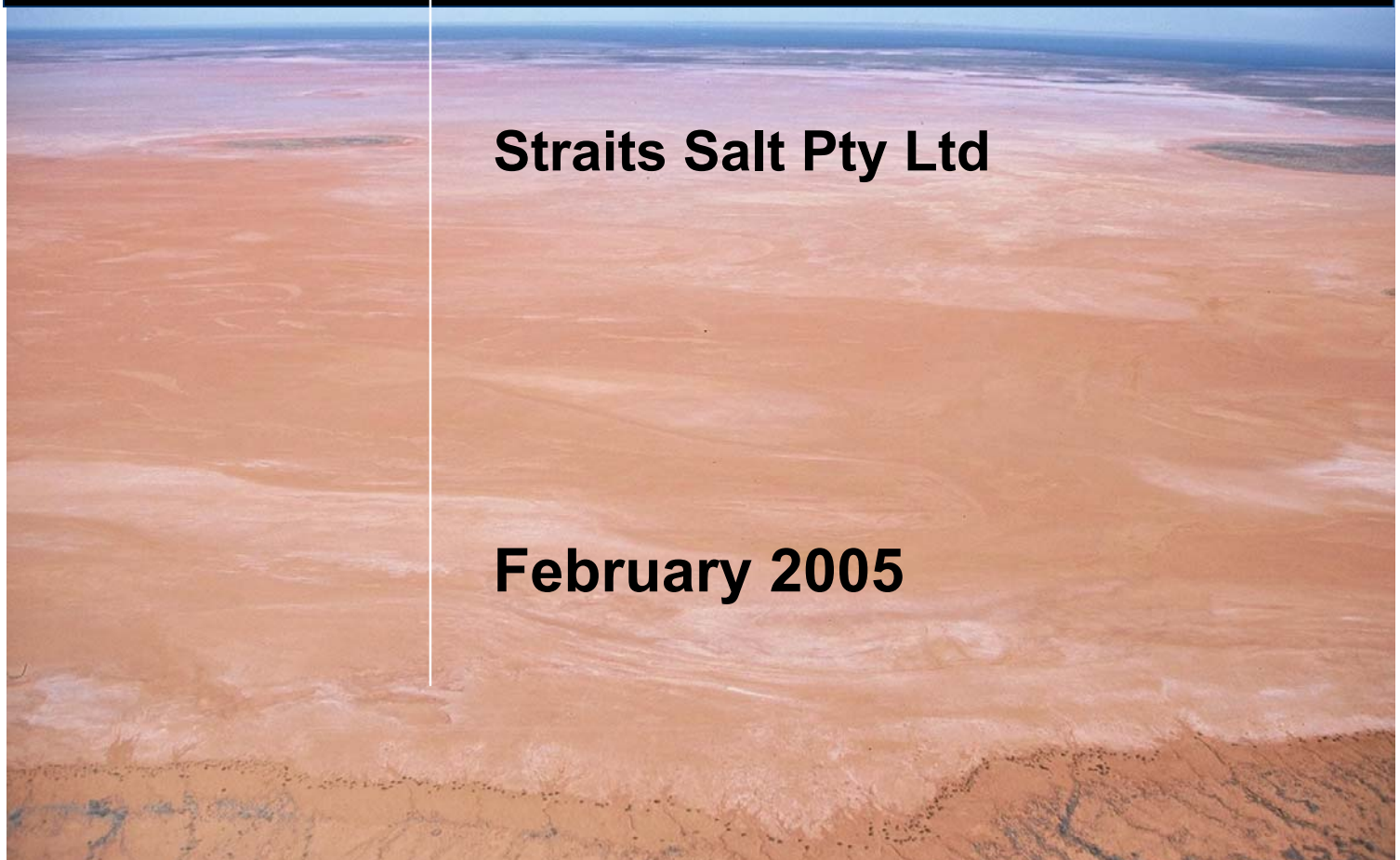
Straits Salt Project

Environmental Review and Management Programme

Environmental Scoping Document and Terms of Reference



Straits Salt Pty Ltd

February 2005

This page has been left blank intentionally

Straits Salt Project

Environmental Review and Management Programme

Environmental Scoping Document Terms of Reference

Prepared for:

Straits Salt Pty Ltd

Prepared by:

Straits Salt Pty Ltd
Biota Environmental Sciences Pty Ltd
Oceanica Consulting Pty Ltd
DC Blandford & Associates Pty Ltd

February 2005

Contents

Tables

Figures

Appendices

1.0 Executive Summary

Straits Salt Pty Ltd (Straits) is planning to develop a 10 million tonne per annum (Mtpa) solar salt field along the eastern margin of Exmouth Gulf. A referral document was prepared and submitted to the Western Australian Environmental Protection Authority (EPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (*EP Act 1986*) on 15th April 2004. The EPA determined that the level of assessment for the proposed Straits Salt Project would be set at Environmental Review and Management Programme (ERMP).

The project was also referred to the Department of the Environment and Heritage (DEH) in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999*). The DEH confirmed that the project would be treated as a controlled action on the basis of listed threatened communities and migratory species and that assessment under the *EPBC Act 1999* would be required. This assessment would, however, be conducted in accordance with the bilateral agreement between the Commonwealth and the State Governments whereby it would primarily follow the Western Australian environmental assessment process.

Therefore, while this Environmental Scoping Document has been prepared in accordance with the requirements of Part IV of the *EP Act 1986*, it also meets the requirements of the Federal *EPBC Act 1999* in providing Terms of Reference for the purposes of Federal environmental assessment of a controlled action.

The Proposal

Straits Salt Pty Ltd proposes to undertake the construction and subsequent operation of all necessary facilities for a conventional solar salt field and the subsequent export of the salt product. This is a sustainable project that relies on natural processes and the renewable resources of seawater and sunlight, with approximately 99.9% of the power consumed to produce salt sourced from solar energy. The growth of organic matter in the base of the ponds will also result in the sequestration of carbon dioxide.

The philosophy of the engineering design will be to investigate and understand the existing environment and environmental constraints in the region, and then design the salt field to minimise or eliminate potential impacts. As such the engineering is being conducted in parallel with the environmental studies and a finalised design will be provided in the ERMP document.

The facilities will consist of intake pumps delivering seawater into a series of concentration ponds. Seawater within the concentration ponds undergoes natural evaporation resulting in an increase in the salt concentration. The resultant brine (high salt concentration sea water) is then pumped into a series of smaller crystalliser ponds where again, via natural evaporation, the salt concentration in the brine reaches a point where solid salt (NaCl) crystals are formed. The salt crystals build up to a depth of approximately 0.5 m in the pond. The pond is drained and a mechanical harvester removes the salt crystals which are then taken to a salt washing facility to produce export quality salt; the target product. This salt is stockpiled before being loaded onto barges. It is then transhipped into the central Gulf and unloaded onto waiting bulk carrier ships. These ships will then transport the salt to customers in the Asian region.

The residual brine (known as bitterns), which contains remnant salts from the seawater, will be either retreated or discharged. Several disposal options are currently being investigated.

Project Justification and Alternatives Considered

The proponent undertook a scoping study to justify the viability of a new solar salt production facility and to establish the location of the proposed project.

Market research on current salt producers and consumers indicates there will be an increasing shortfall in the ability of existing Australian producers to export salt to meet the demands of the target market of the Asia-Pacific region. It is expected this deficit could grow to almost 10 million tonnes per annum (Mtpa) over the next 10 years.

The most economically viable long-term production method for salt production is via solar salt production from seawater in a region with favourable climatic conditions. The northwest coast of Western Australia is already known as one of the world premier regions for solar salt production.

Salt is a bulk commodity and it is necessary to establish large integrated facilities to ensure that competitive unit costs of production and sufficient market volume can be achieved and maintained. The minimum economic capacity is considered to be 2.5 to 3 Mtpa, ideally with a capacity to expand as market forces dictate.

Straits investigated potential locations for a solar salt field on the north-west coast of Western Australia, with the major criteria being that the site would be large enough for an initial start up capacity of 2.5 to 3 Mtpa, with sufficient area to allow for future expansion. The selection criteria also included topographic data, maritime survey map data, tenement information, environmental constraints and native title claim data, as well as general site characteristics, site locations relative to transport routes (road, port and airfield facilities), closeness to population centres (personnel) and existing salt operations.

This comprehensive regional evaluation found that only the eastern Exmouth Gulf met the key area/production criteria. The area provides significant flexibility in design and layout to allow for the incorporation of environmental, heritage and engineering constraints. It also became evident during the investigation that this area has previously been identified by the State Government as an area suitable for solar salt production. To this end, Ministerial Temporary Reserve 70/5350 was set aside over this entire area for the purpose of producing solar salt, gypsum and limestone.

The good environmental record of other salt fields in Australia provided Straits with confidence that a salt field could be constructed and operated in an environmentally acceptable manner in this location. There is potential for further improvement in environmental performance as Straits (and the regulators) can build on the experience from other salt fields.

Stakeholder Consultation

Straits acknowledges the importance of engaging all relevant stakeholders throughout the life of the project, in particular during the environmental approvals stage. In line with this philosophy, the proponent commenced its consultation program over 12 months ago and has had initial contact with many of the key stakeholders. Identified stakeholders are diverse and include a broad spectrum of Government departments, Non Government Organizations (NGOs), landowners, business and community groups and various research organizations that have worked within the region.

As part of this ongoing program, Straits has developed Stakeholder Reference Group (SRG's) in Exmouth and Onslow, which will be consulted regularly to disseminate up to date information about the project and to ensure that varying viewpoints are captured. Attempts will be made to address issues as they arise.

While the SRG's are a significant part of the consultative process, they only form part of the overall strategy. A Stakeholder Consultation Plan has been developed that provides a schedule for both routine and targeted consultation both for the SRG's and other stakeholders. Numerous triggers have been established within the Plan, such as the release of this Environmental Scoping Document/Terms of Reference, which will result in a round of consultation being undertaken. Straits has produced a Project Brochure, commenced publication of a monthly newsletter and Frequently Asked Question sheets are being developed periodically in response to questions raised. All of these mechanisms will be used to raise stakeholder awareness about the project and to enhance further consultation. All of this information will be made available on the Straits Resources Limited website (www.straits.com.au).

Key Environmental Policies

The project area has long been recognised as having significant environmental importance by the EPA and the MPRA and there are two key documents, which directly refer to the project area:

- The Marine Parks and Reserves Selection Working Group (MPRSWG) "Wilson Report" (1994); and
- EPA Guidance Statement No. 1: Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline (EPA 2001).

In 1994, the MPRSWG, in the Wilson Report, recommended that, "*the nearshore waters on the eastern and south-western side of Exmouth Gulf be considered for reservation for the protection of mangal habitat, prawn and fish nursery areas, turtle and dugong feeding areas, and coastal marine fauna and flora generally and for recreational fishing and such commercial fishing and mariculture and may be consistent with the former purposes*."

EPA guidance statement No. 1 found that for this coast: "No development should take place that would adversely affect the mangrove habitat, the ecological function of these areas and the maintenance of ecological processes which sustain the mangrove habitats". Straits is aware that the EPA will give these mangroves formations the highest degree of protection with respect to geographic distribution, biodiversity, productivity and ecological function and has recognised this in its approach to the design of this proposal. It is therefore Strait's belief that the project can be designed and managed such that the EPA's environmental objectives will be met.

Existing Environment

Exmouth Gulf is a dominant feature of the West Australian marine environment, representing one of the largest embayments on the West Australian coast. The Gulf is a large (approximately 3,000 km^2) shallow basin set in a remote, arid tropical area enclosed by the Cape Range Peninsula to the west and by the Yannarie Coastal Plain to the east. The catchment contributing runoff sediments and water to Exmouth Gulf is relatively small (approximately 6,400 km^2) compared to the water area of the Gulf (Brunskill et al. 2001), meaning that the Gulf is an estuary dominated by marine factors.

The eastern margin of the Gulf is characterised by shallow waters adjacent to an extensive system of intertidal mudflats and mangrove swamps. The tidal range within the Gulf is approximately 2 m. The benthic habitat of the shallows (water <5 m deep) of the east coast is dominated by ephemeral seagrasses (*Halodule uninervis*, *Halophila ovalis*, *H. spinulosa*, *Cymodocea serrulata* and *Syringodium isoetifolium*), brown macroalgae (*Sargassum* spp.) and red and green algae.

These shallow waters containing seagrass and algae are a significant component of the Gulf ecosystem, providing habitat for juvenile prawns and fish and an important food source for dugong. The Gulf is believed to support a population of approximately 1,000 dugongs, as well as turtles (predominantly green turtles, though loggerhead, hawksbill and flatback turtles are likely to be present in smaller numbers) bottlenose dolphins, and manta rays. The deeper waters of the Gulf are also known to be an important refuge for humpback whales with calves over the period August/September/October. All these species are protected under the *EPBC Act 1999*.

The Gulf is commercially harvested by a fleet of prawn trawlers. There are also active pearling and aquaculture leases. The tourism industry based out of Exmouth is largely centred on the attractions of Cape Range and the adjoining Ningaloo Marine Park, however some minor tourism activities do occur within the Gulf.

The project area falls within the Carnarvon bioregion according to the Interim Bioregionalisation of Australia (IBRA). The area proposed for the construction of the salt field is situated within the Yannarie Coastal Plain region and encompasses part of the Giralia Anticline area in the south. Geologically, most of the intertidal flats and mangrove swamps together with the supratidal mudflats consist of coastal and shallow marine deposits that are of Holocene age. These are interspersed with occasional elevated areas or 'islands' which are effectively mainland remnants arising from historical marine transgressions. The mudflats grade inland to claypan areas interspersed with dunes, which ultimately then grade inland into dune and sandplain deposits.

Vegetation across all these areas (except the mudflat itself) includes hummock grasses *Triodia pungens* on sandy areas or samphire, saltbushes and bluebushes (*Halosarcia*, *Atriplex* and *Maireana* species) on the saline areas behind the mangroves and between the mudflats and supratidal areas. Extensive cyanobacterial algal mats occur on the intertidal mudflat behind the mangrove zone. The mangrove complex is largely pristine in regards to human disturbance, and comprises one of the largest mangrove complexes in the State. The complex is generally dominated by *Avicennia marina* and *Rhizophora stylosa* but four other species occur at low frequency in the system. These mangroves have been recognised by the EPA as being of Regional Significance (Guideline 1 of EPA Guidance Statement No. 1 (Tropical Arid Zone Mangroves) (2001)). The east coast of Exmouth Gulf is also a Commonwealth "Directory Wetland" (listed in the Commonwealth Department of the Environment and Heritage's "A Directory of Important Wetlands in Australia"). This listing covers the mangrove coast and intertidal area and is on the basis that the site is a good example of this type of wetland occurring within this biogeographic region of Australia.

The terrestrial vertebrate fauna of the study area are relatively poorly known, with most survey data limited to offshore island studies completed by the Department of Conservation and Land Management (CALM) and other regional studies and reviews. There are a number of CALM Nature

reserves in the eastern Gulf area, including Burnside, Simpson, Tent and Whalebone Island Reserves, and Sandalwood Landing Reserve.

Key Environmental Impact Issues and Scope of Investigations
This Environmental Scoping Document identifies the relevant potential environmental impacts associated with the proposal and potential monitoring and management requirements to address these (see Section 6.0). The impacts have been categorised into physical and ecological issues within the marine and terrestrial areas, however the significance of the interactions and connectivity of the system (see Section 6.7) has also been identified. The potential impacts on the entire system will be assessed fully within the ERMP.

The ERMP will provide:

- an account of pre-existing impacts in the project area (or locality if necessary) relevant to the factor;
- relevant aspects of the project that are the source of the potential impacts;
- an evaluation of the potential impact mechanisms and their spatial scale;
- an integrated assessment of the impacts and the management implications; and
- project design and management response to ameliorate or eliminate the potential impact.

Based on the initial reviews, site appraisals and stakeholder consultation, Straits believes there are four key environmental concerns associated with the development of the salt field:

1. Potential for direct and indirect loss of mangroves and associated biota such as algal mats in an area of recognised significance for these systems.
2. Potential shipping and salt production related impacts on marine fauna (i.e. whales and dugongs), which are protected at State and Federal levels, and the habitat supporting these fauna.
3. Potential modification to existing surface water hydrology, tidal flushing and marine and terrestrial nutrient inputs introduced by the presence of the salt field and the significance of this to wider ecosystem function of Exmouth Gulf (with linkages to impacts on fisheries and aquaculture).
4. Development in an area recommended by the MPRSWG (1994) to be set aside as a marine conservation reserve and the project design and management required to maintain the environmental values of such a reserve.

However, Straits believes that the ERMP will demonstrate that the salt field can be designed and managed such that the environmental values of the region will be maintained. The project provides the mechanism for active management of the locality to be improved. Details of the scope of investigations to address these key areas are set out in Section 6.0. Other second tier environmental issues raised by the proposal are also outlined in Table 6.1.

Avoiding and Minimising Impacts
In response to the above concerns:

1. Impacts on mangroves and algal mats will be minimised or avoided through the design of the salt field, including the location of the salt field out of the mangrove zone and the use of trestleways and other infrastructure to minimise changes to tidal flushing.

2. With respect to marine fauna, Straits is undertaking surveys to understand temporal and spatial distribution of key species and will develop management alternatives to avoid or minimise disturbance to these target species.

3. The underlying design philosophy behind the planning of the salt field is to avoid interrupting water flows, either coastal, intertidal or from the hinterland to the ocean. For this reason, the salt ponds are to be placed inland of the intertidal zone and designed such that hinterland flows will not be interrupted and marine structures will not affect tidal flows. The hypothesis is that if the water flows are not interrupted, then the key nutrient fluxes and other energy flows (which are associated with tidal flows) will not be interrupted. This conceptual model largely defines the work for the ERMP, in which the degree to which the design approach has been achieved will be assessed in terms of the potential impact of the proposal on water flows. Hydrodynamic modelling will be used as a key tool in the assessment. The model outputs will be used to predict the likely impacts on mangrove and algal mat communities.

4. With respect to the recommended marine conservation reserve, Straits will enter into discussion with the MPRA and stakeholders on the objectives, boundaries and management framework. The hydrodynamic model will also assist this process by allowing accurate delineation of the high water mark, which was used by the Wilson Report (1994) to define the proposed hinterland boundary of any future marine management reserve. Specifically, the Report recommended that the boundary should be 40 m inland of the high water mark, which also generally defines the seaward extent of pastoral lease boundaries. At present, maps for this region show an approximate boundary which appears to be significantly and erroneously landward (5 to 15 km) from the high water mark, with subsequent ramifications for any planning and management assumptions made on the basis of this 'approximate' boundary. Straits will consult with the MPRA on this issue prior to release of the ERMP.

2.0 Introduction

2.1 Purpose of this Scoping Document

Straits Salt Pty Ltd (Straits) is planning to develop a 10 million tonne per annum (Mtpa) solar salt field along the eastern margin of Exmouth Gulf (see Figure 2.1). A referral document, which broadly described the project, the regional environment, likely impacts and proposed management measures was prepared in accordance with Section 38 of the *Environmental Protection Act 1986 (EP Act 1986)*. This was submitted to the Western Australian Environmental Protection Authority (EPA) on 15th April 2004 (Straits 2004). The EPA determined that the level of assessment for the proposed Straits Salt Project would be set at Environmental Review and Management Programme (ERMP). This decision was advertised on Monday 3rd May 2004, followed by a two-week period during which appeals could be lodged against the level of assessment set by the EPA. A single appeal was lodged, which was subsequently dismissed by the Minister for the Environment.

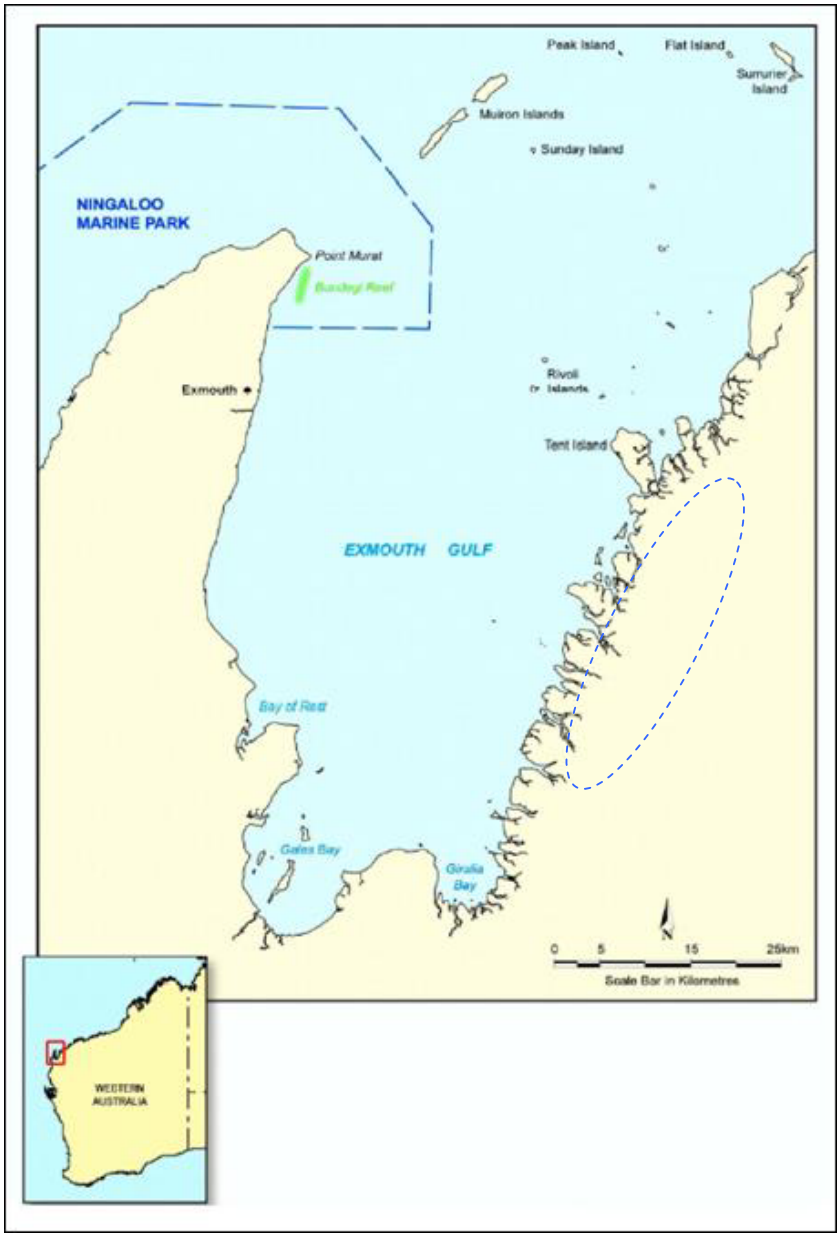


Figure 2.1: Exmouth Gulf and general area of interest (dashed line) for the proposed Straits Salt Project.

This Environmental Scoping Document has been prepared in accordance with the requirements of Part IV of the *EP Act 1986.* It also jointly meets the requirements of the Federal *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*) in providing Terms of Reference for the purposes of Federal environmental assessment (see Section 4.2). The purpose of this document is to provide a framework for the formal environmental assessment of the project. It sets out the basis for the EPA's assessment in respect to the scope of the ERMP, in addition to providing an indicative timeline for the assessment. This document provides a summary of the potential environmental impacts, their significance and possible management responses, proposed scope of works for the various environmental investigations, relevant legislation, guidelines and standards, stakeholder consultation programme, project and assessment schedule, study team and peer review mechanisms.

2.2 The Proponent

The proponent and owner of the proposed solar salt field will be Straits Salt Pty Ltd, a wholly-owned subsidiary of Straits Resources Pty Ltd. The relevant contact details are provided below in Table 2.1.

Table 2.1: Key contact details.

Organisation	Proponent Representative	Consultant Contact
Straits Salt Pty Ltd First Floor, 35 Ventnor Avenue West Perth WA 6005 PO Box 1641 West Perth WA 6872 http://www.straits.com.au/ Telephone (61 8) 9480 0500 Facsimile (61 8) 9480 0520 ACN 056 601 417	Mr David Readett Project Manager – Straits Salt Telephone: (08) 9480 0500 Facsimile: (08) 9480 0520 Mob: 0418 969 291 e-mail: dreadett@straits.com.au	Mr Garth Humphreys Director Biota Environmental Sciences 14 View Street North Perth, WA 6006 Telephone: (08) 9328 1900 Facsimile: (08) 9328 3168 e-mail: garth@biota.net.au

2.3 Straits Resources Pty Ltd

Straits Resources Pty Ltd is a diversified Australian resource company that has been listed on the Australian Stock Exchange since 1994. Straits Resources has been operating the 2.5 Mtpa Sebuku Coal Mine (Sebuku) in Kalimantan since its construction by Straits Resources in 1998. Straits Resources is also developing the Whim Creek Project in WA, which is due to be commissioned late in 2004. Straits Resources also holds a 100% interest in the Hillgrove Gold Project in NSW; a 70% interest in the Mt Muro Gold Project in central Kalimantan, Indonesia; and an interest in the Tritton Copper Project in NSW. The group also manages a diversified exploration portfolio throughout Australia.

Straits Resources is a resource development company that has:

- focussed and responsible management;
- a Western Australian presence and a desire to continue operating in this State;
- local knowledge of the Pilbara, through its Whim Creek assets (and previous ownership of the Nifty Copper Operation);
- bulk commodity and marine/shipping expertise developed at Sebuku;
- worldwide bulk commodity marketing experience; and
- co-operative relationships developed with the Pilbara aboriginal community, specifically the Ngarluma/Yindjibarndi, Martu, Gnulli and Thalanyji Peoples.

Coupled with these skills, a desire to continue investing in Western Australia and to develop a new sustainable and long term business in the State where the proponent bases itself, Straits Resources has decided to pursue the development of a solar salt business in the north-west of Western Australia.

2.4 Study Team

The primary study team supporting Straits Salt in the preparation of the ERMP comprises:

- Biota Environmental Sciences (Biota);
- Oceanica Consultants (Oceanica);
- DC Blandford & Associates; and
- Dr Eric Paling (Murdoch University Marine and Freshwater Research Laboratory).

The structure of this study team is shown below in Figure 2.2.

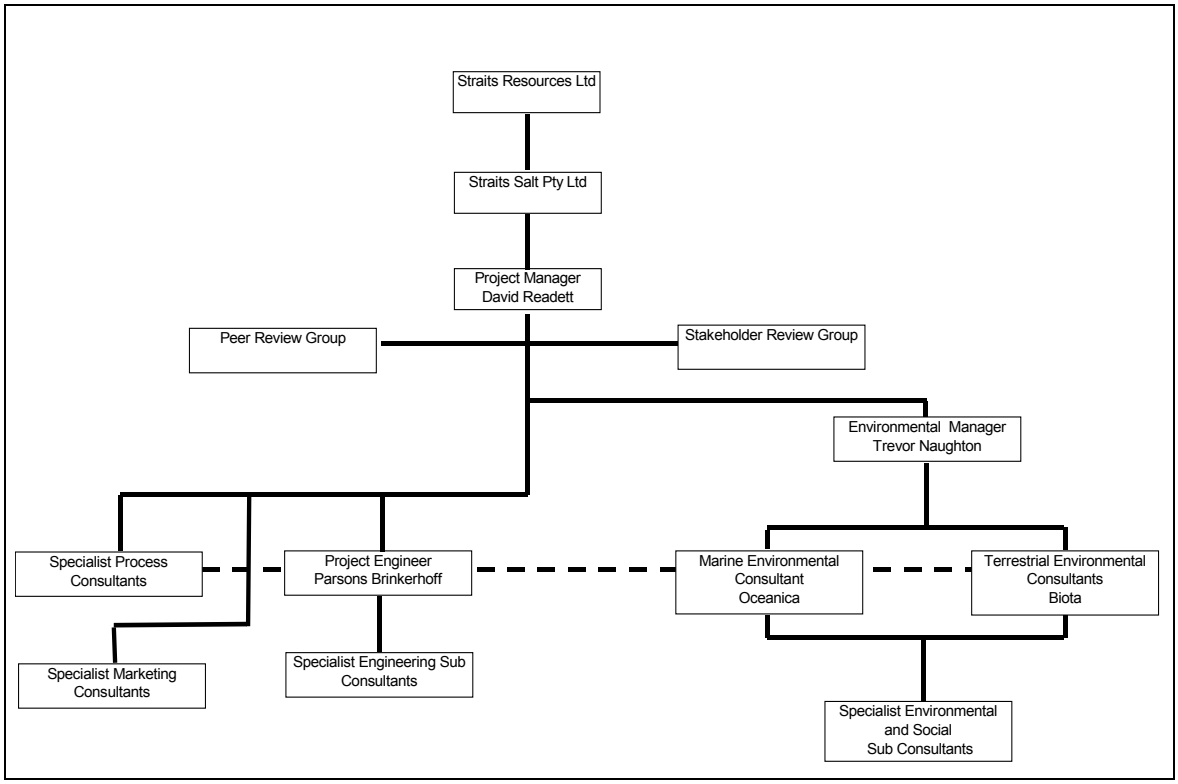


Figure 2.2: Study team structure for the Straits Salt project environmental assessment.

The project team members have extensive experience in assessing the key impacts associated with this proposal, including specific backgrounds on salt field and coastal developments in the region. The principal authors of the ERMP will be Mr Mark Bailey (Oceanica; marine issues) and Mr Garth Humphreys (Biota; Mangroves and terrestrial ecology), both of whom have 15 years' experience on similar assessments. Mr Doug Blandford, who has 35 years' experience on large scale impact assessments, will also author sections of the ERMP relating to physical terrestrial processes, in addition to providing overall internal review and guidance to the document.

This team will also be supported by:

- Parsons Brinckerhoff (engineering feasibility, geotechnical and hydrological investigations);
- Sagaramore, CGV and K Wellisch and Associates (engineering and management consultants with specific salt project expertise);
- MP Rogers & Associates (marine investigations and coastal engineering);
- Worley, Asia Pacific Applied Sciences and Centre for Water Research, UWA (hydrodynamic modelling);
- Oceanwise (Helen Penrose; dugong specialist);
- Curt Jenner (specialist whale biologist); and
- Q & A Communications/URS (stakeholder consultation programme/social impact assessment).

It is likely that further specialists will be engaged as the ERMP studies progress.

2.5 Stakeholder Consultation

Straits acknowledges the importance of engaging all relevant stakeholders throughout the life of the Project, in particular during the environmental approvals stage. In line with this philosophy, Straits commenced its consultation program over 12 months ago and has had initial contact with many of the key stakeholders. Identified stakeholders are diverse (Table 2.2) and include a broad spectrum of Government departments, Non Government Organizations (NGOs), landowners, business and community groups and various research organizations that have worked within the region.

As part of this ongoing program, Straits has developed Stakeholder Reference Group (SRG's) in Exmouth and Onslow (see Table 2.3 for current membership of the SRG's), which will be consulted regularly to disseminate up to date information about the project and to ensure that varying viewpoints are captured. Attempts will be made to address issues as they arise.

While the SRG's are a significant part of the consultative process, they only form part of the overall strategy. A Stakeholder Consultation Plan has been developed that provides a schedule for both routine and targeted consultation both for the SRG's and other stakeholders. Numerous triggers have been established within the Plan, such as the release of this Environmental Scoping Document/Terms of Reference, which will result in a round of consultation being undertaken. Straits has produced a Project Brochure, commenced publication of a monthly newsletter and Frequently Asked Question sheets are developed periodically in response to questions raised. All of these mechanisms will be used to raise stakeholder awareness about the Project and to enhance further consultation. All of this information will be made available on the Straits Resources Limited website (www.straits.com.au).

