Albany Protected Harbour Development

Environmental Protection Statement

Prepared for
LandCorp
by Strategen

September 2008

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Environmental Protection Statement

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September 2008

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Client: LandCorp

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary Draft Report	V1	LC	CW	1 electronic	20 Sep 06
Draft Report	V2	LC	CW	1 electronic 2 hard copies to the EPASU	16 Nov 06
Draft Report	V4	LC/MC/KH		1 electronic to LandCorp	8 May 07
Final Draft Report	V5	LC/MC/KH	CW/JY	1 electronic 3 hard copies to the EPASU	5 Jun 07
Final Draft Report 2	V6	LC/KH	DEC	1 electronic 2 hard copies to the EPASU 6 hard copes	29 Nov 07 5 Dec 07
Final Draft Report 3	V8	LC/KH		1 electronic 2 hard copies to the EPASU	11 Apr 08
Final Draft Report 4	V9	LC/KH		8 hard copies to the EPA	5 Jun 08
Final Report	V10	LC/KH		Public release	8 Sep 08

EXECUTIVE SUMMARY

1 INTRODUCTION

LandCorp proposes to construct a boat harbour for commercial and recreational craft through the extension of the existing Albany Town Jetty with a breakwater that will effectively shelter a 6.6 ha area of water. The proposal will include construction of boat harbour structures, a breakwater, parking, hardstand areas and boardwalks. The area is currently used for mooring and there are several boat pens along the jetty. The number of boat pens is very limited and the water is not protected from southern storms.

The project is designed to complement the Albany Foreshore Redevelopment Project which will create a tourism and entertainment precinct on the adjacent foreshore area.

1.1 LOCATION

The Protected Harbour Development proposal is located immediately south of the Albany town centre, on the south coast of Western Australia, approximately 420 kilometres south east of Perth. The Protected Harbour is within Princess Royal Harbour and adjoins the Albany Foreshore Redevelopment area.

1.2 ASSESSMENT PROCESS AND EPA ADVICE

This document presents an Environmental Protection Statement (EPS) prepared in accordance with Administrative Procedures for environmental assessment prescribed under the *Environmental Protection Act 1986* (EP Act). The Environmental Protection Authority (EPA) will report on its assessment of this proposal to the Minister for the Environment pursuant to section 44 of the EP Act.

The expedited EPS procedure was considered appropriate due to the amount of community consultation that has been undertaken previously for the project and the high level of understanding of the issues involved. In addition to broad consultation with the community during the Albany Waterfront Structure Plan process, LandCorp has consulted extensively with Government agencies and key non-government organisations as part of the EPS process.

2 DESCRIPTION OF THE PROTECTED HARBOUR DEVELOPMENT

The Protected Harbour Development proposal affects approximately 6.6 ha of water area and includes:

- provision for approximately 130 boat pens (including large pens for charter operators) that will be built in two stages with Stage 1 comprising about 74 boat pens and Stage 2 the remainder
- a total of 3.4 ha of reclamation within Princess Royal Harbour (Figure S1) which includes:
    - reclamation of 0.3 ha to adjacent to the Albany Foreshore Redevelopment area to create a marina edge wall (sea wall and revetment)
    - reclamation of about 0.85 ha for fishing industry hardstand including, a sea wall and revetment, fishing industry wharf, jetty with fuel and sullage pump out facilities
    - construction of two breakwaters with a total footprint of 2.25 ha; one to widen and extend the existing Albany Town Jetty (1.8 ha) and one internal cutoff breakwater (0.45 ha), which will separate the boat harbour from the existing tug boat harbour

- excavation of the harbour area using earthmoving equipment working from a temporary sand platform. Total excavation will include around 15,000 m^3 of sediment over an area of 1.4 ha to give a maximum depth of -2.8 m AHD
- public fishing platform with disabled access
- public boat ramps, rubbish collection and trailer parking.

Material excavated from the harbour will be used in the reclamation and construction of the fishing industry reclamation area. Any material that is found to not meet the geotechnical specifications due to organic matter will be taken to landfill.

The Protected Harbour proposal is adjacent to the Albany Foreshore Redevelopment and they are both parts of the overall Albany Waterfront Development.

The key characteristics of the proposal are shown in Table S1.

Table S1 Key characteristics of the Albany Protected Harbour Project

Aspect	This Proposal
Project timeframe	Construction to commence in 2008 and first stage completed in 2009. Second stage (additional pens) completion depends on demand
Location	Northern edge of Princess Royal Harbour, south of the Albany town centre
Boat harbour	
Capacity	Total of approximately 130 boat pens, with about 74 built in the first stage and the remainder when there is demand.
Boat harbour depth	Excavated to -2.8 m AHD
Protected water area	6.6 ha (excluding the existing Albany Port Authority tug harbour 2.2 ha)
Excavated sediment	About 15,000 m^3
Area excavated outside proposed seawalls	1.4 ha
Disposal of excavated material	Used in land reclamation or if geotechnically unsuitable, it will be taken to a licensed landfill site.
Breakwaters, reclamation on eastern side of breakwater, groyne, fishing industry reclamation	
Location	Refer Figure S1
Total reclamation and breakwaters area	Approximately 3.4 ha
Reclamation area fill material	Excavated material from onsite and imported sand fill from a local licensed sand pit.
Breakwater material	Quarried rock core - granite or ferricrete.
	Quarried granite armour

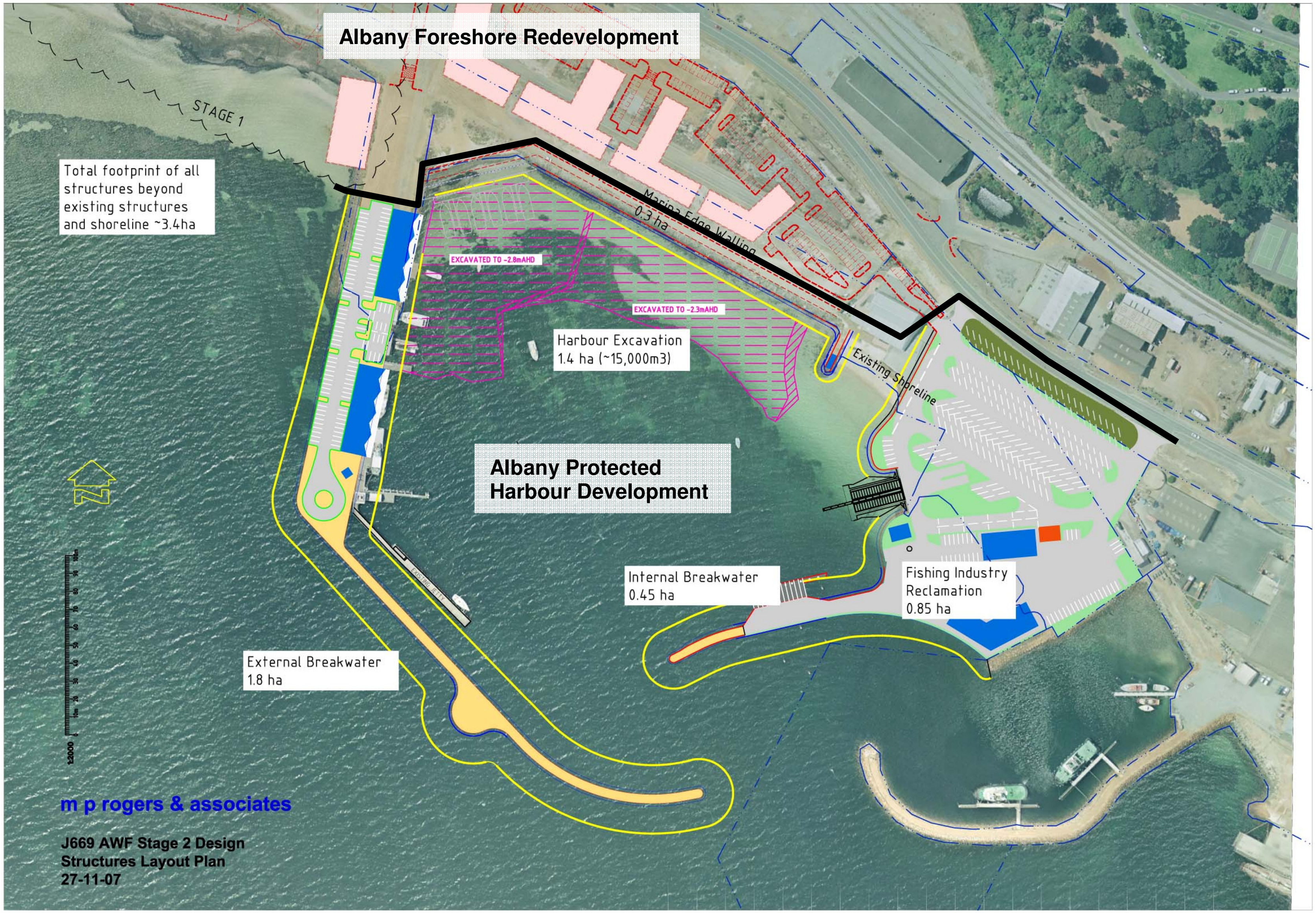

Figure S1 Protected Harbour Development Layout Plan

3 STAKEHOLDER CONSULTATION

There has been extensive consultation with the general public during the development of the Albany Waterfront Project. During the preparation of the EPS, the following groups were consulted directly on potential environmental issues associated with the Albany Protected Harbour Development:

- Department of Environment and Conservation (DEC), Marine Ecosystems Branch
- DEC Environmental Protection Authority Service Unit
- Department of Water (DoW), Albany
- Conservation Council of Western Australia
- Albany Environment Centre.

In addition, a Community Reference Group (CRG) was formed in 2006 to provide community input into the Albany Waterfront Project, including the Protected Harbour Development. The CRG has been involved in the development of the Structure Plan and Precinct Plan, and will continue to be consulted during the environmental assessment and construction phases of the project.

Key issues raised

The main issues raised by stakeholders related to water quality during construction and operation, seagrass loss, heritage values of the Albany Town Jetty, potential contamination in dredge spoil[1] and traffic.

Outcomes of the consultation process

The issues raised by stakeholders have been addressed in this EPS, and specifically, the following studies investigated key areas of concern:

1. **Water quality and sediment quality** sampling and analysis to establish a baseline for monitoring and investigate the potential for contamination in the area to be excavated.
2. **Ecological risk assessment** to determine the potential impacts of contaminants in groundwater, stormwater and sediments on the marine ecosystem.
3. **Circulation and flushing study** to assess the flushing characteristics of the project and determine any impact of the project on circulation patterns in Princess Royal Harbour.
4. **Benthic habitat mapping** to provide up to date information on the extent and density of seagrass meadows in Princess Royal Harbour.
5. **Coastal processes investigation** to determine the processes that influence the small pocket of beach west of the town jetty and predict the impact that the development would have on the beach alignment and stability.
6. **Traffic study** to assess the effect of the project on local traffic volumes.
7. **Archaeological assessment and management plan** to provide expert advice on the protection of maritime archaeological and heritage values of the Albany Town Jetty and surrounds.

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[1] Previous proposals for the area involved dredging and the use of the dredge spoil in the development of a beach to the west of the Albany Town Jetty, this is no longer proposed.

4 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

4.1 KEY ENVIRONMENTAL FACTORS ADDRESSED

The following key environmental factors relevant to this proposal were identified:

- marine water quality during construction and operation
- marine ecosystem
- coastal processes.

Other factors examined were:

- sediment contamination
- dust, noise and odour
- heritage
- traffic.

A summary of the key environmental issues, potential impacts, management and outcomes are provided in Table S2.

4.1.1 Marine water quality

The construction of a solid breakwater to create the Protected Harbour will alter the current water movement in the area and reduce the water exchange within the sheltered harbour area. The reduction in water exchange will cause some reduction in water quality through the reduced dilution of nutrient and contaminant inputs (boats, groundwater and stormwater) and the accumulation of nutrients and contaminants in the sediments of the Protected Harbour.

The Protected Harbour is expected to flush within 3.4 to 6 days throughout the year. Highly conservative calculations indicate chlorophyll a concentrations (indicative of phytoplankton in the water column) within the harbour will be 3 to 4 fold higher than those of outside waters. Environmental Quality Guidelines (EQGs) for chlorophyll a levels outside the Protected Harbour (High Protection Zone) will easily be met and it is likely that there will be no significant impact on the water quality or marine ecosystem of Princess Royal Harbour from the operation of the marina.

EQGs for chlorophyll a for a Moderate Protection Zone will not be met within the proposed marina, but it is anticipated that Environmental Quality standards (EQSs) will be met, indicating that Environmental Quality Objectives (EQOs) will also be met and therefore Environmental Values (EVs) protected[2].

[2] Under the Environmental Quality Management Framework viewed by the DEC as a template for WA's coastal waters, exceedance of EQGs does not mean that EQOs aren't met, but does requires further comparison of data against EQSs to determine whether EQOs are met and therefore EVs are protected.

It is proposed that the following management objectives are appropriate for the project, and are expected to be met by the proposed design:

- maintenance of water quality within the Protected Harbour such that the EVs of 'ecosystem health' (moderate level of protection), 'seafood safe for eating', 'industrial water supply', 'cultural and spiritual' and 'recreation and aesthetics' are protected (this will capture aspects of phytoplankton blooms, water clarity, faecal bacteria, potentially toxic species of phytoplankton and contaminants)
- maintenance of sediment quality within the Protected Harbour to protect the EV of 'ecosystem health' (moderate level of protection)
- maintenance of water quality within the Protected Harbour such that all EVs of 'ecosystem health' (high level of protection), 'seafood safe for eating', 'recreation and aesthetics' are protected in the adjacent waters of Princess Royal Harbour.

During the construction phase, there is the potential for water quality to be affected over the short term, through increased turbidity and possible mobilisation of contaminants in sediments during breakwater construction, reclamation and excavation. Sediment contaminant levels in the area to be excavated meet relevant marine guidelines, indicating a low risk of adverse effects on marine biota from any release of contaminants. Turbidity from breakwater construction will be minimised through quality control of rock and armour to ensure low fines content. Monitoring of adjacent seagrass areas will also be undertaken to enable contingency measures to be put in place if turbidity levels exceed trigger values.

Reclamation will be performed behind constructed sea walls and all excavation will be undertaken within an area surrounded by a silt curtain, which will reduce water quality effects on the harbour.

4.1.2 Marine ecosystem

The construction of the Protected Harbour will cause direct seagrass losses due to the development footprint, and may cause indirect losses of seagrass through the development of a bare sand "halo" (caused be either smothering or erosion from sediment movement) adjacent to the proposed breakwater. Due to the low energy environment of Princess Royal Harbour, bare sand halo's around existing structures are limited, as demonstrated by the presence of dense seagrass meadows within 10 m of the existing jetty. Seagrass growth around the proposed breakwater is likely to be similar.

Estimated seagrass losses are as follows:

- direct loss of 0.111 ha of dense seagrass and 1.259 ha of sparse seagrass (5% cover) within the Protected Harbour due to excavation (predominantly *Posidonia australis*)
- direct loss of 0.053 ha seagrass due to the breakwater footprint (comprising 0.036 ha with a density of 20% and 0.017 ha with a density of less than 15%) (*Posidonia sinuosa*)
- potential indirect loss of up to 0.124 ha due to a "halo" effect, allowing for a 15 m halo around the breakwater. Most of the seagrass within this area has a density of 20% (*Posidonia sinuosa*).

Total anticipated potential losses are 0.111 ha of dense seagrass and 1.436 ha of sparse seagrass (equivalent to approximately 0.259 ha if expressed in terms of 75% cover seagrass).

No seagrass loss is expected from turbidity generated during construction activities; excavation will be a land-based exercise that takes place behind a silt curtain and furthermore will be carried out following construction of the main breakwater, ensuring any turbidity is largely contained within the Protected Harbour. In addition, monitoring and contingencies will be in place to ensure there are no permanent impacts.

No seagrass loss or reduction in seagrass health is expected from the outflow of poorer quality water from the Protected Harbour once it is constructed as the EQSs for seagrass meadows[3] outside of the Protected Harbour are expected to be met (note, it has been assumed that all seagrass meadows within the Protected Harbour will be lost). Monitoring of water quality will be conducted in Princess Royal Harbour to determine the potential for any changes to seagrass health.