Table 2.2: Stakeholders identified by the proponent in the development of the proposal

Department of Industry and Resources: Office of Major Projects Mineral Titles Section, Environment Branch
Geological Survey: Environmental Sustainability Branch
Department of Environment: Pilbara Region Office, Mid-West Gascoyne Region, Mining & Petroleum Assessments Branch, EPA Assessment Unit, Natural Resources Management, Hydrology and Water Resources, Karratha District Office
Department of Conservation and Land Management: Exmouth District Office, Marine Conservation Branch, Management Planning Section, Wildlife and Ecology Branch, Pilbara Regional Office
Department of Infrastructure and Planning: Marine Transport
Department of Land Administration
Fisheries Western Australia: Exmouth, Perth
Agriculture Western Australia: South Perth Head Office, Carnarvon District Office
Marine Parks and Reserves Authority
Bureau of Meteorology: Exmouth, Perth
Department of the Environment and Heritage
Environmental Protection Authority
Australian Quarantine Inspection Service
Conservation Council of WA (Inc.)
Exmouth Shire Council
Ashburton Shire Council
Murdoch University School of Environmental Science
James Cook University
University of Western Australia
The Marine & Coastal Community Network
Australian Institute of Marine Science
CSIRO
Pastoral Stations: Urala Station, Koordarrie, Yanrey, Giralia Station, Minderoo
MG Kailis Group
Webb & Rinken (Aquaculture)
Cape Seafarms Pty Ltd
RecFish West
Gnulli People, Yamatji Land and Sea Council
Thalanyji People
Cape Conservation Group – Exmouth
The Wilderness Society
Various Members of Parliament: Minister for the Environment, Minister for Resource Development, Member for the Greens Party
Gascoyne Development Commission
Pilbara Development Commission
Office of the Minister for the Environment

Office of the Minister for Agriculture, Forestry & Fisheries
The Exmouth and Onslow communities

Table 2.3: Membership of the Stakeholder Reference Groups

Exmouth	**Onslow**
Shire of Exmouth	Onslow Employment Project
MG Kailis Group	Thalanyji People
Fisheries WA	Shire of Ashburton
Exmouth Visitors Centre	Ashburton Fisheries
Department of Conservation and Land Management	Onslow Chamber of Commerce and Industry
Exmouth Indigenous Representative	Onslow Visitors Centre
Exmouth Game Fishing Club	
Cape Conservation Group	
Exmouth Bluewater Tackle	

While the consultation process has found that there are many supporters for the project, there are also many people with valid concerns, which will need to be addressed by Straits. Environmental concerns raised by the consultation process to date included:

- arid zone Mangroves seen as being of State and National significance;
- EPA "Red Book" (EPA 9.7) area identifying the region for potential future conservation reserve - wetlands/mangroves;
- proposed RAMSAR Wetland (based on significance to migratory birds) (AW/7);
- potential impact of transhipment and other marine activity on dugongs, whales, dolphins and other marine mammals in the Gulf;
- potential effects on algal mat zones and tidal creeks linked with the mangrove issues and fisheries production;
- area within the Gulf proposed to be a marine conservation zone - fisheries reserve area for the promotion of fisheries in the Gulf;
- regionally close to Ningaloo Reef, and adjacent to flora and fauna conservation areas being Tent, Burnside, Simpson and Whalebone Islands;
- potential impacts to seagrass beds adjacent to the coast (dugong feeding grounds);
- potential area of acid sulphate soils – disturbance of these soils is seen as a major drawback to approvals for the project;
- potential to introduce exotic pest and pathogens to the Gulf through exchange of foreign ballast water;
- sheer size of the project seen as having major impacts on energy and resource flows from terrestrial systems to the Gulf regarded as partly responsible for biological productivity in the Gulf;
- additional sediment loads affecting marine systems (on top of that created by trawling activities beyond the fish nursery areas of the east side of the Gulf, especially in respect to any need to dredge);
- bitterns discharge and contaminant flow and management in respect to impacts on nearshore marine life;
- greater potential for hydrocarbons to be introduced into the Gulf through normal operations of a salt field with barging and shipping facilities;
- effects of storm surge and cyclones on the salt field and the potential impacts to adjacent areas should there be any catastrophic failures in bunds, infrastructure, fuel storage facilities etc – effects of erosion and flooding; and
- potential for the area to be included in a World Heritage listing.

The environmental investigations proposed will gather scientific data to address these and other issues (see Section 6.0).

2.6 Peer Review Process

Straits recognises the value that the EPA places on the veracity of the technical work underpinning environmental assessments. As such, Straits intends to subject key elements of the work to a review process prior to final presentation to the EPA. The peer review group will have input at several stages of the assessment process as outlined in Figure 2.3. The following people have already assisted or agreed to assist with the review process:

Documentation Review
Mr Ian LeProvost (URS Consultants, marine scientist and former EPA board member)

Technical Review
Seagrass and marine ecology: Dr Gary Kendrick (Department of Botany, UWA)
Department of Fisheries: Rob Tregonning (Program Manager Fish and Fish Habitat Protection)
Terrestrial ecology: Dr Ric How (Curator of Vertebrates, WA Museum)
Hydrodynamic Modelling: Dr Chris Fandry (CSIRO Perth) and Dr Cliff Hearn (USGS Florida)

Other reviewers will be contacted as technical issues are further explored. For example, Straits have also been making enquiries for a suitable specialist to review the assessment of impacts on mangroves.

Any formal reports prepared by the reviewers and the changes made on the basis of the reports will be provided as support to the ERMP document.

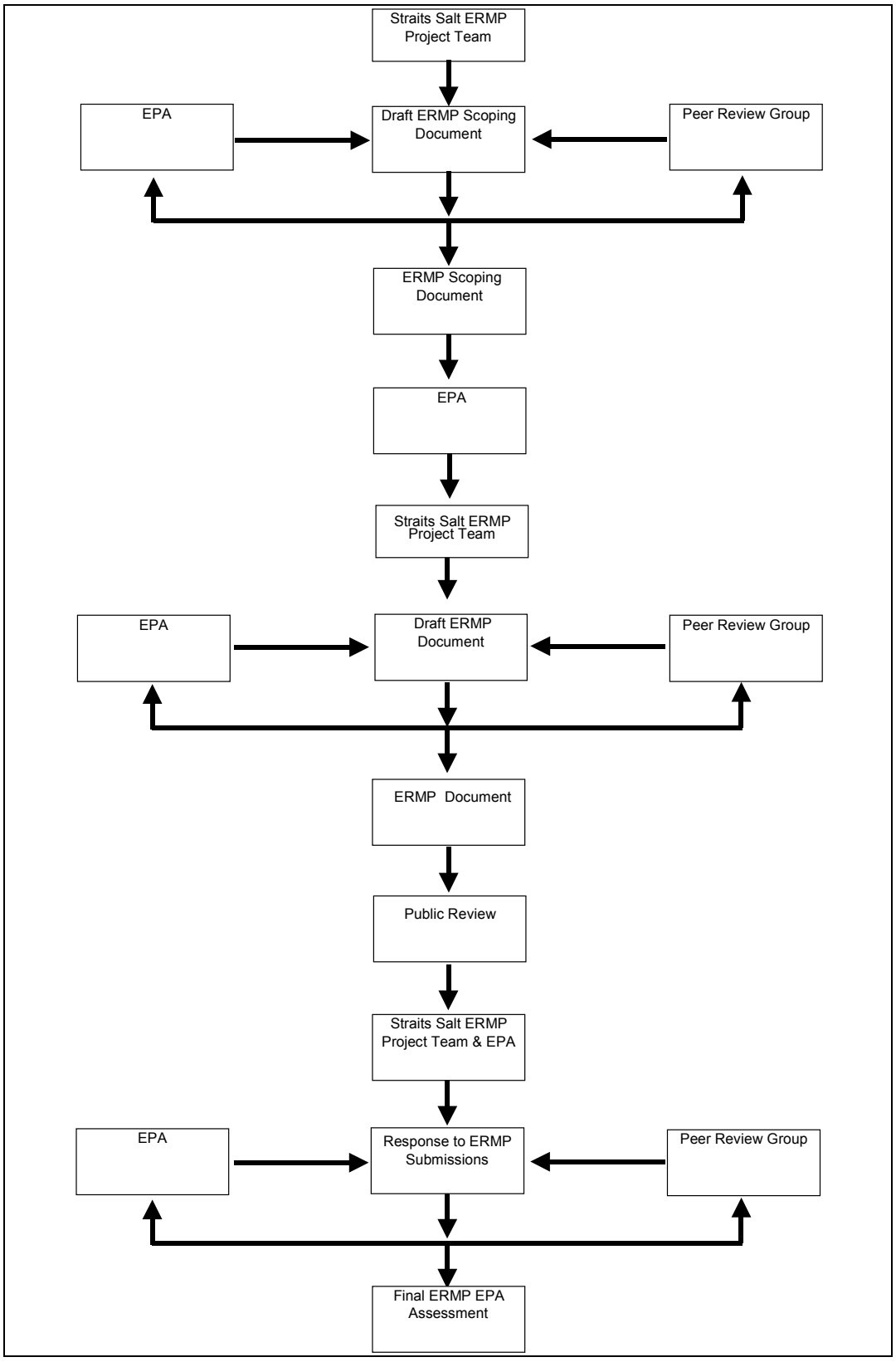


Figure 2.3: Flowchart showing staged peer review group inputs to the formal assessment process.

3.0 Project Description

3.1 Project summary

Table 3.1 outlines the key characteristics of the project where currently known. These characteristics will be refined prior to release of the ERMP; however, the characteristics remain indicative of the scope of the project. It is anticipated that the project will be designed such that it will commence production at a steady state rate of approximately 3 Mtpa and as market forces dictate, it will expand up to its design capacity of 10 Mtpa. While the project is planned to occur as a series of staged developments, approval is being sought for the ultimate 10 Mtpa salt field. Given this staged approach, the characteristics of a 3 Mtpa salt field are also provided.

Table 3.1: Key Characteristics of the Straits Salt project (10 Mtpa).

Element	Characteristics	
General		
Construction commencement	6-18 months post approval	
Construction duration	Approx. 12-18 months for 3 Mtpa field, further 5 to 6 years before completion of ultimate 10 Mtpa field (market dependant).	
Production of first salt	18-24 months after construction of pond zero	
Export Tonnage	3 Mtpa initially, ramping to 10 Mtpa	
Project Design Life	Minimum of 50 years	
Design Parameters		
Annual Rainfall	260 mm (Onslow)	
Annual Evaporation	3,030 mm (Onslow)	
Concentrator Seepage	150 mm per annum	
Crystalliser Seepage	100 mm per annum	
Seawater Intake Density	SG 1.0235 - Approx 2.6% NaCl by weight	
Concentration ponds		
Production	3 Mtpa	10 Mtpa
Area	approx. 9,000 ha	approx. 25,000 ha
Volume of seawater required	approx. 200 M m^3/pa	approx. 600 M m^3/pa
Volume of bitterns discharged	2-3% of input	2-3% of input
Processing and Export		
Production	3 Mtpa	10 Mtpa
Mechanical Harvester	1 x 800 tph	2 x 800 tph
Road Train Transport to Washplant	3 x 50 t trailers	9 x 50 t trailers
Washplant	3 Mtpa	10 Mtpa
Transport to Stockpile	3,000 tph Conveyor	3,000 tph Conveyor
Stockpile	0.75 Mt	2.5 Mt
Materials handling	Stacker (3000 tph) Reclaimer (3000 tph)	Stacker (3000 tph) Reclaimer (3000 tph)
Marine export facility	Piled wharf or dredge channel to 5 m CD or 3000 tph barge loading rate. Barges @ 7,500 – 10,000t approx. 4.5 m draft with attendant tugs (2) Ships from 40,000 to +100,000 DWT 40-50 ships/annum Ship mooring offshore	Piled wharf or dredge channel to 5 m CD or 3000 tph barge loading rate. Barges @ 7,500 – 10,000t approx. 4.5 m draft with attendant tugs (2) Ships from 40,000 to +100,000 DWT 120-150 ships/annum Ship mooring offshore
Buildings	Administration Office/Amenities Wharf amenities Power Station/Substations Workshop/Warehouse	Administration Office/Amenities Wharf amenities Power Station/Substations Workshop/Warehouse
Infrastructure		
Power	1.5 to 3.5 MW from diesel generators	
Water	5 m^3/day from bore field or package desalination	
Fuel	4 million Lpa diesel for plant	
Fuel storage	Bunded tank area	
Roads	Primary access road south via Yanrey Station Internal roadways incorporated as part of levee bund structure	
Sewage	Construction – package treatment plant Operations – dry bio system	

A conceptual layout of a 10 Mtpa project is shown outlined in Figure 3.1. The layout will be refined as the engineering studies, environmental studies and preliminary design progress.

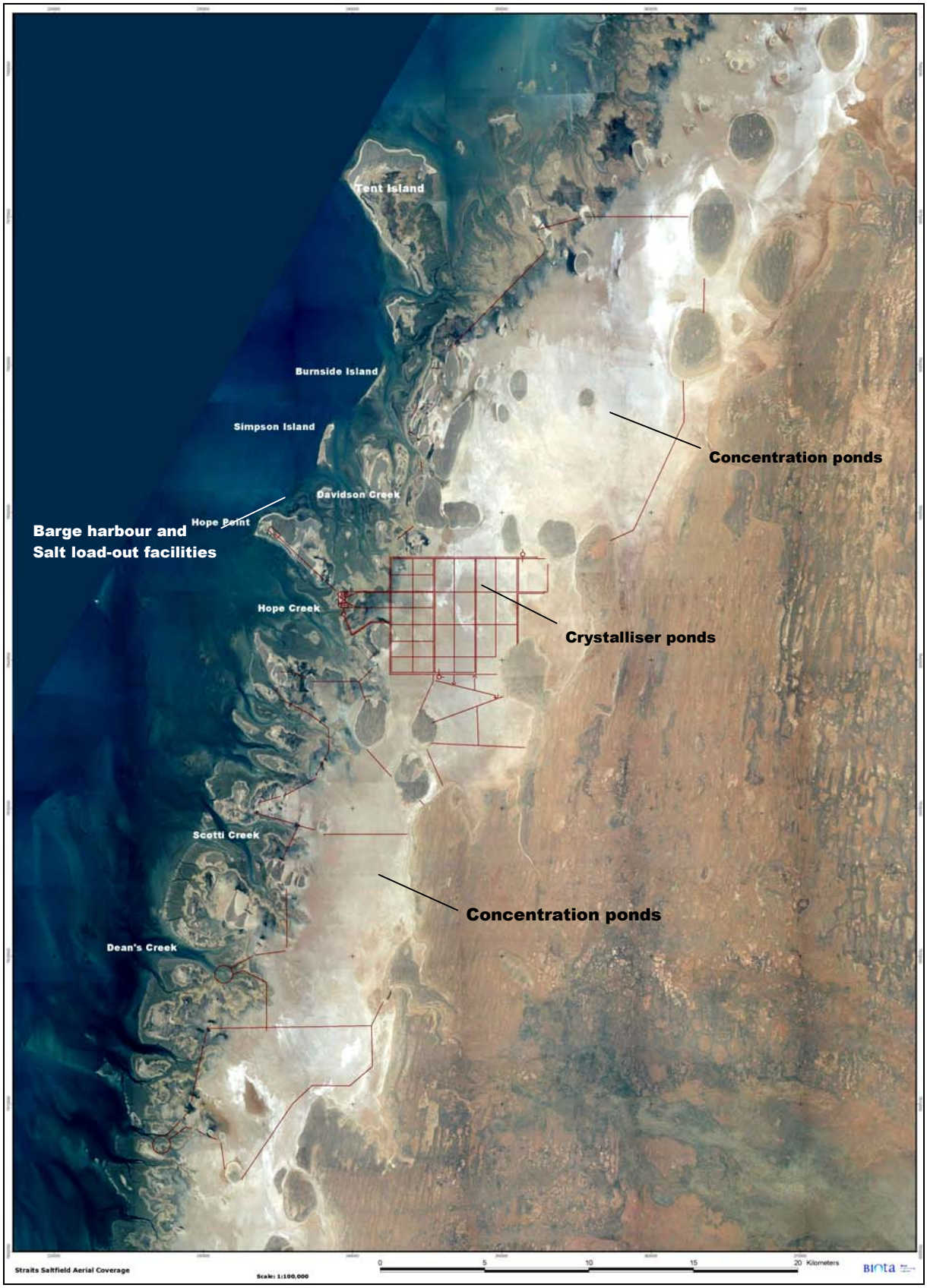


Figure 3.1: Conceptual layout for a 10 Mtpa project

3.2 Salt Field

Straits Salt proposes to undertake the construction and subsequent operation of all necessary facilities for a conventional solar salt field and the subsequent export of the salt product. The project utilises a naturally occurring process harnessing solar energy to evaporate water from seawater resulting in the final production of salt (NaCl) crystals and residual brine (known as bitterns and containing the remnant salts present in sea water).

The philosophy of the engineering design will be to investigate and understand the existing environment and environmental constraints in the region and then design the salt field to minimise impact on the environment. As such the engineering is being conducted in parallel with the environmental studies and a completed design will be provided in the ERMP document.

The facilities will consist of seawater pumps pumping salt water into a series of concentration ponds. Seawater within the concentration ponds undergoes natural evaporation resulting in an increase in the salt concentration. The resultant brine (high salt concentration sea water) is then pumped into a series of smaller crystalliser ponds where again, via natural evaporation, the salt concentration in the brine reaches a point where solid salt (NaCl) crystals are formed. The salt crystals build up to a depth of approximately 0.5 m in the pond. The pond is drained and a mechanical harvester removes the salt crystals which are then taken to a salt washing facility to produce export quality salt; the target product. This salt is stockpiled before being loaded onto barges. It is then transhipped into the central Gulf and unloaded onto waiting bulk carrier ships. These ships will then transport the salt to customers in the Asian region.

The residual brine (known as bitterns), which contains remnant salts from the seawater, will be either retreated or discharged. Several disposal options are currently being investigated.

A schematic flowchart for the production of salt by this process is shown in Figure 3.2. As can be seen, the salt field infrastructure will be centred close to Hope Point. The crystalliser ponds will be located on the mudflat area behind Hope Point. Concentration ponds will be placed both to the north and south of the crystalliser ponds. These ponds will be placed to the east of the mangrove and algal mat area and traverse the mudflat up to the sand dune hinterland.

Details of the proposed facilities are provided in the following subsections.

3.2.1 Seawater Pumps

These will be installed in two or three tidal creeks and allow for the pumping of seawater into the salt field with minimal impact on the sensitive mangrove and algal mat areas.

3.2.2 Concentration Ponds

These will be established by the construction of a series of connected rock armoured levees, built from local soils and rock, on the mud flats. The ponds will be constructed on the eastern side of the mangrove and algal mat area. They will extend across the mudflats to where the mudflats meet the sand dune hinterland. Seawater will flood the mudflats within the pond to a depth of approximately 1 m. In these ponds seawater is evaporated by the sun, resulting in an increasing concentration of salt.

3.2.3 Crystalliser Ponds

These are constructed in a similar manner to Concentration ponds but are much smaller in size. Brine from the Concentration ponds is pumped into these ponds where further evaporation of the brine leads to the production of salt crystals, which build up to a layer approximately half a metre deep in the bottom of the pond. The salt is allowed to dry out prior to harvesting. It takes approximately two years from when seawater is pumped into the field until salt is produced, as the process is totally reliant on natural processes.

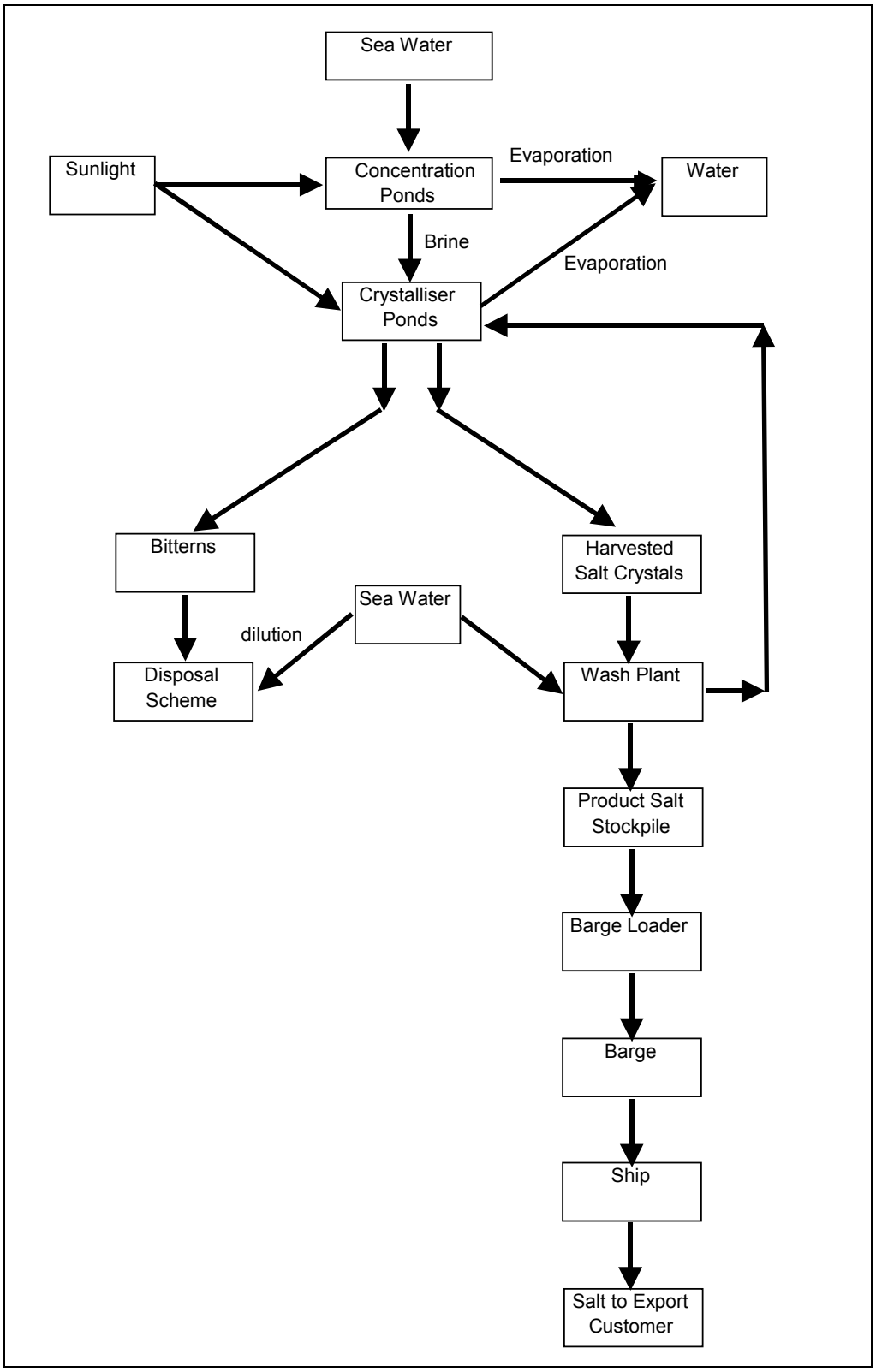


Figure 3.2: Flowchart outlining the solar salt production process.

3.2.4 Bitterns Ponds

These ponds are constructed in a similar manner to Concentration ponds and will allow for the storage of bitterns. The current design allows for dilution of the bitterns with seawater prior to controlled release back into the Gulf via a tidal creek. However several re-treatment and alternative disposal options are currently being investigated, including options for recovery of additional products from the bitterns. Straits is aware that the discharge of bitterns to tidal creeks in an uncontrolled manner is not consistent with current best practice and the design of an appropriate method for bitterns discharge will be a key engineering consideration.

3.2.5 Salt Harvester

The harvester resembles a “combine harvester” used by Australian farmers. The harvester mechanically picks up the salt and transfers it into road train trailers.

3.2.6 Salt Washing Facility

This facility will consist of a number of mechanical devices that allow the crystals to be transferred from the road train and then washed with seawater to remove any residual impurities. After washing, as much of the seawater as possible is removed from the salt crystals by a screen and a centrifuge.

3.2.7 Salt Stockpile and Reclaimer

An area will be established where the salt can be stored in a large stockpile(s). A reclaimer will be constructed that recovers the salt from the stockpile and then transfers it, via a conveyor belt, to the barge loader.

3.2.8 Barge Harbour and Barge Loader

A 4 to 5 m deep barge harbour will be excavated on Hope Point, which will provide an area where the barges can be secured during loading. Loading will be via a conveyor belt system linked to the stockpile. The barge harbour will also provide a safe haven during severe weather events such as cyclones.

3.2.9 Self-Unloading Barges

A barge is a large vessel designed to carry bulk materials such as salt. These barges will be designed with a superstructure system consisting of two excavators and a conveyor system that will allow them to unload the salt cargo onto any size bulk carrier (ship). The barges will be pushed/pulled by a dedicated tugboat.

3.2.10 Barge Channel

A barge channel will be dredged from the exit/entrance of the barge harbour to a depth of 4 – 5 m. This will allow the loaded barges to be pushed by the tugs into the deeper Gulf waters and allow empty barges to be returned to the barge harbour. Alternatives to the barge harbour and dredge channel however will continue to be investigated.

3.2.11 Ship Mooring

In the deep waters of the central western region of the Gulf a mooring(s) will be established for the bulk carrier ships. These ships will moor and then be loaded with salt from the barges. The ships will then deliver the salt to customers in the Asian region.

3.2.12 Infrastructure

It is anticipated that the project will have the following requirements:

- primary access road running 55 km from the existing Yanrey Station access road to the site boundary;
- general site access roads within Hope Island and associated hardstand for parking;
- an airstrip for general site access and emergency evacuation;
- freshwater supply and distribution infrastructure for up to 20,000 litres / day via a desalination plant;
- site administration buildings and meteorological station;
- fixed plant workshop and stores buildings;

- construction camp (to be supplied and operated under contract); during operations phase minimal site based accommodation will be provided;
- power supply by diesel generators with power distribution via transformers, switchgear and motor control centres;
- bunded fuel storage area; and
- telemetry and communications.

The operational workforce for the project will be based in Exmouth and commute to site on a daily basis.

The design of the salt field will be such that Straits will initially construct a facility with a production level of approximately 3 Mtpa and then expand the field in a series of increments to ultimately have the capacity to produce 10 Mtpa. The preliminary timetable, following environmental approval, comprises:

- four years to first production;
- five years to 3 Mtpa; and
- at least five more years to ramp up to 10 Mtpa, dependent on market conditions.

3.3 Alternatives Considered

Straits is a Perth based company and understands the environmental, social and political environment in Western Australia. Straits did not investigate other less suitable regions in Australia and it did not investigate any international locations due to the risks associated with the social and political environments in these locations.

Straits therefore investigated potential locations for a solar salt field on the north-west coast of Western Australia, with the major criteria being that the site would allow for an initial start up capacity of 2.5 - 3 Mtpa and if possible allow for future expansion up to 7 – 10 Mtpa. Salt field design experts indicated to Straits that a region of approximately 8 - 10,000 hectares would be necessary to allow for establishment of a 3 Mtpa solar salt field. Additional production would require the same ratio of production versus area.

The selection criteria also included topographic data, maritime survey map data, tenement information, environmental constraints and native title claim data, as well as general site characteristics, site locations relative to transport routes (road, port and airfield facilities), closeness to population centres (personnel) and existing salt operations.

Twenty possible sites were located initially along the coast, with varying suitability. In all locations investigated there were environmental constraints of significance. Five locations were identified which potentially had attributes to warrant further investigation:

- Balla Balla Port area;
- Mardie Station;
- Tubridgi Point;
- Talandji Salt Evaporator; and
- East Exmouth Gulf – North of Giralia Point.

Balla Balla Port and Mardie Station however only had sufficient area to establish a 2.5 – 3 Mtpa salt field. The Balla Balla area is also dissected by Balla Balla Creek, which was considered problematic environmentally. Neither of these two sites had been set aside by the State for future potential solar salt production.

Tubridgi Point, Talandji Salt Evaporator and East Exmouth Gulf – North of Giralia Point were contiguous and therefore provide an ideal opportunity for development of an initial salt field with potential expansion capabilities. The large available area also provides significant flexibility in design and layout to allow for the incorporation of environmental, heritage and engineering constraints.

This area had also previously been identified by the State Government as a suitable area for future potential solar salt production, following the pilot study conducted with the construction of the Talandji salt evaporator. To this end, Ministerial Temporary Reserve 70/5350 was set aside over this entire area for the purpose of producing solar salt, gypsum and limestone. This location would therefore not require a change in the proposed land use. On this basis Straits selected the current site location.

While undertaking these site selection studies it was found that all of the other export salt producers in the region, except for Onslow salt, did not have any additional space suitable for future expansion capacity. Utilising some of Onslow Salt's infrastructure (namely the marine based ship loading facilities) was considered but the capital and operating costs of transporting product salt to Onslow were prohibitive.

The good environmental record of other salt fields in Australia provided Straits with confidence that a salt field could be constructed and operated in an environmentally acceptable manner in this location. There is potential for further improvement in environmental performance as Straits (and the regulators) can build on the experience from other salt fields.

3.4 Project Justification

The most economically viable long-term production route for salt production is via solar salt production from seawater in a region with favourable climatic conditions. The north-west coast of Western Australia is already known as one of the world premier regions for solar salt production due to its regional climatic conditions of very high evaporation rate and very low rainfall.

Salt is a bulk commodity and it is necessary to establish large integrated facilities to ensure that competitive unit costs of production and sufficient market volume can be achieved and maintained. The minimum economic capacity is considered to be 2.5 to 3 Mtpa (similar in size to the most recent new salt field – Onslow Salt), ideally with a capacity to expand as market forces dictate.

3.4.1 Target Market

Currently, world demand for salt is around 220 million tonnes with the US, Europe and Asia accounting for more than 70 percent of world demand. This level of demand has been growing at 2 - 3% pa and is linked to general world industrial production. Demand for salt is largely driven by consumption in the chemical manufacturing industries, being principally caustic soda/chlorine (70%), followed by edible salt (20%) and de-icing salt and other uses (10%).

The current market demand for imported solar salt into the project's target markets of China, India, Japan, South Korea, Taiwan, Indonesia, the Philippines, Malaysia, Thailand, South Africa, Nigeria and Qatar is around 16 million tonnes as shown in Table 3.2.

Table 3.2: Total salt imported into Target Market 2002.

Country	Imports of Salt (Mtpa)
Japan	8.0
South Korea	2.6
Taiwan	1.5
Indonesia	2.1
China	1.0
Others	1.0
Total	**16.2**

The increase in demand over the past 10 years has mainly come from chemical industries in South Korea, Taiwan, Indonesia and China. New caustic/chlorine plants and expansions to existing plants have been brought on-line to meet the growth in demand for both caustic soda and chlorine; particularly the demand for chlorine in the manufacture of polyvinylchloride (PVC). PVC accounts for up to 30% of the total demand for chlorine, and is used extensively for piping and other building products in both the developed and developing regions of the world.

30 – 40 Mtpa of salt produced worldwide is exported. Australia is the largest exporter of salt in the world, closely followed by Mexico. The majority of salt exported by Australia goes into the Asia-Pacific region, which is the target market for the project.

The export salt market in the Asia-Pacific region is dominated by two companies; Mitsubishi (producing salt in Mexico) and Rio Tinto (producing salt in Western Australia). In order to establish a long term viable business it will be necessary to establish a capacity in the same order of magnitude as the major competitors. As such a long-term production rate of 7-8 Mtpa will be required to ensure a long-term viable business.

3.4.2 Demand Growth

Growth in the target market has averaged 4% pa between 1993 and 2000. The construction of chemical plants in China, India, South Korea, Taiwan and Indonesia has led this growth in salt demand. Optimisation of plant capacity in Japan enabled continued growth there despite a reduction in soda ash capacity. There was also an increase in demand for imported salt for edible use as local production either failed or was cut back in Japan, South Korea, Taiwan, Indonesia and the Philippines.

China and India are two of the largest populations in the world and currently have consumption rates of PVC and soda ash an order of magnitude lower than that of the USA and Western Europe. Both China and India have economies that are expanding at rates sometimes in excess of 10% GDP per annum. Therefore there will be an increasing fundamental need for salt in China and India. China only started importing salt last year and this year it will import in excess of 1Mt.

An average growth rate of 4% has been forecast through the period under review (up to 2015). In China and India alone, demand for salt over the next decade is expected to increase by approximately 10%pa.

3.4.3 Supply and Demand

Straits believes there will be an increasing demand for export salt in the Asia-Pacific region and that Western Australia is ideally suited to meet that demand. It is anticipated that by 2010 there could be a deficit of 3 Mtpa of export salt (based on current maximum capacity of WA producers) with this deficit possibly increasing to near 10 Mt in 2015. As the proponent cannot enter the market before this date, the existing suppliers will need to be close to their maximum capacities to cope with the demand through 2007. The recent increase in China's demand for export salt could not be fully met by the current Western Australian producers.

While undertaking these site selection studies it was found that all of the other export salt producers in the Western Australia, except for Onslow salt, do not have any additional space suitable for future expansion capacity. Salt production is a natural process that relies on evaporation to produce salt so rate of production is therefore directly related to evaporation area available.

To meet forecast demand, supply from other sources would need to be found if the existing suppliers have limited expansion capacity. This project therefore appears to have a significant window of opportunity to enter the market and supply international demand. The project with its future expansion potential will also be able to capture additional market demand for many years.

3.5 Project Schedule

A schedule for the Straits Salt ERMP Environmental Approvals Process is provided in Appendix 1. Key approvals and project milestones are summarised in Table 3.3.

Table 3.3: Key approvals and project milestones for the salt project.

Project Milestone	Schedule Timing
Environmental Surveys commenced	August 04
Archaeological and Ethnographic studies commenced	September 04
Scoping Document published by EPA	November 04
ERMP document published	April 05
Public submission period ends	July 05
Straits Salt responds to public submissions	October 05
Approval granted subject to Ministerial Conditions	March 06
Construction of the salt field commences	February 07
Commencement of seawater pumping	July 07
First salt harvest	July 09

4.0 Applicable Legislation

In addition to obtaining approval from the Minister for the Environment, Straits will have to comply with legislation and regulations administered by a number of State Government bodies. In addition to the State Government legislation there is also Commonwealth legislation that Straits must comply with.

4.1 State Government Legislation

State legislation relevant to the proposal includes:

- *Aboriginal Heritage Act 1972*
- *Agriculture and Related Resources Protection Act 1976*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Environmental Protection Act 1986*
- *Environmental Protection Amendment Act 2003*
- *Explosives and Dangerous Goods Act 1961*
- *Dangerous Goods (Transport) Act 1998*
- *Land Administration (Amendments) Act 1997*
- *Local Government Act 1995*
- *Rights in Water and Irrigation Act 1914*
- *Town Planning & Development Act 1928*
- *Wildlife Conservation Act 1950-1979*
- *Mines Safety and Inspection Act 1994*
- *Mining Act 1978*

The *EP Act 1986* is the principal statute relevant to environmental protection in Western Australia. The *EP Act 1986* makes provision for the establishment of the EPA for the prevention, control and abatement of pollution and for the conservation, preservation, protection, enhancement and management of the environment. The *EP Act 1986* provides for the control and licensing of potentially polluting activities and is the Act under which the State environmental assessment process operates.

It has been determined by the EPA that the project requires a formal level of environmental assessment at the level of ERMP. The process for the preparation, submission and assessment of an ERMP is shown in Figure 4.1 and is summarised below.

1. The proponent refers the proposal to the EPA to set the level of assessment (a Referral for this project was submitted on 15th April 2004).
2. The EPA determines the level of assessment as an ERMP and advertises this decision and the length of the public review period, subject to appeal (the EPA advertised an ERMP level of assessment for this project on 3rd May 2004).
3. The proponent prepares an Environmental Scoping Document (this document) outlining the scope of works for the ERMP assessment.
4. The EPA approves the Environmental Scoping Document as the basis for the ERMP.
5. The Environmental Scoping Document is released for public review (two weeks).
6. The proponent responds to submissions and finalises the Scoping Document to the requirements of the EPA.
7. The ERMP is prepared by the Proponent.
8. The ERMP is approved by the EPA for release as a public document.
9. The Proponent responds to submissions on the ERMP after the public review period (10 weeks).
10. The EPA undertakes its assessment of the proposal and the proponent's response to any submissions, and publishes its recommendations to the Minister as a public Bulletin.
11. The Bulletin is subject to a two week appeals period.
12. The Minister determines any appeals, and consults with the key Decision Making Authorities to seek agreement on whether or not, and in what manner, the proposal may be implemented.
13. The Minister issues a Statement.

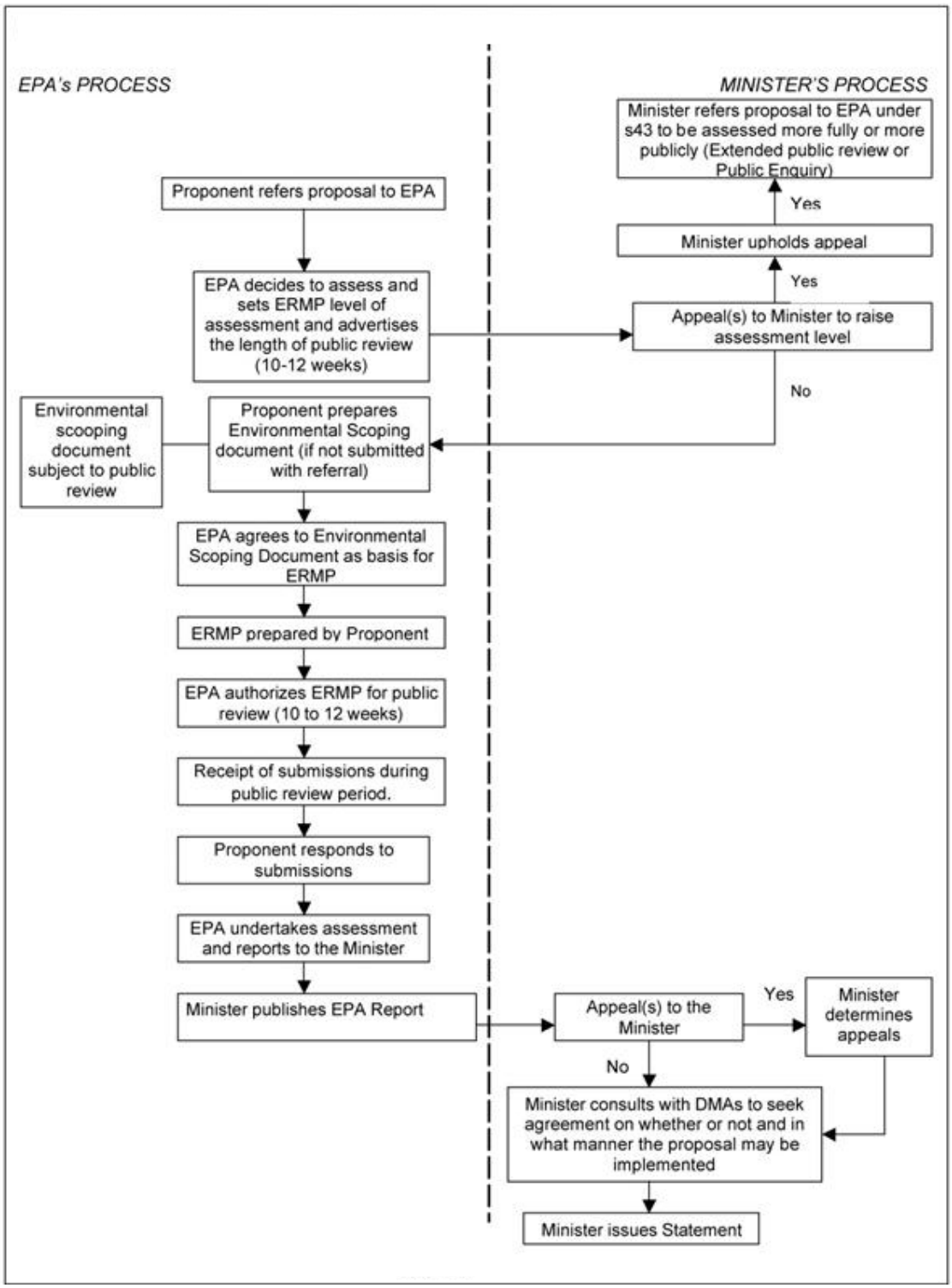


Figure 4.1: EPA process diagram for the ERMP assessment (Source: EPA).

The anticipated schedule for the State assessment process is outlined in Section 3.5 of this Scoping Document.

4.2 Federal Government Legislation

Under the *EPBC Act 1999*, an action requires approval from the Federal Minister for the Environment and Heritage if the action has, will have, or is likely to have, a significant impact on a matter of National

environmental significance. The factors currently defined as matters of National environmental significance under the *EPBC Act 1999* include:

- World Heritage properties;
- Ramsar wetlands of international importance;
- listed threatened species and communities;
- migratory species protected under international agreements;
- nuclear actions; and
- the Commonwealth marine environment.

This project has been referred to the Federal Minister for the Environment and Heritage for consideration as there are potential impacts on threatened and/or migratory species under the *EPBC Act 1999*. After discussion with the Federal Department of Environment and Heritage (DEH) Straits has elected to nominate the action of constructing and operating the salt field as a Controlled Action for the purposes of the *EPBC Act 1999* and this has been confirmed by the DEH. This document therefore also serves as Terms of Reference for the Federal environmental assessment of the proposal, which will run in parallel under the terms of the Bilateral Agreement between State and Federal environmental agencies.

In addition, if Straits decides that sea disposal of dredge material is necessary, then an application to dump dredge material at sea will also be submitted to the Minister for the Environment and Heritage in accordance with the *Environment Protection (Sea Dumping) Act 1981* (*EP(SD) Act 1981*).

The *National Native Title Act 1993* is Commonwealth legislation also likely to be relevant to the Project.

4.3 Applicable Standards, Policies and Guidelines

In addition to the statutes discussed above, a number of State Government policies and guidelines are applicable to the assessment of the environmental factors relevant to this proposal. These include:

EPA Position Statements
- Position Statement 6 Towards Sustainability (August 2004)
- Position Statement 7 Principles of Environmental Protection (August 2004)
- Position Statement 9 Environmental Offsets (Preliminary) (July 2004)

EPA Guidance Statements
- EPA Guidance Statement No. 1 (Tropical Arid Zone Mangroves);
- EPA Draft Guidance Statement No. 26 (Management of Surface Run-off from Industrial and Commercial Sites);
- EPA Guidance Statement No. 29 (Benthic Primary Producer Habitat Protection);
- EPA Guidance Statement No. 51 (Terrestrial Fauna Surveys for Environmental Impact Assessment); and
- EPA Guidance Statement No. 56 (Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment).

Community Consultation
- EPA Interim Industry Consultation Guide to Community Consultation (2003).

Environmental Values and Environmental Quality Criteria
- Pilbara Coastal Waters: Have your Say (2004)
- Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (November 2002) (this currently provides a template for management of marine waters elsewhere in the State).

Straits understands that the proposal comes at a time when the EPA is developing Environmental Values and Environmental Quality Objectives for the marine waters of the Pilbara region and while the east coast of the Gulf is being considered in terms of its World Heritage Values (see Section 6.7.3). During the ERMP preparation process, Straits will liaise with CALM and the EPA to ensure that the most current environmental policies for this region are presented and the environmental issues will be addressed within this framework.

5.0 Regional Environmental Setting

5.1 Introduction

The project area falls within the Carnarvon bioregion according to the Interim Bioregionalisation of Australia (IBRA) (Thackway and Creswell 1995). This is described as: *"Quaternary alluvial, aeolian and marine sediments overlying Cretaceous strata. A mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrubs on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with* Acacia startii / bivenosa *shrublands outcrop in the north, where extensive tidal flats in sheltered embayments support Mangal. Arid."* (Thackway and Creswell 1995, Environment Australia 2000).

The area proposed for the construction of the salt field is situated within the Yannarie Coastal Plain region and encompasses part of the Giralia Anticline area in the south (Beard 1975). Geologically, most of the intertidal flats and mangrove swamps together with the supratidal flats consist of coastal and shallow marine deposits that are of Holocene age. These are interspersed with occasional elevated areas or 'islands' which are effectively mainland remnants arising from historical marine transgressions. (Van de Graaff et al. 1980, 1982). The flats grade inland to claypan areas interspersed with dunes, which ultimately then grade into dune and sandplain deposits. These alluvium, colluvium, claypan and to a lesser extent, dune deposits have been locally calcreted (Van de Graaff et al. 1980).

5.2 Major Physiographic Units

Payne et al. (1988) describe the project area as part of the Littoral Land System, which is essentially described as extensive bare coastal mudflats flanked by mangroves in the intertidal zone and narrow sandy plains. Slightly higher areas give rise to samphire areas while branching shallow tidal creeks intersect the mangrove seaward fringes.

The key landforms of the area include:

1. Mudflats
Hypersaline mudflats dominate the project area and are bare and near flat in topography. These mudflats may be occasionally inundated by during storm and/or flood events but are primarily terrestrial units.

2. Mangal
The landward margin is bounded to the west by an extensive mangrove zone that varies in width up to 1 km. This area includes creeks and adjacent mudflats in the intertidal zone.

3. Islands
Within the mud flat areas are sandy islands ovoid or circular in shape, with sandy soils often with a calcareous nature. While small on the scale of the project area, some of the islands are up to 3 km in diameter.

4. Samphire
Areas slightly raised above the mud flats support samphire communities (behind the mangrove zone along the coastal fringe, the eastern margin of the mudflats and boundaries of the sandy islands within the mudflats). Saline soils in these areas range from hard setting reddish-brown gradational soils changing from silty loams to silty clays but calcareous in nature.

5. Dunes
There are sand dunes with hummocky micro-relief generally up to 4 m high and up to 4 km in length occurring in the hinterland east of the mudflats (Payne et al. 1988). These dunes comprise loose white calcareous sand.

6. Marginal slopes
On the margins of the mudflats before rising up to the sand dunes are areas of marginal slopes up to 3% grade and as wide as 0.5 km but up to 6 km long in places. They have hummocky micro-relief with parallel drainage lines that may be incised up to 1 m deep.

7. Sandy Plains

Also adjacent to the mudflats but landward of the samphire areas are sandy plains which are transitional areas between the Littoral Land System and the Yankagee and Donovan Land Systems (Payne et al. 1988). These areas are associated with dunes and again comprise loose white calcareous sand of variable depths over limestone or in some areas, clays. These extend up to 2 km in length.

5.3 Flora, Vegetation and Fauna

Vegetation across all these areas, except on the mudflat itself, includes hummock grasses *Triodia pungens* on sandy areas or samphire, saltbushes and bluebushes (*Halosarcia*, *Atriplex* and *Maireana* species) on the saline areas behind the mangroves and between the mudflats and supratidal areas. Extensive cyanobacterial algal mats occur on the intertidal mudflat behind the mangrove zone. The mangrove complex is largely pristine and comprises one of the largest mangrove complexes in the State. The complex is generally dominated by *Avicennia marina* and *Rhizophora stylosa* but four other species occur at low frequency along the eastern coastline of Exmouth Gulf (Pedretti and Paling 2001, McKenzie and Start 1988). The terrestrial vertebrate fauna of the study area is relatively poorly known, with most survey data limited to offshore island studies completed by the Department of Conservation and Land Management (CALM) and other regional studies and reviews (e.g. Storr and Harold 1981). Much of the wider region has been subject to pastoral activity for most of the last century and therefore there has been degraded through grazing pressure and the introduction of feral predators and weed species.

5.4 Marine Environment

Exmouth Gulf is one of the largest embayments on the West Australian coast. Exmouth Gulf is a large (approximately 3,000 km^2) shallow basin set in a remote, arid tropical area enclosed by the Cape Range Peninsula to the west and by the Yannarie Coastal Plain to the east. The catchment contributing runoff sediments and water to Exmouth Gulf is relatively small (approximately 6,400 km^2) compared to the water area of the Gulf (Brunskill et al. 2001).

The pelagic primary productivity of the Gulf was found to be relatively low by McKinnon and Ayukai (1996), who reported that chlorophyll *a* concentrations were fairly uniform at about 0.2 µg/L throughout the Gulf, although higher values occurred at a site along the eastern margin and towards the south eastern corner. The influence of the tidal creeks and resuspension of sediments by wind waves in the shallows means that the waters along the east coast tend to be more turbid than waters in the Ningaloo region for example. Tidal range increases with distance south into the Gulf and therefore tidally induced turbidity is also expected to be most pronounced in the south.

Brunskill et al. (2001) reported that sediments in the Gulf are dominated by coarse to medium carbonate sands, quartzose fine sand, mud, coralline gravel and shell.

The eastern margin of the Gulf is characterised by shallow waters (water <5 m deep) adjacent to a coast comprising low rocky shores, intertidal mudflats, mangrove lined creeks and salt flats. The east coast of Exmouth Gulf is also a Commonwealth "Directory Wetland", "Exmouth Gulf East – WA007" (listed in the Commonwealth Department of the Environment and Heritage's "A Directory of Important Wetlands in Australia"). This listing covers the mangrove coast and intertidal area and is described as, "An outstanding example of tidal wetland systems of low coast of north-west Australia, with well developed tidal creeks, extensive mangrove swamps and broad saline coastal flats".

The benthic habitat of the shallows of the east coast is dominated by ephemeral seagrasses (*Halodule uninervis*, *Halophila ovalis*, *H. spinulosa*, *Cymodocea serrulata* and *Syringodium isoetifolium*), brown macroalgae (*Sargassum* spp.) and red and green algae. (Kangas 2003, Loneragan et al. 2003). Unlike seagrass species found further south, the species in the Gulf are ephemeral with peak biomass found in wet season months and senescence over the dry season. This may be a result of combined low water temperatures ~ 17^{o}C and increased turbidity over the dry season. In addition, it has been recorded that there may be substantial loss in storms (such as Cyclone Vance) but then rapid recovery within a few years (Loneragan et al. 2003). Corals may also be found where suitable substrate is present.

The combined presence of algal mat, mangrove, seagrass and algae provides a significant component of the Gulf ecosystem. The mangroves and shallow water habitat provide spawning and nursery grounds for fish and prawns, while the seagrasses also are an important food source for dugongs. The Gulf is believed to support a population of approximately 1,000 dugongs (Prince 2001), as well as

turtles (predominantly green turtles, though loggerhead, hawksbill and flatback turtles are likely to be present in smaller numbers) bottlenose dolphins, and manta rays (Preen et al. 1997). The deeper waters of the Gulf are also known to be used by humpback whales as a resting area during their southward migration. All these species are protected under the *EPBC Act 1999*.

The Gulf is commercially harvested by a fleet of prawn trawlers. There are also active pearling and aquaculture leases and popular recreational fishing areas (Sumner et al. 2002). The tourism industry based out of Exmouth is largely centred on the attractions of Cape Range and the adjoining Ningaloo Marine Park, however some minor tourism activities do occur within the Gulf.

5.5 Episodic climatic events

The Exmouth Gulf region is affected by episodic extreme climatic events (cyclones, storm surges, tsunamis and flooding). Straits is fully aware of the potential for cyclones and the accompanying storm surge (with an estimated maximum of approximately 6 m above mean sea level occurring in this region during Cyclone Vance in 1999) and destructive winds. The region is also subject to flooding between periods of prolonged drought.

These episodic events are a natural feature and tend to dominate the pattern of natural change in the area. For example, Cyclone Vance was observed to have caused widespread destruction of coral reef, loss of seagrass and mangroves. In addition, the high water levels and high seas would have significantly altered creeks and dunes and other shoreline features. The regular occurrence of these events has undoubtedly shaped the ecosystems that have come to dominate the Pilbara coast as, for example, documented by Woodroffe and Grime (1999) in other northern areas of Australia.

5.6 Mining

Limited mining activities occur in the region. Existing operations consist of solar salt production at Lake McLeod and Onslow, and a limestone quarry present on the opposite side of the Gulf, south of Exmouth. Straits Salt Exploration Licences aside, there are no other known mining proposals in the Yannarie Coastal Plain area.

5.7 Fishing and Aquaculture

Fishing within the Exmouth Gulf region is a popular recreational activity, however the majority of fishing effort is focussed around North-west Cape and across to Eva and Y Islands and there is limited recorded fishing pressure on the east coast (Sumner et al. 2002). Commercial fishing and trawling (predominantly prawns and scallops) have also been occurring for approximately 40 years. There are several aquaculture leases within the Gulf.

The Exmouth Gulf Prawn Managed Fishery targets western king prawns *Penaeus latisulcatus*, brown tiger prawns *Penaeus esculentus*, endeavour prawns *Metapenaeus* spp. and banana prawns *Penaeus merguiensis*. This fishery had a landed value of approximately $19M in 1999/2000 (Department of Fisheries 2003), although this will vary depending on factors such as catch levels, species mix, market prices and exchange rates.

The DEH recently assessed the Exmouth Gulf Prawn Managed Fishery against the Commonwealth guidelines for sustainable fisheries. The application against these guidelines was successful and the fishery is now considered to meet the requirements under Part 13 A of the *EPBC Act 1999*, to enable the western king prawn (*Penaeus latisulcatus*), tiger prawn (*Penaeus esculentus*), endeavour prawn (*Metapenaeus endeavouri*), banana prawn (*Penaeus merguiensis*) and other relevant by-products of this fishery to remain on the section 303DB list of species exempt from export regulations.

5.8 Pastoral Activities

Farming activities have occurred in the region for more than 100 years. The pastoral industry occupies 80% of the regional land area (Western Australian Planning Commission 2004). This industry has been traditionally based on wool production, however opportunities for diversification are being supported by the Gascoyne Murchison Rangeland Strategy (Gascoyne Development Commission 2003) and as a consequence cattle are now a dominant source of income.

The Exploration Licences overlay five pastoral stations:

- Yanrey;

- Minderoo;
- Giralia (recently acquired by CALM);
- Urala; and
- Koordarrie.

Consultation with the station owners and occupiers has commenced and will continue throughout the life of the project. Specific liaison will be undertaken with CALM to discuss boundary and land management issues associated with the proposed Giralia conservation Park.

5.9 Tourism

Tourism in the Exmouth Gulf region is a significant contributor to the local economy. In 2001 and 2002 Exmouth had 103,500 overnight visitors (based on a two year rolling average). Of these, 73% were domestic visitors (Bureau of Tourism Research 2002).

The greatest proportion of the tourism activity is based on the Cape Range area and the much clearer waters of Ningaloo Marine Park. Popular tourist activities in the region include outdoor/ecotourism, fishing, diving, and whale and whale shark watching/swimming. Tourists do not frequent the project area, although an ecotourism lease has recently been granted in the area. Straits is working with the leaseholder to ensure that the proposed salt field is compatible with this venture.

5.10 Heritage

5.10.1 Aboriginal Heritage

Straits has Native Title agreements in place with the two relevant claimant groups, namely the Gnulli Group (comprising a number of groups working as one claimant) and the Thalanyji People. A number of small-scale Aboriginal Heritage surveys have been completed to date, with more planned.

There are four registered aboriginal sites within the Exploration Licences granted for this project (Department of Indigenous Affairs database 2004). During recent survey work however several other Aboriginal sites have been identified and it is probable that additional sites exist. Project specific ethnographic and archaeological surveys will be undertaken to assess this.

A summary of the Aboriginal Heritage survey work undertaken to date is provided in Table 5.1

Table 5.1: Aboriginal Heritage survey work to date

Date of Survey	Aboriginal Group	Type of Survey	Results of Survey/comments
3-4 August 04	Thalanyji	Site avoidance survey	Clearance given for drill holes and test pit installation
7 September 2004	Gnulli	Site avoidance survey	Clearance given for drill holes and test pit installation
6-8 September 2004	Thalanyji	Ethnographic	Several sites identified

5.10.2 European and Maritime Heritage

There are no known significant European Heritage sites within the project area. Although there are a number of shipwreck sites within the region, none have been identified in locations that are likely to be affected by the project.

6.0 Potential Environmental Impacts and Scope of Investigations

6.1 Introduction and Overview

This section sets out the key potential environmental impacts associated with the proposal and potential monitoring and management requirements based on current thinking (recognising that the aim of this document is to scope the work required for the assessment rather than present an assessment). The impacts have been categorised into physical and ecological issues within the marine and terrestrial areas, however the significance of the interactions and connectivity of the system (see Section 6.7) has also been identified. The potential impacts on the entire system will be assessed fully within the ERMP.

Based on the initial reviews, site appraisals and stakeholder consultation, Straits believes there are four key environmental concerns associated with the development of the salt field:

1. Potential for direct and indirect loss of mangroves and associated biota such as algal mats in an area of recognised significance for these systems.
2. Potential shipping and salt production related impacts on marine fauna (i.e. whales and dugongs), which are protected at State and Federal levels, and the habitat supporting these fauna.
3. Potential modification to existing surface water hydrology, tidal flushing and marine and terrestrial nutrient inputs introduced by the presence of the salt field and the significance of this to wider ecosystem function of Exmouth Gulf (with linkages to impacts on fisheries and aquaculture).
4. The Marine Parks and Reserves Selection Working Group (MPRSWG) "Wilson Report" (1994) recommended that, "*the nearshore waters on the eastern and south-western side of Exmouth Gulf be considered for reservation for the protection of mangal habitat, prawn and fish nursery areas, turtle and dugong feeding areas, and coastal marine fauna and flora generally and for recreational fishing and such commercial fishing and mariculture and may be consistent with the former purposes*." The ERMP will therefore need to address the issue of development in an area recommended by the MPRSWG (1994) to be set aside as a marine conservation reserve and the management required to maintain the environmental values of such a reserve.

However, Straits believes that the ERMP will demonstrate that the salt field can be designed and managed such that the environmental values of the region will be maintained. The project provides the mechanism for active management of the locality to be improved.

Details of the scope of investigations to address these key areas are set out in Section 6.0. A range of other second tier environmental issues raised by the proposal are also outlined in Table 6.1.

A range of investigations and design and management measures will be presented in the ERMP to respond to the above concerns:

1. Impacts on mangroves and algal mats will be minimised or avoided through the design of the salt field, including the location of the salt field out of the mangrove zone and the use of trestleways and other infrastructure to minimise changes to tidal flushing.

2. With respect to marine fauna, Straits is undertaking surveys to understand temporal and spatial distribution of key species and will develop management alternatives to avoid or minimise disturbance to these target species.

3. The underlying design philosophy behind the planning of the salt field is to avoid interrupting water flows, either coastal, intertidal or from the hinterland to the ocean. For this reason, the salt ponds are to be placed inland of the intertidal zone and designed such that hinterland flows will not be interrupted and marine structures will not affect tidal flows. The hypothesis is that if the water flows are not interrupted, then the key nutrient fluxes and other energy flows (which are associated with tidal flows) will not be interrupted. This conceptual model largely defines the work for the ERMP, in which the degree to which the design approach has been achieved will be assessed in terms of the potential impact of the proposal on water flows. Hydrodynamic modelling

will be used as a key tool in the assessment. The model outputs will be used to predict the likely impacts on mangrove and algal mat communities.

4. With respect to the recommended marine conservation reserve, Straits will enter into discussion with the MPRA and stakeholders on the objectives, boundaries and management framework. The hydrodynamic model will also assist this process by allowing accurate delineation of the high water mark, which in turn is used to define the Wilson Report (1994) used to establish the proposed hinterland boundary of any future marine management reserve. The Wilson Report (1994) Specifically, this recommended that the boundary be 40 m inland of the high water mark, which also generally defines the seaward extent of pastoral lease boundaries. At present, maps for this region show an approximate boundary which appears to be significantly and erroneously landward (5 to 15 km) from the high water mark, with subsequent ramifications for any planning and management assumptions made on the basis of this 'approximate' boundary. Straits will consult with the MPRA on this issue prior to release of the ERMP.

For each area considered below, the ERMP will provide:

- an account of pre-existing impacts in the project area (or locality if necessary) relevant to specific factors;
- relevant aspects of the project that are the source of the potential impacts;
- an evaluation of the potential impact mechanisms and their spatial scale; and
- project design and management response to ameliorate or eliminate the potential impact.

A brief discussion of each relevant area and the potential impact mechanisms is provided in Sections 6.2 to 6.8, with a summary and consolidation into the standard EPA factors table format in Section 6.9.

6.2 Definition of Spatial Scales

The definition of spatial scales is important to provide clarity to all parties as to the extent of issues and the frame of reference within which each is being considered. Terms to be defined will include 'regional', 'local' and 'project area'. The definition of the latter term will be based on the concept of a full definition of all project components and collateral impacts to identify zones of influence associated with the proposal.

For the purposes of the ERMP, the following frames of references will be applied:

- National / State: Australia / Western Australia
- Regional: Carnarvon Bioregion (terrestrial), Pilbara and Gascoyne coast (marine)
- Locality/Local: Yannarie / Giralia Coastal Plain (terrestrial), Exmouth Gulf (marine)
- Project Area: Eastern side of Exmouth Gulf (as outlined below)

The preliminary boundaries of the 'project area' have been defined by considering the spatial extent of the various elements of the proposal and any associated zones of influence (Figure 3.1).

6.3 Project Design and Justification

Straits recognises the environmental significance of the region and it is therefore Straits' intention to refine the design of the project as environmental constraints become better identified during the ERMP studies. A key factor in obtaining such an extensive lease area was to allow these changes to be made to minimise adverse impacts without jeopardising the size or layout of the salt field.

The project preliminary design will be prepared prior to release of the ERMP and will be based on the following key engineering studies:

- surface hydrology modelling;
- geotechnical surveys;
- hydrographic surveys;
- sediment surveys;
- aerial photography;
- digital terrain modelling;
- collection of current and tidal data; and
- preliminary engineering design of key components and operations.

The project justification will catalogue the decisions made with regard to the final location and configuration of the proposal presented in the ERMP and the reasons that these decisions were made.

The summarised findings of the environmental performance of existing solar salt operators in Western Australia will be also reviewed and the results presented in the ERMP. Where appropriate, Straits will provide detail on the measures it intends implementing to avoid any occurrences of environmental incidents that may have occurred elsewhere.

6.4 Terrestrial Biophysical

6.4.1 Geology, Soils and Landforms

Potential Impacts
A broad overview of the existing physiography of the project area is provided in Section 5.2. The ERMP will define the existing environment of the project area, the systems operating and the nature of the physical framework. An understanding of geology, landforms and soil landscapes will provide the physical context for environmental impact assessment and relationships with the biological environment, in addition to informing engineering design.

Potential impacts in this area that may arise from the proposal include:

- increases or changes in erosion through changes in water flows;
- landform removal or modification; and
- exposure of potential acid sulphate soils.

Scope of ERMP Studies
An understanding of the geology of the project area is necessary for surface and groundwater hydrology and contributes to an understanding of soils, landforms, and geomorphology. A review of regional geological mapping and other relevant reference materials will be conducted, along with input from engineering geotechnical studies.

The data and soil sample analyses collected during field investigations will contribute to the development of a soil landscape map and an understanding of surface stability, erosion potential, potential acid sulphate soils, rehabilitation issues for disturbed areas such as borrow areas, sediment source areas, and drainage control requirements for roads and access tracks.

Given the location and scale of the proposal, the potential for acid sulphate soil (ASS) generation is a key concern. Straits will undertake a thorough assessment of the potential for ASS generation and assess the magnitude of any adverse ecological effects arising from acidification. While the probability of potential acid sulphate soils being present is high, the development of any significant management issues is likely to be low given the nature of the proposal. The design philosophy for the field is to keep infrastructure and associated ground disturbance out of the intertidal zone (and therefore mangrove system sediments). The majority of the salt field development would in fact submerge any potential acid generating soils that may present further inland on the supratidal mudflat beneath the salt field pond system.

Prior to sampling, an ASS sampling plan will be prepared based on the DoE guidelines for "*Identification and investigation of acid sulphate soils and groundwater*" (DEP/WRC, 2003) and the National Strategy for the Management of Coastal Acid Sulphate Soils (ANZECC/ARMCANZ, 2000). Straits will seek guidance on the ASS sampling plan and assessment of results from the DoE Land and Water Quality Branch prior to sampling finalising the ERMP.

Specific objectives relating to the plan will be as follows;

- collection of sediment samples to achieve sufficient coverage of all areas in which soils/sediments will be disturbed such that ASS could be generated;
- collection of sufficient samples from each soil/sediment horizon;
- maintenance of rigorous sample handling, transport and storage processes to ensure sample integrity; and
- determination Acid Sulphate Soil parameters.

Geotechnical studies being completed as part of parallel engineering feasibility investigations are also addressing soil properties and stratigraphy across the site. This includes collection of samples for potential ASS analysis from a transect based series of samples on the mudflat area.

Soil landscapes will be mapped, along with characterisation of soils and definition of Principal Profile Forms, erodibility and potential sediment source areas. The ERMP will also provide definitions of landform units and identification of significant geomorphic features (in the local and regional contexts). Soils and landform data will also be spatially related to the flora and fauna survey data to develop an overall picture of habitat units and any key ecological relationships with flora, vegetation and fauna. The landscape values of the project area, and the changes introduced by the proposed development, will also be considered in the ERMP. The Draft Site Closure Plan to be prepared as part of the ERMP will also consider this issue.

6.4.2 Groundwater and Surface Water

Potential Impacts
The proposed salt field is located in an area influenced by the outflow of the Yannarie River. Surface hydrology and flood regimes will therefore be one of the key terrestrial assessment issues, from both environmental and engineering design perspectives. The interaction between surface water and groundwater in the area is also of importance in understanding the current regime. The operation of the salt field also has the potential to influence local groundwater levels and quality, including salinisation of freshwater lenses.

Potential impacts in this area that may arise from the proposal include:

- hinterland flood diversion and displacement due to placement of bunds;
- changes to (and channelling of) site surface water drainage;
- changes to sediment transport;
- alteration to local groundwater regime (recharge, flow paths etc);
- reduction in groundwater quality and introduction of potential contaminants (e.g. diesel fuel);
- bund wall and hypersaline pond water seepage;
- development of potable water supply by a new bore field; and
- saline groundwater intrusion into superficial freshwater aquifers.

Scope of ERMP Studies
Preliminary consideration of topographic data and satellite imagery for the region confirmed the presence of two major surface drainage systems. These are the Yannarie River and the Rouse Creek systems, each with its own discrete catchment area and which, either singularly or in combination, has the potential to contribute surface flow to the project area. Both systems lose their identity on a large flood-out area before discharging to the supratidal flats.