Seagrass rehabilitation

All the seagrass loss caused by the Protected Harbour project, both direct and indirect, will be offset by the replanting of 0.4 ha of seagrass in other areas of Princess Royal Harbour at a planting density to achieve 75% average cover, which is more than the area that may be lost in terms of 75% seagrass cover ‘equivalents’. Potential sites for seagrass rehabilitation close to the project area have already been identified. Completion criteria for the successful rehabilitation of seagrass will be developed in conjunction with DoW and DEC.

4.1.3 Coastal processes

The beach west of the Albany Town Jetty is narrow and fairly stable due to the low energy environment. An analysis of aerial photographs from 1957 to 2001 showed that the size and alignment of the beach has remained reasonably constant with a maximum width of around 20 m and a seasonal rotation of approximately 5 to 10 degrees due to changes in winds and currents.

Construction of the breakwater has the potential to alter the magnitude and direction of the longshore sediment transport resulting in an increase in the build up of sand to the west of the Albany Town Jetty and the beach is likely to rotate by approximately 10 to 20 degrees clockwise. This change is not expected to cause any significant change to the environmental or social values in the area as the current beach is not well used for recreation.

4.1.4 Sediment contamination

The Protected Harbour requires excavation of some 15,000 m^3 of sediment and this material will be used to create a 0.85 ha hardstand area around the fishing industry precinct to the east of the Albany Town Jetty. Detailed investigation of the sediment characteristics and contaminant levels at nine sites within the area to be excavated were undertaken to assess potential contamination. Samples were analysed for heavy metals, organics, nutrients, particle size, tributyltin (boat anti-foulant) and acid sulphate soil potential.

Contaminant levels in the sediments to be excavated were found not to exceed the relevant Environmental Investigation Levels (EILs) or Health Investigation Levels (HILs) for use of the material in reclamation. Based on detailed investigations of the characteristics of the sediments to be disturbed, ecological values in the vicinity of the project area are not expected to be affected. Excavated sediment from the project area will be suitable for reclamation from a contamination point

[3] Under the DEC’s proposed Environmental Quality Management Framework for WA coastal waters, there are no EQGs for seagrass health, only EQSs.

of view and no further testing for contamination is required. The level of contaminants in sediments to be excavated presents negligible risk to the marine biota of Princess Royal Harbour in situ or when sediments are disturbed by excavation. Nor will the temporary and highly localised disturbance of sediments that occurs during placement of breakwater material cause any added contaminant burden to the marine biota of Princess Royal Harbour.

4.1.5 Dust, noise and odour

The aspects of the proposal with the potential to generate dust, noise and odour during construction are from movement of construction vehicles, earthworks, dust lift-off from stockpiled material and the disturbance of any anoxic sediment leading to odour emissions.

Approximately 15,000 m^3 of sediment will be excavated to deepen the marina basin and used for reclamation in the fishing industry area. The material to be excavated will be wet and is not expected to be dust prone. In addition, the majority of material is comprised either of fine – medium sands or coarse sands – gravel, with only small percentages of silts and clays.

This excavated material would also not be expected to cause odour problems when exposed to air.

The noise generated during operation of the boat harbour is not expected to be significant as there are no residential areas in proximity to the boat harbour and boat speeds within the boat harbour will be restricted.

Dust and noise will be managed in accordance with a Construction Environmental Management Plan (CEMP) that is being prepared in consultation with DEC and DoW (Appendix 8).

4.1.6 Heritage

The Albany Town Jetty is listed on the State Register of Heritage Places and is the oldest jetty in Western Australia that has been in continuous use. The Albany Town Jetty is significantly altered and little remains of its early heritage. Its significance lies in the remnants that do occur and its continued use. The Protected Harbour Development will construct a breakwater adjacent to the existing jetty structure. Some sections of the Albany Town Jetty are known to be in poor condition and are likely to be removed. The new breakwater alignment has been chosen where possible to avoid the sections of Town Jetty that will be retained.

The Albany Town Jetty has been determined to fall within the jurisdiction delegated to the Western Australian Museum by the Western Australian *Maritime Archaeology Act 1973*. There is the potential for protected archaeological material related to the early settlement of Albany to be located on the seabed or in existing foreshore area.

The construction of the breakwater and excavation of the seabed will be referred to the Heritage Council for consideration under the *Heritage of Western Australia Act 1990* (Heritage Act) and to the Western Australian Museum under the *Maritime Archaeology Act 1973*. An archaeological survey of the areas to be excavated and reclaimed will be undertaken prior to construction to:

- identify any visible artefacts,
- determine appropriate management of any artefacts identified
- determine the potential for disturbance of unknown artefacts during construction
- recommend methods to identify and preserve artefacts during excavation.

These measures and contingencies are being determined in consultation with the Heritage Council and the Western Australian Museum and will be outlined in the Heritage Management Plan prepared by a qualified maritime heritage consultant.

The majority of the earthworks will cover rather than remove seabed material as only a small amount of excavation will occur.

4.1.7 Traffic

A traffic assessment has been conducted to assess the effect of the project on traffic flows in the surrounding area. The Protected Harbour Development will result in a <5% increase in 2006 traffic volumes along Princess Royal Drive and York St and no specific management measures are proposed.

4.2 Environmental Management

The design of the construction program has focussed on ensuring turbid plumes from breakwater construction, excavation, marina edge wall construction and reclamation do not affect sensitive marine habitats (seagrass). Detailed management measures are addressed in the CEMP that has been developed for the proposal in consultation with the DoW and DEC. The CEMP is included in Appendix 8 and includes:

- quality control of rock core materials in breakwaters to reduce the amount of fines
- baseline monitoring of water quality and seagrass health at selected sites
- monitoring of water quality and seagrass health at selected sites during and post-construction
- agreed reporting requirements, management triggers for water quality and seagrass health, and contingency actions if management triggers are exceeded.
- seagrass rehabilitation elsewhere in Princess Royal Harbour.

Ongoing monitoring of water quality, seagrass health, seafood quality and coastal processes will be undertaken to ensure that no unexpected impacts occur as a result of the Protected Harbour. The monitoring will be carried out to ensure that the Ministerial Conditions associated with the project are met.

5 CONCLUSION

The key environmental factors identified by the proponent, Government agencies and other key stakeholders in regard to the development and operation of the Protected Harbour Project were:

1. Marine water quality – Turbidity generated by construction and potential reduced water quality both within the Protected Harbour and in adjacent areas of Princess Royal Harbour, through reduced water exchange in the project area as a result of the breakwater construction.
2. Marine ecosystem – Direct and potential indirect seagrass losses due to the development footprint, 'halo' effects of erosion and smothering around the breakwater and potential for adverse effects on seagrass from construction turbidity. This will be offset by replanting seagrass elsewhere in Princess Royal Harbour.
3. Coastal processes – Erosion and accretion around the harbour structures and the beach to the west of the Albany Town Jetty.

The targeted consultation program indicated that the foremost issue raised by stakeholders regarding this proposal related to marine water quality; primarily affects on marine water quality during and following construction.

5.1 ENVIRONMENTAL COSTS

The environmental costs of the proposal are as follows:

1. Localised, temporary reduction in water quality due to turbidity generated by breakwater and seawall construction, excavation, reclamation and potential construction runoff.
2. Reduction of water quality within the Protected Harbour due to decreased water exchange after breakwater construction.
3. The construction of the Protected Harbour will potentially result in a total loss of around 0.111 ha of dense seagrass and 1.436 ha of sparse (<10% density) seagrass (which is equivalent to 0.259 ha of seagrass meadow with 75% seagrass cover).
4. The alignment of the beach west of the Albany Town Jetty may rotate between 10 to 20 degrees clockwise from the current situation.

5.2 ENVIRONMENTAL BENEFITS

A number of environmental benefits will arise from the implementation of this proposal and continued operation of the Protected Harbour:

1. The project supported a joint study with DoW to map the seagrass extent and density in Princess Royal Harbour in 2006 (based on aerial photography and ground-truthing) showing a recovery in seagrass cover. The last seagrass mapping of Princess Royal Harbour was carried out in 1996.
2. Seagrass rehabilitation will be carried out west of the project area to more than offset any seagrass losses associated with the project.
3. Continued monitoring of water quality in Princess Royal Harbour.
4. The slipway that currently exists in the project area is a potential source of contamination. The slipway will be filled and capped as part of the reclamation for the fishing hardstand/parking area. This will effectively reduce exposure of contamination to the marine environment and contain any historic sediment contamination.

5.3 ENVIRONMENTAL RISKS AND MANAGEABILITY

The approach taken in this environmental review has been based on a risk assessment approach to characterise environmental factors, identify environmental aspects, determine potential impacts and develop mitigation measures.

LandCorp has extensive experience in managing community and land development projects while the Department for Planning and Infrastructure (DPI) has extensive experience managing and designing boat harbours and this experience is anticipated to lead to a greater certainty in achieving desirable environmental outcomes.

The construction environmental aspects of the proposal will be primarily managed through the CEMP and the performance review, which will be prepared in consultation with the relevant agencies. The CEMP sets out the monitoring requirements, triggers and contingencies that will be the basis of the project management during construction (Appendix 8).

Monitoring after construction will be undertaken in accordance with an Operation Environmental Monitoring and Management Plan to determine whether the boat harbour is having the predicted effects and whether a management response is required. The five year performance review will review the water quality within the Protected Harbour and in adjacent Princess Royal Harbour, the performance of the seagrass rehabilitation and any changes to the beach alignment as a result of the development.

Extensive consultation has been undertaken during the development of the project and during the preparation of the EPS in order to scope the environmental issues associated with the project and to determine their significance and the develop of mitigation measures. This process substantially increases the likelihood that all significant environmental issues have been identified, investigated, mitigated and offset as appropriate.

Table S2 Summary of key environmental issues, potential impacts and management

Factor	Preliminary EPA objective	Existing environment	Potential impact	Potential management	Predicted outcomes
Marine water quality	To ensure that emissions do not adversely affect environmental values of Princess Royal Harbour or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards	Princess Royal Harbour is a well mixed waterbody due to tides and wind and the water quality is similar to that of King George Sound. The project area has similar water quality to the rest of Princess Royal Harbour.	Construction of the breakwater, seawall, excavation and reclamation has the potential to increase turbidity and affect nearby seagrass health. Anti-foulants and fuels and sullage spills from boats could affect water quality. Presence of the breakwater will reduce water exchange within the Protected Harbour which could reduce water quality within the harbour and adjacent areas of Princess Royal Harbour.	Breakwaters to be constructed using clean quarried material with low fines content. Excavation to take place behind a silt curtain and reclamation behind seawalls. Excavation and reclamation to take place after the main and cutoff breakwaters are completed, ensuring containment of any turbidity with the Protected Harbour. Monitor water quality throughout the construction period and adapt excavation and seawall and breakwater construction activities in accordance with the Construction Environmental Management Plan (CEMP). Monitor water and sediment quality within and adjacent to the marina in accordance with the Ministerial Conditions.	Construction activities will be managed to reduce impacts on water quality such that there are no long-term adverse effects on seagrass adjacent to the Protected Harbour. Once constructed, the Protected Harbour is expected to flush within acceptable timeframes (3.4 to 6 days) and will be managed to ensure no adverse effect on social and ecological environmental values of the Protected Harbour and the broader waters of Princess Royal Harbour.
Marine ecosystem	To maintain the abundance, diversity, geographic distribution and productivity of seagrass species and the ecological values supported by seagrass.	There have been extensive seagrass losses in Princess Royal Harbour due to historically poor water quality associated with industrial effluent and agricultural runoff. Seagrass health and water quality have improved in response to management and decreased industrial effluent discharge since the early 1990's. Seagrass mapping of the entire Princess Royal Harbour has been undertaken with DEC in 2006 as part of this project. The seagrass in the project area is mostly *Posidonia sinuosa* and *Posidonia australis* with <15% density.	Direct loss of 0.111 ha of dense seagrass and 1.312 ha of sparse seagrass (<10% density). Potential indirect losses due to a 'halo effect' (sediment scour or smothering effects) of up to 0.124 ha of seagrass (<10% density) Turbidity generated from construction activities could cause short-term effects on seagrass health near the project area. Seagrass is an important marine habitat and any loss has the potential to affect marine fauna.	Seagrass losses will be determined by monitoring for two years after construction. Estimated seagrass losses are equivalent to 0.259 ha, if expressed as meadows of 75% cover. This potential loss will be offset through the rehabilitation of 0.4 ha of seagrass planted at a density to achieve 75% cover within 10 years. Rehabilitated areas will be monitored and reported on annually for four years to confirm that survival and growth of rehabilitated seagrass is sufficient to ensure the total seagrass loss is offset within 10 years.	The construction of the Protected Harbour will potentially result in the loss of approximately 0.111 ha of dense seagrass and 1.436 ha of sparse seagrass from direct and indirect impacts. This loss will be offset by rehabilitation of 0.4 ha (greater than the 0.259 ha as 75% cover equivalents lost) in Princess Royal Harbour to ensure no net loss of seagrass in Princess Royal Harbour in the medium to long term. The impact of the project on water quality is not expected to cause any loss of seagrass or reduction in seagrass health, and the implementation of the CEMP will ensure that monitoring criteria and contingencies are in place to address any unexpected impacts. There is not expected to be any significant impact on marine fauna habitat from affects on seagrass.

Factor	Preliminary EPA objective	Existing environment	Potential impact	Potential management	Predicted outcomes
Coastal processes	To maintain the integrity, ecological functions and environmental values of the soil and landform	The project area is in a low energy marine environment. Longshore sediment movement along the beach is currently limited by the Albany Town Jetty and the Princess Royal Drive seawall to the west. Seasonal changes in conditions result in a 5 to 10 degrees rotation of the beach. The beach is narrow, backed by a seawall and is not well used for recreation.	The construction of the breakwater will change the wave energy hitting the beach to the west of the Albany Town Jetty. This is predicted to result in a rotation of the beach alignment 10 to 20 degrees clockwise.	The rotation of the beach is not expected to require management. Changes to the beach alignment as a result of the project will be reviewed during the five year performance review for the project.	The nearshore coastal processes will be altered by the breakwater as an extension of the existing Albany Town Jetty. The change is expected to increase the build up of sand to the west of the Albany Town Jetty and the beach is likely to rotate by approximately 10 to 20 degrees clockwise. This change is not expected to cause any significant change to the environmental or social values in the area.
Sediment contamination	To ensure that disturbance of sediment does not result in the release of contaminants that adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards	15,000 m^3 of sediment needs to be excavated to meet depth requirements for the boat harbour. The material to be excavated is mainly sand. Sediment testing was carried out to determine sediment characteristics and contamination levels. Contaminant levels in the sediment do not exceed any Environmental or Health Investigations Levels applicable for land reclamation, or guidelines for the protection of the marine environment.	Excavation and the use of excavated sediment in reclamation have the potential to affect either environmental or human health through the release of contaminants contained in the marine sediment or through human contact with the excavated sediment. Reclamation has the potential to reduce the release of contaminant from the existing slipway sediments. Breakwater construction has the potential to reduce the release of contaminants from the existing sediments in the breakwater footprints	The reclaimed sediments will be used in the construction of the fishing industry hardstand area and will predominantly be placed under carpark, therefore reducing the potential for human contact. The excavation and reclamation process will be carried out in accordance with the CEMP. Monitoring of contaminant levels in mussels will be undertaken prior to, during and after construction to ensure that disturbance of sediments does not cause elevated levels of contaminants in seafood and that it is safe for human consumption.	Contaminant levels in the sediment to be excavated are such that contaminant-related ecological Environmental Values in the vicinity of the project area will be protected. The EPA objectives to protect environmental values in marine waters and to ensure sediments are of an acceptable standard for the intended land use will be met.