The scope of work proposed for the ERMP will address three key components.

1. The contribution of each catchment to surface flow will be defined and then a combined flow determined for a range of rainfall/runoff events. It is proposed to use normal Intensity-duration-frequency data as well as the data generated by less frequent episodic events associated with the passage of cyclones and rain depressions. The discharge and distribution characteristics of both individual and combined flows will then be defined so that discharge patterns can be confirmed.

2. A stage-height-discharge analysis using a digital elevation model will be carried out to identify key drainage directions and the role of the outwash-plain and the hinterland dune/claypan system in either impeding or enhancing surface flow. Such analyses will define the major discharge points from the mainland onto the supratidal flats as well as defining the volumes of flow reporting to each location.

3. Once discharge locations have been defined and the discharge points ranked according to outflow, the distribution of the discharge at each outflow point will be defined in terms of volume and velocity of flow. These data will then allow the role of these discharge events in contributing to an overall energy transfer linking the hinterland to the tidal zone. The potential of these flows to contribute sediment to the tidal zone on Exmouth Gulf will also be assessed. These data will then be used in conjunction with engineering design to ensure, if necessary, that discharge events are not impeded and that energy transfer systems remain intact.

The ERMP will identify hinterland catchments, surface water flow paths and discharge volumes and provide a description of terrestrial flood regimes and local climatic variables. The alteration or displacement of surface flood events by the presence of the salt field will also be assessed. Existing patterns of sediment transport and deposition will be documented, along with potential changes to sediment deposition patterns introduced by changes to surface hydrology.

Groundwater regimes will also be defined in terms of characterisation of the existing groundwater system. Aquifer characteristics, water quality, variability in depth and regional flow direction will be defined. Data loggers will be installed to help define depth and variability of the depth of groundwater below the surface. Preliminary drilling has occurred and these data indicate that the salinity of the groundwater varies with increasing distance from the flood plains of the Yannarie River and Rouse Creek systems. Accordingly, while it is proposed to maximise the data available from existing bores, it is also proposed to drill additional bores to further define and clarify the groundwater system in the area, including identifying variability in groundwater salinity. Additional drilling is to be completed during the engineering feasibility phase, with the programme to be developed after a review of the existing results. Links between the groundwater system and the potential of the flood plain areas of the Yannarie and Rouse systems to act as major intake beds will be defined.

Once the mainland groundwater system is defined, potential links between this system and the groundwater system on the supratidal flats will be assessed. Data available prior to the start of field investigations indicate that groundwater on the mainland is at a depth of around 10 to 15 m below ground level and on the supratidal flat, highly saline water generally occurs at a depth of less than one metre. This will allow for a risk assessment of any groundwater related changes introduced by the construction and operation of the salt field to be undertaken. Data from soils characterisation (Section 6.4.1) will also be used as an input to this assessment, particularly in respect of potential saline groundwater intrusion and pond seepage.

6.4.3 Terrestrial Flora and Vegetation

Potential Impacts

The general nature of the terrestrial flora and vegetation in the project area is described in Section 5.3. Construction and operation of the proposed salt field will result in ground clearing activities for infrastructure and material sourcing. This will affect vegetation on supratidal mudflat islands and the adjacent hinterland. It is also possible that low-lying and fringing areas of islands within the salt field will be affected by intrusion of saline groundwater and wave-induced erosion during the operational phase. This may degrade vegetation through water-logging and increases in soil salinity.

Potential impacts on terrestrial flora and vegetation that may arise from the proposal include:

- vegetation clearing;
- disturbance to Threatened Flora populations;
- degradation / loss of vegetation due to saline groundwater intrusion;
- changes to surface water flows;
- weed introduction and transport; and
- dust deposition.

Scope of ERMP Studies

Limited systematic flora and vegetation survey work has been completed in the project area. Regional level mapping of broad vegetation units is available from the mapping of Beard (1975) and subsequent work completed on land system units by Department of Agriculture WA (AgWA). More detailed flora and vegetation work is currently being carried out by CALM as part of ongoing survey work of Giralia Station to the south of the project area. These studies aside, the majority of the remaining reference information in regards to flora again provides regional context rather than site-specific information.

With the lack of site-specific data on terrestrial flora and vegetation, a systematic survey is required. This will provide vegetation mapping of the entire project area, based on ground-truthing and systematic flora data. The work will be completed in accordance with EPA Guidance Statement No. 51 (Terrestrial Flora Surveys for Environmental Impact Assessment).

The ERMP will document:

- vegetation types present and their local and regional representation;

- the regional context for the flora and vegetation types of the project area;
- the findings of other survey work completed in the region and locality;
- the flora species present (including an account of introduced flora);
- assess the impacts on EPBC listed threatened species;
- the local and regional conservation significance of the flora present (including any Threatened flora taxa present or likely to occur);
- the extent of pre-existing environmental impacts; and
- potential impacts on flora and vegetation from the project (particularly in respect of clearing and saline groundwater intrusion).

6.4.4 Terrestrial Fauna

Potential Impacts

The mudflat islands (Section 5.3) also support vertebrate and invertebrate fauna communities. Some of these mudflat supratidal areas will become true islands within the salt field once this is flooded, isolating any fauna populations. Fauna habitat will also be removed by construction clearing and may also be affected by the intrusion of saline groundwater affecting superficial freshwater lenses on these islands (Section 6.4.3).

Potential impacts on terrestrial fauna that may arise from the proposal include:

- habitat clearing during materials sourcing and construction;
- habitat degradation due to saline groundwater Intrusion;
- isolation of island populations of fauna once the salt field is flooded;
- increased opportunities for feral fauna movement within the area;
- increased attraction of ponds for migratory waders; and
- increased vehicle movement and road kill potential.

Scope of ERMP Studies

There has been limited terrestrial fauna survey work completed in the proposal area. CALM has previously conducted trapping on some of the islands within Exmouth Gulf, has seabird records from these islands and is currently undertaking surveys of Giralia Station to the south of the project area. The WA Museum completed terrestrial fauna survey work along the Tubridgi gas pipeline corridor to the north of the current project area. Biota has previously undertaken systematic sampling for fauna on behalf of Onslow Salt to the north of the project area. These studies aside, the majority of the available terrestrial fauna information is more regional level reference studies (e.g. The Herpetofauna of the Exmouth and Onslow – Ashburton Regions (Storr and Hanlon 1980, Storr and Harold 1981)).

Given the lack of site-specific data on terrestrial fauna and habitat types, a systematic fauna survey of the project area is required. Fauna survey sites will be selected within the study area so that they:

- sample a representative set of the fauna habitats/community types present in the locality;
- address the areas most likely to be impacted by the proposed salt field development;
- sample across the geographic extent of the project area; and
- investigate any areas of particular conservation significance.

All terrestrial vertebrate groups will be sampled, along with selected invertebrate groups from the range of habitat types present in the project area. The surveys will be completed during August-September. Records of fauna will be obtained both by systematic (i.e. using traps) and non-systematic censusing (which involves actively searching for fauna). A fauna habitat based assessment will also be undertaken to assess the possible occurrence of other species not recorded from the site. A search of the WA Museum's FaunaBase and consolidation of literature review information will be undertaken to assist this. The work will be completed in accordance with EPA Guidance Statement No. 56 (Terrestrial Fauna Surveys for Environmental Impact Assessment).

Key wader roost sites along the east Exmouth Gulf coast will be identified as part of field surveys to obtain quantitative species-specific wader counts. This study will include three seasonal surveys by specialist wader ornithologists during different times of the year. This will coincide with different phases of northward and southward migration of the target wader species. These data will also be correlated with the year-long wader survey dataset collected from within the same region at Barrow Island by the same authors. Comment will then be provided based on expert opinion and the available data on the likely response of these species to salt pond potential habitat creation.

Targeted groups of terrestrial invertebrates will be collected during the field survey, both via hand searching and as a component of the systematic sampling. This will be largely aimed at those taxa that represent potential short-range endemics (millipedes, land snails, and other groups), consistent with EPA Guidance Statement No. 56.

The ERMP will provide an assessment of:

- the regional context for the fauna of the project area;
- the findings of other survey work completed in the region;
- habitat units present and their local and regional representation;
- the fauna and fauna assemblages present (including feral predators);
- the local and regional conservation significance of the fauna present (including any Threatened fauna present or likely to occur); and
- potential impacts on fauna from the project, including the potential changes that may be introduced to the local system from habitat creation as a result of the construction of the salt ponds. This has resulted in the creation of substantial areas of habitat for migratory waders at other salt fields in the region.

6.4.5 Subterranean Fauna

Potential Impacts
Subterranean fauna comprise stygofauna (aquatic, groundwater fauna) and troglofauna (obligate terrestrial subterranean fauna). While Cape Range, on the western side of Exmouth Gulf, is well recognised for its subterranean fauna, there is little evidence to date that the project area has any significance for this fauna. The majority of the project area is hypersaline mudflats that would not comprise suitable habitat for this fauna.

Potential impacts on subterranean fauna (if present) include:

- excavation of habitat strata;
- low level groundwater abstraction for water supply; and
- intrusion of hypersaline groundwater into superficial freshwater aquifers.

Scope of ERMP Studies
The potential for subterranean fauna will be assessed on the basis of a desktop review and liaison required in consultation with the WA Museum and CALM. This will be based on the findings of the site geotechnical and hydrogeological investigations, combined with opportunistic sampling where targeted bores are available.

6.5 Marine Biophysical

6.5.1 Hydrodynamics, coastal processes and wetlands

Potential Impacts
The proposal may impact on coastal processes and hydrodynamics as follows:

- intertidal flows may be interrupted with the construction of bunds;
- alteration of flows during storm surge events with corresponding changes to patterns of sedimentation and erosion;
- alongshore sediment transport may be affected with the construction of a barge harbour and dredging an access channel; and
- containment and flooding of significant sections of the saline mudflats within ponds and resultant changes to the physical and biological function of those areas.

Scope of ERMP Studies
Water flows link the intertidal zone to the nearshore or coastal zone, and in turn, the coastal zone to the Gulf. The Australian Institute of Marine Science (AIMS) suggest that nutrients carried from the coastal zone to the Gulf may comprise an integral part of the Gulf ecosystem. As the proposal involves building port associated infrastructure that may interfere with coastal hydrodynamics, the ERMP work will describe the circulation at the Gulf scale, the wetting and drying of the intertidal system and the likely impacts on these flows.

The project would require the construction of sea walls and bunds across the mudflats that make up a large part of the registered wetland, which could have potential impacts on the functionality of the

wetland. The significance of any changes will be assessed from a physical and biological perspective. The potential impacts from habitat creation are considered in Section 6.4.4 Terrestrial Fauna.

Given the importance of the modelling work to the assessment, the work will be peer reviewed prior to submission in the ERMP. Dr Chris Fandry and Dr Cliff Hearn have agreed to act as peer reviewers for this component.

The work will be managed by Oceanica with the modelling done by a consortium comprising Asia Pacific Applied Sciences, Worley and the UWA Centre for Water Research. The 'model' will be a combination of the HYDROMAP and Environmental Fluid Dynamics Code (EFDC) models and will be capable of modelling baroclinic flows in three dimensions as well as wetting and drying of the intertidal areas. The following broad scope of hydrodynamic work will be undertaken:

- review existing studies on the Gulf;
- obtain relevant validation data from AIMS (two months of continuous current meter and water level data have been sourced from AIMS for this coast, which will be used in model validation);
- collect further validation data as required;
- appoint peer reviewers for the modelling process;
- obtain sufficiently detailed bathymetry and topographic survey data to represent the Gulf, the eastern coast, the intertidal flats and the tidal creeks in a hydrodynamic model;
- define the model domain;
- obtain and/or model meteorological data suitable for forcing the hydrodynamic model;
- after initial validation against current and water level data, validate the model against the algal mat and mangrove mapping work to ensure that the model is recreating the tidal inundation curves compatible with known mangrove and algal mat extent;
- as tidal inundation is the primary factor controlling mangrove and algal mat distribution the validated model will be used to predict the potential impact of the project on these habitats and optimise the design to minimise influence of water flows;
- assess the inland extent of the astronomical tidal fronts;
- apply the model at appropriate scales to resolve fine scale processes/impacts as required; and
- use the model to describe the movement of water from the Hope Point region to the Gulf.

In addition the model will be used to assess the likely fate and transport of oil spills and bitterns dispersion (see Section 6.5.2).

The model outputs will be used to inform the assessment of the impacts on mangrove and algal communities as well as communicate key points to the community and the regulators. A valid model will also provide an important service to the broader community in that it will allow accurate delineation of the high water mark, which in turn defines the proposed hinterland boundary of any future marine management reserve (the Wilson report recommends that the boundary be 40 m inland of the high water mark; see Section 6.1).

Given the proposed longevity of the project, an assessment of the potential for long-term sea level rise (over next 50 to 100 year) in the region will be undertaken and if it is found that there will be significant changes, the results of this assessment will also be modelled.

The eastern coast of the Gulf is generally a low energy coast with the coastline comprising mangrove shoreline, tidal deltas and occasionally beaches. Some areas have been formed through the deposition effects of overland flows. The existing coastline and the processes which formed it will be described, and the potential impacts and management of these impacts assessed. The following specific coastal process investigations will underpin the assessment:

- describe the primary mechanisms that have led to the formation of the existing coastline;
- describe typical climatic patterns as well as extreme events and how they relate to the proposal (e.g. storm surge);
- survey sediment thickness and particle size in the project area;
- measure currents and tides at Hope Point;
- quantify the likely short and long term sediment transport processes and volumes;
- determine the best location for a barge channel and barge safe haven in order to minimise impacts on coastal processes and minimise the requirement for any maintenance dredging;
- assess potential impacts on sediment movement by coastal infrastructure;
- assess potential impacts on sediment deposition zones and corresponding risk of impacts on mangroves and other benthic habitat;

- assess frequency of future maintenance dredging; and
- develop the basis for an appropriate coastal management and monitoring program.

6.5.2 Water and Sediment Quality

Potential Impacts
The proposal may impact on water quality as follows:

- bitterns and desalination water dispersal;
- dredging and spoil disposal;
- changes in salinity, dissolved oxygen, nutrient budgets, dissolved contaminant availability due to changes in pH (e.g. acid sulphate soils);
- accidental discharge of wastewater from construction and operations phases;
- spills of diesel, oil and grease;
- reduced flushing within a barge harbour;
- changed intertidal wetting and drying regimes; and
- shipping and barging operations.

Scope of ERMP Studies
The sediment and water quality on the east of the Gulf is expected to be generally unimpacted by anthropogenic activity, although removal of vegetation through long-term grazing of the hinterland and modification of the seabed through trawling may be two factors which will have potentially increased turbidity on the region. Therefore, it is important that the ERMP process describes water and sediment quality and that any adverse impacts on water and sediment quality are avoided or minimised. The objectives for this element of the ERMP will not only be to describe water and sediment quality, but also to use this information to evaluate the extent and severity of predicted changes from the baseline condition that may arise from the proposal.

The following key tasks will be undertaken:
- review and collate existing water and sediment quality information;
- a programme of sampling and analysis to characterise existing water and sediment quality, with sampling and analysis undertaken in accordance with appropriate procedures (e.g. DAL Science and Engineering 2004);
- assess meteorological records and model output to establish suitable 'worst case' scenarios for simulations;
- identify all potential marine discharges in terms of location, quantity and quality;
- examine all possible mechanisms to avoid, minimise and recycle discharges;
- if no alternative can be found to discharging bitterns to the marine environment:
    - use a valid hydrodynamic model to assess the best options to maximise dilution of bitterns and the likely extent of impacts on water quality in the context of current EPA Environmental Quality Objectives and Guidelines;
    - undertake investigations as to the probable concentration of the constituents of the bitterns, the concentration of existing (natural) constituents of seawater (including heavy metals), and the potential environmental implications;
    - undertake whole of effluent toxicity (WET) testing on either a 'mocked up' bitterns or material sourced from an existing operation to assess the potential ecological impacts of bitterns discharge to the marine environment;
    - address the issue of increased conductivity/density and potential for increased temperature associated with the bitterns, and the interplay between the two;
    - use the results of the above to establish the need for, and the size of, an appropriate Low Ecological Protection Area (LEPA; or 'mixing zone') for the bitterns discharge point;
- use a valid hydrodynamic model to assess the likely flushing times of the barge harbour and the likely impacts on water quality in the context of current EPA Environmental Quality Objectives and Guidelines. The outputs of the hydrodynamic model will inform the evaluation of ecological impacts of the proposal and understanding the environmental quality likely to result from any changes in hydrodynamic conditions;
- assess potential transient and long-term impacts on water and sediment quality, with emphasis on turbidity, anti-foulants, oil spills, bitterns discharge, harbour water quality, and nutrient related impacts;
- examine the potential impacts of the project on nutrient flows to the Gulf;
- examine the potential for impacts on the Ningaloo Marine system; and

- examine the potential for impacts on prawning grounds, pearl farms, fishery areas and other aquaculture operations.

A programme of preliminary water quality sampling has been implemented and there will be a baseline survey designed for the period leading up to salt production.

6.5.3 Mangroves

Potential Impacts

The mangrove systems associated with the eastern shore of Exmouth Gulf are extensive (up to 1 km in width) and are of recognised regional significance (MPRSWG 1994, EPA 2001). EPA guidance statement No. 1 found that for this coast: *"No development should take place that would adversely affect the mangrove habitat, the ecological function of these areas and the maintenance of ecological processes which sustain the mangrove habitats"*. Straits is aware that the EPA may adopt a presumption against finding the proposal environmentally acceptable if there is loss of mangroves and that the ERMP will therefore need to demonstrate, using technically defensible data and arguments, that the proposed design will not adversely affect mangrove habitat, the ecological function of these areas and the maintenance of ecological processes which sustain the mangrove habitats.

The potential impacts of the project on these systems will be one of the key issues to be addressed by the ERMP. Mangrove communities provide a range of significant ecological functions including physical stabilisation of sediments (Thom 1982, Semeniuk 1985), provision of terrestrial and marine fauna habitats (Robertson and Duke 1987, Robertson 1991) and inputs of nutrients to coastal ecosystems (Semeniuk et al. 1978, Paling and McComb 1994).

Mangroves also provide habitat for bird and bat species that are largely or entirely restricted to this coastal habitat (Johnstone 1990). Due to their restricted distribution, these species are more at risk of population and taxon level impacts arising from habitat reduction. The extent of use of the project area by migratory waders is also a potentially significant issue, particularly in respect of trigger factors under the *EPBC Act 1999*.

The construction of the salt field has the potential to impact mangroves in a variety of ways including:

- clearing of mangroves;
- changes to sediment transport;
- changes to local ground and surface water flows;
- restriction of tidal flushing;
- saline water seepage; and
- seawater pumping.

Scope of ERMP Studies

A range of mangrove system related research work has been completed in Exmouth Gulf and along the wider Pilbara coast, particularly by AIMS. Relevant data from this earlier work will be utilised in completing the assessment for the ERMP. In addition to these data, field surveys will be completed to document in detail the mangrove and algal mat systems occurring along the coast adjacent to the project area.

- Mangrove Community and Algal Mat Field Surveys

The mangrove communities potentially affected by the proposed salt field development will be surveyed and be subject to field mapping from current colour aerial photography. Ground-truthing will be carried out to determine the total mangrove species pool and to describe the associations identified from the aerial photography. Geomorphological conditions, tidal channels and inundation regimes, mangrove condition and other relevant information will also be recorded. Spot heights will be collected along the upper limit of the mangrove zone to assist in identification of regular high tide extent and for input into the hydrodynamic modelling (Section 6.5.1). Mangrove dependent bird communities will be surveyed during the course of the field exercise via dedicated bird censuses and area searches. Migratory wader use will also be assessed through surveys and interpretation of potential foraging and resting habitats. As some bat species are thought to be largely restricted to mangrove habitats, bat occurrence will be assessed through use of harp traps (where appropriate), Anabat recordings and investigation of potential roost sites in mature *Avicennia marina*.

Algal mats will be mapped from aerial photography and classified as apparently active and lithified/inactive (generally in areas out of the regular tidal range). The ERMP work will include a

process to validate the classification process (e.g. ground-truthing). Samples will be collected from algal mats to enable constituent species to be identified to validate comparisons with nutrient related research previously completed in the region (Paling et al. 1989, Paling and McComb 1994).

- Analysis of Historical Patterns of Mangrove Change

A preliminary site visit indicated that Cyclone Vance (which crossed the coast in 1999) has had a significant impact on mangroves of east Exmouth Gulf and this study would quantify the nature and extent of that change. Archived Landsat imagery will be used to analyse patterns of recent change in mangrove assemblages along the eastern coast of Exmouth Gulf. The study will utilise GIS and image analysis software to analyse and interpret historical imagery of the project area against current imagery to quantify changes over time in the mangrove communities. Cyclone Vance was a relatively recent event in the timeframe of mangrove community dynamics and the system is currently experiencing a variety of ongoing ecological and physical processes arising from this event. It is therefore essential to obtain an understanding of these processes to be able to assess any impacts that may arise from the proposed development. This work will also provide a key input to the application of EPA Guidance No. 29, which requires an estimate of pre-European settlement extent of mangrove cover (the current extent of healthy mangal will be added to the total cyclone impacted area). The ERMP will also discuss the processes that drive recovery of mangroves in this area (e.g. is the system predominantly open or closed with respect to new recruitment?).

Mangrove condition will be analysed by image band processing via Normalised Difference Vegetation Index (NDVI). This utilises the strength of the infrared signal in imagery to assess and quantify condition levels in vegetation (including mangroves). This will be particularly useful in accurately distinguishing dead and degraded mangrove areas from good condition assemblages. Image analysis software will enable area figures to be determined from this process. The ERMP studies should include work to field-validate the imagery-based approach being taken to evaluate mangrove condition in the study area.

The ERMP will provide an assessment of:

- the regional context for the mangrove communities present (particularly in respect of areas of extent of mangrove coverage);
- a summary of the key findings of other mangrove studies completed in the region (particularly data available from work completed by AIMS in Exmouth Gulf, other industrial development mangrove assessments completed by Dr Eric Paling, and previous mangrove assessment and monitoring work completed by Biota at Onslow (Biota 2003));
- a review of historical mangrove change and current condition based on satellite imagery analysis (including change maps);
- the total mangrove species richness for the project area;
- mangrove community types present and their local and regional representation by area;
- the condition of mangrove communities and the extent of any recovery, recruitment or other change since the impact of Cyclone Vance;
- an account of other mangrove dependent biota (particularly mangrove birds);
- habitat availability and use of the intertidal zone by migratory waders;
- potential impacts of the proposal on *EPBC Act 1999* listed threatened and migratory species; and
- a spatial analysis of the potential direct and indirect impacts on mangrove communities arising from the project (including GIS analysis of any project-induced mangrove clearing impacts and changes to hydrodynamics via tie-ins with the output of hydrodynamic modelling (see Section 6.5.1).

The ERMP will also identify and justify an appropriate Management Unit (or Units) for mangrove benthic primary producer habitat (BPPH) in accordance with the requirements of Guidance Statement No. 29 (EPA 2004) (see Section 6.5.4). The potential loss of mangrove BPPH in any management unit will also be identified in the ERMP as an output from this work.

6.5.4 Benthic Primary Producer Habitats

Potential Impacts

The proposal may impact on benthic primary producer habitats (BPPH; being the flora attached to the seafloor and the substrates supporting them (including mangroves)) as follows:

- direct loss of BPPH through dredging;
- shading of BPPH by turbidity arising from dredging, barging and shipping;

- bitterns and desalination water discharges and dispersal;
- introduced species (via dredge, barges, shipping hulls and ballast water);
- impacts on BPPH as a result of changes in sediment dynamics and water flows; and
- large spills of salt.

Scope of ERMP Studies

The marine flora of the eastern margin of the Gulf is characterised by extensive shallow beds of algae and ephemeral seagrass species. The seagrass and algal meadows serve as nursery habitat for juvenile prawns and the seagrasses are an important food source for local dugong populations. In addition, there are known to be areas of coral on suitable substrates. There have been a number of studies of seagrass abundance along this coast (e.g. McCook et al. 1995) and benthic habitat work will largely follow the procedures established by previous studies (e.g. Kangas 2003). The key tasks in undertaking the benthic habitat surveys will be:

- collection of ortho-rectified, geo-referenced imagery of the nearshore zone, with suitable water penetration; this will provide a valuable framework for subsequent ground-truthing of the main habitat types in the region. Analysis of satellite imagery and project specific aerial photography suggests that the imagery will be suitable for mapping to depths of ~3 m, which is a large portion of the eastern margin;
- collection of underwater video transects of marine communities along the alignments of the proposed dredge channels and identification of key species present;
- benthic habitat mapping will be completed for areas likely to be affected by the dredging (e.g. turbidity, sedimentation, reduced water quality, changed sediment characteristics) and identification of key species present;
- identification of BPPH in the vicinity of the locations where bitterns discharge or seawater pumping may occur;
- use of field identification surveys and aerial imagery to generate maps of BPPH suitable for planning to avoid/minimise loss and assessing impacts;
- placement of any impacted or at risk habitats in context with the broader habitat of the east coast of Exmouth Gulf;
- spatially define the locations and extent of potential impacts on BPPH within appropriate management unit/s by marking out the impacted areas on an appropriately scaled benthic habitat map for any defined management unit/s;
- results of benthic habitat mapping, hydrodynamic modelling and other relevant work to be used to inform assessments of the best, most probable and worst case temporal and spatial scale of direct and indirect impacts on BPPH in a management unit;
- use the results of the mapping and hydrodynamic modelling to assess the best options for management and monitoring of dredging and spoil disposal plume impacts;
- use the results of the mapping and hydrodynamic modelling to assess the best options for pond locations, dispersal of bitterns and desalination flows and location of seawater intake areas with particular regard to seagrass habitat, prawn nurseries, mangroves and aquaculture facilities;
- assess direct and indirect losses of BPPH against Guidance Statement No.29;
- assess the risk of foreign species introduction; and
- develop the basis for an appropriate benthic habitat management and monitoring programme.

6.5.5 Marine Fauna

Potential Impacts

Potential impacts on marine fauna associated with the development include:

- habitat loss and modification;
- disturbance from noise and vibration;
- effects of light spill on turtles and other marine fauna;
- collision with or disturbance of *EPBC Act 1999* listed threatened and migratory fauna from vessel movements (high speed ferry between Exmouth and Hope Point, salt barges and Panamax size ships within the Gulf);
- lethal and sub-lethal effects of contamination associated with anti-foulants;
- the effects of bitterns discharge;
- the effects of other discharges (e.g. stockpile run-off);
- introduction of foreign marine organisms with potential impacts on local aquaculture;
- loss of eggs and juveniles to salt ponds via seawater pumps;
- ‘growing out’ and management of fish within the concentration ponds;
- increase in refuse and potential scavenging by fauna;

- smothering and increased turbidity of the water column associated with sediment plumes;
- changes to patterns of longshore drift and coastal currents; and
- brine disposal from desalination plant.

Scope of ERMP Studies
Exmouth Gulf was known to support a population of approximately 1,000 dugongs prior to Cyclone Vance, as well as other large fauna protected under the *EPBC Act 1999*, such as humpback whales, turtles, dolphins and manta rays (Preen et al. 1997, Prince 2001). The ERMP will describe the large marine fauna species present, their temporal and spatial distribution, the threats that these species face and the risks posed to these species by the proposal. In addition, the ERMP will outline how the proposal is to be managed to minimise or mitigate these risks. This work will be undertaken in consultation with the CALM Marine Group.

Turtle hatchling disorientation is one of the main potential impacts of light spill from the proposed port facilities. Utilisation of any local beaches in the project area as marine turtle nesting sites will be assessed during field surveys. Other data on wider turtle activity within the Gulf (including as a sheltered area for juvenile turtles), will also be collated in the ERMP. Any potential impacts on other marine fauna will also be considered in the ERMP.

The field survey will also determine the location of any local seabird nesting sites and following this an assessment will be made as to the risks posed to seabirds.

6.6 Pollution Management

6.6.1 Solid and Liquid Waste Disposal

The construction and operation of the salt field will generate wastes. The ERMP will describe the type and quantities of:
- domestic wastes (e.g. wastewater and workshop wastes);
- process wastes (e.g. bitterns and desalination water); and
- construction wastes.

The environmental threats posed by the wastes will be identified and appropriate disposal procedures and relevant limits and standards will be specified.

6.6.2 Hazards and Spills

The ERMP will describe the types and quantities of hydrocarbons and hazardous materials to be used or stored on-site. The environmental risks posed by these materials and the manner of their storage and use will be assessed using appropriate and documented procedures. If the risk assessment suggests that there is a high risk of a significant spill in the Gulf or the intertidal zone, then spill trajectory modelling will be undertaken for representative and credible spill scenarios.

6.7 Integrated Environmental Factors

6.7.1 Ecosystem Integrity

Given the large scale of the project and its location adjacent to Exmouth Gulf, the ERMP will undertake an assessment of the potential effects of the project on ecosystem integrity. This will involve review and consolidation of the outputs from all the technical studies, particularly the mangrove and algal mat investigations, hydrodynamic modelling and surface and groundwater investigations. This cross-disciplinary approach will also involve reviews of relevant literature, liaison with specialist researchers to develop a conceptual model of ecosystem process in the Gulf and intertidal environment.

The current model of nutrient contribution to the Gulf builds on work conducted by AIMS and work conducted by other researchers in similar coastal environments in the region (particularly Robertson 1991, Gordon 1988, Paling et al. 1989, Paling and McComb 1994). Both mangrove communities and areas of algal mats have been shown to be significant contributors of organic nitrogen, carbon and phosphorus. This occurs primarily through daily tidal exchange and flushing of these systems by marine waters, although rainfall events incident on the intertidal zone can transport nutrients to the marine environment via local freshwater run-off.

The supratidal mudflat that backs the intertidal zone is of considerable extent; up to 15 km in width before the hinterland is reached (see Figure 3.1). Preliminary hydrological investigations suggest that few rainfall and surface flood events from the hinterland are of sufficient size to cause flows across this expanse great enough to reach the intertidal zone. The data to date suggest that most 'typical' rainfall events probably do not generate enough surface flow for this to occur and that hinterland floodwaters only reach the intertidal area during larger cyclonic flood events. Given the episodic and intermittent nature of these larger events (typically long periods apart), it is unlikely that they are central to routine maintenance of the coastal mangrove strip and contribution of nutrients to the Gulf. This model and understanding of these ecosystem processes will be further assessed and analysed as part of the ERMP. This work will also be a key contributor to the refinement of the Wilson Report boundary.

The underlying design philosophy behind the salt field is to avoid interrupting water flows, either coastal, intertidal or from the hinterland to the ocean. For this reason, the salt ponds will be designed to be inland of the intertidal zone such that tidal flows will not be blocked, marine structures will be designed such that longshore flows are not adversely impacted and levees will be designed to allow hinterland flows to reach the Gulf. The hypothesis is that if the water flows are not interrupted, then the key nutrient fluxes and other energy flows (which are all associated with water flows) will not be interrupted. This conceptual model largely defines the work for the ERMP, in which the degree to which the design approach has been achieved will be assessed in terms of the impact of the proposal on water flows.

Key parameters for consideration in this section of the ERMP will include identification of key biophysical processes such as:

- surface water flows (both from incident rainfall and from hinterland floods);
- groundwater flow patterns; in respect of water quality (principally nutrients and salinity) and flow rates;
- supratidal and intertidal erosion and sediment transport;
- wetting and drying of the intertidal zone from tidal flushing; and
- circulation and water movement from the near shore environment to other parts of the Gulf.

The ERMP will consider the EPA's comments that:

1. episodic rainfall events in arid environments (e.g. flooding of desert lakes) can trigger highly significant ecological processes that may be important for the maintenance of biodiversity and ecosystem integrity until the next event.
2. rainfall events may not necessarily be the only drivers of flow from land to sea. Storm surge events that deposit sea water on areas above the normal tidal range may play important roles in maintaining biodiversity and ecosystem integrity as well driving transport processes from land to sea; and
3. the flow of ecological subsidies is unlikely to be in the one direction (i.e. from land to sea). Flow of subsidies from the sea to land should be given some consideration.

Biological attributes of the systems to be considered jointly with the above processes include:

- identifying key nutrient contributors to the coastal zone (particularly algal mats, mangrove systems and supratidal vegetation); and
- quantifying rates of nutrient contribution, uptake and cycling where information is available.

The objective of this work will be to develop a broad model synthesising physical and biological processes in the Gulf, intertidal zone and adjoining hinterland. This will be used to identify key ecosystem processes that may be affected by the construction and operation of the salt field. The changes to these will be quantified as far as possible based on data derived from literature, consultation with specialists and the technical studies, particularly modelling and intertidal community mapping.