Factor	Preliminary EPA objective	Existing environment	Potential impact	Potential management	Predicted outcomes
Dust, noise and odour	Noise: To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards. Air quality: To ensure that emissions do not affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The main existing sources of noise near the project area are the Albany Port, rail traffic and road traffic along Princess Royal Drive. The Protected Harbour development is outside the Albany Port Noise Buffer Area that was established in 2000. Excavated material used in reclamation will have a low fines content. Odour is sometimes generated by the seagrass wrack currently accumulates to the west of the Albany Town Jetty	Vehicle movements and machinery operation including earth moving machinery, trucks and small vehicles will generate noise. Earthworks, vehicle movement and stockpiled material may generate dust. Excavation may disturb anoxic sediments that cause odour. The accumulation of algal wrack within the marina is anticipated to be low	Dust and noise will be managed according to the CEMP. Odour from the excavation of sediment is not expected to require particular management.	The EPA objectives are expected to be met as there is a low potential for odour, dust and noise that would affect the amenity of nearby residents. Odour is not expected to require management. Dust and noise during construction will be managed according to a CEMP.
Heritage and culture	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	There are no Aboriginal Heritage sites recorded on the Department of Indigenous Affairs Register System within the project area. The Albany Town Jetty is registered as site 3607 on the State Register of Heritage Places and all pre 1900 archaeological material is protected under the *Maritime Archaeology Act 1973*. Little remains of the original jetty structure (pre 1900); however, the original form of the place is discernible despite historic reclamation. The current use of the place, as a jetty to service the Port of Albany, and as a place for recreational purposes, is compatible with the cultural heritage significance of the place	The breakwater will be an extension of the existing Albany Town Jetty which is on the site of the original jetty structure. The construction of the breakwater may potentially affect the heritage values of the jetty. Excavation has the potential to disturb any historical material contained in the seabed.	The extensions and disturbance of the seabed will be referred to the Heritage Council for consideration under the Heritage Act and to the Western Australian Museum under the *Maritime Archaeology Act 1973.* An archaeological assessment and management measures will be developed with the WA Museum prior to construction.	The Albany Town Jetty extension will be undertaken in accordance with the *Heritage of Western Australia Act 1990* and the *Maritime Archaeology Act 1973*.

Factor	Preliminary EPA objective	Existing environment	Potential impact	Potential management	Predicted outcomes
Traffic	To ensure that the increase in traffic resulting from the proposal does not adversely affect social surroundings or increase the risk to local public safety.	The Protected Harbour Development will be directly serviced by Princess Royal Drive which is a key link to York St. Princess Royal Drive is a primary access road leading to the Albany Port, it falls under the control of Main Roads Western Australia and is currently constructed as a wide two-lane boulevard style road.	The project will generate a relatively small amount of traffic within the capability of the local road network.	A pedestrian bridge is being constructed over Princess Royal Drive.	The Protected Harbour Development will result in a <5% increase in 2006 traffic volumes along Princess Royal Drive and York St and no specific management measures are proposed. From a daily traffic flow perspective, local roads can be expected to operate within acceptable levels of service with the full development of the Albany Waterfront Project for the next twenty years.

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1. INTRODUCTION

1.1 PROJECT SUMMARY

The Protected Harbour proposal involves the construction of a boat harbour for commercial and recreational craft through the extension of the existing Albany Town Jetty with a breakwater. This area is currently used for mooring and there are several boat pens along the jetty but numbers are limited and the water is not protected from southern storms.

The proposal is located south of the City of Albany CBD and will consist of construction of harbour structures, a breakwater, parking, hardstand areas and boardwalks.

The Protected Harbour Development proposal affects approximately 6.6 ha of water area and includes:

- provision for approximately 130 boat pens (including large pens for charter operators) that will be built in two stages with Stage 1 comprising about 74 boat pens and Stage 2 the remainder
- a total of 3.4 ha of reclamation within Princess Royal Harbour (Figure 4) which includes:
  - reclamation of 0.3 ha to adjacent to the Albany Foreshore Redevelopment area to create a marina edge wall (sea wall and revetment)
  - reclamation of about 0.85 ha for fishing industry hardstand including, a sea wall and revetment, fishing industry wharf, jetty with fuel and sullage pump out facilities
  - construction of two breakwaters with a total footprint of 2.25 ha; one to widen and extend the existing Albany Town Jetty (1.8 ha) and one internal cutoff breakwater (0.45 ha), which will separate the boat harbour from the existing tug boat harbour
- excavation of the harbour area using earthmoving equipment working from a temporary sand platform. Total excavation will include around 15,000 m^3 of sediment over an area of 1.4 ha to give a maximum depth of -2.8 m AHD
- public fishing platform with disabled access
- public boat ramps, rubbish collection and trailer parking.

Material excavated from the harbour will be used in the reclamation and construction of the fishing industry reclamation area. Any material that is found to not meet the geotechnical specifications due to organic matter will be taken to landfill.

1.2 PROJECT HISTORY AND RELATED APPROVALS

1.2.1 Early project history

The first concept plan for redevelopment of the project area was developed in 1982 in the Frederickstown Redevelopment Project and in 1985 in an Albany Tomorrow Strategy Report. The aims of the study included establishing links between the harbour and the town centre and enhancing the foreshore area (ERM 1995).

In 1989, an Albany Foreshore Development Study was completed that investigated the opportunities and constraints of the area, developed four preliminary development options, which were then made available for public comment. As a result, two revised options were finalised. These options included a boat harbour, land reclamation for residential housing and a hotel complex and realignment of Princess Royal Drive and the railway immediately south of Stirling Terrace.

The outcome of the Albany Foreshore Development Study was that a basic planning concept for redevelopment was adopted by the Great Southern Development Commission (GSDC) and endorsed by the Town Of Albany Council in 1990. By 1993, a set of Detailed Urban Design Guidelines had been accepted for the Albany Foreshore Redevelopment project. This led to the development of the final concept plan that was released by the Premier in July 1994. Responsibility for project management and land ownership was then given to LandCorp.

1.2.2 Albany Foreshore Redevelopment Project 1995

In August 1994, a proposal to redevelop land for residential, tourist and commercial usage along the foreshore south of Princess Royal Drive in Albany (excluding dredging and boat harbour development) was referred to the EPA for environmental impact assessment. The foreshore redevelopment was to be part of a larger redevelopment plan proposed for Albany, which had the support of the GSDC and the Albany Town Council.

In view of the potential environmental impacts associated with the proposed reclamation, the EPA determined that the appropriate level of assessment for the project was a 'Consultative Environmental Review' (CER) with a four week public review period (ERM 1995). The Minister for the Environment approved the project in June 1996 subject to conditions as outlined in Ministerial Statement 421. This approval was later extended by the Minister to the end of June 2006.

The project has recently been modified and the changes to the proposal have received approval under section 45C of the *Environmental Protection Act* 1986 (EP Act). The City of Albany is now the proponent for the Anzac Peace Park and LandCorp is the proponent for the Albany Waterfront Foreshore Redevelopment. Neither of these projects included a boat harbour development.

1.2.3 Albany Waterfront Project 2003 - current

The most recent project has been an initiative of the City of Albany, with LandCorp becoming involved as the proponent for some aspects. The planning process for the current Albany Waterfront Project, which includes the Albany Foreshore Redevelopment and the Protected Harbour Development, has included:

1. Albany Waterfront Concept Plan – commercial overview, February 2005: Independent advice on the proposed development concept.
2. Concept Plan 2005 outlining the key elements of the development
3. Structure Plan 2006 outlines the general distribution of land uses within the project area. In response to public comment on the Concept Plan, the Structure Plan included an enlarged boat harbour, changes to building layout to reduce impact on harbour views from the Albany CBD, and a detailed traffic management plan for the project.
4. Draft Precinct Plan identifies five distinct land use precincts within the Albany Waterfront area and outlines the vision, objectives and detailed planning and design guidelines for each. The Precinct Plan details the proposed use of all land within the project area and includes a set of design guidelines for private developers.

5. Community consultation has provided input into each stage of the planning process and the Community Reference Group has provided detailed feedback on the Structure Plan and Precinct Plan (Section 4.1).

A Memorandum of Agreement (MOA) was signed on 6 September 2005 by Planning and Infrastructure Minister Alannah MacTiernan, Local Government and Regional Development Minister John Bowler and Albany Mayor Alison Goode. The MOA formalises the commitment to the Albany Waterfront Project by the State Government and the City of Albany.

The overall Albany Waterfront Project now consists of the following projects that each have separate proponents:

1. Anzac Peace Park – City of Albany
2. Foreshore Redevelopment – LandCorp
3. Protected Harbour – LandCorp.

1.3 PROPONENT DETAILS

LandCorp is the proponent for this project. It is intended that LandCorp will transfer the proponency for this project to the Department for Planning and Infrastructure (DPI) sometime after construction. This change of proponency will be subject to approval under Part IV of the EP Act and an agreement between LandCorp and DPI.

The key contact for this proposal is Chris Carman at Benchmark Projects.

Benchmark Projects
Level 4 Eastside Cove
10 Eastbrook Terrace
EAST PERTH, WA 6004
Telephone: (08) 9225 4255

1.4 JUSTIFICATION FOR PROPOSAL

1.4.1 Demand studies

The City of Albany commissioned a demand study in 2001 to make a preliminary assessment of the existing and likely future requirements for a boat harbour and associated land adjacent to the Albany Town Jetty in Princess Royal Harbour (International Marina Consultants 2001). The report concluded that there was an immediate need to upgrade the facilities on the Albany Town Jetty and that there is sufficient demand for a boat harbour and land based support facilities.

In 2003, the DPI conducted its own demand study which included interviews with fishing and tour industry operators and the Princess Royal Sailing Club.

1.4.2 Regional and State benefits

The Emu Point Boat Harbour is located 14 kilometres from the centre of Albany in Oyster Harbour. It is the primary boating facility for vessels (up to a maximum length of 20 metres) operating out of

Albany. The Emu Point facility has the capacity for 60 recreational boats and 39 commercial boats. The pens are fully allocated.

The Protected Harbour Development will provide a safe and protected anchorage for recreational and commercial vessels within Princess Royal Harbour and expand the total number of boat pens available in Albany. The number of commercial boat pens is currently a limiting factor for marine industries. Therefore, the proposal is expected to have commercial benefits.

The project will also help Albany develop its potential as a tourism destination in Western Australia. The whale watching and dive charter boats that currently operate from the Albany Town Jetty have little shelter and no supporting infrastructure. The Protected Harbour development is an integral part of the Albany Waterfront Project which is focussed on marine based tourism, recreation and entertainment. One of the key objectives of the Albany Waterfront Project is to re-connect the Albany town centre to Princess Royal Harbour.

Specific benefits to the local community of the overall Albany Waterfront Project include:

- reconnecting the Albany CBD to the Princess Royal Harbour foreshore
- creating a vibrant mixed-use waterfront focus for the city
- attracting visitors and businesses to the area
- reinvigorating the adjoining lower York Street tourism precinct
- improving facilities and providing a safe and protected boat harbour for the charter and fishing industries and recreational boat users
- improving community facilities at the Princess Royal Harbour foreshore, which will also be linked to the new Anzac Peace Park
- long-term jobs and business opportunities.

1.4.3 Selection of site

The site for the Protected Harbour proposal was chosen because of the association of the harbour with the Albany Foreshore Redevelopment Project. The two projects are both part of the overall Albany Waterfront Project and have been designed as complementary projects.

The redevelopment of the Albany waterfront has been a topic for ongoing discussion and investigation since 1982. A number of studies have been conducted to investigate options to improve links between the town centre and the harbour (Saleeba 1989).

The Vancouver Waterways Project was commissioned in July 1999 to examine existing infrastructure in Princess Royal Harbour, Oyster Harbour and King George Sound; the report from this project provided recommendations to improve water based activities. The proposed location for the redevelopment was chosen from eight potential sites during a workshop and adopted due to the ability to improve connectivity of the town centre to existing water based activities. This formed the basis of future proposals for the area.

The Foreshore Redevelopment Project was designed to reconnect the Albany CBD to the foreshore, by re-establishing the historical links between the town centre and Princess Royal Harbour. A Foreshore Focus Group was formed by the City of Albany, and provided 19 recommendations on projects to improve connectivity of the town and existing water based activities. These recommendations were subject to a public consultation process which resulted in the current location being recommended for the development.

A report commissioned in 2001 by the City of Albany investigated the requirements of commercial and larger recreational vessel owners. This 2001 report included a study into the suitability of existing infrastructure, and provided recommendations based on current and future demands (International Marina Consultants 2001). The recommendations from this report included, amongst other findings, the need for a development at this site to provide sheltered berthing for commercial and larger recreational vessels.

1.5 PURPOSE AND STRUCTURE OF THIS DOCUMENT

The purpose of this document is to present an environmental review of the construction and operation of the key components of the proposal in the form of an Environmental Protection Statement (EPS).

The document structure is as follows:

Introduction and the proposal

- Introduction
- Description of proposal
- Overview of existing environment

Environmental impact assessment approach

- Stakeholder consultation
- Environmental principles and sustainability
- Assessment of environmental impact of proposal

Assessment of key environmental factors

- Factor by factor detailed assessment and management of key environmental issues

Assessment of other environmental factors

- Factor by factor outline of other environmental issues and their management

Proposed environmental management and environmental outcomes of project

- Proposed environmental management and monitoring in relation to each factor
- Environmental costs and benefits of the project.

1.6 ENVIRONMENTAL ASSESSMENT PROCESS

This Environmental Protection Statement (EPS) has been prepared in accordance with *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002* (the Administrative Procedures) for environmental assessment prescribed under the *Environmental Protection Act 1986* (EP Act). The EPS process is outlined in Figure 1.

Although a Scoping Document is not required for an EPS level of assessment, a draft Scoping Document was provided to the Environmental Protection Authority Services Unit (EPASU) as background information for discussions on the project information requirements and likely level of assessment. Based on this information, the Environmental Protection Authority (EPA) advertised its intention of setting an EPS level of assessment for this project on 17 July 2006.

Following submission of this EPS document, and if EPS is still considered the appropriate level of assessment, the EPA will set the level of assessment as EPS and release the EPA assessment report (Bulletin) under section 44 of the EP Act at the same time. The Bulletin will include the conditions and procedures that the EPA considers should be applied to the proposal. The EPA will advertise the EPS level of assessment and the availability of the EPA report. The completed EPS will be made available to the public as required by the EPA. The level of assessment and the EPA advice are then open to appeal to the Minister for the Environment.

The intent of the EPS process is to require considerable upfront investigation and community consultation to resolve any environmental issues before the release of the EPS. The proponent has consulted with Government agencies and other relevant stakeholders as part of the EPS process (Section 4.1).

The EPS document must demonstrate to the EPA that certain criteria have been met to ensure that an EPS level of assessment is appropriate. These are:

- the community, key stakeholders and Government agencies have been adequately consulted and their views taken into account
- all necessary studies have been carried out in a competent manner
- results of the studies have been incorporated into the design and intended operation and management of the proposal
- proposal conforms with applicable environmental guidelines, policies, standards and procedures
- required environmental factors have been adequately addressed
- appropriate environmental commitments have been made.