6.7.2 Sustainability

A well designed and managed solar salt project will be highly sustainable, relying on solar power and seawater to make a product of significant economic value to Western Australia using procedures which have very low environmental impact.

Project design and management will be developed along the sustainability principles outlined in the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992). A sustainability assessment will be completed as part of the ERMP.

6.7.3 Proposed World Heritage and Regional Environmental Values

The proposal comes at a time when the EPA is developing Environmental Values and Environmental Quality Objectives for the marine waters of the Pilbara coast. In addition, the Ningaloo Reef, Cape Range and Exmouth Gulf region is currently being assessed in terms of its potential World Heritage Values as the Government is considering an application for World Heritage listing.

A summary of the values ascribed to the area proposed for World Heritage listing, and how these need to be considered in the context of the proposed saltfield development, has been provided by CALM in Appendix 4. The proposed development will be designed and managed to ensure that the identified World Heritage values of the proposed Ningaloo/ North West Cape World Heritage property. These values are:

- the wilderness values associated with the mangroves, samphires and algal flats, and with the adjacent near-shore environments, along the east coast of Exmouth Gulf;
- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in contributing to the productivity of the marine ecosystems of Exmouth Gulf and Ningaloo Reef;
- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in controlling the inputs of sediments and nutrients into the marine ecosystems of Exmouth Gulf and Ningaloo Reef;
- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the presence of population outliers of plant and animal species associated with these habitats;
- the shallow marine environments adjacent to the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the biodiversity they support, including seagrasses, dugong populations, solitary corals, sponge gardens, and marine invertebrates. It should be noted that some of these marine organisms have considerable biogeographic and evolutionary significance and illustrate the complex geological, geomorphological history of the Ningaloo/ North West Cape/ Exmouth Gulf/ Lake MacLeod area.

Some additional biodiversity values may also be relevant to the proposed World Heritage listing, but these are not yet supported by data (see Appendix 4). These include the biodiversity associated with the seasonal freshwater springs on the seaward end of the Yanrey River delta, and the seasonal populations of migratory waders, shorebirds and other water birds associated with the coastal habitats of the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf. A similar potential geomorphological value appies to the captured delta of the Yanrey River relevant to criterion viii (geoevolutionary history): *"Outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features"*

The consideration of World Heritage Values will also take into account the wilderness values of the project area and the potential for visitors to experience any identified wilderness qualities.

Salt fields in general have a good environmental track record. The primary impacts occur in the first two to three years, after which the salt field itself becomes an important component of the local ecosystem, for example providing large-scale wetland habitat. Large salt fields elsewhere have been shown to be compatible with World Heritage values (e.g. Shark Bay and Baja, Mexico). Straits will provide more detailed commentary on compatibility with World Heritage values in the ERMP.

During the ERMP preparation process, Straits will liaise with CALM and the EPA to ensure that the most current environmental policies for this region are presented and the environmental issues will be presented within this framework.

6.7.4 Cumulative Impacts

Terrestrial

The Yannarie Salt Flats area has been subject to pastoral operations, an earlier attempt to build a solar salt field and ad hoc camping. There will be an integration of these prior impacts with the Straits impacts, and these cumulative impacts will be discussed in the context of the appropriate physical scale.

Marine

The Gulf has been subject to approximately 40 years of commercial fishing, with significant documented pressure from the prawn trawling industry. Other lower level impact processes operating in the locality include tourism, recreational fishing and existing marine traffic.

As part of the ERMP there will be an overview of the existing threats, pressures and risks and a discussion, with quantification where possible, of the degree to which the Straits Salt proposal will add to these existing risks. This will be in the context of the recent certification of the Exmouth prawn fishery as a sustainable fishery and the work recently completed by Fisheries in assessing the impacts of the fishery on the environment.

6.8 Other Issues

6.8.1 Cultural Heritage

The significance of cultural heritage is well recognised. The ERMP will present the results of the heritage surveys, including archaeological, ethnographic and European heritage. It will also include a summary of the consultative process undertaken and a plan identifying any significant sites within the project footprint will be produced (where approved by Traditional Owners).

6.8.2 Fisheries and Aquaculture

Key concerns will be whether the proposal impacts on prawn nursery grounds and/or disrupts existing or planned pearling or other aquaculture operations.

The Gulf contains commercially important fishing and aquaculture grounds. These will be described in detail in the ERMP as well as any information relating to recreational fishing, including:

- maps showing designated trawling grounds and aquaculture leases;
- recent catch statistics and aquaculture species farmed;
- information on factors known to influence catches (e.g. rainfall, cyclones);
- information of seasonal closure times;
- information on known life histories of key species with emphasis on the significance of intertidal areas;
- water quality requirements for pearling and aquaculture;
- current information on the environmental, economic and social influences of trawling, aquaculture and where possible recreational fishing;
- the most likely number of vessel movements and their locations within the Gulf; and
- the current status of environmental accreditation of the industry.

On the basis of this information, the potential impacts on existing commercial and recreational fishing and aquaculture operations will be assessed and potential management measures presented.

6.8.3 Research

Straits Salt is aware of the significance of the Gulf and its coastline and, as a long-term stakeholder in the region, will actively seek to support research into issues relevant to the proposal and to the understanding of the Gulf and it surrounds. As part of the ERMP technical studies, Straits Salt will seek opportunities to support research for the region.

6.8.4 Tourism

As part of the ERMP, Straits Salt will assess the potential for positive and negative impacts on existing operations and outline possible future tourism activities that could be tied to the project.

6.8.5 Consultation

Straits has commenced its consultation program and has engaged with many key stakeholders already. As part of its ongoing program, Straits has developed Stakeholder Reference Group (SRG's) in Exmouth and Onslow, which will be consulted regularly to disseminate up to date information about the Project and to ensure that varying viewpoints are captured. Attempts will be made to address issues as they arise.

6.8.6 Local and Regional Community

A Social Impact Assessment will be conducted to ensure that potential effects on the local and regional communities are identified. As issues are identified, the relevant ones will be incorporated into the stakeholder consultation program. Straits will describe the proposed workforce arrangements in terms of employees, housing and transport requirements and the likely impacts on the community. The scope of the SIA is as follows:

- description of the human environment;
- actual impact assessment;
- public scoping; and
- integration and definition of impacts.

The types of actual impact variables that will be considered during the assessment are listed below. These will be considered across the project lifecycle, and will include:

- population and demographic impacts;
- education and employment impacts;
- economic impacts;
- industry participation;
- infrastructure and service delivery impacts;
- amenity issues and environmental values considerations;
- safety and security impacts;
- community development opportunities and impacts;
- accommodation and land use impacts;
- culture and heritage impacts; and
- communication.

6.9 Summary Table

A preliminary summary of the potential environmental issues and management measures was presented in the Environmental Referral (Straits Salt 2004) and has been updated in the preceding Sections. Table 6.1 presents the environmental factors considered to be relevant to the assessment of the environmental impacts of the Project.

Table 6.1 also includes reference to the EPA's objectives in relation to the factors, potential impacts, additional investigations required, potential management strategies and applicable standards and guidelines. This information will be further developed and presented in the ERMP. The scope of works proposed for the ERMP to investigate the potential impacts associated with the project are summarised in Table 6.1, with more detail on the issue and proposed scope of works contained in Sections 6.1 to 6.8 above.

The ERMP will also outline Environmental Management Plans (EMP's) for the construction and operational stages of the project. The objective of the EMP is to provide work specifications that will include procedures to eliminate or minimise impacts on the environment. The EMP's will identify:

- aspects and impacts of the project;
- environmental objectives;
- proposed management techniques;
- proposed monitoring programmes;
- completion criteria; and
- reporting requirements.

Table 6.1: Relevant environmental factors, potential impacts and scope of investigations for the proposed Straits Salt Project.

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
Integrated						
Ecosystem Integrity	To maintain the integrity, ecological functions and environmental values associated with Exmouth Gulf, the intertidal zone and adjacent hinterland.	All aspects of the project.	Changes to wider ecosystem function, disruption to nutrient inputs and cycling, reduction in key biophysical processes.	Document current understanding of broader ecological function and role of algal mats, mangrove systems and tidal flows in Exmouth Gulf. Review of site-specific data collected on algal mats, mangrove systems and tidal flows in the context of existing ecological models of the Exmouth Gulf system. Integration of outcomes of physical modelling work on both terrestrial and marine systems. Consultation with relevant specialists.	Design and operation of the facility to eliminate any disruption to ecosystem function in the locality.	EPA Guidance Statement No. 1: Guidance Statement for protection of tropical arid zone mangroves along the Pilbara coastline, EPA Guidance Statement No. 29
Ecological Sustainability	To ensure that the proposal meets or is consistent with the sustainability principles in the National Strategy for Ecologically Sustainable Development (Commonwealth 1992).	Salt production and transport, and accommodation and transport of the workforce.	Poor design and management of the proposal could result in unacceptable economic, environmental and social impacts.	A Sustainability Assessment for the Project will be undertaken.	Project design and management will be developed along the sustainability principles outlined in the National Strategy for Ecologically Sustainable Development.	National Strategy for Ecologically Sustainable Development (Commonwealth 1992). Hope for the future: The Western Australian State Sustainability Strategy (Govt. WA, 2003). EPA Guidance Statement No. 55. Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
Proposed World Heritage **NB: This section on Proposed World Heritage was written by CALM, it was included on the direction of the EPA.**	To protect the World Heritage values of the proposed World Heritage area The identified World Heritage values that must not be adversely impacted by activities in or adjacent to the proposed Ningaloo/ North West Cape World Heritage property are: - the wilderness values associated with the	All aspects of the project.	Any direct or indirect alterations to existing physical or ecological processes which may affect the integrity of the identified World Heritage Values for the proposed Ningaloo / North West Cape World Heritage area (see Section 6.7.3)	Investigate the additional biodiversity values, and ensure their protection as if they were already an identified component of the Ningaloo/ North West Cape World Heritage nomination. Investigate the captured delta of the Yanrey River was identified as a geomorphological value relevant to criterion viii (geoevolutionary history).	Project design modifications	Operational Guidelines for implementing the World Heritage Convention EPA Guidance Statement No. 55. Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	mangroves, samphires and algal flats, and with the adjacent near-shore environments, along the east coast of Exmouth Gulf; - the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in contributing to the productivity of the marine ecosystems of Exmouth Gulf and Ningaloo Reef; - the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in controlling the inputs of sediments and nutrients into the marine ecosystems of Exmouth Gulf and Ningaloo Reef; - the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the presence of population outliers of plant and animal species associated					

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	with these habitats; - the shallow marine environments adjacent to the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the biodiversity they support, including seagrasses, dugong populations, solitary corals, sponge gardens, and marine invertebrates. It should be noted that some of these marine organisms have considerable biogeographic and evolutionary significance and illustrate the complex geological, geomorphological history of the Ningaloo/ North West Cape/ Exmouth Gulf/ Lake MacLeod area. Additional biodiversity values not yet supported by data. These include the biodiversity associated with the seasonal freshwater springs on the seaward end of the Yanrey River delta, and the seasonal					

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	populations of migratory waders, shorebirds and other water birds associated with the coastal habitats of the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf. Geomorphological value - The captured delta of the Yanrey River was identified as relevant to criterion viii (geoevolutionary history). Natural Environment Criterion vii – "Outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features".					
Cumulative Impacts	Ensure that appropriate consideration is given to cumulative impacts of marine based activities on Exmouth Gulf.	Barge channel and marine infrastructure, shipping and barging operations.	Exmouth Gulf is home to a trawler fishing fleet which has impacts on the marine ecosystem. The Straits proposal may have impacts which add to these existing environmental impacts. The proposal will add to the existing shipping traffic in the Gulf.	Assess existing threats, pressures and risks and establish the degree to which the proposal may add to these.	The project design and management will be developed to ensure that cumulative impacts are avoided or minimised and can be managed to meet the EPA's objectives.	
Terrestrial Biophysical						
Landforms and Soils	To maintain the integrity, ecological	Concentration ponds, drains,	Soil erosion and sediment mobilisation.	Definition of soil landscapes, characterisation of soils and definition of	Project design measures to reduce erosion and sediment transport.	Identification and investigation of acid

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	functions and environmental values of soils and landforms.	bund walls, causeways, borrow areas and access roads.		Principal Profile Forms, erodibility and potential sediment source areas		sulphate soils and groundwater. (DEP/WRC, 2003)
			Landform modification, destabilisation of coastal landforms.	Definition of landform units, identification of significant geomorphic features.	Landform reconstruction for long-term stability, project design to avoid significant features.	National Strategy for the Management of Coastal Acid Sulphate Soils (ANZECC/ARMCANZ, 2000).
			Acid generation from acid sulphate soil (ASS) disturbance.	Assess the likelihood of ASS being present and being exposed by project implementation.	Develop strategies to manage ASS and potential impacts on mangroves.	
			Materials sourcing for construction of earthworks.	Select suitable locations for materials sources and define rehabilitation requirements.	Topsoil management, management of drainage systems, site design, and operation and closure methods.	
Groundwater	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected.	Concentration ponds, crystalliser ponds and water supply borefield option.	Salinisation of island superficial freshwater aquifers.	Assess the impact of the salt field on groundwater levels, particularly with respect to groundwater elevation and salinisation of freshwater lenses, and identify extent of potential affected areas.	Project design modifications.	ANZECC/ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
			Alteration to existing groundwater regime.	Characterisation and definition of existing groundwater regime.	Drainage design and monitoring programme.	Water and Rivers Commission (2000). Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5
			Salinisation of pastoral lease bores in the locality	Determine groundwater contours and assess potential for salinisation of pastoral lease bores in locality.	Monitoring programme with review of management solutions if required	
			Alterations to groundwater quality	Assess existing groundwater quality (salinity, nutrients).	Potential contaminant management and storage controls.	
			Reduction in local groundwater levels.	Identify extent of change to existing groundwater levels and aquifer storage.	Modifications to pumping regimes	
Surface water	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected. To minimise the potential for displacement of flood waters and erosion.due to stormwater flows	Concentration and crystalliser ponds bund walls, wash plant, stockpile, access roads.	Displacement of flood waters.	Identification of hinterland catchments, surface water flow paths and discharge volumes with description of terrestrial flood regimes. Predict potential alteration/displacement of surface flood events introduced by the salt field.	Project design modifications, flood diversion works.	ANZECC/ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
			Modification of sediment transport, erosion and deposition patterns.	Identify existing patterns of sediment transport and deposition. Identify potential changes to sediment deposition patterns introduced by changes to surface hydrology.	Flood diversion design, maintenance of earthworks.	EPA Draft Guidance Statement No. 26 Management of Surface Run-off from Industrial and Commercial Sites.
			Salt field bund failure and uncontrolled pond discharge.	Incorporation of flood hydrology study outcomes into salt field bund design and flood protection works.	Project design modifications, flood diversion works, contingency plans.	Water and Rivers Commission (2000). Environmental Water Provisions Policy for

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
						Western Australia: Statewide Policy No. 5
			Changes to ecosystem function.	Identify ecological significance of episodic surface water flows to littoral communities.	Project design modifications.	
Wetlands	To maintain the integrity, ecological functions and environmental values of listed wetlands	Exmouth Gulf East wetlands from Giralia Bay to Urala Creek, Lockyer Point – including marine waters less than 6m deep at low tide, tidal mudflats, saline	Alteration to hydrodynamics, coastal processes and ecology of the marine (saltmarsh) wetland area.	Documentation of physical and ecological systems and components of the marine wetland. Identification of project components that may influence the values and processes associated with the listed wetland.	Design and manage the saltfield such that the special ecological values of the wetland are maintained	International agreements (JAMBA, CAMBA, Ramsar agreements) EPA Position Statement No. 4
Mangroves and Algal Mats	To maintain the abundance, diversity, geographic distribution and productivity of mangroves and mangrove associations, through no loss of mangrove associations including algal mats. EPA guidance statement No. 1 found that for this coast: "*No development should take place that would adversely affect the mangrove habitat, the ecological function of these areas and the maintenance of ecological processes which sustain the mangrove habitats".*	Concentration and crystalliser ponds, bund walls, pump stations, access roads, port facilities, , wash plant, stockpile, dredging, bitterns discharge.	Alteration to hydrodynamics, including a reduction in the extent of tidal flushing.	Identify aspects of the project with the potential to restrict or alter tidal flushing. Collect elevation data on mangrove limits to relate to modelled tide heights and predict areas of potential change.	Project design modifications to reduce or eliminate reduction in tidal flushing.	EPA Guidance Statements No. 1 and No. 29, EPA Position Statement No. 9
			Direct clearing and removal of mangrove and algal mat communities.	Document the condition and local and regional representation of mangrove species/assemblages: • document species and assemblages present based on field survey and/or aerial photography/satellite imagery; • map extent and nature of algal mat coverage from ground-truthing and imagery classification; • evaluate local and regional significance of affected mangrove and algal mat areas; • outcomes for the proposed works to assess direct and indirect losses of BPPH against Guidance Statement No.29; and • quantify the losses, spatially and temporally, in terms of predicted best, worst and most probable extent of clearing on mangroves / algal mats.	Project design modifications to minimise clearing of mangroves and algal mats. Management of adverse impacts and improve management through improvements in knowledge	
			Hypersaline ponding / influence in tidal creeks	Identification of bitterns discharge location and management strategy, and potential mangrove impact zones	Investigation of alternative options for bitterns management to avoid/minimise bitterns release.	
			Sediment deposition	Modelling of marine sedimentation processes under pre-project conditions	Drainage design, erosion control and monitoring of mangrove systems	

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
				and under project design scenarios to predict new deposition zones.		
			Localised increases in scour and reduction in flushing	Modelling of impacts of intake pumping on Scott Creek (extent of flushing, scour and changes to sedimentation patterns).	Management of pumping operations in the context of tidal cycles.	
			Evaporator pond saline water seepage into areas beyond the salt field	Characterisation of core material and method of bund construction to ensure saline water seepage is minimised, identification of foundation engineering.	Sourcing of suitable core material and use of best practice investigation and bund construction methods.	
			Bund failure	Assess the risk of bund failure and the likely impacts on adjacent mangroves via storm surge assessment and engineering analysis.	Design the project such that any failure is least likely to occur immediately adjacent to mangroves (and to acceptable engineering risk standards)	
Terrestrial Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at the species and ecosystem levels through avoidance or management of impacts and improvement in knowledge. To protect species listed under the *EPBC Act 1999* and Schedule and Priority Fauna consistent with the provisions of the *Wildlife Conservation Act 1950*.	Flooding of concentration ponds, construction of roads, material sourcing	Habitat loss/modification from direct clearing and elevation of saline groundwater	Field survey of project area to document fauna communities, threatened taxa and potential short-range endemics. Evaluation of the local and regional significance of the fauna and communities present. Quantify reduction in extent of habitat units attributable to the project, with evaluation of impacts on fauna occurring on the affected habitat types.	Project design modifications to reduce clearing impacts on sensitive areas.	EPA Position Statement No.3, EPA Guidance Statement No. 56
			Loss of mangroves and effects on fauna endemic to this habitat	Complete field surveys to document representation of mangrove dependent bird guilds and mangrove dependent bat species. Assess local and regional scales of habitat loss.	Project design modifications and other measures to minimise loss of mangrove habitats and effects on associated fauna.	
			• Local reduction in extent of intertidal mudflats • habitat creation as a result of pond construction and operation	Carry out field surveys to assess local and regional significance of intertidal flats for migratory birds (including *EPBC Act 1999* requirements) and analyse the potential regional impact on fauna species.	Construction of the shallow salt field ponds will provide new local habitat for waders.	
			Isolation of fauna populations on chenier (mudflat) islands	Fauna survey of chenier islands to document fauna communities, threatened taxa and potential short-range endemics. Identification of species or communities of conservation significance.	In situ management and monitoring if necessary.	
			Increased access for introduced fauna between mudflat islands	Assessment of current levels of introduced fauna on mudflat islands during fauna survey. Review of design to identify potentially affected islands.	Baiting and other control measures post-construction	
Subterranean	To maintain the	Water supply,	Modifications to groundwater levels	Complete desktop review of potential	Review water supply strategy, project	EPA Guidance

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
Fauna	abundance, diversity, geographic distribution and productivity of subterranean fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	wash plant and port site construction, flooding of concentration and crystalliser ponds	or salinity, dewatering, direct removal of subterranean habitat	presence of subterranean fauna (based on existing records, geotechnical / hydrogeological investigations and consultation with specialists). Carry out sampling where access to the subterranean environment is possible and where the desktop review suggests any potential for fauna being present. Identify potential impacts on this fauna if present.	design modifications to minimise impacts to subterranean fauna if present.	Statement No. 54
Terrestrial Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at the species, community and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Access roads, concentration and crystalliser pond bund wall materials sourcing areas, washplant, stockpile and port area	Clearing for project infrastructure	Field surveys of project area to document and map vegetation types and flora species present. Identification of any Threatened or priority flora, unusual or poorly known taxa, or restricted vegetation types (including Threatened Ecological Communities (TECs). Evaluation of the local and regional conservation significance of the species and vegetation types present, including geographical limits. Spatial analysis of clearing areas to quantify loss of vegetation types and identify impacts on Threatened or priority flora or TECs.	Modification of project design to avoid, minimise, offset impacts from clearing on flora and vegetation, including threatened flora, restricted vegetation types of flora at geographical limits. Clearing control procedures to be implemented during construction.	EPA Position Statements No.3 and No. 9. EPA Guidance Statement No. 51
			Weed introduction and spread	Field survey to document the existing extent and occurrence of introduced flora in the project area, including the species present and their biology.	Development of weed management and hygiene plan for the construction of the salt field. Ongoing weed control programme to be implemented during operations.	
			Vegetation loss on chenier islands due to saline groundwater intrusion, margin erosion and salt deposition.	Collect elevation data on all chenier islands situated inside the salt field. Complete a spatial analysis relating to existing ground levels to future pond heights to identify areas that may be affected by saline groundwater rise. The outcomes of this analysis will be combined with vegetation mapping to quantify potential loss of vegetation.	Monitoring of vegetation change during operation with rehabilitation or other management initiatives where feasible.	
			General construction impacts such as dust generation, fire risk and other issues.	Document all construction techniques and work methods to enable potential impact mechanisms to be identified.	Construction Environmental Management Plan (EMP) to address general construction phase impacts.	
Marine Biophysical						
Hydrodynamics and coastal	To maintain the integrity and stability	Concentrator and	Potential impacts and issues associated with the development	Obtain bathymetric, topographic, wind and tidal data to validate a	The project will be designed such that impact on sediment transport processes is	ANZECC/ARMCANZ 2000. Australian and

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
processes	of the coast and tidal creeks. To maintain the integrity of intertidal flows.	Crystalliser ponds, bund walls, pump stations, port facilities, dredging and other marine works.	include: • changes to local coastline; • modification of tidal inundation patterns; • increased residence times of barge harbour; • changes to nearshore currents; and • containment and flooding of significant sections of the saline mudflats within ponds	hydrodynamic model of the Gulf, with emphasis on the project area. Use a valid hydrodynamic model in combination with habitat mapping work to examine the mechanisms controlling mangrove and algal mat distribution and assess the potential impact of the project on these habitats. Describe storm surge sea levels, which will dictate the bund design, which in turn will dictate the amount of amour and fill material to be sourced. Determine the best location for a barge channel and barge safe haven in order to minimise impacts on coastal processes and minimise the requirement for maintenance dredging. Assess potential impacts on sediment movement by coastal infrastructure. Assess potential impacts on sediment deposition zones and corresponding risk of impacts on mangroves. Assess potential impacts of long-term sea level change. Assess the potential impacts on the functionality of the wetland and the significance of any changes.	either avoided or minimised. Strategies will include the Development of a Coastal Management Plan to address: • Shoreline and creek change monitoring; • Shoreline and creek protection; and • Contingency for impacts.	New Zealand Guidelines for Fresh and Marine Water Quality. EPA Position Statements No.9.
Sub-tidal Flora (seagrasses, corals and algae)	To maintain the ecological function, abundance, species diversity and geographic distribution of seagrass and algal communities. To protect habitat important to *EPBC Act 1999* listed threatened and migratory species. To meet the EPA's objectives with respect to Guidance Statement No. 29: Benthic Primary Producer Habitat Protection for Western	Dredging, desalination and bitterns discharge, shipping.	Potential impacts and issues associated with the development include: • Direct/indirect loss of benthic primary producer habitat; • smothering and shading from turbidity plumes; • bitterns and desalination flows; and • introduction of foreign marine organisms.	Characterisation and mapping of the marine community in the vicinity of planned marine structures, dredged and dredge spoil disposal areas and bitterns disposal areas, and place these areas in context with the broader habitat of the east coast of Exmouth Gulf. Use mapping and a valid hydrodynamic model to assess the best options for management and monitoring of dredging plume impacts. Results of benthic habitat mapping, hydrodynamic modelling and other relevant work will be used to inform assessments of the best, most probable and worst case temporal and spatial	The project will be designed to avoid, where possible, the direct loss of benthic primary producer habitat. Procedures and criteria will be developed to ensure that there are no long-term adverse impacts on benthic habitat due to construction, dredging and operations. Design desalination and bitterns discharge schemes to ensure no loss of habitat results. Implement an appropriate benthic habitat monitoring program to measure compliance. Implement appropriate quarantine management procedures.	EPA Guidance Statement No. 29 EPA Position Statement No. 9 ANZECC/ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (November 2002)

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	Australia's Marine Environment			scale of direct and indirect impacts on BPPH in a management unit. Use mapping and a valid hydrodynamic model to assess the best options for dispersal of bitterns and desalination flows with particular regard to corals, seagrass habitat, prawn nurseries, mangroves and aquaculture facilities. Assess the risk of foreign species introduction and develop an appropriate benthic habitat monitoring program to measure compliance. Develop appropriate quarantine management procedures.		
Water and Sediment Quality	Maintain or improve marine water and sediment quality to protect the sediment and water quality guidelines documented in Australian and New Zealand Water Quality Guidelines (ANZECC 2000).	Construction, dredging, salt loading desalination, bitterns discharge, barging and shipping, harbour operations, bund walls.	Potential impacts and issues associated with the development include: • turbid plumes; • release of contaminants from ships and barges; • Tributyltins (TBT) and anti-foulants • turbidity from spillage during loading; • effects of bitterns; • reduced water quality within the barge harbour; and • changes to nutrient related water quality if nutrient flows from the land to the Gulf are interrupted.	Characterise existing water and sediment quality. Assess impacts of construction and operations of desalination intakes if a desalination plant is to be utilised to supply freshwater. Assess means to avoid, recycle and reduce bitterns discharge. If bitterns discharge is required, assess likely characteristics and ecological toxicity. Use a valid hydrodynamic model to assess the best options for dispersal of bitterns with particular regard to seagrass habitat, prawn nurseries, mangroves and aquaculture facilities. Use a valid hydrodynamic model to assess the likely flushing times of the barge harbour and associated impacts on water quality. Assess potential transient and long-term impacts on water and sediment quality, with emphasis on turbidity, anti-foulants, bitterns discharge, harbour water quality and nutrient related impacts. Examine the key sources of nutrients to the Gulf and the potential impacts of the project on these nutrient flows, and the likely extent to which any effects on nutrient flows may be propagated within the Gulf. Provide comment on potential linkages with the Ningaloo system.	Design and manage the project such that long-term water quality in the area is maintained in accordance with the EPA's objectives. This will include optimising the harbour design and designing and implementing appropriate water and sediment quality monitoring programs. Examine means to avoid, recycle and minimise the impacts of bitterns discharge. Locate the bunds so that potential impacts on nutrient exchange between the land and the Gulf are minimised.	Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (November 2002)
Marine Fauna	To maintain the	Dredging,	Potential impacts associated with	Describe large marine fauna species	Design and manage the project such that	AQIS guidelines for

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
(Humpback Whales, dugongs, turtles)	abundance, species diversity and geographic distribution of marine fauna. To ensure that any impacts on locally significant marine communities are avoided, minimised and/or mitigated. To protect *EPBC Act 1999* listed threatened and migratory species. To protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act 1950.*	desalination and bitterns discharge, barging and shipping, ballast water management, harbour operations, ferry operation	the development include: • habitat loss and modification; • disturbance from light, noise and vibration; • collision or disturbance to fauna from vessel movements; • lethal and sub-lethal effects of contamination associated with anti-foulants and bitterns; • introduction of foreign marine organisms on ships and in ballast water; • increase in refuse and potential scavenging by fauna; • smothering and increased turbidity of the water column associated with sediment plumes; • entrainment of larvae and juveniles in seawater pumps; • changes to patterns of longshore drift and coastal currents; and • brine disposal from desalination plant.	present, the threats that these species face and the risks posed to these species by the proposal. Describe how the proposal is to be managed to minimise or mitigate these risks. Assess the potential impacts on migratory species present. Assess potential impacts on seabirds. Describe infauna of mangrove sediments in key impact areas. Assess risks of introduction of exotic marine organisms and document management and monitoring procedures.	risks to marine fauna are minimised.	ballast water management.
Pollution Management						
Solid and liquid and waste disposal	To ensure that liquid and solid wastes do not adversely affect groundwater or surface water quality or lead to soil contamination.	Washplant and mobile plant operation, stockpile, construction earthworks, shipping and marine operations, bitterns discharge.	Potential impacts associated with the development include: • contamination of soil, and surface, ground and marine waters; and • contamination of marine sediments.	Describe the type and quantities of: • domestic and industrial wastes (e.g. wastewater and workshop wastes); • process wastes (e.g. bitterns and desalination water); and • construction wastes. Assess the environmental threats posed by the wastes identified. Determine appropriate disposal procedures and specify relevant limits and standards.	Design of the project to minimise waste and incorporate environmentally appropriate technologies for waste management. Development of a waste management plan with procedures to ensure appropriate handling, treatment and disposal of wastes and identification of opportunities to avoid, reduce, ameliorate and manage development wastes.	ANZECC/ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance.
Hazards and spills	To ensure hydrocarbons and hazardous materials are handled and stored in a manner that minimises the potential impact on	Washplant and mobile plant operation, barging and shipping operations.	Potential impacts associated with the development include: • discharge of hydrocarbons and other liquid chemicals to the environment.	Describe the types and quantity of hydrocarbons and hazardous materials to be used or stored on-site. Assess the environmental risks posed by these materials and the manner of their storage and use.	Appropriate design to minimise risk of harm from liquid chemical spills. Minimise volume of hydrocarbons stored on-site. Develop robust procedures for	

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	the environment through leaks, spills and emergency situations.			Undertake spill trajectory modelling for representative and credible spill scenarios.	construction and operations. Develop monitoring and spill response procedures.	
Social Surroundings						
Cultural heritage	To avoid or minimise impacts to Aboriginal and non-Indigenous cultural heritage sites. To ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*. To ensure that the proposal complies with the requirements of the *Heritage of Western Australia Act 1990*.	All aspects of the project located on the eastern Gulf.	Inadvertent disturbance of culturally significant sites.	Undertake comprehensive Aboriginal Heritage surveys in consultation with relevant representative groups. Complete a desktop review of non-Indigenous heritage surveys including maritime heritage sites.	Develop a plan highlighting all sites of significance, which will be used to manage potentially impacting activities onsite. Appropriate footprint design to minimise impact to identified sites. Continue the consultative process with relevant representative groups. Comprehensive heritage surveys to be completed prior to any ground disturbing activities being undertaken.	EPA Draft Guidance Statement No. 41: Assessment of Aboriginal Heritage Department of Environment, Interim Industry Guide to Community Involvement, December 2003
Existing fishing and aquaculture operations	To avoid or minimise impacts on commercial and recreational fishing. To avoid or minimise impacts on commercial aquaculture operations. That the proposal does not impact adversely on the Exmouth Gulf fishery.	Shipping and barging operations, bitterns discharge, bund walls.	Potential impacts associated with the development include: • navigation risks posed by increased vessel movements; • loss of nursery habitat; • 'growing out' of fish populations within the concentration ponds; and • possible interruption of nutrient flows to the Gulf.	Describe the current commercial and recreational fishing and aquaculture operations in the Gulf in terms of fishing and aquaculture grounds and periods of activity. Describe the current vessel movements within the Gulf. Describe the current understanding of the key environmental requirements for the fishing and aquaculture industries. Assess potential impacts on existing prawning, pearling and other aquaculture operations in the context of the above.	Consult with fishing and aquaculture groups during the assessment and design process to establish appropriate strategies to minimise impacts. Develop a shipping and navigation management plan in consultation with key stakeholders in the Gulf. Consult with Fisheries (WA) in regard to measurement and management of potential impacts on fish stocks.	
Research	To recognise the opportunity the project will provide for improving the understanding of this significant region.	All aspects of the project located on the eastern Gulf.	The project is located adjacent (or within) to a region of scientific importance.	Actively seek to support research into issues relevant to the proposal. Develop links with Australian research institutions with the aim of determining research capabilities with respect to research priorities for the region.	Use the results of ongoing research in this region to refine management and monitoring during the operations.	
Local community	To maximise social and economic	Construction and operation of the	Although the bulk of the work will be undertaken by state, national and	Establish a stakeholder reference group for the project with social impacts on the	A commitment to integration and consultation with the community of	

Environmental Factor	Environmental Objective	Relevant Project Components	Potential Impacts	Work Required	Potential Management	Applicable Standards
	benefits to the local community. To work with the community to minimise disruption.	salt field.	international companies, this will create significant flow-on opportunities for local businesses and contractors. The operations phase will result in permanent local jobs. It is Straits intention to base these employees permanently in Exmouth. The project will add an important, year-round economic base for the community which currently relies heavily on seasonal work (tourism, aquaculture and fishing).	agenda. Detail the proposed workforce arrangements in terms of employees, housing and transport requirements and the likely impacts on the community. Undertake a Social Impact Assessment to determine potential impacts on the local and regional communities.	Exmouth such that Straits decisions regarding the proposal are aligned with the interests of the community.	