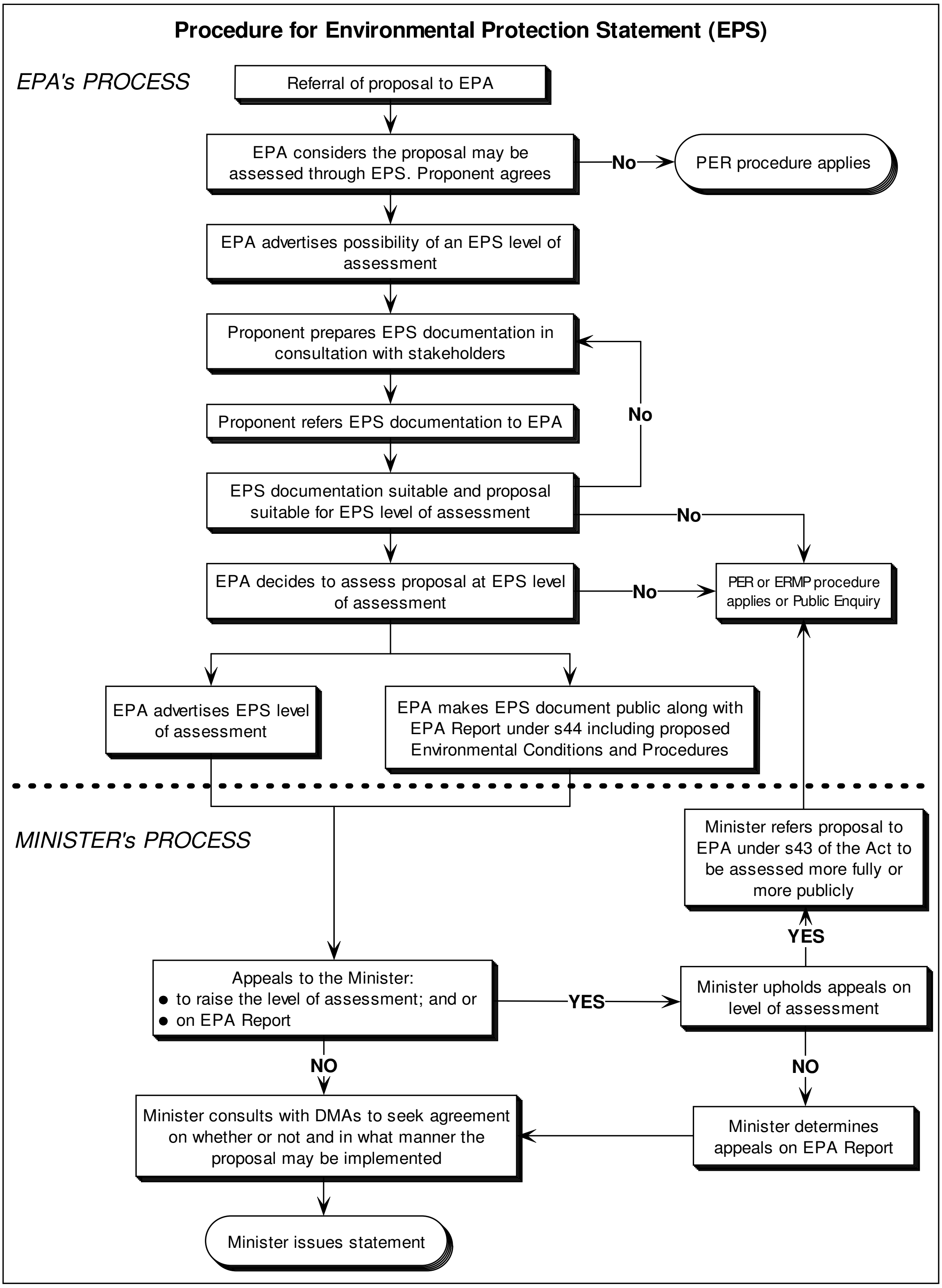


Figure 1 Flowchart of Environmental Protection Statement procedure

1.7 RELEVANT LEGISLATION AND POLICY

The project is being developed in accordance with the requirements of the EP Act and will take into consideration all applicable State legislation and regulations. Current State legislation applicable to the project includes the following:

- *Aboriginal Heritage Act 1972*
- *Building Regulations 1989*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Environmental Protection Regulations 1987*
- *Health Act (and Regulations) 1911*
- *Heritage of Western Australia Act 1990*
- *Land Administration Act 1997*
- *Local Government Act 1995*
- *Wildlife Conservation Act 1950*
- *Metropolitan Region Town Planning Scheme Act 1959*
- *Town Planning and Development Act 1928*
- *Waterways Conservation Act 1976*.

Relevant Western Australian policies and strategies

In addition to existing legislation, the following State Government agency strategies and policies are of relevance to the environmental assessment and management of this project:

- Western Australian State Sustainability Strategy 2003
- Conservation Policy for Western Australia 1997
- Environmental Protection Authority Position Statements
- Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment, Guidance Statement no. 29, 2004
- Albany Harbours Planning Strategy 1997
- Vancouver Waterways Project 2000
- EPA Bulletin 442: Recommendations of the EPA in relation to the environmental problems of the Albany harbours 1990.

Commonwealth legislation and policies

Commonwealth polices and legislation applicable to the project includes:

- *Aboriginal and Torres Straight Islander Heritage Protection Act 1984* (which operates concurrently with any existing State laws in so far as those laws would not be consistent with this Act)
- *Australian Heritage Commission Act 1975*
- *Native Title Act 1993*
- *Environment Protection and Biodiversity Conservation Act 1999*
- National Strategy for Ecologically Sustainable Development 1992
- Intergovernmental Agreement on the Environment 1992
- National Strategy for Conservation of Australia's Biological Diversity 1996.

2. PROPOSAL DESCRIPTION

2.1 LOCATION

The Protected Harbour Development proposal is located immediately south of the Albany town centre, on the south coast of Western Australia, approximately 420 kilometres south east of Perth (Figure 2). The Protected Harbour is proposed in an area of Princess Royal Harbour known as Hanover Bay. Princess Royal Harbour, along with Oyster Harbour, are embayments of King George Sound.

The Protected Harbour Development is approximately bounded by (Figure 3):

- the western side of the Albany Town Jetty to the west
- the Albany Port tug boat harbour to the east
- the high water mark (at AHD 0.4 m) to the north
- extends into the harbour approximately 300 metres to the south.

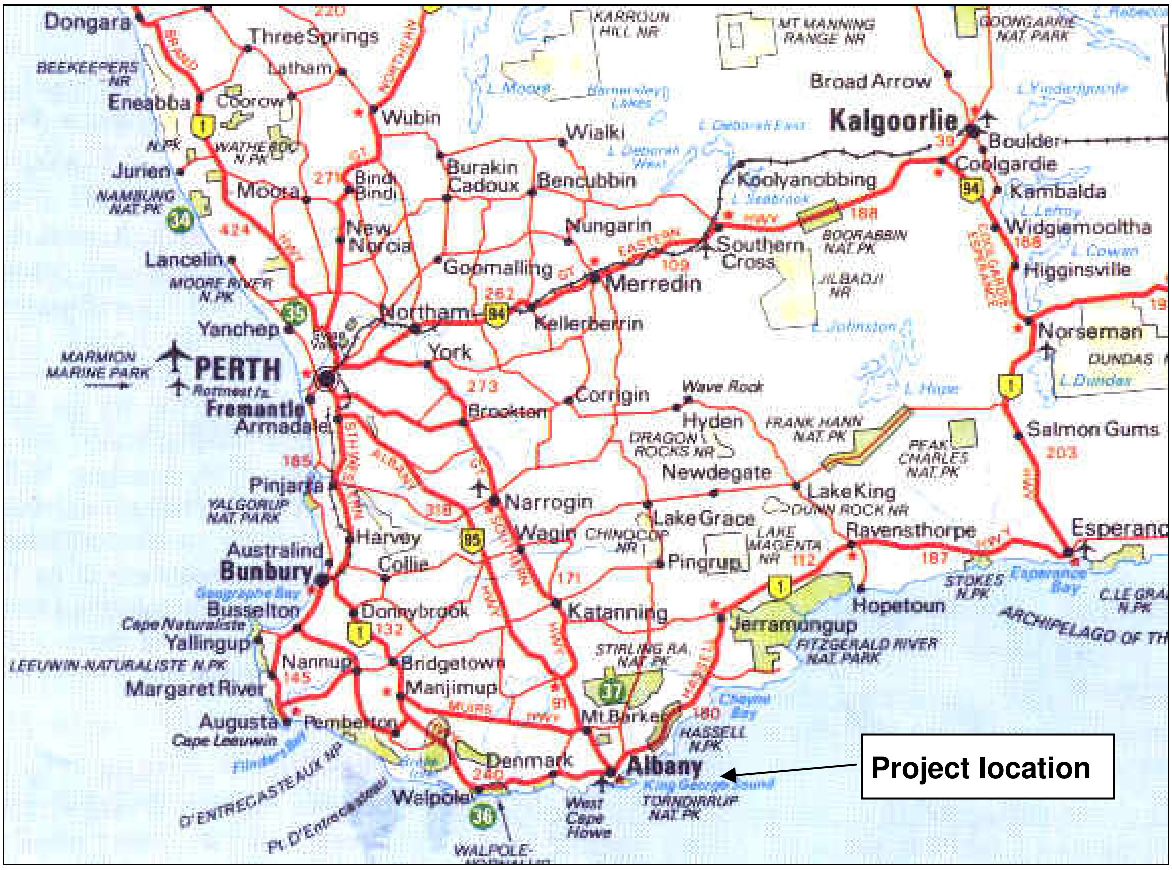


Figure 2 Regional location

2.2 KEY CHARACTERISTICS

The Protected Harbour Development proposal affects approximately 6.6 ha of water area and includes:

- provision for approximately 130 boat pens (including large pens for charter operators) that will be built in two stages with Stage 1 comprising about 74 boat pens and Stage 2 the remainder
- a total of 3.4 ha of reclamation within Princess Royal Harbour (Figure 4) which includes:
  - reclamation of 0.3 ha to adjacent to the Albany Foreshore Redevelopment area to create a marina edge wall (sea wall and revetment)
  - reclamation of about 0.85 ha for fishing industry hardstand including, a sea wall and revetment, fishing industry wharf, jetty with fuel and sullage pump out facilities
  - construction of two breakwaters with a total footprint of 2.25 ha; one to widen and extend the existing Albany Town Jetty (1.8 ha) and one internal cutoff breakwater (0.45 ha), which will separate the boat harbour from the existing tug boat harbour
- excavation of the harbour area using earthmoving equipment working from a temporary sand platform. Total excavation will include around 15,000 m^3 of sediment over an area of 1.4 ha to give a maximum depth of -2.8 m AHD
- public fishing platform with disabled access
- public boat ramps and trailer parking.

Material excavated from the harbour will be used in the reclamation and construction of the fishing industry reclamation area. Any material that is found to not meet the geotechnical specifications due to organic matter will be taken to landfill.

The Protected Harbour proposal is adjacent to the Albany Foreshore Redevelopment and they are both parts of the overall Albany Waterfront Development.

Stormwater from the Protected Harbour and Albany Foreshore Redevelopment will be discharged to the boat harbour through an existing stormwater drain. The amount of stormwater generated will be low and as part of this project, a gross pollutant trap will be installed on the stormwater discharge outlet.

The key characteristics of the proposal are shown in Table 1.

Table 1 Key characteristics

Aspect	This Proposal
Project timeframe	Construction to commence in 2008 and first stage completed in 2009. Second stage (additional pens) completion depends on demand
Location	Refer Figure 4
Boat harbour	Refer Figure 4
Capacity	Total of approximately 130 boat pens, with about 74 built in the initial construction phase and the remainder when there is demand.
Boat harbour depth	Excavated to -2.8 m AHD within the harbour area.
Protected water area	6.6 ha (excluding the existing Albany Port Authority tug harbour 2.2 ha)
Excavated sediment	About 15,000 m^3
Area excavated outside proposed seawalls	1.4 ha
Disposal of excavated material	Used in land reclamation or if geotechnically unsuitable, it will be taken to a licensed landfill site.
Breakwaters, reclamation on eastern side of breakwater, groyne, fishing industry reclamation	
Location	Refer Figure 4
Total reclamation and breakwaters area	Approximately 3.4 ha
Reclamation area fill material	Excavated material from onsite and imported sand fill from a local licensed sand pit.
Breakwater material	Quarried rock core - granite or ferricrete.
	Quarried granite armour

Figure 3 Key features of project area and surrounds

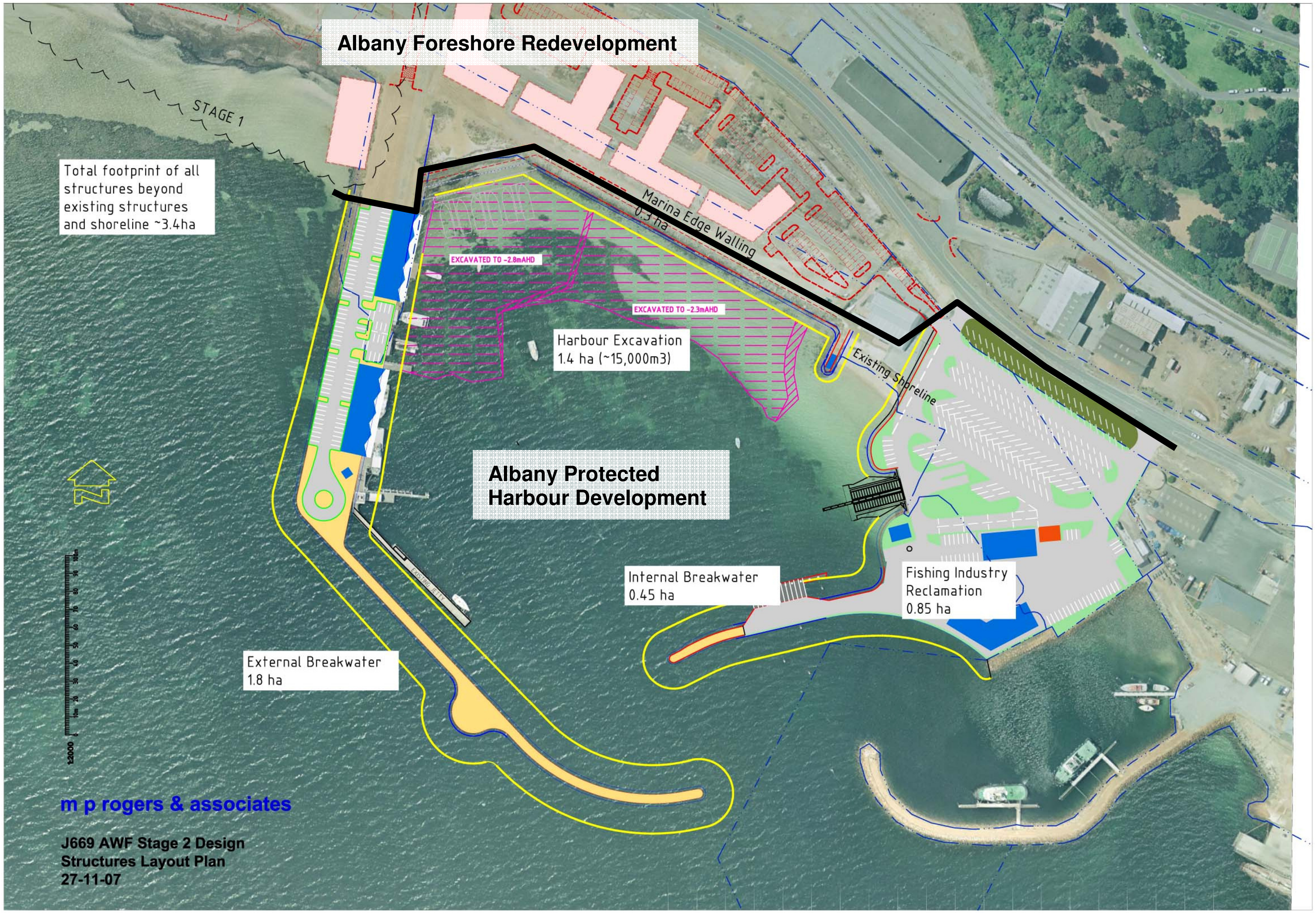
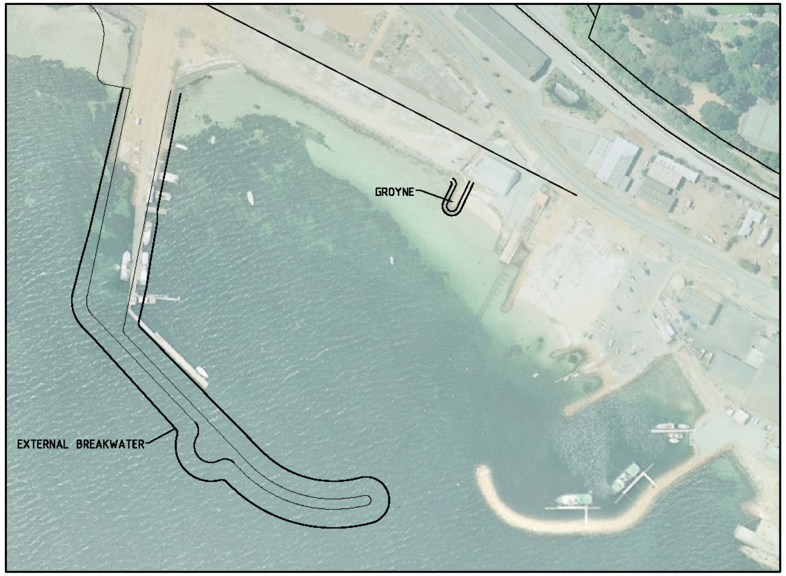
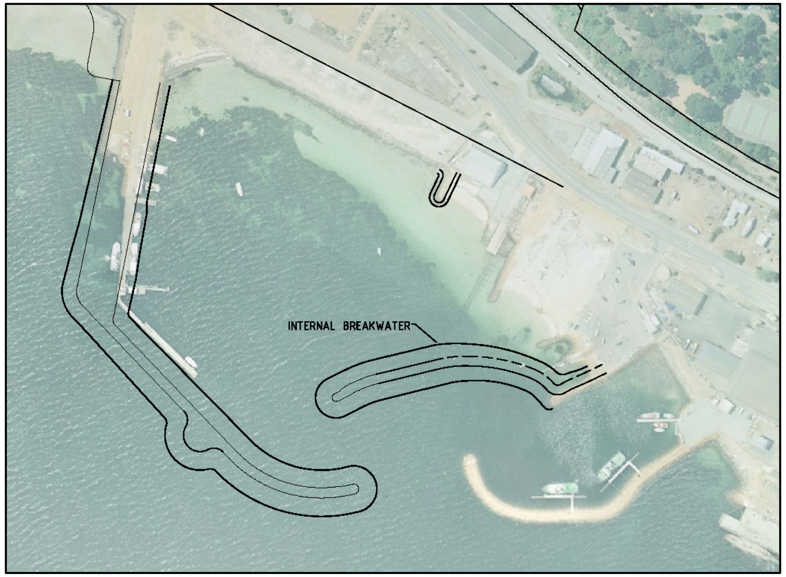


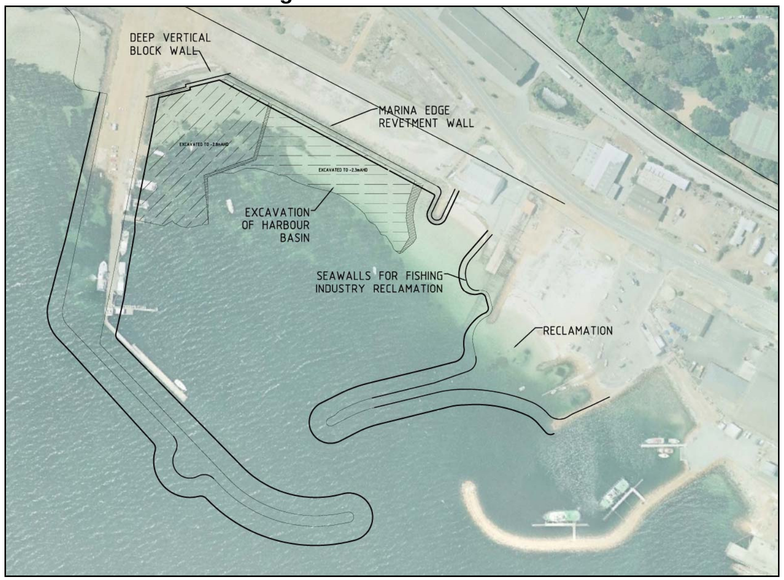
Figure 4 Protected Harbour Development Layout Plan



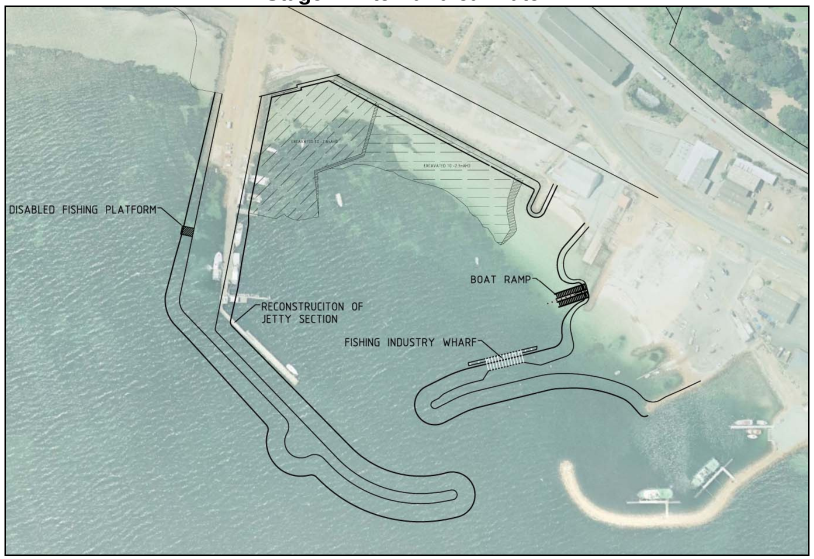
Stage 1 External breakwater



Stage 2 Internal breakwater



Stage 3 Excavation, reclamation and marina walls



Stage 4 Boat ramp, fishing platform and wharf

Figure 5 Staging of construction

2.3 CONSTRUCTION

The order of construction is shown in Figure 1.

Breakwater construction

The main breakwater extension of the Albany Town Jetty and the cut-off breakwater will be constructed in the same way as many of the existing breakwaters around Western Australia. The breakwaters will consist of quarried rock core and armour stone (the exposed rock) from licensed quarries in the district. The rock core will be granite or ferricrete and will be delivered to site by trucks using public roads. The new armour stone will be granite. The rock materials will be tipped from the truck into the water and the breakwater will be progressively lengthened. The core will be shaped as required using conventional earthmoving equipment such as front end loaders and hydraulic excavators. The armour stone will be placed on to the core and trimmed using hydraulic excavators. An access road and public walkway will be constructed along the entire length of the main breakwater.

Marina edge wall, boat ramps and deepening of parts of the marina basin

Geotechnical investigations have shown that there is some debris such as tyres, old moorings and steel scrap on the marina seabed. This material will be removed before excavation and taken to the appropriate licensed landfill site. Where practicable, the debris will be recycled rather than put into a landfill.

The shallow parts of the marina basin will be deepened to between 2.3 to 2.8 m below AHD, using a land-based excavator working from a series of temporary sand platforms. The material to be excavated is predominately sandy and if geotechnically suitable, it will be used as compacted fill to create the hardstand area in the fishing industry precinct (Figure 4). Detailed investigation of the sediment characteristics and contaminant levels has been undertaken and the results confirm that the material is suitable for reclamation works (Oceanica 2008 in Appendix 1). Any material that is found to not meet the geotechnical specifications due to organic matter or fines content will be taken to landfill.

Following excavation and construction of the edge walling, the temporary sand platforms and underlying material will be removed to a depth of -2.3 to -2.8 mAHD using excavators and trucks. The silt curtain will be left in place to contain turbidity generated during removal of the sand platform. The material removed may be stockpiled and will be used (if geotechnically suitable) in the reclamation in the fishing industry area (Figure 4). The excavated natural sediments (i.e. not the imported sand bund) will be placed above the watertable within the fishing industry area.

Revetments and reclamation in the fishing industry area

Reclamation and establishment of revetments around the fishing industry area will be progressively undertaken following construction of the breakwaters and marina edge wall. Excavated material will be transported directly to the fishing industry hardstand area to be used in that reclamation along with imported material from a licensed sand mine. The revetment construction will include an initial sand/rock structure to allow construction of the revetment. Subsequent reclamation will occur behind the revetment. The reclamation revetment for the fishing industry will have granite armour.

Jetties and floating pens

The various jetties and floating pens will be supported and/or anchored using piles driven into the seabed. The pile driving activities will be managed to minimise the impacts of noise and vibration and will be completed in accordance with the various legislative and local Government requirements.

Timing

The sequence, timing and duration of construction activities are anticipated to be as follows:

1. Construction of main breakwater to commence in June 2008, expected duration 16 to 20 weeks
2. Construction of cut-off breakwater to commence in September 2008, expected duration 8 to 12 weeks
3. Marina revetment construction to commence in January 2009, expected duration 8 weeks
4. Excavation of a small portion of the marina basin using temporary sand platforms to provide access for the land based excavators. Works to commence in March 2009, expected duration 4 weeks
5. Fishing Industry area revetments and reclamation to commence in April 2009, expected duration 8 weeks

3. PROJECT ENVIRONMENT

3.1 SOCIAL ENVIRONMENT

3.1.1 Socio-economic setting

The estimated population of the City of Albany for June 2005 was 31,981 with a median age of 39 (ABS 2006).

Albany is one of the State's leading tourist bases for marine-related activities, including tours of the scenic south coast, whale watching, recreational diving (especially around Michaelmas and Breaksea Islands and the HMAS Perth dive site), fishing and the 'Whaleworld' museum. The waters and beaches of King George Sound, Princess Royal Harbour and Oyster Harbour are also used heavily for recreation by local residents.

The Albany Port and its associated activities are major employers in the Albany region, comprising the Albany Port Authority, Co-operative Bulk Handling, tug boat operators, stevedoring companies, shipping agents and shipping contractors. Fertiliser products are a major import and major exports are grain (wheat, barley, oats, canola and lupins), woodchips and silica sand. The Port has three land-backed berths (No. 1, 2 and 3, which mainly handle grain), a new dolphin berth (No. 6, which handles woodchips) that commenced operation in February 2002, and two tugs. The maximum laden draft for vessels is 9.8 m for No. 1 and 2 berths and 11.5 m for No. 3 and 6 berths. The Albany Port Authority is presently seeking environmental approval (EPA Assessment No. 1594) for a major facility upgrade, comprising widening of and extending the existing shipping channel from King George Sound into Princess Royal Harbour (involving dredging and disposal of 8.1–13.8 million cubic metres of sediment), and the construction of a new berth (No. 7). The proposed upgrade is required to meet shipping requirements associated with the Southdown Magnetite Proposal, plus projected increases in imports and exports from the Great Southern Region.

The main commercial fisheries that operate in the region are the Abalone Fishery (which targets Roe's abalone in the Albany region), the Demersal Gillnet and Longline Fishery (which target mainly whiskery shark, dusky whaler shark and gummy shark) and South Coast Purse Seine Fisheries (which targets pilchards and other small pelagic fish such as anchovies and sprats). Smaller fisheries include:

- a beach net fishery for salmon
- a crustacean trap fishery that largely targets southern rock lobsters and an increasing number of deep sea crabs
- an estuarine fishery (which encompasses Princess Royal and Oyster Harbours) that mainly targets black bream, cobbler, sea mullet, Australian herring and King George whiting
- a trawl fishery for scallops.

Aquaculture (largely in King George Sound) includes the production of oysters and mussels, and a hatchery and grow-out facilities for green-lip mussels. Recreational fishing is mainly in King George Sound. On the coast, recreational shore fishing focuses on Western Australian salmon, herring, whiting and trevally, and boat fishing targets pink snapper, queen snapper, blue groper, shark, red snapper and samson fish.

3.1.2 Land tenure and adjacent land use

The project area is zoned "Foreshore Development" under the City of Albany Town Planning Scheme No. 1A. The project area includes the existing Albany Town Jetty which is primarily utilised by boat charter companies with boat pens and some sheds along the jetty. The northern portion of the jetty is reclaimed land used for temporary car parking. The area of Princess Royal Harbour to be included in the project is Location 7601.

The Foreshore Development zone under the City of Albany Town Planning Scheme No. 1A does not contain any reference to specific land uses. Appropriate land uses within this zone will be determined through the Structure and Precinct Planning process. The Scheme required that a Structure Plan show the general distribution of land uses within the plan area and that a Precinct Plan show the proposed use of all land within the area. Once adopted by Council, the Precinct Plan will become binding on development within that precinct.

The adjacent land to the north is currently open vacant land that will become part of the Albany Foreshore Redevelopment. Further north is Princess Royal Drive and a railway line that services the Albany Port. The Albany Port Authority exists to the east, with the Duyfken workshops and slipway located closest to the project area. To the west of the site is the area to be developed as Anzac Peace Park by the City of Albany. The southern boundary abuts and extends into Princess Royal Harbour (Figure 3).

3.1.3 Aboriginal heritage and culture

There are no Aboriginal heritage sites listed on the State or Federal lists for the project area and surrounds.

Native title claims that exist over the Albany area are:

- Southern Noongar WAD: registered, in mediation with the NNTT, represented by the South West Aboriginal Land and Sea Council (SWALSC)
- Single Noongar Claim Area 2: unregistered, represented by SWALSC
- Wom-Ber: unregistered, in mediation with NNTT, represented by Pat Morich.

Native Title has been extinguished as it is reclaimed land and the foreshore and water body has been gazetted as Foreshore Development.

3.1.4 European heritage and culture

Albany is the oldest European settlement in Western Australia and was founded in 1826. The Albany Town Jetty within the project area is listed as site 3607 on the Western Australian Register of Heritage Places. The jetty was first built in 1862 and the site was registered as it is believed to be the oldest jetty in Western Australia in continuous use and it has historical, landmark and archaeological significance. Jetty heritage values are further addressed in Section 8.3.

The current town centre is in the same location as the early settlement adjacent to the port and the project area. The Register of the National Estate lists the following historic sites in the centre of the Albany townsite adjacent to the project area:

1. Albany Courthouse, 184-190 Stirling Tce, Albany
2. Albany House, 119-125 York St, Albany
3. Albany Post Office (former), Stirling Tce, Albany
4. Heritage Park, Marine Forts Rd, Albany
5. House, 25 Rowley St, Albany
6. Norman House Cottage, 26-30 Stirling Tce, Albany
7. Offices, 133-135 York St, Albany
8. Old Gaol, 2-4 Parade St, Albany
9. Patrick Taylor Cottage, 37 Duke St, Albany
10. Residency (former), Residency Rd, Albany
11. Rotunda, Stirling Tce, Albany
12. St John the Evangelist Anglican Church, York St, Albany
13. St Johns Anglican Church Hall (part of complex), York St, Albany
14. St Johns Anglican Church Rectory, York St, Albany
15. Taxi Rank and Women's Rest Room, York St, Albany.

3. Albany Post Office

There are no sites within Albany on the National Heritage List or the Commonwealth Heritage List.

3.2 TERRESTRIAL ENVIRONMENT

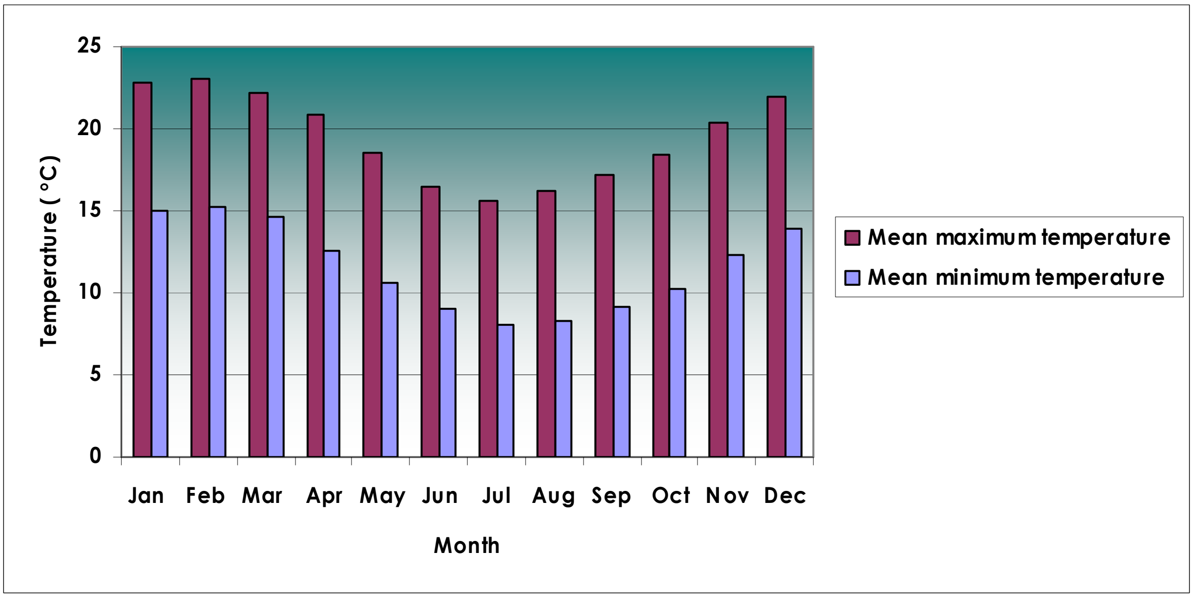
3.2.1 Climate

The long term (1877 to 2004) average annual rainfall for Albany is 930 mm, with the majority falling between May and September (BOM 2006) (Figure 7). Average monthly minimum and maximum temperatures range between 15 and 23 degrees Celsius in summer and 8 and 16 degrees Celsius in winter (Figure 6).

Predominant wind directions are shown in Table 2. Moderate wind speeds are experienced throughout the year, typically about 3-5 m/s in the morning, and increasing to typical speeds of 5-7 m/s in the afternoon. Autumn is the least windy season. Wind roses for Albany airport are shown in Figure 8.