7.0 Acknowledgements

This report was prepared by Garth Humphreys (Biota), Mark Bailey (Oceanica), Doug Blandford (DC Blandford & Associates), and Trevor Naughton and Dave Readett (Straits). This document was improved by comments from Ian LeProvost (URS), Rob Tregonning (Fisheries), Gary Kendrick (UWA) and Ric How (WA Museum)

8.0 References

ANZECC/ARMCANZ (2000a) National Strategy for the Management of Coastal Acid Sulfate Soils

ANZECC/ARMCANZ. (2000b). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Beard, J.S. (1975). Vegetation Survey of Western Australia. 1:100,000 Vegetation Series Mapsheet 5 - Pilbara.

Biota Environmental Sciences (2003). Onslow Solar Salt field Annual Environmental Report. Unpublished report prepared for Onslow Salt Pty Ltd.

Brunskill, G.J., Orpin, A.R., Zagorskis, I., Woolfe, K.J. and Ellison, J. (2001). Geochemistry and particle size of surface sediments of Exmouth Gulf, Northwest Shelf, Australia. Continental Shelf Research 21, 157-201.

DAL Science & Engineering (2004). Standard Operating Procedures. DAL Science and Engineering Pty Ltd, Perth.

Department of Environment (2003). Preparation of acid sulphate soil management plan (ASSMP). Acid Sulphate Soil Guideline Series.

Department of Fisheries (2003). State of the Fisheries Report 2002/2003.

Ellison, J. C. (1999). Impact of Sediment Burial on Mangroves. *Marine Pollution Bulletin*, 37(8-12): 420-426.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1, Summary Report. Environment Australia, November 2000.

Environmental Protection Authority (2001). Guidance statement for protection of tropical arid zone mangroves along the Pilbara coastline, EPA Guidance statement No. 1. EPA, Perth.

Environmental Protection Authority (2003a). Guidance statement for Terrestrial fauna surveys for environmental impact assessment in Western Australia. EPA Guidance statement No. 56. EPA, Perth.

Environmental Protection Authority (2003b). Guidance Statement No. 51: Terrestrial flora and vegetation surveys for Environmental Impact Assessment in Western Australia.

Gordon, D. M. (1988). Disturbance to mangroves in tropical-arid Western Australia: hypersalinity and restricted tidal exchanged as factors leading to mortality. *Journal of Arid Environments*, 15: 117-145.

Johnstone, R.E. (1990). Mangroves and Mangrove Birds of Western Australia. *Rec. West. Aust. Mus. Suppl*. No. 32.

Kangas, M. (2003). Seagrass Monitoring – Exmouth Gulf. Department of Fisheries.

Loneragan NR, Kenyon RA, Crocos PJ, Ward RD, Lehnert S, Haywood MDE, Arnold S, Barnard R, Burford M, Caputi N, Kangas M, Manson F, McCulloch R, Penn JW, Sellars M, Grewe P, Ye Y, Harch B, Bravington M, Toscas P (2003). Developing techniques for enhancing prawn fisheries, with a focus on brown tiger prawns (*Panaeus esculentus*) in Exmouth Gulf. Final Report on FRDC Project 1999/222. CSIRO, Cleveland.

Marine Parks and Reserves Selection Working Group (MPRSWG) ("the Wilson Report") (1994). *A Representative Marine Reserve System for Western Australia*. Department of Conservation and Land Management, Perth.

McCook, L.J., Klumpp, D.W. and McKinnon, A.D. (1995). Seagrass communities in Exmouth Gulf, Western Australia: a preliminary survey. Journal of the Royal Society of Western Australia 78, 81-87.

McKenzie, N.L. and Rolfe, J.K. (1986). Structure of bat guilds in the Kimberley mangroves. *Australia. Journal of Animal Ecology*, 55: 401-420.

McKinnon, A.D and Ayukai, T. (1996). Copepod egg production and food resources in Exmouth Gulf, Western Australia. Marine and Freshwater Research 47: 595-603.

Pedretti, Y. and E.I. Paling (2001). The WA Mangrove Assessment Project. Murdoch University, Perth. (http: http://dseweb.murdoch.edu.au/wamangrove/).

Paling, E.I., A.J. McComb and J.S. Pate (1989). Nitrogen fixation (acetylene reduction) in non-heterocystous cyanobacterial mats from the Dampier Archipelago, Western Australia. *Australian Journal of Marine and Freshwater Research*, 40: 147-153.

Paling, E.I. and A.J. McComb (1994). Cyanobacterial mats: a possible nitrogen source to arid coast mangroves. *International Journal of Ecology and Environmental Science*, 20: 47-54.

Payne, A.L., Mitchell, A.A. and Holman, W.F. (1988). Western Australian Department of Agriculture Technical Bulletin No. 62: An inventory and condition survey of rangelands in the Ashburton River catchment, Western Australia. Commissioned by the Pastoral Appraisal Board, Perth, Western Australia.

Preen, A.R., H. Marsh, I.R. Lawler, R.I.T. Prince and R. Shepard (1997). Distribution and abundance of dugongs, turtles, dolphins and other megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia. *Wildlife Research*, 24:185-208.

Prince, R. I. T. (2001). Aerial survey of the distribution and abundance of dugongs and associated macrovertebrate fauna – Pilbara coastal and offshore region, WA. Completion report by Department of Conservation and Land Management May 2001.

Robertson, A.I. (1991). Plant-animal interactions and the structure and function of tropical mangrove systems. *Aust. J. Ecol*., 16: 433-443.

Robertson, A.I. and N.C. Duke (1987). Mangroves as nursery sites: comparisons of the abundance and species composition of fish and crustaceans in mangroves and other nearshore habitats in tropical Australia. *Mar. Biol*., 96: 193-205.

Saenger p31-54 in: Clough, B. F. (ed.) (1979). *Mangrove Ecosystems in Australia: Structure, function and management*. Australian Institute of Marine Science, Canberra.

Semeniuk, V., J.F. Kenneally & P.G. Wilson (1978). *Mangroves of Western Australia*. Handbook No. 12, Western Australian Naturalists Club, Perth.

Semeniuk, V. (1985). Development of Mangrove habitats along ria coasts in north and north-western Australia. *Vegetatio*, 60: 3-23.

Start, A. N. and McKenzie, N.L. (1992). Conservation values of Islands in Exmouth Gulf: A Preliminary Report. Unpublished internal report - Department of Conservation and Land Management, Perth Western Australia.

Storr, G. M. and T.M.S Hanlon (1980). Herpetofauna of the Exmouth Region, Western Australia. *Records of the Western Australian Museum*, 8(3): 423-439.

Storr, G. M. and G. Harold (1985). Herpetofauna of the Onslow Region, Western Australia. *Records of the Western Australian Museum,* 12(3): 277-291.

Sumner, N.R., P.C. Williamson and B.E. Malseed (2002). A 12-month survey of recreational fishing in the Gascoyne bioregion of Western Australia during 1998-99. Fisheries Research Report 139.

Thackway, R. and Cresswell, I.D. (ed.) (1995). *An Interim Biogeographic Regionalisation for Australia: A framework for setting priorities in the national reserves system cooperative program, Version 4.0*. Australian Nature Conservation Agency, Canberra.

Thom, B.G. (1982). Mangrove Ecology – A Geomorphological Perspective. In: Clough, B.F. (1982) (Ed). *Mangrove Ecosystems in Australia: Structure, Function and Management*. Proceedings of the Australian National Mangrove Workshop. Australian Institute of Marine Science, Canberra.

Van de Graaff, W.J.E., Denman, P.D., Hocking, R.M. and Baxter, J.L. (1980). Yanrey – Ningaloo Western Australia Sheets SF49-12, SF50-9 International Index, 1:250 000 Geological Series – Explanatory Notes. Geological Society of Western Australia, Perth, Western Australia. pp 24.

Van de Graaff, W.J.E., Denman, P.D., Hocking, R.M. (1982). Onslow Western Australia, Sheet SF 50-5 International Index, 1:250 000 Geological Series – Explanatory Notes. Geological Society of Western Australia, Perth, Western Australia. pp 27.

Western Australian Planning Commission (2004). Carnarvon-Ningaloo Coast: Planning for Sustainable Tourism and Land Use. May 2004.

Woodroffe, C.D. and D. Grime (1999). Storm impact and evolution of a mangrove-fringed chenier plain, Shoal Bay, Darwin, Australia. *Marine Geology* 159: 303-321.

9.0 Glossary of Terms and Abbreviations

AHD - Australian Height Datum

AIMS - Australian Institute of Marine Sciences

ASS - Acid Sulphate Soils

Astronomical Tide - Sea level change caused solely by the motion of the sun and moon

Brine - The liquids that contain high concentrations of salt, from which product salt crystals are grown

Bitterns - The highly saline liquor that remains after most of the salt has been deposited from seawater

Borrow pits - Excavations, to provide rock material for levee and road construction

CD - Chart Datum

Concentration ponds - Ponds where water is evaporated from seawater such that the salt concentration is increased

Crystalliser ponds - Ponds where salt is grown under controlled conditions

Crystalliser Levee - Engineered levee structure utilised for the crystalliser ponds

CALM - Department of Conservation and Land Management

DEH - Department of the Environment and Heritage (Federal)

DoE - Department of Environment (State)

DRF - Declared Rare Flora

EMP - Environmental Management Programme

EMS - Environmental Management System

EPA - Environmental Protection Authority (State)

EPBC Act 1999 - *Environment Protection and Biodiversity Conservation Act 1999*

ERMP - Environmental Review and Management Programme

Greenhouse gases - Gases that alter the thermal properties of the atmosphere, to create the 'greenhouse effect'

Gypsum - Calcium sulphate mineral used in plasterboard and cement manufacture

Hydrocarbons - Compounds such as diesel, petrol, greases and oils used in mechanical equipment

IBRA - Interim Biogeographic Regionalisation of Australia

Internal Armour - Graded limestone rock placed on internal surface of Sea Wall levee and Internal Levee

Internal Levee - Engineered levee structure utilised to separate concentrator ponds

Intertidal Zone - The area between the highest and lowest astronomical tides.

ISO 14001 - The International Standards Organisation standard for environmental management systems

MPRSWG - Marine Parks and Reserves Selection Working Group

Mtpa - Million tonnes per annum

NDVI - Normalised Difference Vegetation Index – a means of analysing remote imagery to measure vegetation biomass and health

Pickle Pond - Pond where high-density brine is stored

Potable water - Water suitable for drinking

Salt - Sodium chloride, recovered by crystallisation from solution for use in the manufacture of chemicals and food processing

Salt field – solar salt production facility

Sea Wall Levee - Engineered levee structure utilised to separate concentrator ponds from the sea

Sea Wall Armour - Graded limestone rock placed on Sea Wall Levee surface facing the sea

SG - Specific Gravity

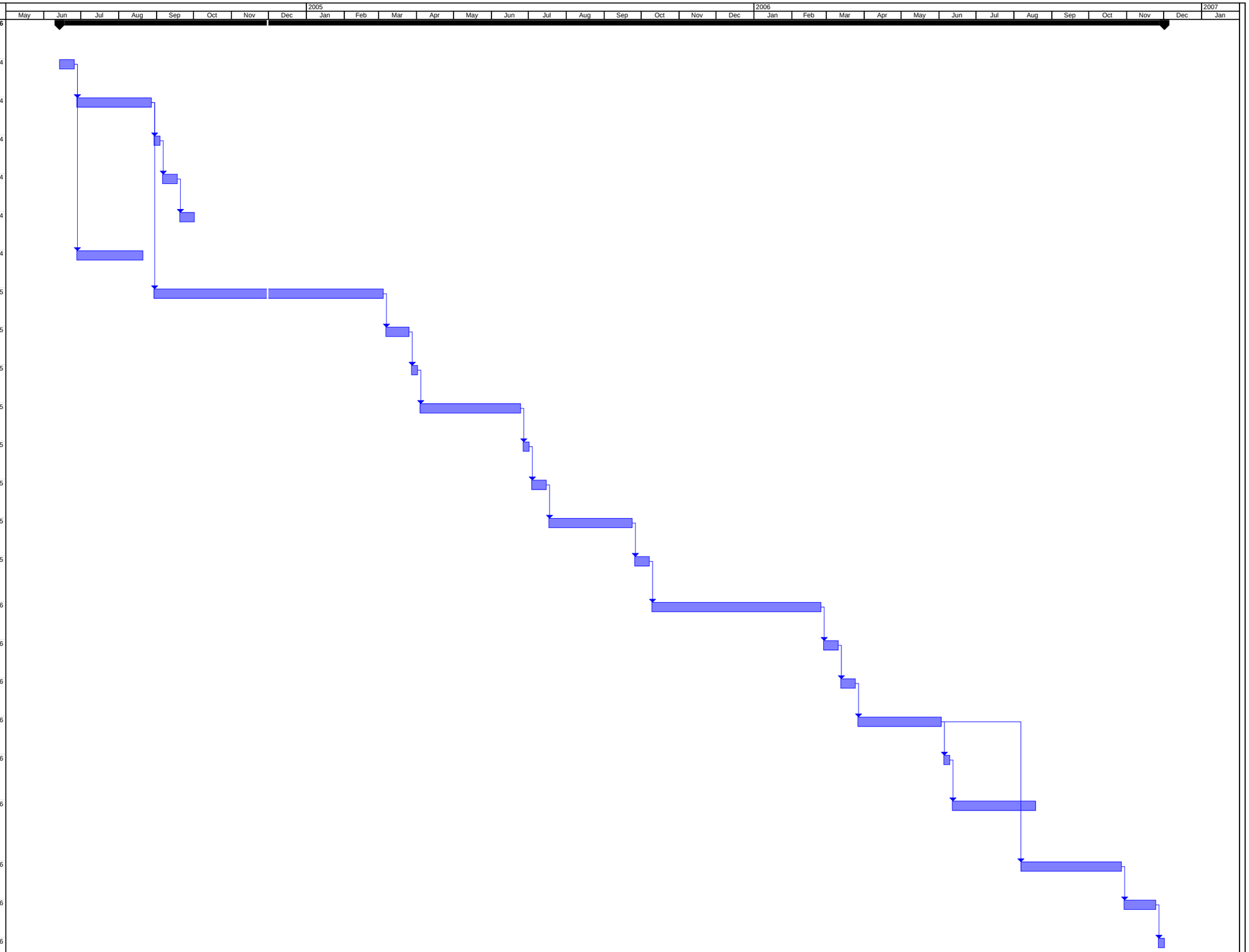
Supratidal Zone - The land area above highest astronomical tide

Wash Plant - Facility for the mechanical washing of salt using sea water or brine as the wash media

Appendix 1

ERMP Environmental Approvals Process Schedule

ID	Task Name	Duration	Start	Finish
1	**ENVIRONMENTAL APPROVALS PROCESS**	**129 wks**	**Mon 14/06/04**	**Fri 1/12/06**
2	Prepare Environmental Scoping Document	2 wks	Mon 14/06/04	Fri 25/06/04
3	Environmental Scoping Document out for comment	9 wks	Mon 28/06/04	Fri 27/08/04
4	Scoping Document published by EPA	1 wk	Mon 30/08/04	Fri 3/09/04
5	Public review of Scoping Document	2 wks	Mon 6/09/04	Fri 17/09/04
6	Submissions reviewed and document updated as required	2 wks	Mon 20/09/04	Fri 1/10/04
7	Referal to DEH - EPBC	8 wks	Mon 28/06/04	Fri 20/08/04
8	ERMP Technical Studies + Draft Report Prepared, submitted to DoE	27 wks	Mon 30/08/04	Fri 4/03/05
9	DoE review of ERMP prior to submission to EPA	3 wks	Mon 7/03/05	Fri 25/03/05
10	EPA sign off of ERMP	1 wk	Mon 28/03/05	Fri 1/04/05
11	Public Review of ERMP	12 wks	Mon 4/04/05	Fri 24/06/05
12	EPA receives and forwards submissions to Straits	1 wk	Mon 27/06/05	Fri 1/07/05
13	Straits consolidates submissions	2 wks	Mon 4/07/05	Fri 15/07/05
14	Straits response to submissions	10 wks	Mon 18/07/05	Fri 23/09/05
15	EPA reviews summary prepared by Straits (common to resubmit document based on EPA comments)	2 wks	Mon 26/09/05	Fri 7/10/05
16	EPA undertakes assessment and reports to the Minister	20 wks	Mon 10/10/05	Fri 24/02/06
17	Minister issues approval with conditions	2 wks	Mon 27/02/06	Fri 10/03/06
18	Appeals period on Bulletin and recommended conditions	2 wks	Mon 13/03/06	Fri 24/03/06
19	Minister considers appeals and issues approval	10 wks	Mon 27/03/06	Fri 2/06/06
20	WA Env Minister sends letter to Env Minister Dept of Environment and Heritage notifying of project approval	1 wk	Mon 5/06/06	Fri 9/06/06
21	Dept of Environment and Heritage review approval conditions and give additional approval	10 wks	Mon 12/06/06	Fri 18/08/06
22	Straits prepares detailed EMPs	12 wks	Mon 7/08/06	Fri 27/10/06
23	Approval of detailed EMPs	4 wks	Mon 30/10/06	Fri 24/11/06
24	DEP issues construction approval	1 wk	Mon 27/11/06	Fri 1/12/06



Appendix 2

ERMP Generic Guidelines

PER/ ERMP GUIDELINES

Environmental Protection Authority

Guidelines for Preparing a Public Environmental Review/ Environmental Review and Management Programme

Contents

These generic guidelines are provided to assist the preparation of the proponent's environmental review document.

Project specific information related to the proposal, environmental factors, impacts, management, consultation and proposed investigations are required to be outlined in the Environmental Scoping document prepared by the proponent (refer to www.epa.wa.gov.au/). The Environmental Scoping document, along with these generic guidelines, comprises the EPA-agreed project guidelines.

The environmental review document must address all elements of the agreed Environmental Scoping document and these guidelines prior to approval being given to commence the public review. Where relevant the environmental review document must also address any requirements of the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (refer to the Department of Environment and Heritage's website at www.deh.gov.au). The Commonwealth may, through bilateral agreements, delegate to the State the responsibility for conducting assessments consistent with the provisions of the agreement.The Environmental Protection Authority (EPA) expects the proponent to fully consult with interested members of the public and relevant stakeholders, and to ensure that any other relevant environmental factors, which may be of interest to the public and stakeholders, are addressed. The environmental review should document the results of all consultation undertaken.

Guidelines for preparing a Public Environmental Review/ Environmental Review and Management Programme

1. Overview

All environmental reviews have the objective of protecting the environment. Environmental impact assessment is deliberately a public process in order to obtain broad ranging advice. The review requires the proponent to:

- describe the proposal;
- describe the receiving environment;
- outline the potential impacts of the proposal on factors of the environment;
- identify the proposed management strategies to ensure those environmental factors are appropriately protected;
- address the principles of environmental protection; and
- demonstrate that the proposal should be judged by the EPA to be environmentally acceptable.

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to design the proposal to improve the protection to the environment. The EPA Service Unit administers the environmental impact assessment process on behalf of the EPA Board.

The primary purpose of the environmental review is to provide information to the EPA on the proposal within the local and regional framework, with the aim of emphasising how the proposal may impact the relevant environmental factors and how those impacts may be mitigated and managed so as to be environmentally acceptable.

How the proponent will outline the environmental setting of the proposal, address environmental principles and issues/factors and their management, and undertake consultation during the preparation of the environmental review are required to be described in the Environmental Scoping document.

To assist proponents, the EPA has published a series of Position Statements and associated Guidance for the Assessment of Environmental Factors which provides an indication of the EPA's views on matters of environmental importance and expectations about how to address specific factors. Proponents should ensure that they are aware of and utilise the information in these documents.

The language used in the body of the environmental review should be kept simple and concise, considering the audience includes non-technical people, and any extensive, technical detail should either be referenced or appended to the environmental review. The environmental review will form the legal basis for the Minister for the Environment's approval of the proposal and therefore the environmental review should include a description of all the main and ancillary components of the proposal.

Information used to reach conclusions should be properly referenced, including personal communications. Such information should not be misleading or presented in a way that could be construed to mislead readers. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

2. Objectives of the environmental review

The objectives of the environmental review are to:

- place this proposal in the context of the local and regional environment;
- adequately describe all components of the proposal, so that the Minister for the Environment can consider approval of a well-defined project;
- provide the basis of the proponent's environmental management program, which shows that the environmental impacts resulting from the proposal, including cumulative impact, are minimised and can be acceptably managed;
- communicate clearly with stakeholders (including the public and government agencies), so that the EPA can obtain informed comment to assist in providing advice to government; and

- provide a document which clearly sets out the reasons why the proposal should be judged by the EPA and the Minister for the Environment to be environmentally acceptable.

3. Preparation of the environmental review document

Proponents are encouraged to maintain close contact with the EPA Service Unit project officer during the preparation of the environmental review. The environmental review should be provided to the EPA Service Unit project officer as a draft for comment. At this stage the document should have all figures produced in the final format and colours.

The proponent and EPA Service Unit project officer/Manager should agree on the time to be taken to review the draft, taking into account the level of consultation during the environmental review preparation, EPA Service Unit project officer's availability, the need for external review and any peer review arranged by the proponent. Revision of the document may be requested to ensure that it addresses all topics and issues in these guidelines, can be read by the educated layperson, contains no significant error of science and meets the required format.

Where the proposal is subject to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the environmental review should also address requirements under that Act. These can be obtained from www.deh.gov.au.

When the EPA is satisfied with the standard of the environmental review document it will provide a written sign-off to the proponent, giving approval to advertise the document for public review. The review document should not be advertised for release before written approval is received.

Following approval to release the review for public comment, the final environmental review document should be provided to the EPA Service Unit project officer in both hard copy and electronic form, including figures.

The EPA encourages proponents to prepare and publish the environment review and appendices in electronic format (CD and/or on the internet), although there remains the requirement for printed copies of the document. This should be discussed with the EPA Service Unit project officer early in the preparation of the environmental review document.

4. Contents of the environmental review document

The environmental review document should include an executive summary, introduction and at least the following:

4.1 The proposal

General requirements

The environmental review document should provide a comprehensive description of the proposal including its location (address and certificate of title details where relevant). Specific matters requiring attention are:

- the identification of the proponent and proposal location;
- justification and objectives for the proposed development;
- the legal framework, including existing zoning and environmental approvals, and decision making authorities and involved agencies; and
- alternatives considered, including location options.

Brief description of the proposal which is the subject of these guidelines

A description of the proposal and location, in sufficient detail to enable readers to clearly understand the nature and scale of the proposal, and to support later discussion of impacts. This should include an outline of the various components of the proposal (including how this proposal relates to other operations or proposals).

The proposal and its location should be indicated on attached plans.

Key characteristics of the proposal

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[1] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

Include a description of the key components of the proposal, including the nature and extent of works proposed. This information must be summarised in the form of a table, an example of which follows:

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	< 5 yrs (continual operation)
Size of ore body	682 000 tonnes (upper limit)
Depth of mine pit	less than 30m
Water table depth	50m below ground surface
Area of disturbance (including access)	100 hectares
Mine operation	Daylight hours only, Monday to Friday
List of major components • pit • waste dump • infrastructure (water supply, roads, etc)	refer 'Plans, specifications, charts' section immediately below for details of map requirements
Ore mining rate • maximum	 • 200 000 tonnes per year
Solid waste materials • maximum	 • 800 000 tonnes per year
Water supply • source • maximum hourly requirement • maximum annual requirement	 • XYZ borefield, ABC aquifer • 180 cubic metres • 1 000 000 cubic metres
Fuel storage capacity and quantity used	50 000 litres; 300 000 litres per year

Plans, specifications, charts

Provide adequately dimensioned plans showing clearly the location and elements of the proposal which are significant from the point of view of environmental protection. Locate and show dimensions (for progressive stages of development, if relevant) of all relevant components of the proposal.

Only those elements of plans, specifications and charts that are significant from the point of view of environmental protection are of relevance here.

Always include:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;

[1] Changes to the key characteristics of the proposal following final approval would require assessment of the change. Depending on the significance of the change, it would be assessed under either s45C if the environmental impacts are not significant, or section 46 or section 38 if the change is significant. Changes to other aspects of the proposal are generally inconsequential and can be implemented without further assessment. It is prudent to consult with the Department of Environment about changes to the proposal.

- a map showing the proposal in the regional context; and, if appropriate,
- a process chart / mass balance diagram showing inputs, outputs and waste streams.

The plan/s should include contours, north arrow, scale bar, legend, grid coordinates, the source of the data, and a title. The dates of any aerial photos should be shown.

Other logistics

- timing and staging of project; and
- ownership and liability for other aspects related to the proposal, such as waste during transport, disposal operations and long-term disposal (where appropriate to the proposal).

4.2 The environment

Provide a description of the existing environment in a local and regional context, with an emphasis on those aspects that may affect or be affected by the proposal, including:

- key ecosystem processes;
- biodiversity;
- existing site condition; and
- other environmental issues that may be constraints or fatal flaws to the proposal.

4.3 Environmental factors and principles

The environmental review should focus on the key or more significant environmental issues and the environmental factors associated with these issues. The EPA has often combined several factors which have clear relationships into environmental issues or broadly interpreted a single factor to encompass a range of related impacts. These may be significant in a local, regional or cumulative context. Where this occurs, it is important that the factors are still identified.

The identification of key issues and relevant environmental factors for the proposal must be incorporated into the proponent's Environmental Scoping document and agreed by the EPA.

The EPA has prepared a *Guide to Preparing an Environmental Scoping Document* and a *Guide to EIA Environmental Principles, Factors and Objectives* to assist proponents of proposals being formally assessed. These guides are available at www.epa.wa.gov.au.

These environmental factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA is required to address relevant environmental factors in its report to the Minister for the Environment.

Reference to relevant Position Statements and demonstration of compliance with associated Guidance for the Assessment of Environmental Factors should be included in the discussion about environmental issues/ factors.

The EPA expects the proponent to fully consult with interested members of the public and take due care in ensuring all other relevant environmental factors, which may be of interest to the public, are addressed.

Additional environmental factors may be identified during the preparation of the environmental review. These should be addressed in the PER/ERMP. On-going consultation with the EPA and other relevant agencies is recommended. The EPA Service Unit can advise on the recommended EPA objective for any new environmental factors raised. Minor matters which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

The EPA will expect to see a discussion of the extent to which best practice will be applied to the proposal and also an explanation of how the principles of environmental protection have been given attention, where appropriate.

Discussion under each environmental issue/factor should include:

- a description of where this factor fits into the broader environmental / ecological context (only if relevant - may not be applicable to all factors);
- a clear definition of the area of assessment for this factor;

- the EPA objective for this factor;
- a description of what is being affected - why this factor is relevant to the proposal and how is it significant;
- a description of how this factor is being affected by the proposal - the predicted extent of impact;
- a straightforward description or explanation of any relevant standards / regulations / policy;
- environmental evaluation - does the proposal apply best practice and does it meet the EPA's objective as defined above;
- if not, what environmental management is proposed to ensure the EPA's objective is met; and
- predicted outcome.

The proponent should provide a summary table of the above information for all environmental factors, under the three categories of biophysical, pollution management and social surroundings as shown in Table 2:

Table 2: Environmental factors and management (example only)

Environ-mental Factor	EPA Objective	Existing environment	Potential impact	Environmental management	Predicted outcome
BIOPHYSICAL					
vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Reserve 34587 contains 45 ha of community type 20b and 34 ha of community type 3b	Proposal avoids all areas of community types 20b and 3b	Surrounding area will be fully rehabilitated following construction	Community types 20b and 3b will remain untouched Area surrounding will be revegetated with seed stock of 20b and 3b community types
POLLUTION MANAGEMENT					
Dust	To ensure that emissions do not adversely affect the environment or health, welfare and amenity of people and nearby land uses by meeting statutory requirements and acceptable standards	Light industrial area - three other dust producing industries in close vicinity Nearest residential area is 800 metres	Proposal may generate dust on two days of each working week.	Dust Control Plan will be implemented	Dust can be managed to meet EPA's objective
SOCIAL SURROUNDINGS					

Visual amenity	To ensure that aesthetic values are considered and that measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.	Area already built-up	This proposal will contribute negligibly to the overall visual amenity of the area	Main building will be in 'forest colours' and screening trees will be planted on road	Proposal will blend well with existing visual amenity and the EPA's objective can be met

4.4 Principles

The proponent should provide a table showing how consideration has been given to the principles of environmental protection, as shown in Table 3:

Table 3: Consideration given to principles (example only)

Principle	**Relevant Yes/No**	**If yes, consideration**
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by – (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk – weighted consequences of various options. (c)	**No**	Investigations required to provide sufficient information to address potential environmental impacts.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	See 3. Information on long-term emissions, greenhouse gas emissions, with respect to Guidance Statement No. 12.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	Flora and fauna surveys to be undertaken. DRF, TECs etc. to be checked. Quantity of vegetation loss.
4. Principles relating to improved valuation, pricing and incentive mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and	No	

abatement. (3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.		
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Yes	To be addressed in EMP.

4.5. Environmental management

The EPA expects the proponent to have in place an environmental management system (EMS) appropriate to the scale and impacts of the proposal, including provisions for performance review and a commitment to continuous improvement.

The system may be integrated with quality and health and safety systems and should include the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation of environmental requirements;
- measurement and evaluation of environmental performance; and
- review and improvement of environmental outcomes.

A brief description of the environmental management system should be included in the environmental review documentation. If appropriate, the documentation can be incorporated into a formal environmental management system (such as AS/NZS ISO 14001). Public accountability should be incorporated into the approach on environmental management.

The environmental management program (EMP) is the key document of an environmental management system. The EMP should provide plans to manage the relevant environmental factors, define the performance objectives, describe the resources to be used, outline the operational procedures and outline the monitoring and reporting procedures which would demonstrate the achievement of the objectives.

4.6. Environmental management commitments

The final stage of the Environmental Impact Assessment (EIA) process is reached when the Minister for the Environment issues the Ministerial Statement for the project, which is a set of legally enforceable conditions and procedures for the implementation of the project. One of the standard procedural conditions is a requirement for the proponent to implement the key commitments which have been made during the EIA process and which the EPA and the proponent wish to become legally enforceable.

A list of the proponent's key commitments will be attached to the Minister's statement, however, it is not compulsory for the proponent to make any legally enforceable commitments. The EPA will recommend conditions to address environmental matters that the implementation of the proposal

should be subject to. The EPA expects proponents to implement all the commitments, which are finalised during the EPA's consideration of the proposal, as part of their commitment to good environmental management.

Commitments that are to be made legally enforceable should not be made lightly and should focus on the important, on-going, high-risk issues that will need a higher level of environmental management in terms of achieving a satisfactory outcome. They would be key components within the proponent's environmental management system and would be subject to both internal (company) and external (regulator) audit processes to ensure both compliance and outcome.

Smaller-scale, generalised, overly-specific and/or non-controversial management actions, objectives and policies that the proponent intends to undertake in implementing the proposal (eg. return 150 mm of topsoil, avoid coral reefs, minimise clearing of vegetation) do not need to be included in the list of legally enforceable commitments.

Ideally, management actions, etc, should be separated from the commitments in the public review document and they would not become specifically legally binding as would the commitments. However, the proponent would still be expected to implement these management actions as part of responsible environmental management as this is what the EPA will base its recommendations of acceptability upon.

It is important to ensure the commitments are auditable and, therefore, proponents are advised to follow a tabular format as explained below.

4.6.1. Commitment components

The commitments need to be framed in a format so that they have clarity and enforceability and, therefore, can be readily implemented by the proponent and audited efficiently by the Department of Environment (DoE). The required standard format for all commitments comprises a number of components as follows:

The proponent will, for a specific topic (environmental issue), undertake an action (**what, how, where)** to meet an environmental objective (**why**) to a time frame (**when)**, and on advice from a relevant advisory agency (**from whom**, eg. government agencies such as Department of CALM, Department of Industry and Resources, Shire Council). With regard to 'advice from whom', this need be included only if the expertise and/or statutory responsibility of the third party is relevant to implementing the commitment.

It is important for the consolidated list of commitments to be numbered correctly for easy reference in the implementation and auditing stages of the project. These should therefore be sequentially numbered 1, 2, 3, ... without use of subgroups such as 1.1, 1.2 or 2(i) or 2(a), 2(b).

Writing the commitment in paragraph form can result in a confusing or clumsy sentence structure that may be difficult to interpret for future auditing purposes. Hence, a paragraph format is not acceptable and a tabular format is required.

4.6.2. Tabular format

It is recommended that the table column headings be titled: 'commitment number', 'topic', 'actions', 'objectives', 'timing' and 'advice from'. The example in paragraph format above can be written in tabular form as per Example 1 below. Note that the tabular format also overcomes the sometimes long-winded sentence structure where there are multiple specific actions for the plan to address. Also, it is desirable to create a separate commitment for the preparation and implementation parts of the commitment. Finally, the tabular format provides an immediate audit framework for use both by the proponent and the DoE, which enables efficient administration of environmental approvals. An example of the three most common formats is given below and Example 4 shows how to rewrite a management strategy into a commitment.

Example 1. Prepare and Implement format

This is the most common format and will apply most of the time where there is an on going need to address the issue.

No.	Topic	Actions	Objectives	Timing	Advice from*
1.	Dust management	Prepare a Dust Control Plan for the foreshore construction site which addresses: 1) prevention of dust generation; 2) prevention of dust emissions off-site; and 3) monitoring and compensatory measures to address accidental emissions off-site.	1) Maintain the amenity of nearby residents. 2) Dust levels at nearest critical premise are within EPA dust control criteria (EPA, 1996).	Design phase (prior to the start of construct-ion)	Shire of Widgie
2.	Dust management	Implement the approved Dust Control Plan referred to in commitment 1.	Achieve the objectives of Commitment 1.	During construction	Shire of Widgie

* this may be left blank if no advisory local or state government agency is relevant; note that the DoE or the EPA or the Minister for the Environment and Heritage are never noted in this column. They are the regulators and the commitments are to their requirements, not advice.

Example 2. Once-off Action format

This format is for actions that have a clear completion time.

No.	Topic	Action	Objectives	Timing	Advice from
3.	Fauna protection	Undertake a trapping programme, approved by CALM, for capturing and relocating the Southern Brown Bandicoots from the area to be cleared.	Relocate the Southern Brown bandicoots to an area and in a manner where the population will be protected	Design (prior to the start of ground disturbance)	CALM

Example 3. Prepare, Implement and Upgrade format

This format is for circumstances when there is a clear need to modify a plan based on a study that is yet to be completed.

No.	Topic	Action	Objectives	Timing	Advice from
4.	Waste Rock Dump	Prepare a Waste Rock Dump Management Plan that: 1) ensures natural drainage is reinstated; 2) identifies rehabilitation options and techniques; 3) achieves a visual quality objective of level 3; 4) etc.	Construct a waste rock dump that: 1) blends with local landscape; 2) is stable in the long-term; and 3) will not produce leachate that would pollute the nearby wetlands.	Prior to the start of construction of the mine	Dept. Industry and Resources

5.	Waste Rock Dump	Implement the WRDM Plan referred to in commitments 4 and 6.	As for commitment 4.	During construction and operations	DOIR
6.	Waste Rock Dump	Modify the WRDM Plan referred to in commitment 4 after the Acid Mine Drainage study referred to in commitment 9 is completed and the study findings approved by the EPA.	Ensure that drainage, including subsurface leachate, does not exceed water quality criteria (NHMRC, 1999).	During operations	DOIR

Example 4. How to rewrite a management action, etc, into a commitment

No.	Topic	Action	Objectives	Timing	Advice from
1.	Waste material	Remove waste material which cannot be accommodated on-site due to potential changes in final design levels to an acceptable landfill. **this is a management action and is rewritten below**	To prevent contaminated material removed from the western part of the site being relocated inconsistent with the final plans for the development.	During remedial works	Shire of Widgie
1.	Excess waste material	Prepare a Waste Material Plan for any excess contaminated material that: 1) identifies the quantity and location of the material; 2) specifies the methods of removal and transport of the material; and 3) identifies the landfill site for disposal and the monitoring methods for the landfill disposal operation.	Ensure that contaminated material that cannot be contained on-site is disposed of at an acceptable landfill site.	During the remedial stage (prior to the validation stage)	Shire of Widgie
2.	Excess waste material	Implement the approved Waste Material Plan referred to in commitment 1.	Achieve the objectives of commitment 1.	After plan is approved by the DoE (during remedial stage)	Shire of Widgie

5. Public consultation

A description of the public participation and consultation activities undertaken by the proponent in preparing the environmental review should be provided. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross-reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the EPA process can be noted and referenced.

6. Conclusion

The environmental review document should indicate the proponent's view of the environmental costs and benefits of the proposal. This should be a synthesis of the preceding relevant information and aim to show how the proposal would achieve an overall net environmental benefit.

When presenting this synthesis, the proponent should note that the proponent's own commercial arrangements and aspects such as employment opportunities, including economic benefits that might accrue as a result of these, are not matters that the EPA can consider in its assessment.

Where relevant, the implications of the adoption in the proposal design and operation of best practicable measures to minimise environmental impacts should be mentioned. Proponents should also note how the proposal addresses the object and Principles set out in s4A of the EP Act.

Proponents are also requested to outline the basis upon which they believe the EPA should conclude that the proposal is environmentally acceptable.

7. Availability of the environmental review

The EPA expects the proponent to provide copies of the PER/ERMP for distribution free of charge to the EPA, EPA Service Unit and relevant government agencies, local government authorities, libraries and other organisations.

As mentioned previously, the EPA encourages copies of the environmental review documentation to be distributed through electronic means (CD or internet), but a number of printed copies will also be required. The specific number of copies required, the type of copy, and the means of distribution, should be agreed with the EPA Service Unit project officer/Manager during the early stages of preparation of the environmental review document.

Example

Supplied to EPA/ EPA Service Unit:	Library/Information Centre	9
	EPA members	6
	Officers of EPA Service Unit	3
Distributed by the proponent to:		
Government departments	Department of Environment	3
	Department of Industry and Resources	2
	Department of Conservation and Land Management	2
	Department of Indigenous Affairs	1
	Office of Major Projects	1
Local government authorities	Shire of Roebourne	2
Libraries	J S Battye Library	3
	The Environment Centre	2
	Shire of Roebourne Library	2
Others	Conservation Council of WA	1
	Nickol Bay Nats	1
	Dampier Pistol Club	1
	Nickol Bay Speedway	1

Available for public viewing

- Department of Environment Library, Perth;
- Department of Environment Library, Karratha;
- Shire of Roebourne Library;
- J S Battye Library, Perth; and
- your website

Attachment 1

The first page of the proponent's environmental review document must be the following invitation to make a submission, with the parts in square brackets amended to apply to each specific proposal. Its purpose is to explain what submissions are used for and to detail why and how to make a submission.

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions emailed to the EPA Service Unit project officer would be most welcome.

[The proponent] proposes [brief description of proposal]. In accordance with the Environmental Protection Act, a [Public / Environmental Review / and Management Programme (PER/ ERMP)] has been prepared which describes this proposal and its likely effects on the environment. The PER/ ERMP is available for a public review period of [4] weeks from [**date**] closing on [**date**].

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER/ ERMP or the specific proposal. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER/ ERMP:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER/ ERMP;
- if you discuss different sections of the PER/ ERMP, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: [date]

Submissions should ideally be emailed to

project.officer@environ.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822
PERTH
WA 6842

OR

Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: [**Project Officer name**]

Attachment 2

Advertising the environmental review

The proponent is responsible for advertising the release and arranging the availability of the environmental review document in accordance with the following guidelines:

Format and content

The EPA should approve the format and content of the advertisement before appearing in the media. For joint State-Commonwealth assessments, the Commonwealth also has to approve the advertisement. The advertisement should be consistent with the attached example.

Note that the EPA Service Unit project officer's name should appear in the advertisement.

Size

The size of the advertisement should be two newspaper columns (about 10 cm) wide by about 14 cm long. Dimensions less than these would be difficult to read.

Location

The approved advertisement should appear in the Saturday or Monday edition of the news section of the main daily paper ("The West Australian"), and in the news section of the main local paper at the commencement of the public review period. For PER's with a review period in excess of 4 weeks and for ERMP's, the same advertisement should appear again two weeks prior to the closure of the public review period.

Timing

Within the guidelines already given, it is the proponent's prerogative to set the time of release, although the EPA Service Unit should be informed. The advertisement should not go out before the report is actually available to the public, or the review period may need to be extended.

Attachment 3 Example of the newspaper advertisement

Proponent Name

Public/ Environmental Review/and Management Programme

TITLE OF PROPOSAL

(Public Review Period: [**date**] to [**date**])

[Proponent] is planning to [brief description of proposal].

A Public Environmental Review (PER)/ Environmental Review and Management Programme (ERMP) has been prepared by the company to examine the environmental effects associated with the proposed development, in accordance with Western Australian Government procedures. The PER/ ERMP describes the proposal, examines the likely environmental effects and the proposed environmental management procedures.

[Proponent] has prepared a project summary which is available free of charge from the company's office address. The PER/ ERMP is available for examination on the following web site – www.xxxxxxxx.com.au.

Copies of the PER/ ERMP may be purchased for [$10] from:

Company Name
Street
Suburb/Town WA Postcode
Telephone: (08) 9xxx xxxx

A CD version of the PER/ ERMP can be obtained from the above address.

Copies of the complete PER/ERMP will be available for examination at:

- Department of Environment
  Library Information Centre
  8th Floor, Westralia Square
  141 St Georges Terrace
  PERTH WA 6000
- Department of Environment
  Regional Office - if appropriate
- Relevant local libraries

Submissions on this proposal are invited by [**closing date**]. Please email your submission to:

project.officer@environ.wa.gov.au

OR address to:

Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842
Attention: [**Project Officer name**]

If you have any questions on how to make a submission, please ring the project officer, [**Project Officer name**], on (08) 9222 7xxx.

Attachment 4 Air quality and air pollution guide:

Modelling Guidance Notes

1 Introduction

The Department of Environment (DoE) is frequently required to review assessments of the air quality impact of existing or proposed sources of air pollutants. This often occurs in the course of individuals or companies (generically called "proponents" below) meeting their obligations under the *Environmental Protection Act 1986* ("the Act"), notably environmental impact assessment under Part IV of the Act or in relation to Works Approvals and Licences under Part V of the Act.

Most air quality assessments employ computer modelling to provide estimates of the environmental (ambient) air quality impact. The quality of modelling efforts reviewed by the DoE/EPA over many years has varied from highly skilled to very inadequate. These guidance notes have been prepared to provide a clear understanding of the DoE's expectations with respect to air quality modelling.

2 Identify emissions and secondary pollutants

The proponent is responsible for identifying and quantifying all emissions to atmosphere with a potential to have a non-trivial impact on the environment (including impact on human health and well-being; odour; nuisance; amenity; vegetation - natural and agricultural; and fauna - natural and agricultural). Emissions of potential concern include SO_2, NO_X, CO, particulates, volatile organic compounds, fluorides, hydrogen sulphide, other odorous gases, heavy metals, dioxins, furans, PAH and other toxic compounds, unless the emission rates of these are insignificant (to be justified). Additionally, the formation and impact of secondary pollutants such as photochemical smog and aerosols should be assessed if applicable. Greenhouse gases and ozone-depleting compounds are beyond the scope of these guidelines.

3 Modelling to predict impacts (overview)

For all primary and secondary pollutants which cannot be dismissed as being of no significance, the proponent must provide model predictions of the impact of emissions on the various elements of the environment, in the form of concentrations and/or rates of deposition over the range of averaging periods normally associated with "relevant standards" for each pollutant, and assess the magnitude of this impact against the "relevant standards". "Relevant standards" means guidelines/goals/standards which the EPA/DoE has adopted or advised or, in the absence of an EPA/DoE position, guidelines/goals/standards proposed by the proponent on the basis of national or international practice and/or field investigations of environmental sensitivity. Data from experiments or justifiable extrapolations from published literature will also be required on the susceptibility of natural vegetation and crops.

Note:
The proponent may choose to carry out "worst case" screening analyses for particular pollutants (eg via simplified, conservative calculations or models) in order to demonstrate to the DoE/EPA that air quality impacts are insignificant and therefore that comprehensive modelling procedures are not warranted. The worst-case analysis procedures (calculations, models) must be adequately described, with reference to their source. Most of the discussion which follows is directed towards full modelling exercises rather than screening analyses. Nevertheless, a screening analysis will be considered inadequate if it ignores any of the features or factors described below which may be potentially significant.

4 Presentation of model results

Modelling results should be presented in the form of:

- contour plots covering the region of interest (including population centres or isolated residences), with a grid density adequate to avoid significant loss of resolution;
- numerical values of concentrations at the point(s) of maximum impact (explain where this occurs) and other locations (receptors) of interest (eg places of human residence).

For each pollutant so modelled, the contours and numerical values should be presented with reference to relevant standards (eg at the averaging period and percentile level of the relevant standard) and the results evaluated against the standard. The meteorological conditions causing highest concentrations at important receptors should be determined (if possible) to check that the model is yielding sensible results.

5 Modelling cumulative impacts

For each pollutant modelled, the assessment must account for existing concentrations caused by other sources plus (if significant) the background concentration (whether natural or man-made) in order to estimate the cumulative concentration. When cumulative concentrations are modelled, the contribution of the proposal to high percentile short-term (say 1-hour) averages is often masked. Consequently, in order for the contribution to be properly assessed, the DoE/EPA requires modelling results (as described in the foregoing point) to be presented for:

- the existing emissions plus background concentration (pre-proposal);
- the proposed development in isolation (excluding existing emissions); and
- the combined (existing plus proposed plus background) emissions.

The "existing emissions" must include not only those of existing, operating sources of emissions but also those expected from yet-to-be-constructed sources which are at a stage of approval, and commitment to proceed, ahead of the proposal. Such sources will need to be identified on a case-by-case basis. Industries proposed for location in Kwinana or other regions with airshed management policies will need to be assessed in accordance with the provisions of those policies; the DoE/EPA will provide details.

6 Emissions estimates

The DoE/EPA requires assurance that the estimates of emissions employed in modelling assessments are realistic and that uncertainty is balanced by conservatism. Details on how the source parameters (stack dimensions, mass emission rates, gas flow rate, temperature, density, etc) were derived should be summarised. This is to include whether these parameters were derived from stack testing (in relation to an existing facility), from theoretical calculations such as from a mass balance approach, from other existing facilities or standard emission factors (eg USEPA AP42). If the emissions are derived from stack testing, details should be given on how many stack tests were taken and how representative these were. Unless otherwise agreed, the level at which emissions should be set for modelling purposes is described in EPA Vic (1985).

7 Variable or intermittent emissions

In the experience of the DoE, intermittent emissions (plant start-ups, plant upsets, etc) result in more pollution complaints than normal emissions from operating industries. The modelling must properly assess both emissions which are continuous in nature and emissions which are intermittent. Intermittent emissions which are insignificant in magnitude and/or very improbable in the lifetime of the plant may be screened out; the remaining emissions should be modelled together on a probabilistic basis to estimate the total plant impact. Screening of emissions cases must be based on the joint consideration of probability and magnitude of emission. The DoE/EPA is able to provide guidance on how to screen and model intermittent emissions.

8 Model capability

The models and/or worst case calculation procedures and data employed in the assessment must be demonstrably capable of simulating, or accounting for, all of the features which are important in the context of determining the air quality impact of the project. The proponent is responsible for identifying and properly accommodating these. The following list may not be exhaustive but is provided for checking purposes:

- trapping of plumes in mixed layers of limited height or, alternatively, penetration of plumes through elevated temperature inversions;
- vertical plume dispersion in convective conditions;

- fumigation of plumes into an encroaching mixed layer or thermal internal boundary layer near a coastline. Investigations of this phenomenon may require estimates of wind direction shear in stable layers;
- sea breeze trapping, recirculation of pollutants;
- near-surface dispersion under very stable calm conditions (a feature of WA winter meteorology);
- topographic influences - impact of plumes on elevated terrain, effect on spatially varying wind fields, valley winds (anabatic and katabatic winds), ponding of air in stable conditions;
- surface roughness;
- building wake effects, stack tip downwash (avoided by good engineering stack design);
- deposition, chemical transformation;
- effects of positive or negative buoyancy;
- radiation from flares.

The modelling report should describe how each of the relevant features was treated. Examples are:

- Physical description of the site to be modelled. This is to include details on the topography, i.e. highest hill/mountain within the model region, distance to coast or any other major water bodies and how this was dealt with in the modelling;
- For a coastal site, details on how sea breeze effects were incorporated in the modelling;
- The value(s) of the roughness length and details on how this was determined (refer to USEPA (1997) for recommended approaches).

9 Meteorological data for conventional models applied to simple situations

If using a conventional model, the proponent will need to obtain at least one (preferably two or more) years' data on the meteorology of the area, with high data recovery and verifiable data accuracy. In the simplest situations, the data may be limited to that necessary to provide reliable hourly average estimates of:

- wind speed;
- wind direction;
- air temperature;
- mixing height, estimated or measured via methods acceptable to the DoE;
- atmospheric stability, estimated by a method acceptable to the DoE.

Methods described in USEPA (1997) are generally acceptable to the DoE. The report should include a description on the meteorological data used or alternatively a reference to a publicly available report which contains this information. The description is to include details on the methodology used to derive stability classes and mixing heights and is to present (as a minimum) the annual wind rose, annual stability frequency distribution and details on the mixing height distribution. The description should also include details on the quality of the anemometer used and its starting threshold.

10 Meteorological data for complex models and/or complex situations

Specialised and detailed meteorological data and associated calculations are necessary to accurately model some of the features listed in point 8. For example, to model shoreline fumigation, knowledge of the onshore-flow vertical temperature structure is required. The proponent is responsible for assessing the full range of pollution dispersion issues and designing an appropriate monitoring program. Where items of data are not based on the results of continuous monitoring (eg. based instead on intermittent field experiments or unverified hypotheses), the uncertainty of estimates must be offset by conservatism in these estimates. The proponent is invited to demonstrate to the DoE/EPA that complicated or costly monitoring programs and/or modelling procedures for particular meteorological parameters are not warranted.

11 Advanced models

The DoE/EPA accepts that advanced prognostic models may be less reliant on measurements than conventional (eg Gaussian) models. These advanced models would need to be well supported by published validation studies before the would accept their use in isolation.

12 Model acceptability and verification

The DoE/EPA does not generally prescribe which models must be used in particular circumstances. The DoE/EPA takes this position in order to allow scientific and technical advances to be introduced without regulatory delays. However the DoE/EPA reserves the right to reject a proposed model, or application thereof, if it considers it to be inadequate, inappropriate or unproven. The AUSPLUME and ISCST3 models are frequently used in an acceptable manner for modelling industrial emissions, but they have limitations which model users should understand and respect.

Unless the DoE/EPA agrees otherwise, proponents are required to present, in addition to model results, all of the model input files and configuration details to allow the DoE/EPA to check and reproduce the model results. Model output which describes the model configuration should also be provided. If the model has not been well validated and documented in the public domain (like AUSPLUME, USEPA regulatory models), references to model validation reports (and provision of these on request) are required.

References

EPA Vic (1985) Plume Calculation Procedure: an approved procedure under Schedule E of State Environment Protection Policy (The Air Environment). Environment Protection Authority of Victoria, March 1985, Publication 210.

USEPA (1997) On-site meteorological program guidance for regulatory modelling applications. U.S. Environmental Protection Agency, June 1997.

Appendix 3

Draft Table of Contents for ERMP

STRAITS SALT PROJECT: DRAFT ERMP TABLE OF CONTENTS

- Weed Invasion and Transport
- Dust and Salt Deposition
- Design and Management Response

Terrestrial Fauna
- Relevant Aspects of the Project
- Habitat Clearing
- Saline Groundwater Intrusion
- Isolation of Island Populations
- Subterranean Fauna
- Feral Fauna Movement
- Vehicle Movement
- Design and Management Response

Coastal Processes and Hydrodynamics
- Pre-existing Impacts
- Relevant Aspects of the Project
- Changes to Sediment Transport
- Storm Surge
- Harbour and Channel Maintenance
- Spoil Disposal
- Design and Management Response

Water Quality
- Pre-existing Impacts
- Relevant Aspects of the Project
- Bitterns Dispersal
- Flushing and Circulation
- Design and Management Response

Mangroves and Algal Mats
- Pre-existing Impacts
- Relevant Aspects of the Project
- Clearing of Mangroves
- Changes to Sediment Transport
- Restriction of Tidal Flushing
- Saline Water Seepage
- Seawater Pumping
- Design and Management Response

Marine Biota and Habitats
- Pre-existing Impacts
- Relevant Aspects of the Project
- Dredging and Turbidity
- Soil Disposal
- Piling
- Bitterns Dispersal
- Ballast Water Discharge
- Oil Spills
- Design and Management Response

Impacts on ecosystem function
- Pre-existing
- Nutrient flows
- Productivity

Marine Fauna
- Pre-existing Impacts
- Relevant Aspects of the Project
- Shipping Impacts
- Reduction in Breeding Success
- Reduction in Foraging Area
- Bitterns Dispersal
- Oil Spills
- Design and Management Response

Other Marine Uses
- Pre-existing Impacts
- Relevant Aspects of the Project

- Aquaculture
- Fisheries
- Ecotourism
- Recreational Use
- Design and Management Response

Heritage
- Relevant Aspects of the Project
- Disturbance of Archaeological Sites
- Disturbance of Ethnographic Sites
- Disturbance of European Heritage Sites
- Design and Management Response

Social
- Relevant Aspects of the Project
- Landscape and Visual Impacts
- Changes to Recreational Amenity
- Workforce Integration and Accommodation
- Public Access and Safety
- Noise and Dust
- Design and Management Response

10. Sustainability
    - Sustainability Strategy
    - Contribution to Economic Development
    - Contribution to Community Development
    - Contribution to Environmental Management

11. Environmental Management Programmes
    - Terrestrial Environmental Management Programmes (EMP)
        - Pre-Construction and Construction EMP
        - Operations Phase EMP
        - Terrestrial Monitoring Programmes
        - Reporting and Review
    - Marine Environmental Management Programmes (EMP's)
        - Pre-Construction and Construction Marine EMP
        - Operations Phase Marine EMP
        - Marine Monitoring Programmes
        - Reporting and Review
    - Health and Safety
    - Annual Environmental Reports (AER's)
    - Care and Maintenance Plan
    - Decommissioning Plan
    - Environmental Management System (EMS)

12. Proponent Commitments

13. References

14 Glossary

Appendices
- Engineering Feasibility Study
- Conceptual site closure report

Appendix 4

Summary of Proposed World Heritage Area Values (Prepared by Angas Hopkins of CALM)

Proposed Solar Salt Production Facility, East Coast of Exmouth Gulf Straits Resources

Mitigation of potential impacts on World Heritage values.

Angas Hopkins
Department of Conservation and Land Management
7 December 2005

1. Background to the assessment of World Heritage values

The World Heritage Consultative Committee, with the support of the World Heritage expert consultant to the Western Australian Government, Dr Warren Nicholls, reviewed all the available information on the natural and cultural values of the Ningaloo/ North West Cape area, and evaluated that information against the criteria for entry of a property on the World Heritage List (see Operational Guidelines as attached). The 10 criteria given in the Operational Guidelines are an elaboration of the fundamental criterion for entry in the World Heritage List; that is, a place has to be …*of outstanding universal value.*

The Consultative Committee found that the suite of values in the Ningaloo/ North West Cape area would allow the area to be nominated under all four natural environment criteria namely:

Sites nominated should:

vii. contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance; or

viii. be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; or

ix. be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; or

x. contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

In addition, properties nominated for inclusion on the World Heritage List must satisfy the conditions of authenticity and/or integrity. These are explicated for each of the World Heritage criteria in the Operational Guidelines.

2. Identified World Heritage values

In the course of assessing values of the area against the World Heritage criteria, the Consultative Committee prepared maps showing the area that would be required to be

included in a nomination made under that criterion. Copies of these maps are included here as Attachment 2.

In essence, the area of interest to Straits Resources for its solar salt production facility is identified as significant under criteria vii (superlative beauty), ix (biological evolution) and v (biodiversity).

The area included under criterion vii is the coastal strip from Giralia Bay northwards to about Locker Point (coinciding with the northern extent of the proposed Marine Protected Area). The identified area extends from the shallow coastal waters inland to the eastward extent of mangroves and samphire flats. This identified area was included because of its wilderness values.

The area included under criterion ix is the whole of Exmouth Gulf and the entire extent of mangroves and associated samphires and algal flats along the east coast of Exmouth Gulf. The identified area includes the entire extent of the proposed Marine Protected Area. This identified area was included because of the roles of these terrestrial and estuarine ecosystems in contributing energy into Exmouth Gulf and Ningaloo Reef systems, and their roles in mediating inputs of sediments and nutrients into the Exmouth Gulf and Ningaloo Reef systems - this is a fundamental requirement to meet conditions of integrity for this criterion. In addition, the shallow marine environments support a range of marine organisms, including marine invertebrates, that demonstrate the complex geological, geomorphic, biogeograhic and evolutionary history of the Ningaloo/ North West Cape/ Exmouth Gulf/ Lake MacLeod area.

The area included under criterion x is the whole of Exmouth Gulf and the entire extent of mangroves and associated samphires and algal flats along the east coast of Exmouth Gulf. The identified area includes the entire extent of the proposed Marine Protected Area. This identified area was included because of the known population outliers of plant and animal species associated with the habitats in this area, and because of the roles of these terrestrial and estuarine ecosystems in contributing energy into Exmouth Gulf and Ningaloo Reef systems, and their roles in mediating inputs of sediments and nutrients into the Exmouth Gulf and Ningaloo Reef systems. In addition, the shallow marine environments associated with the mangrove and near-shore waters provide significant marine habitat, noted as key nursery areas but also important for the specialised biota they support. The shallow waters of Exmouth Gulf also include specialised habitats developed on submerged Pleistocene dune sequences with solitary corals and associated marine biota. These shallow waters support seagrass beds that are feeding grounds for dugong and provide resting and breeding habitats.

The captured delta of the Yanrey River was identified as a possible World Heritage value under criterion vii, illustrating a typical Pilbara-type drainage system overwhelmed by a Pleistocene dunefield . However, a decision was made not to include this feature as additional evidence of the geoevolutionary history of the western margin of the Australian continental plate, because of a lack of supporting information. Limited work on this potential value did draw attention to the existence of freshwater springs at the seaward end of this feature which will probably have biodiversity significance and therefore be a distinctive biodiversity feature under criterion x.

The mangrove, samphire and associated algal flat ecosystems probably have importance seasonally as habitat for migratory wading birds, shorebirds and other

water birds; however, the Consultative Committee was not provided with supporting data for this proposed value and so have not included reference to it in their report.

Copies of the maps showing the preferred boundary for the World Heritage nomination (the Optimal Boundary) and three compromise boundary options resulting from the work of the World Heritage Consultative Committee are at Attachment 3. The boundary option which the Minister for the Environment chose to take to Cabinet for endorsement as the basis for the nomination to be forwarded to the Australian Government is the one shown as Compromise Boundary 3. You will note that all four boundary options include the whole of the area of the proposed Marine Protected Area on the eastern shore of Exmouth Gulf.

3. Protection of the World Heritage values

It is a fundamental requirement of a State Party to the World Heritage Convention that the World Heritage values for which any property is inscribed be protected in perpetuity. This requirement translates to a responsibility of all those agencies involved in planning (including environmental impact assessment) and environmental management for the World Heritage property to ensure that no activity occurs or is permitted to occur that damages, or may damage, the identified World Heritage values.

The Western Australian Government has made the decision to postpone forwarding the draft World Heritage nomination to the Australian Government (as the State Party) to allow further time for consultation with stakeholders and the community. However, the clearly stated intention is that the nomination will proceed for lodgement with the World Heritage Committee by 1 February 2006. If not effected prior to this lodgement date, the Ningaloo/ North West Cape World Heritage property will be inscribed on the National Heritage List at this time. In other words, by 1 February 2006 at the latest, the area and associated values of the Ningaloo/North West Cape World Heritage nomination will be subject to the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth). Therefore, it would be prudent to ensure now that the environmental impact assessment of projects in or adjacent to the identified area do not affect detrimentally the identified World Heritage values.

The identified World Heritage values that must not be adversely impacted by activities in or adjacent to the proposed Ningaloo/ North West Cape World Heritage property are:

- the wilderness values associated with the mangroves, samphires and algal flats, and with the adjacent near-shore environments, along the east coast of Exmouth Gulf;
- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in contributing to the productivity of the marine ecosystems of Exmouth Gulf and Ningaloo Reef;
- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of their roles in controlling the inputs of sediments and nutrients into the marine ecosystems of Exmouth Gulf and Ningaloo Reef;

- the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the presence of population outliers of plant and animal species associated with these habitats;
- the shallow marine environments adjacent to the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf because of the biodiversity they support, including seagrasses, dugong populations, solitary corals, sponge gardens, and marine invertebrates. It should be noted that some of these marine organisms have considerable biogeographic and evolutionary significance and illustrate the complex geological, geomorphological history of the Ningaloo/ North West Cape/ Exmouth Gulf/ Lake MacLeod area.

It should also be noted that additional biodiversity values are postulated but not yet supported by data. These include the biodiversity associated with the seasonal freshwater springs on the seaward end of the Yanrey River delta, and the seasonal populations of migratory waders, shorebirds and other water birds associated with the coastal habitats of the mangrove, samphire and associated algal flat ecosystems along the east coast of Exmouth Gulf. It is highly desirable that the proponents for the solar salt production facility in this area be required to investigate these postulated biodiversity values, and to ensure their protection as if they were already an identified component of the Ningaloo/ North West Cape World Heritage nomination.

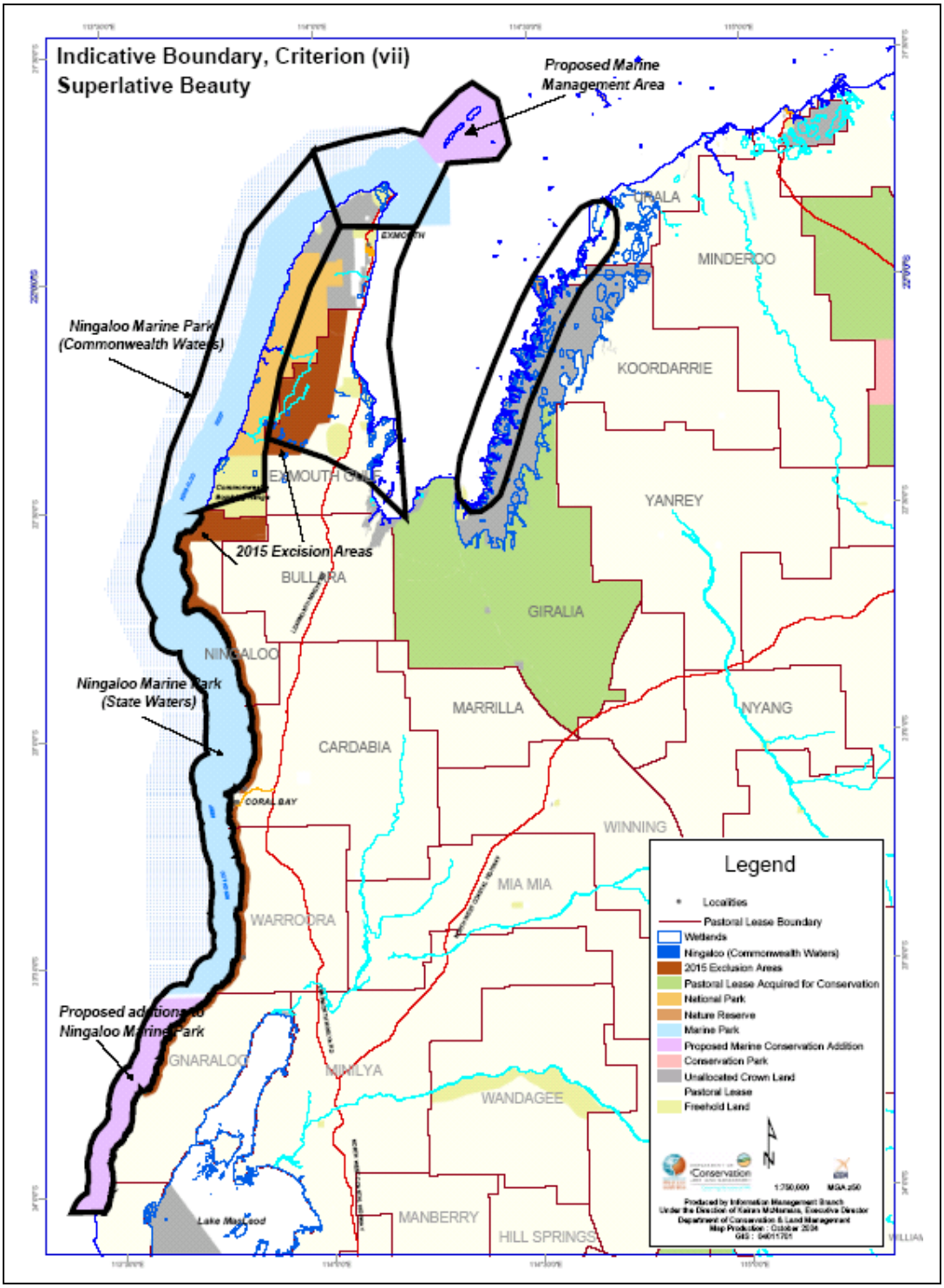
The captured delta of the Yanrey River was identified as a geomorphological value relevant to criterion viii (geoevolutionary history) but was not included in the area proposed for nomination because of a lack of supporting information. This feature warrants further investigation.