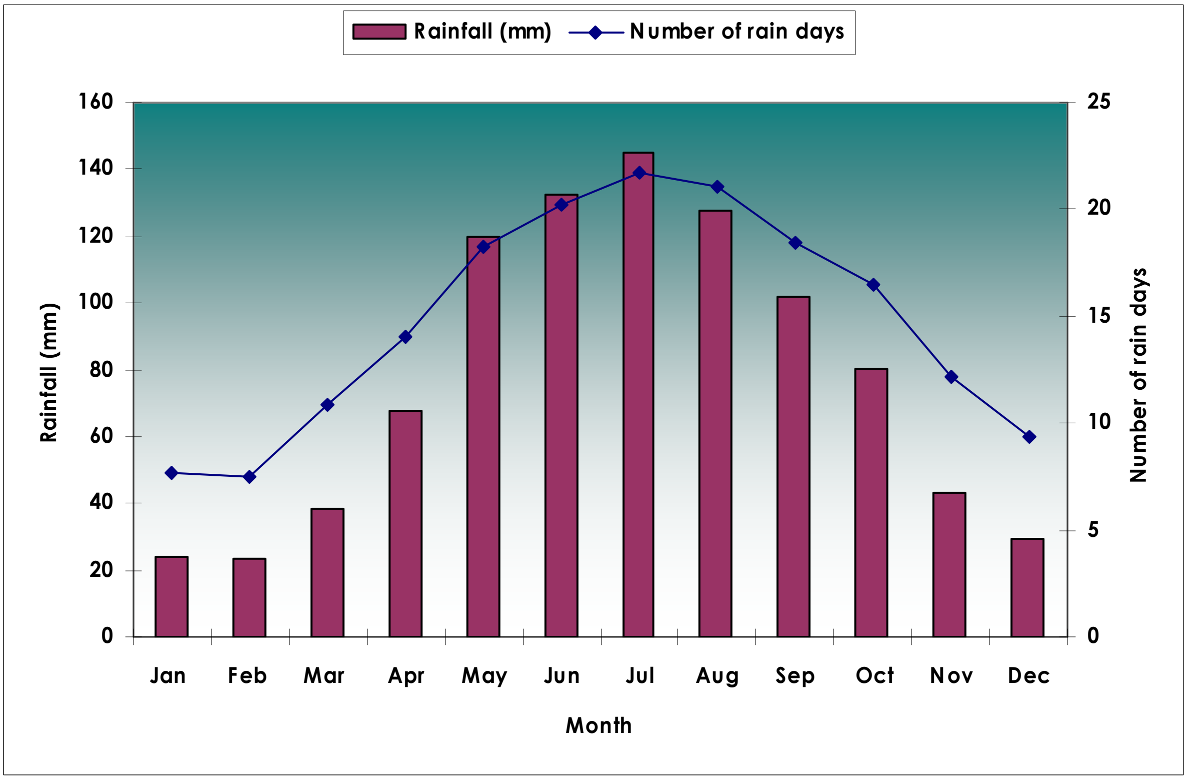
Table 2 Predominant wind direction

	Morning	Evening
December to March	Easterly	South easterly
April to August	North westerly	Westerly
September to November	Westerly	South-westerly



Source: Bureau of Meteorology (2006)

Figure 6 Mean monthly temperatures for Albany from 1877 to 2004



Source: Bureau of Meteorology (2006)

Figure 7 Mean Monthly rainfall and number of rain days for Albany from 1877 – 2004

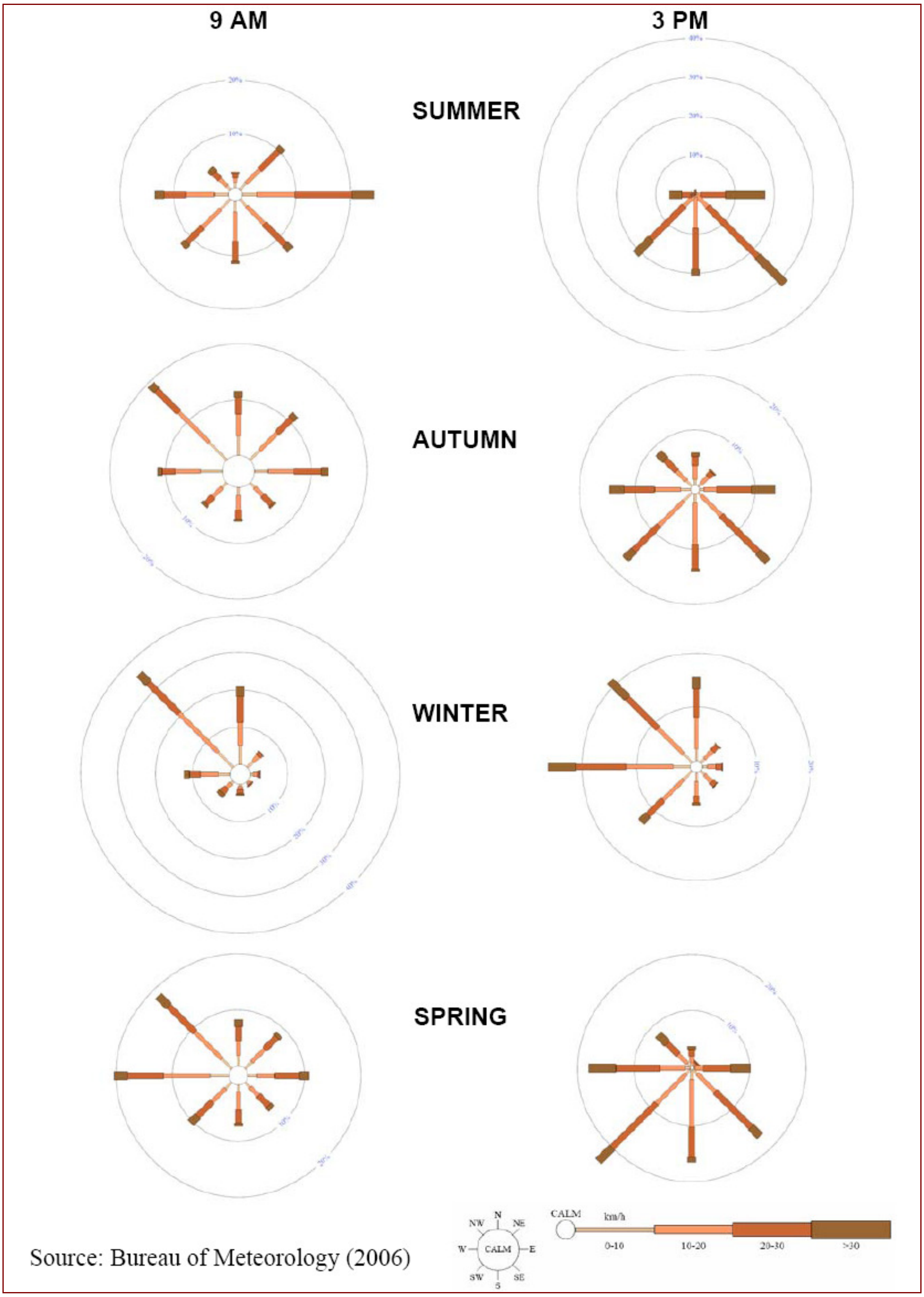


Figure 8 Seasonal wind roses for Albany Airport from 1965 to 2004

3.2.2 Landform, soils and hydrogeology

The project area is underlain by Tertiary sediments with surface alluvial material eroded from the granitoid Mt Clarence to the north (Smith 1997). The foreshore adjacent to the project area is land previously reclaimed from Princess Royal Harbour (ERM 2005). The current topography is flat with free draining sandy soils. There are areas of contamination due to past land uses, which are being addressed as part of the approved Albany Foreshore Redevelopment Project (ERM 2006).

Groundwater flows south from the land based stage of the Albany Waterfront Project into the protected harbour with a hydraulic gradient of <0.01 (ERM 2006). The groundwater level is one to two metres below ground level. The groundwater is fresh with low levels of some contaminants (Section 5.4.3). Oceanica (2006b) has prepared an Ecological Risk Assessment of the potential effects of groundwater on the marine environment (Appendix 2).

3.3 MARINE ENVIRONMENT

3.3.1 Regional overview

Geomorphology

King George Sound and the two related inlets, Princess Royal Harbour and Oyster Harbour, comprise one of the principal features of the South Coast (CALM 1994). The region lies within the distinctive and scenic coastal type known as the Albany Frazer Oregon (Point D'Entrecasteaux to Cape Arid), comprising wide bays with arcuate beaches and high granitic or gneissic headlands. CALM (1994) describes the repeating sequence of coastal types in this region as follows:

- long, wide bays and beach, with shallow shelving shore, often with perched dunes or limestone cliffs and exposed limestone rock platform at sea level (usually at the eastern end of the bay)
- high granitic or gneissic headlands exposed to open ocean swells with wave swept slopes, 'steep-to' shores, cliffs and sometimes small lunate bays set between the projecting elements of the headland
- eastward-facing semi-exposed shore with granite or gneissic boulders and tide pools.

The region is characterised by a series of small bay beaches separated by headlands of Proterozoic granite (ca 1,150 million years before present). These bay beaches extend westward from mid-way along Flinders Peninsula, which forms the southern side of King George Sound. The coastline on the eastern portion of Flinders Peninsula is characterised by a granite-cliffed coastline with only minor amounts of unconsolidated sands at the shore. Many of the bays are wide and provide little protection from the prevailing winds, with the major exception of the King George Sound/Princess Royal Harbour/Oyster Harbour complex.

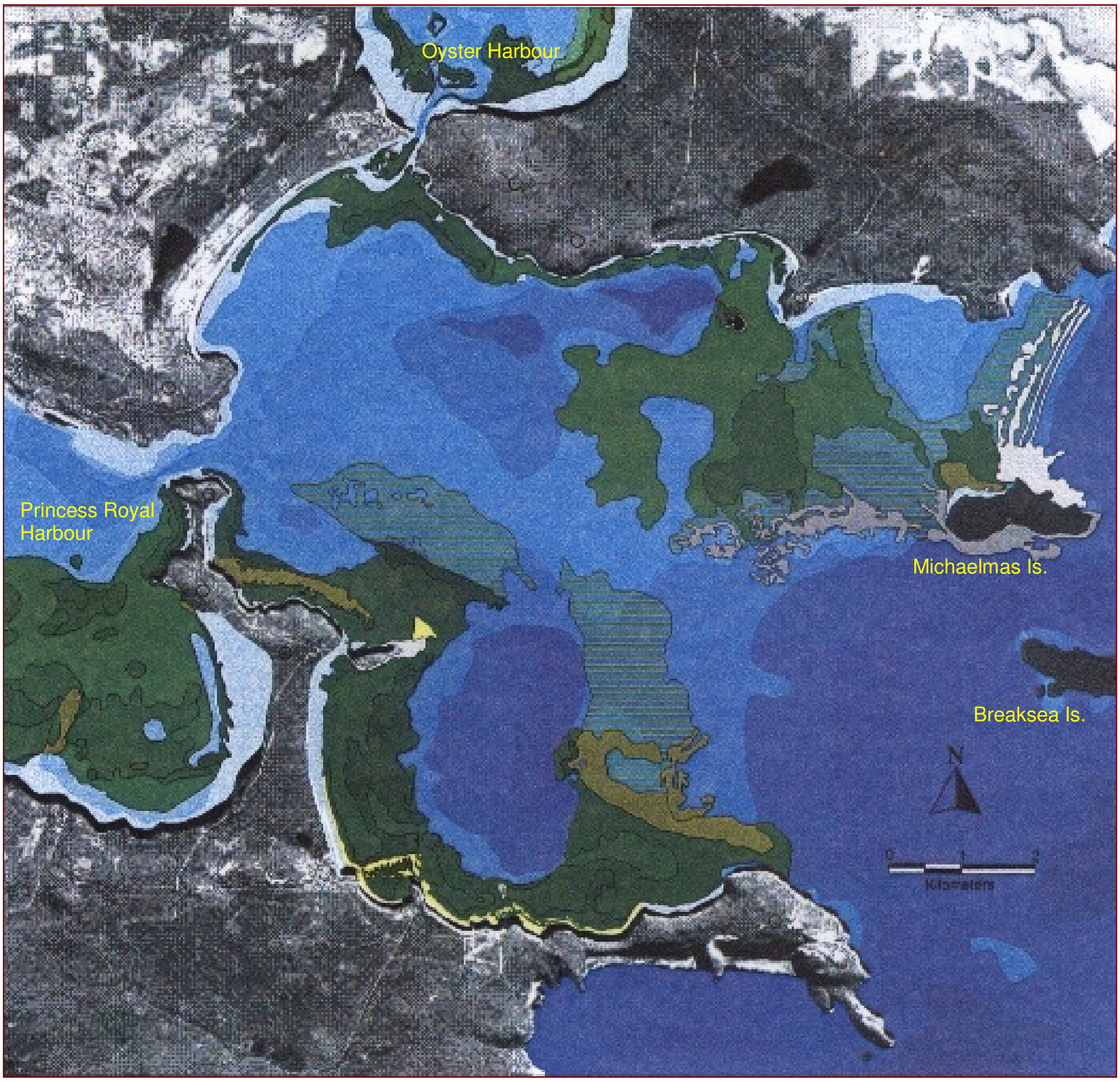
King George Sound, Princess Royal Harbour and Oyster Harbour are all depressions of the Proterozoic land surface now flooded by the sea. King George Sound is an eastwards-facing marine embayment with water depths of 10–35 m, that is protected from southerly winds and swell by the Flinders Peninsula to the south. Breaksea and Michaelmas Islands are high islands at the entrance to King George Sound, a sublittoral rocky ridge connects Michaelmas Island to the northern shore of the mainland, and there is a chain of deep reefs extending west of that island into King George Sound.

Princess Royal Harbour and Oyster Harbour are embayments connected to King George Sound via narrow channels. Princess Royal Harbour is 28.8 square kilometres (km^2) in area, and Oyster Harbour is 15.6 km^2. The geomorphology of the two harbours is similar; both have gently sloping, shallow, sandy margins surrounding deeper (~5-10 m) basins (Bastyan 1986, EPA 1990a). Roughly half of Princess Royal Harbour and a third of Oyster Harbour is less than 2 m deep (Bastyan 1986, EPA 1990a).

Ecology

King George Sound, Princess Royal Harbour and Oyster Harbour are unique along the south coast due to their sheltered location and diverse range of habitats (from open ocean marine through to protected marine inlet to estuarine), and have an exceptionally rich and diverse flora and fauna. The marine flora and fauna are primarily temperate species (there are also a few tropical species), a small proportion of which are endemic (Wells et al. 1990). Breaksea and Michaelmas Islands are both nature reserves and also important breeding areas for several migratory seabirds.

King George Sound contains extensive areas of rocky reefs and seagrass meadows (Evangelisti & Associates 1998). The granite reefs have extensive meadows of kelp, with the vertical walls, caves and overhangs home to a diverse array of coral plates, gorgonian fans, sponges, shells, sea dragons and fish. Waters less than 15 m deep in King George Sound are characterised by extensive seagrass meadows: predominantly *Posidonia sinuosa* in the southern part of King George Sound, and a mixture of *Posidonia* species (*P. sinuosa, P. coriacea, P. ostenfeldii*) in the northern part of King George Sound. Mapping by Evangelisti & Associates (1998) indicates there is about 3000 hectares of seagrass in King George Sound (excluding seagrass in Princess Royal Harbour and Oyster Harbour) (Figure 9).



Note: Green shaded areas denote presence of seagrass meadows. Areas with green horizontal lines have traces of seagrass.

Figure 9 Seagrass distribution in King George Sound (from Evangelisti and Associates 1998)

The shallow margins of Princess Royal Harbour and Oyster Harbour (water depths less than 5 m in Princess Royal harbour, and less than 2 m in Oyster Harbour) support meadows of seagrasses, plus dense stands of unattached macroalgae. The main seagrass species are *Posidonia australis*, *Posidonia sinuosa* and *Amphibolis antarctica* (EPA 1990a). Macroalgal stands are dominated by the green algae *Cladophora prolifera*, *Chaetomorpha* spp, *Enteromorpha* spp. and *Ulva* spp. The brown algae *Cystophyllum muricatum*, *Hormophysa* spp and *Hormosira banksii* are also common (growing attached to cockle shells), as are free floating red algae such as *Gracilaria* species. These seagrass meadows and macroalgal stands are important habitat for juvenile fish (EPA 1990a), and the shallow margins of the western and southern shores of Princess Royal Harbour are also rich feeding areas for water birds, particularly migratory waders during summer.

Humpback and Southern Right whales are commonly observed in the Albany region (Humpback whales in King George Sound, and Southern Right whales in King George Sound and to a much lesser extent in Princess Royal Harbour). The bottlenose dolphin, common dolphin, Australian sea lion and New Zealand fur seal are also seen in King George Sound all year round, and to a lesser extent in the two harbours. The appearance of whales is seasonal as a result of their migratory behaviour. Humpbacks feed on krill in southern Antarctic waters during summer, and then return to warmer waters in winter where calves are born and nursed. Humpbacks appear in the Albany region during their migration north/south in spring and autumn. Southern Right whales also feed in colder waters in summer, and then migrate to warmer waters in winter to breed. Adult females often come in close to shore to give birth and suckle their young for the first two to three months of the calf's life. Mothers with calves are commonly seen in inshore waters along the coast between Albany in Western Australia and Ceduna in South Australia in winter and spring.

According to CALM (1994), marine habitat worthy of consideration for reservation in the region includes Vancouver Peninsula, Frenchman Bay, Seal Island, Flat Rocks, the area from Herald Point to Michaelmas Island and Breaksea Island, and marine habitat on the eastern side of Princess Royal Harbour.

3.3.2 Princess Royal Harbour

Physical characteristics

Princess Royal Harbour covers an area of 28.8 km^2, and is predominately shallow with approximately half of its area less than two metres deep (EPA 1990a). Shallow sand flats form the margins of the harbour and are most extensive along the western and southern shores. The harbour is an almost land-locked bay, connected to King George Sound with a narrow channel at the north eastern end. No major rivers or streams enter Princess Royal Harbour, with freshwater primarily entering the system through groundwater, surface water runoff from within the small catchment, and direct rainfall (ERM 1995).

The circulation of Princess Royal Harbour is generally clockwise in summer (associated with south to east winds) and anti-clockwise in winter (north to west winds) with the predominant circulation anticlockwise (Mills & D'Adamo 2000). Wind results in horizontal mixing of the waters within the harbour. The mixture of wind and tidal movements result in the waters of Princess Royal Harbour being well mixed, and water quality is similar to that in King George Sound.

The tides within Princess Royal Harbour have diurnal (daily) and semi-diurnal (twice daily) variations in water level, the former being stronger. The tidal range rarely exceeds 1.1 m, and varies within periods of approximately 14 days (EPA 1990a).

The north east portion of the harbour is naturally the deepest and this area has been used for port facilities. The shipping area has been dredged to a depth of approximately 12 metres (ERM 1995).

Historical seagrass loss

In 1981 and 1984 the former Department of Conservation and Environment (now the Department of Environment and Conservation) funded surveys of the major marine plant communities in Princess Royal Harbour and Oyster Harbour. The latter survey reported extensive loss of seagrass and proliferations of macroalgae in both waterbodies, which are typical signs of severe eutrophication (nutrient enrichment). In 1987 the EPA prepared an overview report which concluded that the environmental situation in both harbours required urgent attention (EPA 1987). As a result, in

October 1987 the State government approved funding for an intensive two year study into the ecology of the harbours to provide long-term solutions to their environmental problems (EPA 1990).

The two year intensive study coordinated by the EPA concluded that since 1962 about 90% of the seagrass meadows in Princess Royal Harbour and about 80% of the seagrass meadows in Oyster Harbour had been lost. The dieback of seagrass was attributed to stimulation of algal growth (both seagrass epiphytes and macroalgae) by excessive nutrient inputs, with heavy epiphyte loads and macroalgal accumulations effectively shading out the light supply to the seagrasses. Major nutrient inputs to Princess Royal Harbour were traced to point sources that discharged all year round. The Robinson Drain at the north-western end of the Harbour (which included surface runoff and effluent from the licensed outlet of CSBP fertiliser works), a domestic effluent wastewater outfall at King Point (just outside the Harbour entrance) and the Metro Meats abattoir outfall were implicated as the most significant sources of nutrients.

The extent of the problem was fully recognised in 1989 and improved management and the closure of many of these sources has led to a major improvement in water quality. Direct discharge of effluent from CSBP fertiliser works stopped in 1984 (see below), Metro Meats closed in 1993 and the King Point wastewater treatment plant closed in 1995. Macroalgal biomass has also declined (although it is still considerable), and seagrass meadows are recovering. Seagrass recovery is discussed further in Section 6.2.1.

Historical contamination of fish and sediments

In 1983, fish from Princess Royal Harbour were found to contain elevated levels of mercury (Francesconi & Lenanton 1992). Subsequent investigations identified contamination of sediments in the western end of Princess Royal Harbour with mercury (and to a lesser extent lead), due to effluent discharge from CSBP's fertiliser works. The contamination was confined to a relatively small area adjacent to the effluent outfall at the western end of Princess Royal Harbour, and analysis of fish found that most species caught in the western end of the Harbour had mercury levels that exceeded the maximum permitted concentration set by Australian health authorities (0.5 mg Hg /kg wet weight of fish). This led to cessation of the effluent discharge in 1984 and closure of the western end of the Harbour to fishing between May 1984 and August 1992.

The input of mercury to Princess Royal Harbour was estimated as 400 kg (Francesconi & Lenanton 1992) or 900 kg (EPA 1987), which is not large compared to other areas of mercury contamination in the world, but a combination of factors (its location within extensive areas of seagrass and macroalgae that were important fish habitat, within a sheltered embayment) resulted in high mercury levels in fish.

Following closure of the effluent discharge the mercury levels in fish were closely monitored by the Department of Fisheries. By 1992 the levels of mercury in fish had declined to below the maximum permitted concentration for human consumption, and the western end of Princess Royal Harbour was re-opened to fishing (Francesconi & Lenanton 1992).

4. ENVIRONMENTAL IMPACT ASSESSMENT APPROACH

4.1 STAKEHOLDER CONSULTATION

The Albany Waterfront Project has been the subject of extensive community and stakeholder consultation since the development of the Albany Foreshore Redevelopment Project in 1995.

4.1.1 Public consultation for the 1995 CER

The 1995 Consultative Environmental Review of the Albany Foreshore Redevelopment Project required considerable community consultation prior to submission of the document and was also released for public review. The key issues raised in the 12 submissions received (EPA 1995) are addressed in Table 4.

4.1.2 2000 Foreshore focus group

Further public consultation occurred when the City of Albany appointed a Foreshore Focus Group to consider what may best be developed at the harbour and waterfront south of the CBD. The focus group provided the City with 19 recommendations which were subject to a public consultation process; resulting in the Council resolution in September 2000, supporting the project subject to amendments consistent with the recommendations of the focus group. The recommendations made by the Foreshore Focus Group that were adopted by Council and are relevant to the Protected Harbour Development and adjacent areas are addressed in Table 4.

4.1.3 Albany Waterfront Project Concept Plan 2003 - 2004

The process for the formulation of the Albany Waterfront Project began in 2003. Extensive consultation has contributed to the development of concept options, a Concept Plan, Structure Plan and finally the detailed Precinct Plan for each part of the Albany Waterfront Project including the Protected Harbour. The consultation undertaken at each stage is summarised below.

Agency consultation

A series of meetings with Government agencies were held between July 2003 and October 2003. The purpose of the meetings was to get agency feedback on the concept options and advice on the information required in future assessment. Agencies consulted were:

- former Department of Environment (DoE), Albany
- Department for Planning and Infrastructure – Transport Division
- Department for Planning and Infrastructure – Land Assets
- City of Albany – Engineering, Corporate services
- Great Southern Development Commission
- Albany Port Authority
- former Department of Conservation and Land Management (CALM)

- Main Roads WA
- Department of Indigenous Affairs (DIA)
- Westnet Rail
- Department of Housing and Works.

Community groups and service authorities consulted were:

- Port Users Group
- Returned Services League (Albany)
- Great Southern Regional Recreational Fishing Advisory Committee
- Rotary International Albany
- Albany Chamber of Commerce and Industry
- Albany Harbours Planning Group
- South Coast Licensed Fishermen's Association
- Customs
- Albany Ratepayers Association and South Coast Progress Association
- Bureau of Meteorology
- Albany Visitor Centre
- Residency Museum
- Albany Maritime Foundation
- Fisheries WA
- Albany Maritime Advisory Committee
- Great Southern Farmers Market of Albany Inc.
- Albany Senior High School – Science Department
- Peter Watson, MLA for Albany
- Green Skills
- Albany Environment Centre
- Albany Maritime Heritage Association.

The key issues associated with the Albany Waterfront Project raised by the Albany DoE and CALM are included in Table 4

Public Forum No. 1

The first forum in October 2003 was attended by 100 people over two days. Plans and photographs were displayed and used as a basis for written and verbal submissions on ideas, issues and concerns. There was general support for the early concept plans with most concerns regarding water quality, seagrass, public access and recreation.

Public Forum No. 2

Draft Concept Plan Options were displayed at the second forum held in February 2004. The options were developed from background research, regulatory authority requirements and issues and public comment received from the first public forum. Public comment on the draft options was received and feedback was focussed on public amenity, design aspects and desired land uses. The only environmental issue raised in the 65 submissions was water circulation.

Public Forum No. 3

The consultation results were used to prepare a Draft Concept Plan that was put forward for comment at the third forum in March 2004. Forty three submissions were received on the Draft Concept Plan with environment issues raised including water circulation, seagrass monitoring, manage seagrass wrack accumulation and potential sediment contamination in any dredge spoil.

Public Forum No. 4

The fourth public forum was held on 30 April and 1st May 2004, preceded by advertisements in local papers and the website with an invitation to make submissions. Displays of the updated Draft Concept Plan were held for one month at the City Library and at the GSDC. Newsletters were also produced outlining the development and the consultation process and were distributed as inserts in over 17,000 copies of a local newspaper. General public submissions were received at the GSDC with 190 submissions received.

Key environmental issues raised in the public forums are addressed in Table 4.

Public survey

The Survey Research Centre of the University of Western Australia (UWA) was contracted as an independent market research consultant to prepare a questionnaire that sought the views of a sample of City of Albany ratepayers on the development layout, precincts and broad land uses, such as tourist (short stay) accommodation, marine retail and tourist facilities (Survey Research Centre 2004).

The survey was distributed by the Survey Research Centre by mail and 538 completed surveys were received. The survey results showed that 89% of respondents supported the aims of the project, including the Protected Harbour development, while 91% of respondents believe that the development was important to the future of Albany. The survey included a question “What types of development would you like to see?”, followed by a list of potential land uses. Results showed that 66% of respondents supported a Protected Harbour component of the project.

The main areas of concern raised in the survey were transport (noise, fumes, road safety) and continued access to the port. These issues are most relevant to the approved Albany Waterfront Project - Foreshore Redevelopment.

Concept plan approval

The Concept Plan was adopted by the Albany City Council and endorsed by State Government in mid 2005. The information contained within the Concept Plan has been refined and further developed to create a Structure Plan.

4.1.4 Project development 2005 - 2006

Structure Plan 2005/6

The City of Albany adopted the Structure Plan for the Albany Waterfront project on 16 May 2006 following a public comment period. The Structure Plan built on the original Concept Plan with an increased capacity for boats in the Protected Harbour in response to requests for the project to meet long-term demand.

Precinct Plan 2006

The Draft Precinct Plan and detailed Design Guidelines were released for public comment in July 2006. The plan identifies five distinct precincts within the Albany Waterfront area and outlines the vision, objectives and detailed planning and design guidelines for each. The final Precinct Plan and Design Guidelines will guide the City's decision making for all development applications and infrastructure provision within the area.

During the public comment period, the draft Precinct Plan was available on the Albany Waterfront website and displayed in the library, City of Albany offices and the local shopping centre.

4.1.5 Community Reference Group

In 2006, a Community Reference Group (CRG) was formed to provide community input into the Albany Waterfront Project (Table 3). The role of the CRG is to:

1. Convey general community perspectives to assist LandCorp to manage the environmental aspects of the site in a manner which will earn the support of the community.
2. Bring to the attention of LandCorp any general community concerns or specific issues about the future of the site which may have the potential to impact its acceptance by the wider community.
3. To assist in relaying to the wider community information and views about aspects of the proposed site including testing, potential remediation options and site validation.
4. To provide two-way information flow between the community and LandCorp.

The membership of the CRG consists of both invited/appointed members and self-nominated members from across the local community to ensure that a cross section of views is represented. Appointments to the CRG have initially been for two years and will be reviewed annually.

The community reference group has been involved in the development of the Structure Plan and Precinct Plan, and will continue to be consulted during the environmental assessment and construction phases of the project.

Table 3 Members of the Community Reference Group

Association	Representative
LandCorp	Jon Bettink
South Coast Progress Association (Ward/ residents Association) Active interest in environmental issues	Kim Stanton
Commercial Operator	John Woodbury
Port Customer Group	Richard Simonitis
Albany Chamber of Commerce President	Ian Howard
Silver Star Cruises (charter boat)	Paul Guest
Fishing industry	David Wheatcroft
Barrie Bickford & Associates (adjoining business)	Barrie Bickford
Community Representative	Andrew Markovs
Community Representative	Trudi Anderson
Local indigenous group representative	Vernice Gillies

CRG Meeting No.1

The Draft Structure Plan and the environmental impact assessment process for the whole Albany Waterfront Project were outlined at the first CRG meeting. The key issues raised by the CRG in response to the Draft Structure Plan were views, building heights, boat harbour capacity, access links, traffic and parking. Environmental issues raised by the CRG are addressed in Table 4.

CRG Meeting No. 2

More detailed information was presented to the CRG on the key environmental factors, the potential impacts associated with the Protected Harbour proposal and environmental investigations being undertaken were described. Environmental issues raised by the CRG are addressed in Table 4.

CRG Meeting regarding environmental issues

In October 2006, a meeting with the CRG members was held specifically to discuss environmental issues regarding the Protected Harbour Development. All members of the CRG had previously received a draft version of the EPS document. The issues raised by the CRG at this meeting are addressed in Table 4.

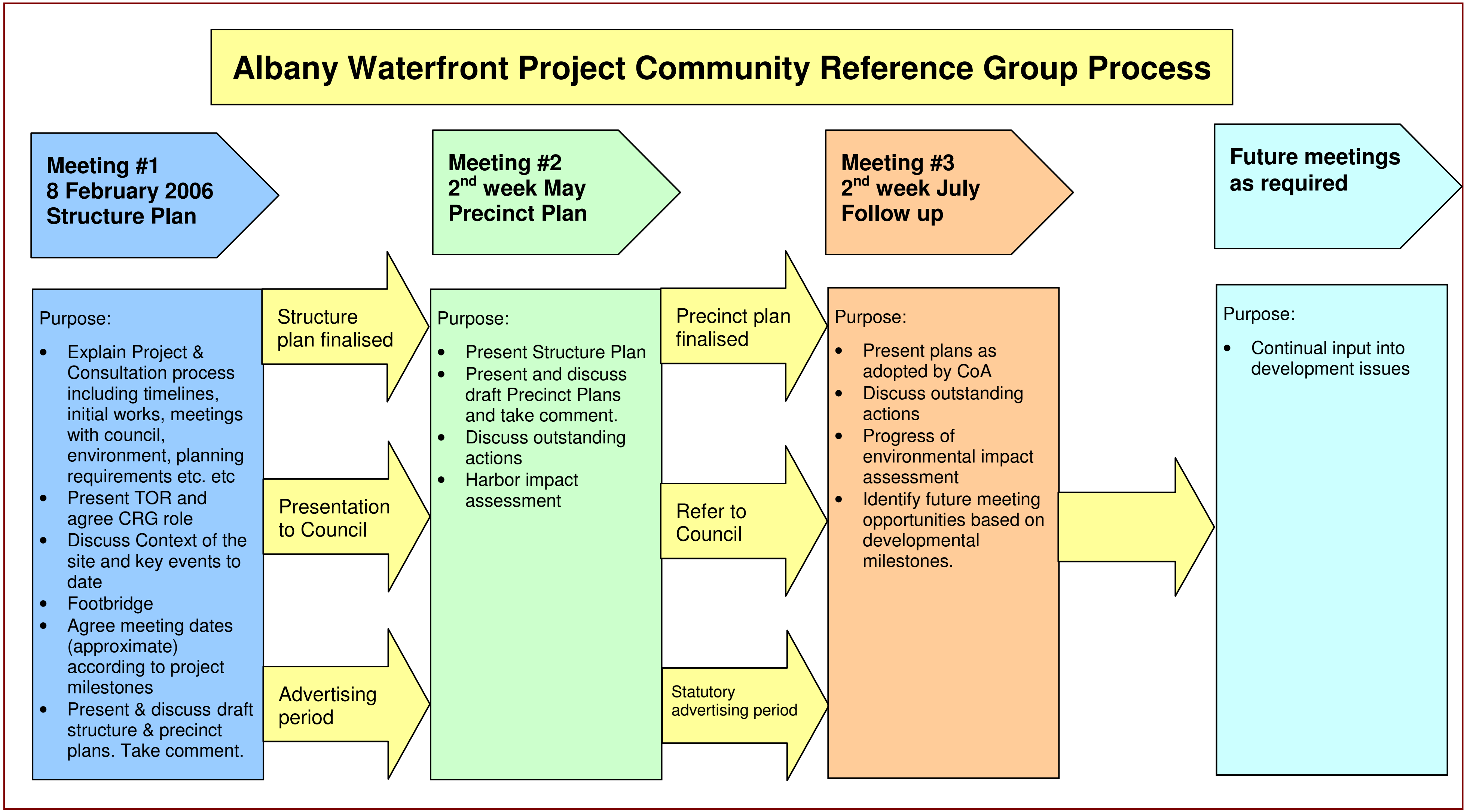


Figure 10 Community Reference Group process

4.1.6 Other consultation during preparation of EPS

Albany Environment Centre

The Albany Environment Centre was briefed on the Protected Harbour proposal and the key environmental factors associated with the proposal on 14 July 2006. The issues raised by the Albany Environment Centre representatives and responses to the issues are included in Table 4.