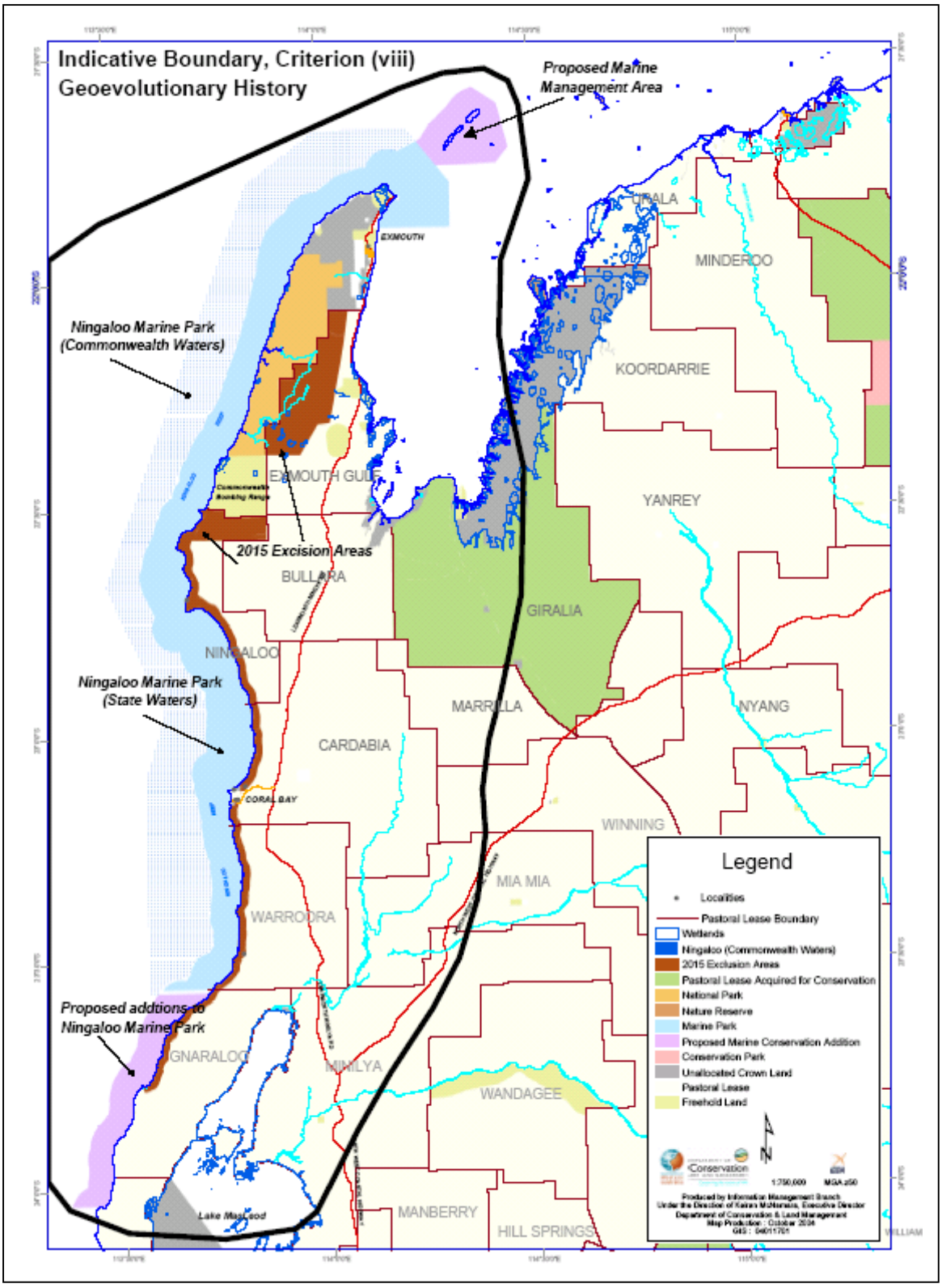
Finally, it should be noted that the total proposal involves production of around 10 million tonnes of salt per annum, other products, the discharge of bitterns and other wastes, and the transport of the products away from the site, which may involve the construction of jetty facilities. The total and cumulative impacts of the proposal should be considered by the EPA at this early stage, otherwise there is a danger of the “death of a thousand cuts” through incremental approvals. The significant values identitied by the World Heritage Consultative Committee within the boundary of the proposed World Heritage property warrant this approach.

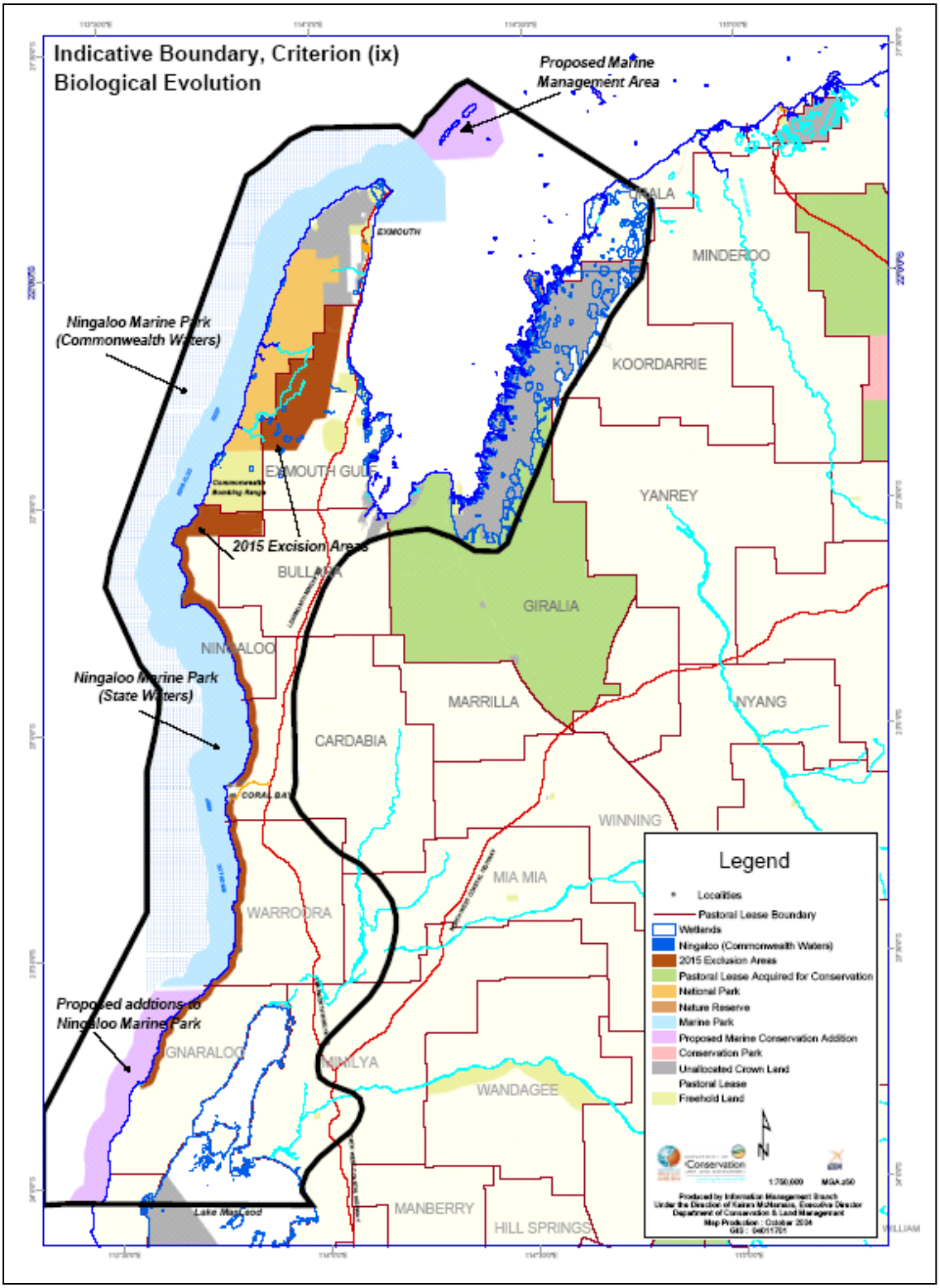
Attachment 1. Operational Guidelines for implementing the World Heritage Convention, effective 1 November 2004.

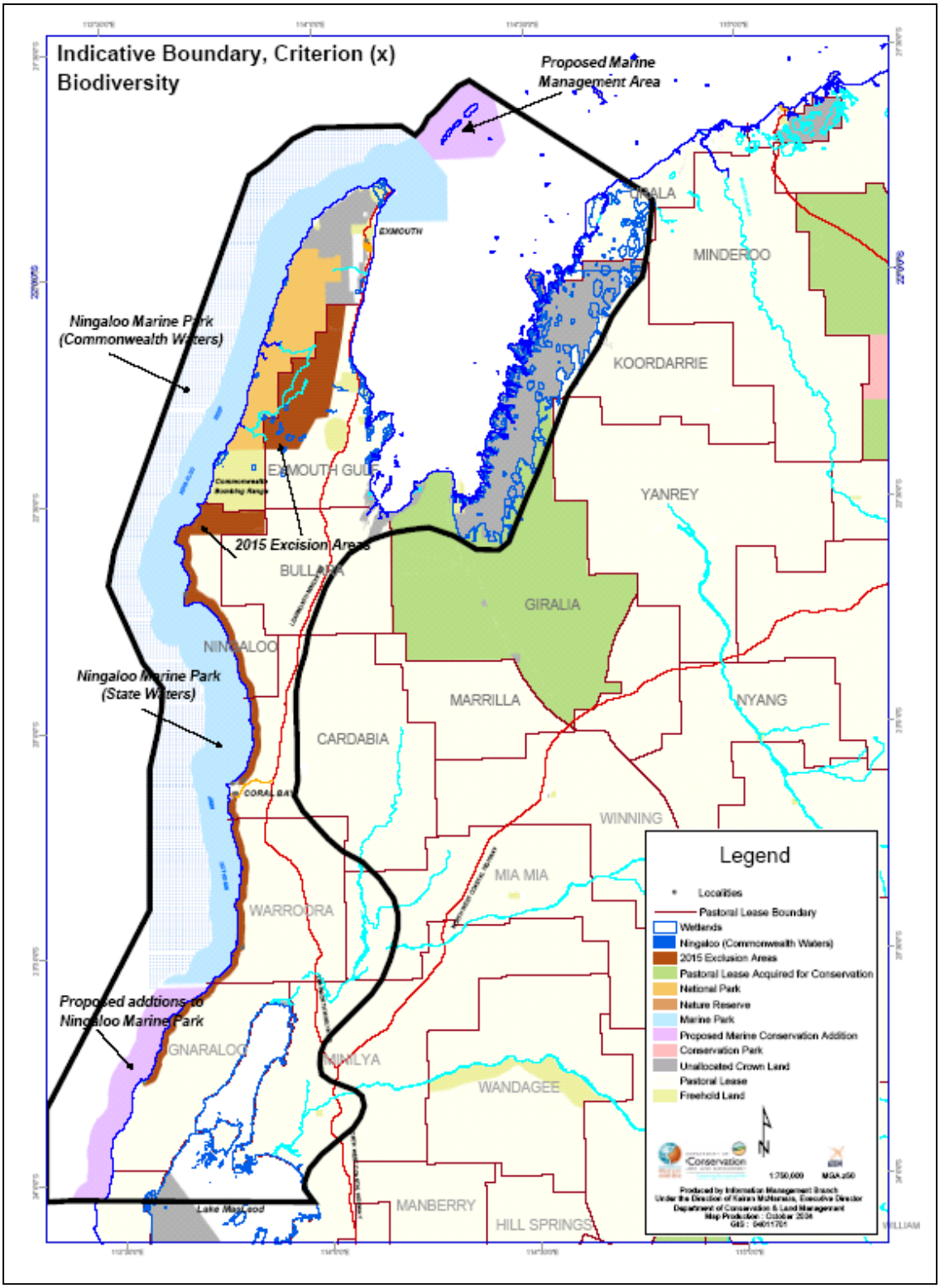
Separate pdf file

Attachment 2. Maps showing indicative boundaries for each of the natural heritage criteria for World Heritage properties.

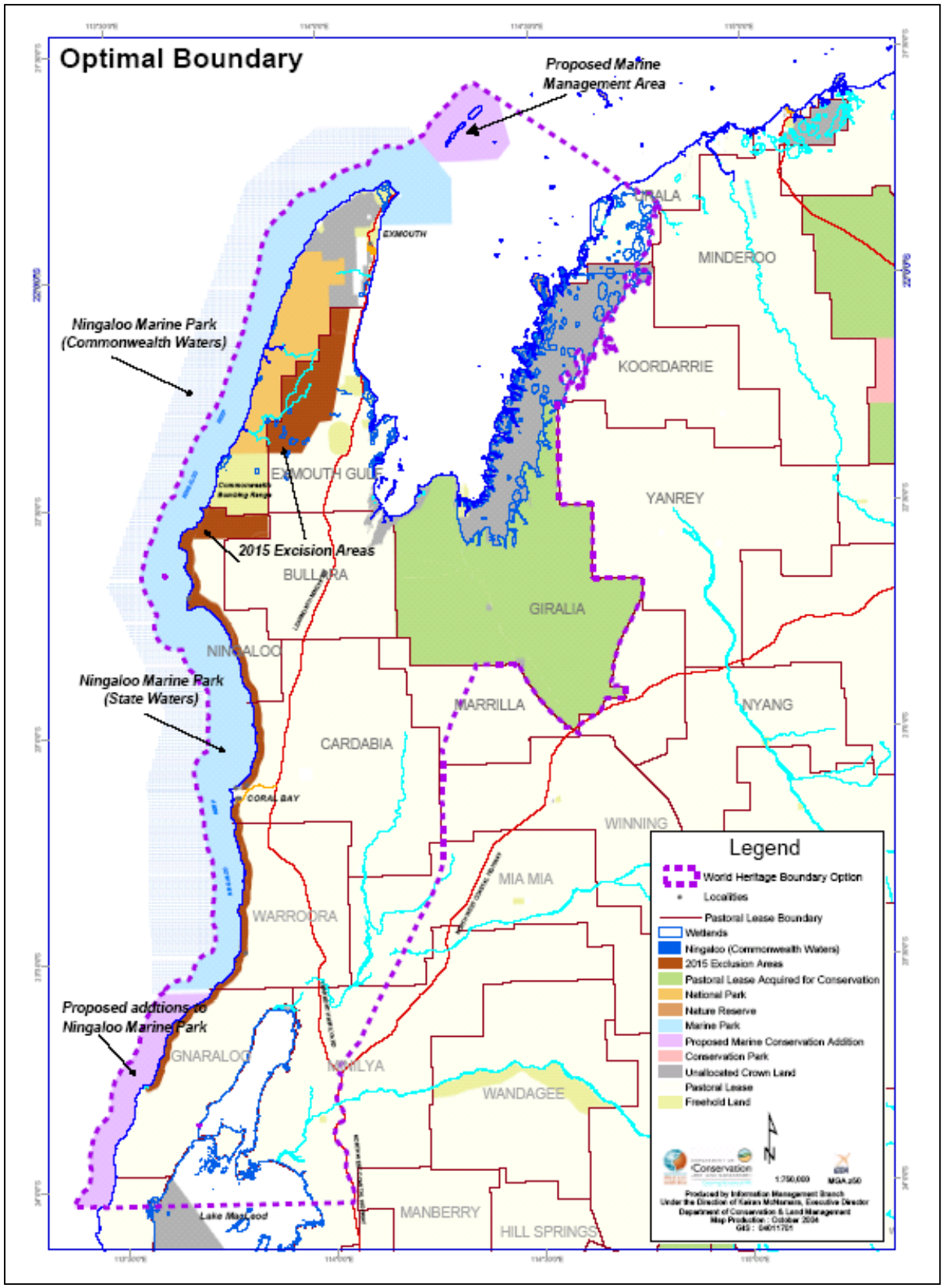


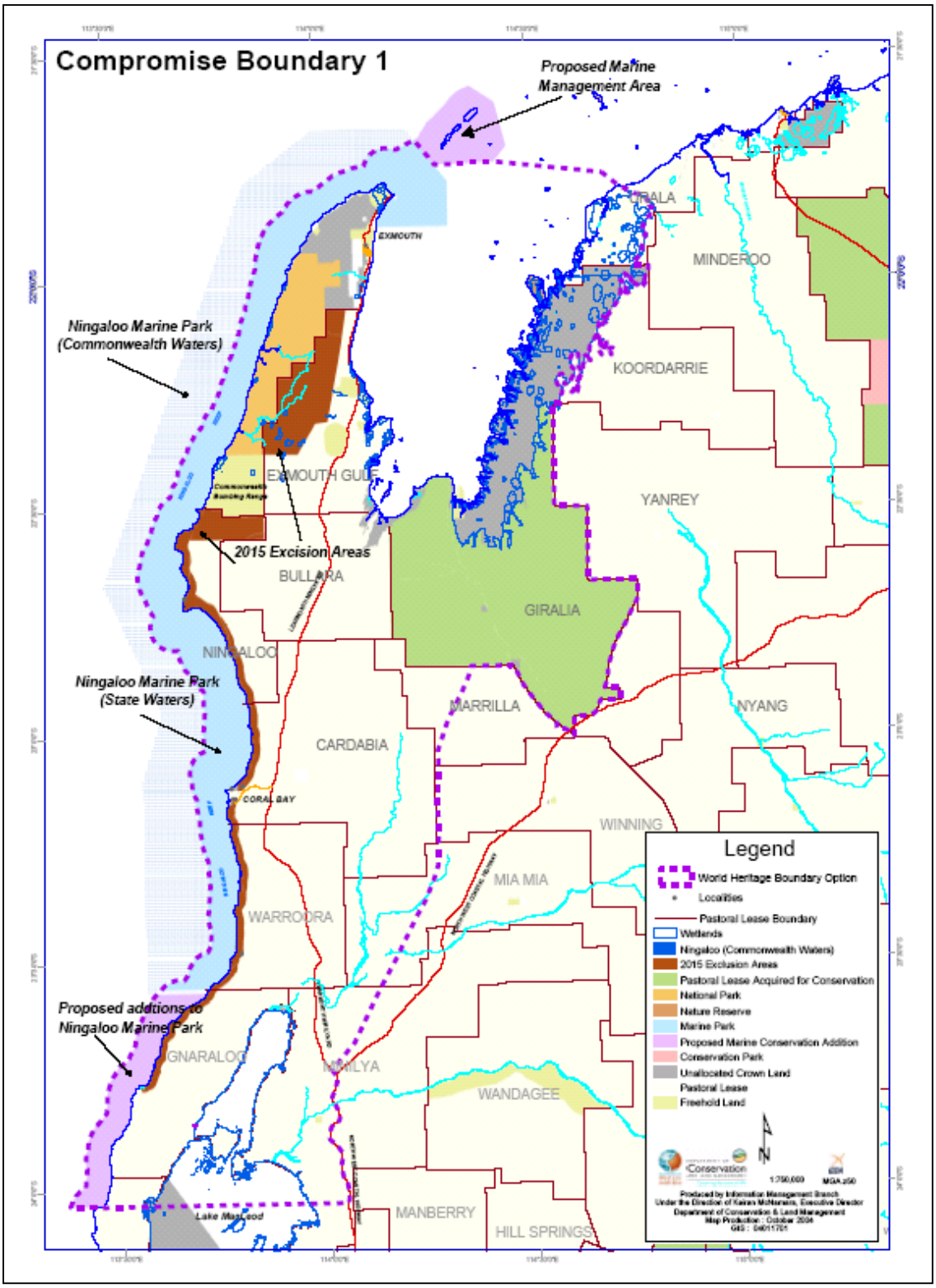

Indicative Boundary, Criterion (viii)
Geoevolutionary History
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
2015 Excision Areas
Ningaloo Marine Park (State Waters)
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
CORAL BAY
Lake MacLeod
UARLA
MINDEROO
KOORDARRIE
YANREY
GIRALIA
BULLARA
NINGALOO
MARRILLA
NYANG
CARDABIA
WINNING
MIA MIA
WARROORA
GNARALOO
MINILYA
WANDAGEE
MANBERRY
HILL SPRINGS
Legend
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land
Conservation
1:750,000
MGA z50
Produced by Information Management Branch
Under the Direction of Kelvin McNamara, Executive Director
Department of Conservation & Land Management
Map Production : October 2004
GIS : 64011701

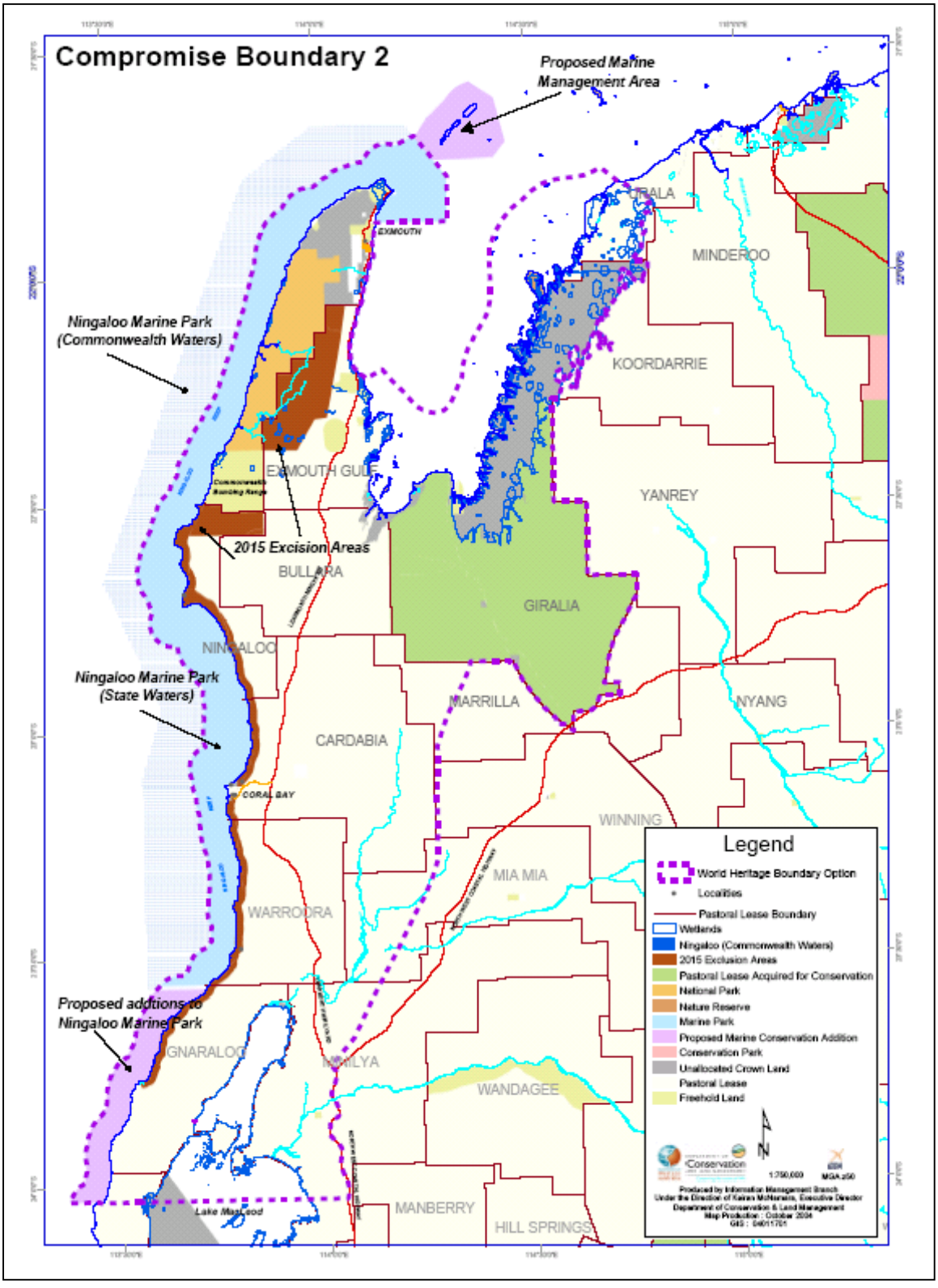

Indicative Boundary, Criterion (ix)
Biological Evolution
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
2015 Excision Areas
Ningaloo Marine Park (State Waters)
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
CORAL BAY
Lake MacLeod
BULLARA
NINGALOO
CARDABIA
MARRILLA
GIRALIA
YANREY
KOORDARRIE
MINDEROO
NYANG
WINNING
MIA MIA
WARROORA
GNARALOO
MINILYA
WANDAGEE
MANBERRY
HILL SPRINGS
Legend
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land
N
1:750,000
MGA z50

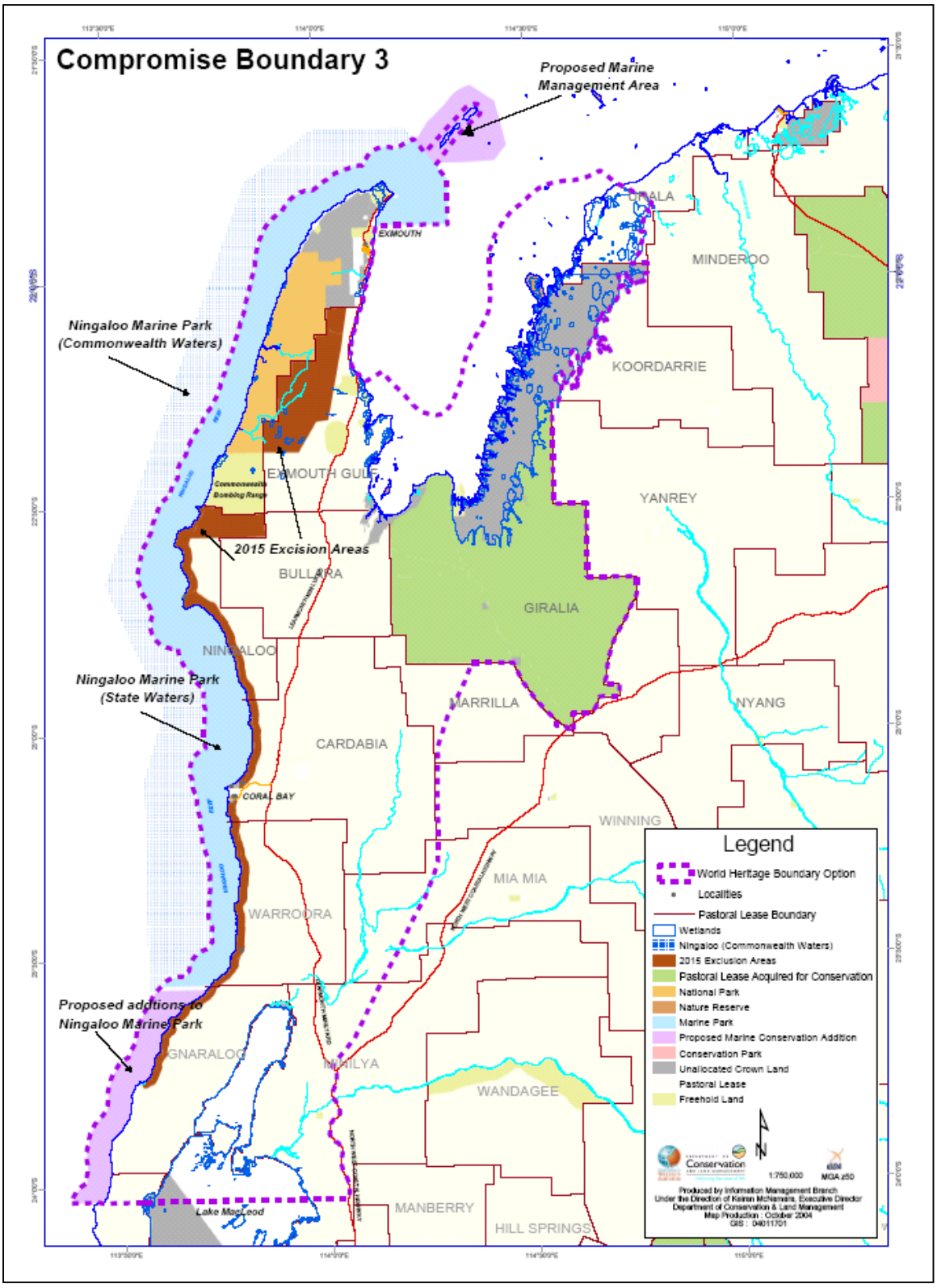

Indicative Boundary, Criterion (x)
Biodiversity
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
2015 Excision Areas
Ningaloo Marine Park (State Waters)
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
BULLARA
NINGALOO
CARDABIA
MARRILLA
GIRALIA
YANREY
KOORDARRIE
MINDEROO
NYANG
WINNING
MIA MIA
WARROORA
WANDAGEE
MANBERRY
HILL SPRINGS
Lake MacLeod
Legend
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land

Attachment 3. Maps of boundary options for the proposed Ningaloo/ North West Cape World Heritage property.




Compromise Boundary 1
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
Ningaloo Marine Park (State Waters)
2015 Excision Areas
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
BULLARA
NINGALOO
CARDABIA
CORAL BAY
MARRILLA
GIRALIA
YANREY
KOORDARRIE
MINDEROO
NYANG
WINNING
MIA MIA
WARROORA
WANDAGEE
MANBERRY
HILL SPRINGS
Lake MacLeod
Legend
World Heritage Boundary Option
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land


Compromise Boundary 2
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
2015 Excision Areas
Ningaloo Marine Park (State Waters)
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
CORAL BAY
Lake MacLeod
OTHALA
MINDEROO
KOORDARRIE
YANREY
BULLARA
GIRALIA
NINGALOO
MARRILLA
NYANG
CARDABIA
WINNING
MIA MIA
WARROORA
WANDAGEE
MANBERRY
HILL SPRINGS
Legend
World Heritage Boundary Option
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land
Conservation
1:750,000
MGA z50
Produced by Information Management Branch
Under the Direction of Karen McNamara, Executive Director
Department of Conservation & Land Management
Map Production : October 2004
GIS : 04011701


Compromise Boundary 3
Proposed Marine Management Area
Ningaloo Marine Park (Commonwealth Waters)
2015 Excision Areas
Ningaloo Marine Park (State Waters)
Proposed additions to Ningaloo Marine Park
EXMOUTH
EXMOUTH GULF
Commonwealth Bombing Range
BULLARA
NINGALOO
CORAL BAY
CARDABIA
WARROORA
GNARALOO
MINILYA
WANDAGEE
MANBERRY
HILL SPRINGS
Lake MacLeod
GIRALIA
MARRILLA
YANREY
KOORDARRIE
MINDEROO
NYANG
WINNING
MIA MIA
Legend
World Heritage Boundary Option
Localities
Pastoral Lease Boundary
Wetlands
Ningaloo (Commonwealth Waters)
2015 Exclusion Areas
Pastoral Lease Acquired for Conservation
National Park
Nature Reserve
Marine Park
Proposed Marine Conservation Addition
Conservation Park
Unallocated Crown Land
Pastoral Lease
Freehold Land
Conservation
1:750,000
GDA
MGA z50
Produced by Information Management Branch
Under the Direction of Keinan McNamara, Executive Director
Department of Conservation & Land Management
Map Production : October 2004
GIS : 04011701