Department of Water

The regional DoW was briefed on the proposal, the key environmental factors and investigations on 14 July 2006. Officers indicated that the key issue was the management of turbidity during construction. This was considered a social as well as an environmental issue due to the high visual amenity values of the site. Management measures should be designed in consultation with the regional office of the DoW and should comply with the *Waterways Conservation Act 1976*.

The transplantation of seagrass as an offset for seagrass losses associated with the project was supported.

Responses to issues raised are included in Table 4.

Conservation Council

Members of the Conservation Council were briefed during July 2006 on the proposal, the key environmental factors and investigations being undertaken. Key issues raised during the discussion and responses are included in Table 4.

Table 4 Stakeholder key issues and responses

Stakeholder	Consultation	Issue	Response
2006: Community Reference Group	CRG meetings and project information	Flushing of the boat harbour	Addressed in Section 5.4.3.
		Alternative designs of breakwater to facilitate flushing	The final design of the harbour has improved predicted flushing from 5-8 days to 3.4 to 6 days. The option of using a floating internal breakwater (a far more expensive option) to maximise flushing was also modelled (Appendix 4) but only made a small difference (average 1 day) to flushing times and so is not proposed. Because the marina is a relatively small structure, additional openings in the breakwater would have a significant effect on the area available for mooring. Additionally – and more importantly from the ecological point of view – seagrass wrack tends to build up on the south-western side of the existing Albany Town Jetty, and any opening on the south-western side may result in wrack material accumulating in the Protected Harbour. This could create considerable water quality problems, as has been found at the Jurien Boat harbour and Geographe Bay marina. Given these constraints, sub-tidal culverts may be the only 'opening' option for improving flushing—if this is deemed the best management option for achieving desired water quality. It is not anticipated that water quality in the protected harbour will adversely affect the environmental values of the Protected Harbour or the broader environment of Princess Royal Harbour. The five year environmental performance review for the protected harbour will allow the flushing of the harbour to be reviewed and management options considered, if necessary.
		Accumulation of floating debris	Floating debris will accumulate in a few locations in the proposed marina. This will be managed by prohibiting the discharge of rubbish into the marina and periodic removal of any debris that accumulates.
2006: Community Reference Group cont'	CRG meetings and project information cont'	Heritage – disturbance of archaeological material during excavation	An archaeological assessment will be undertaken prior to construction and archaeological monitoring will be undertaken during construction as detailed in the CEMP to ensure compliance legislative and WA Museum heritage requirements.
		Native title	Native Title has been extinguished from the project area and the adjacent foreshore as it is reclaimed land and the foreshore and water body has been gazetted as Marine and Harbours (Section 3.1.3).
		More information requested on construction	Additional information on construction has been added to section 2.3.
		Stormwater	Refer to Section 5.4.3
		Climate change impacts	Climate change may affect sea water levels and the frequency of storms. The Protected Harbour Development has been designed in accordance with Department of Planning and Infrastructure guidelines, which include consideration of climate change. The project will provide protection to the adjacent foreshore during storms. Climate change is not expected to exacerbate the potential impacts of the project and is not addressed further in the EPS.

Stakeholder	Consultation	Issue	Response
		Level of assessment	The CRG was advised that the EPS was considered the likely level of assessment but that the level of assessment is set by the Environmental Protection Authority and is open to public appeals to the Minister for the Environment.
		Dredging period	A small volume (15,000m^3) will be excavated from sand platforms; the construction timeline is outlined in Section 2.3.
		Traffic	A traffic study has been undertaken and is described in Section 8.4
		Environmental monitoring and auditing	The monitoring requirements are outlined under each key environmental factor in Sections 5 to 6. The monitoring requirements are set out in the CEMP.
		Public open space	The project area consists of public waterways, parking, fishing hardstand area, public beach and the breakwater. The only area that may have restricted access is the fishing industry area. As the project area consists mostly of water area and reclamation works, parks and green spaces are not appropriate to the design. Public open space has been incorporated into the adjacent foreshore development.
2006: Albany Environment Centre	Project briefing and discussion	Stormwater from car park areas within the Albany Waterfront Project should drain to swales alongside Princess Royal Drive.	Stormwater generated within the Albany Foreshore Redevelopment will be managed by LandCorp. Stormwater generated from the fishing hardstand and parking areas will be collected on site and passed through a gross pollutant trap before being discharged to the harbour.
2006: Albany Environment Centre cont'	Project briefing and discussion cont'	Potential for turbidity impacts on seagrass during construction. Protection of seagrass during the construction of the breakwater.	The proposal has been designed to reduce the generation of turbidity by carrying out the deepening of the harbour after construction of the main breakwater and behind a silt curtain. Monitoring of water quality during construction and contingency measures are proposed to manage water quality impacts during construction. Management of water quality during construction is addressed in Section 5.4.3 and in the context of seagrass in Section 6.4.
		Permanent monitoring of water quality within the marina and within Princess Royal Harbour.	Ongoing monitoring of water quality is proposed. Monitoring is described in Section 5.4.3.
		Protection of the remaining seagrass in the Princess Royal Harbour.	The proposed monitoring of seagrass is described in Section 6.4 and offsets for losses are addressed in Section 6.4.2.
		Offset of unavoidable seagrass loss	Offsets for seagrass losses are addressed in Section 6.4.2
		Accumulation of seagrass wrack	Addressed in Section 7.4.2.
2006: Albany Department of Water	Project briefings, document review and discussion	Management of turbidity during construction	Construction impacts on marine water quality are recognised and addressed in Section 5.4.3.
		Management measures should be designed in consultation with the regional office of the DoW and should comply with the *Waterways Conservation Act 1976*.	The DoW will be considered an advisory agency for the preparation of the CEMP.
		The transplantation of seagrass as an offset for seagrass losses	This offset is proposed and is described in Section 6.4.2.

Stakeholder	Consultation	Issue	Response
		Suitability of excavated sediment for use as a beach	The creation of beaches is no longer part of this proposal.
		Monitoring program should be simple and agreed with DoW	The monitoring program will be detailed in the CEMP that will be prepared in consultation with DoW.
2006: Conservation Council	Project briefing and discussion	Use deeper parts of the Protected Harbour first and undertake dredging later when demand for boat pens increases?	A small amount (15,000 m^3) of material will be excavated from sand platforms to deepen the harbour in the northwest corner.
		Disposal of excavated sediment not suitable for reclamation purposes	The results of the sediment analysis (Appendix 1) indicated that the sediments were suitable for use as reclamation material. The sampling was undertaken to the full excavation depth and across the excavation area and is expected to accurately represent the material that will be excavated. The conclusion of the sampling program was that the majority of material would be suitable for reclamation. Any material not geotechnically suitable will be disposed of to landfill.
2005	Public consultation through advertising and public comment periods regarding the Concept Plan and Structure Plan	No new environmental issues raised. Discussions centred on planning issues	Not applicable.
2003 and 2004: General public	Four public forums in 2003 and 2004 regarding the whole Albany Waterfront Project	Water circulation, potential for stagnant water	Modelling indicates that the Protected Harbour will be adequately flushed (Section 5.4.3)
2003 and 2004: General public cont'	Four public forums in 2003 and 2004 regarding the whole Albany Waterfront Project cont'	Sand movement	Coastal processes and potential accumulation of sand is addressed in 7.4.2
		Noise and public safety issues associated with traffic	Traffic issues are addressed in Section 8.4. As part of the Albany Foreshore Development, an extra lane will be added to Princess Royal Drive so that traffic going to the harbour will not interrupt Port traffic. A pedestrian overpass will be constructed to ensure easy and safe access to the development from the town centre.
		Impacts on seagrass, monitoring required	Seagrass impacts and offsets are addressed in Section 6.4.
		Maintain or improve recreational opportunities and access	The Protected Harbour Development is a public project that aims to increase the opportunity for boating and marine recreation in Albany. Full public access will be allowed along the foreshore and breakwater. The only area that may have limited access is the fishing hardstand area.
		Adequate parkland	Public open space has been incorporated into the adjacent foreshore development.
		Health impact of beach reclamation	The creation of beaches is no longer part of this proposal.
		The accumulation of seagrass wrack	The accumulation of seagrass wrack west of the Albany Town Jetty is an issue that already occurs and will be managed by the City of Albany (Section 7.4.2).
		Potential for sediment contamination in dredge spoil.	Sampling indicates that the sediment to be excavated meets all health and environmental quality criteria (Section 8.1).

Stakeholder	Consultation	Issue	Response
		Diesel fumes and noise	Odour and noise are addressed in Section 8.2
2003: Albany DoE	Project briefing and discussion	Contaminated sediments containing PAHs	No contaminants in the material to be excavated exceeds any health or ecological criteria. It is concluded that, with respect to contaminants, excavated material from the project area will be suitable for reclamation works and no further testing is required. This is addressed in Section 8.1.4
		Seagrass impacts	Direct and indirect seagrass impacts have been defined and all losses will be offset. This issue is addressed in Section 6.4.
		Water circulation and coastal processes	The Protected Harbour is expected to flush in an acceptable time frame (Section 5.4.3). There is expected to be some accumulation of sand to the west of the Albany Town Jetty that will change the beach orientation by 10 to 20 degrees. This is addressed in section 7.4.2
		Groundwater and soil contamination	A Marine Risk Assessment was prepared by Oceanica (2006b), which considered groundwater quality and soil contamination of the foreshore and its potential impact on the marine environment. The conclusions of this report are addressed in Section 5.2 and the report is included in full in Appendix 2. There is no significant contamination within the area to be excavated (Section 8.1)
2003: Albany DoE cont'	Project briefing and discussion cont'	Construction impacts – turbidity	The proposal has been designed to reduce the generation of turbidity by excavation and reclamation being undertaken after construction of the main breakwater and behind a silt curtain. Monitoring of water quality during construction and contingency measures are proposed to manage water quality impacts during construction. Management of water quality during construction is addressed in Section 1.
		Stormwater treatment	Stormwater generated within the Albany Foreshore Redevelopment will be managed by LandCorp. Stormwater generated from the fishing industry hardstand and parking areas will be collected on site and treated through a gross pollutant trap before being discharged to the harbour.
2003: CALM	Project briefing and discussion	Seagrass habitat impacts during and after construction	There is expected to be up to 1.547 ha of seagrass lost through direct and indirect losses. Most of the seagrass that may be affected is <15% density. All seagrass losses will be offset with seagrass rehabilitation. Seagrass impacts are addressed in Section 6.4.
		Impact on marine mammals from sediment plume	The potential impacts on water quality during construction are addressed in Section 1.
		Entanglement or entrapment of marine mammals after construction	The potential impacts of construction on marine fauna is addressed in Section 6.2.2.
		Impacts on invertebrates	The greatest potential impact on marine fauna from the project is the loss of seagrass habitat. All seagrass lost will be offset with rehabilitation so the impact of habitat loss will be temporary. See Section 6.4.
2000: Foreshore Focus Group	Group recommendations	Twenty four hour access to Port	This has been incorporated to the overall design of the Albany Waterfront Project. Both rail and road access to the Port has been maintained.
		Working boat harbour	The Protected Harbour will be a working boat harbour.

Stakeholder	Consultation	Issue	Response
		Access to water's edge	Full public access will be allowed along the foreshore and breakwater. The only area that may have limited access is the fishing hardstand area.
		Dredging to west of Albany Town Jetty	No dredging or excavation is proposed west of the Albany Town Jetty.
		Marine industrial/mixed business to east Albany Town Jetty.	This has been incorporated into the planning for the project and a fishing industry area will be constructed next to the tug boat harbour.
1995: General public	CER public consultation	Stormwater management	Stormwater generated from the fishing hardstand and parking areas will be collected on site and treated as necessary before being discharged to the harbour.
		Disposal of contaminated soil	There is no soil on the site that exceeds health or environmental criteria.
		Noise and traffic management	Addressed in Sections 8.2 and 8.4.
		Reclamation and reclamation management	The construction process will be carried out to minimise impacts on marine water quality. A CEMP will be prepared to ensure construction is carried out appropriately.
1995: General public cont'	CER public consultation cont'	Loss of seagrass communities	Seagrass loss and offset with rehabilitation is outlined in Section 6.4.
		Potential impact of any future dredging.	Maintenance dredging is unlikely to be required due to the low level of longshore sediment transfer in the area and the very limited extent of proposed deepening in the project area (15,000 m^3).

4.2 ENVIRONMENTAL FACTORS AND PRELIMINARY EIA

Environmental factors and aspects were identified through a review of previous environmental assessments, community consultation and targeted agency consultation.

The level of environmental risk posed by an aspect (source of impact) of the proposal is defined by its likelihood of occurrence, its significance and the level of confidence in those predictions. A preliminary impact assessment was conducted to assess the likelihood and consequence of potential impacts in relation to each factor and then an initial assessment of residual risk following application of mitigation measures. Factors that had potential impacts with negligible inherent risk were not considered other environmental factors. The proposed management and impacts on these 'other environmental factors' are outlined in Section 8.

4.3 DETAILED ASSESSMENT OF KEY ENVIRONMENTAL FACTORS

Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the affected environment, and upon the intensity, duration, magnitude and geographic extent of the impacts. The ease and timescale in which impacts may be remedied also affects significance.

Technical information, relevant policy and legislation, and outcomes of the consultation process have been considered in defining the sensitivity, value and quality of the environment. The existing environment section under each factor describes the technical information available on the environment. The legislative and policy context describes the statutory requirements, environmental policy and guidance that are relevant to the environmental factor.

The assessment of potential impacts, mitigation and expected outcome:

- outlines the intensity, duration, magnitude and geographic extent of the impacts
- discusses the significance and/or likelihood of the potential impacts
- outlines the proposed mitigation measures and their likely effectiveness
- makes conclusions about the expected environmental outcome associated with the proposal and its acceptability.

Key environmental factors addressed in the assessment are:

1. Marine water quality
2. Marine ecosystem
3. Coastal processes.

Other environmental factors addressed in less detail:

- sediment contamination
- dust, noise and odour
- heritage and culture
- traffic.

5. MARINE WATER QUALITY

5.1 EPA OBJECTIVE

The EPA objective for water quality in Princess Royal Harbour is:

To ensure that emissions do not adversely affect environmental values of Princess Royal Harbour or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

5.2 DESCRIPTION

5.2.1 Water circulation

The total water volume of Princess Royal Harbour is approximately 90×10^6 m^3 and up to 30×10^6 m^3 of water may leave or enter the Harbour within 8 hrs of rising tides and 16 hrs of falling tides (Mills & D' Adamo 1993). The water accelerates as it passes through the narrow Princess Royal Harbour entrance channel with current speeds up to 0.5 m/s. The funnelling of the tidal flows builds up momentum in the water which is an important factor in the water exchange between the harbour and King George Sound.

The waters of the Harbour are generally well mixed by wind and tides. Wind strongly influences circulation in Princess Royal Harbour. The predominant circulation pattern is a large anti-clockwise gyre when winds are from the north through west (mainly in winter) (D'Adamo et al. 1992). A large clockwise gyre operates when winds are from the east to south (mainly in summer), and south-west winds may generate two counter-rotating gyres (WorleyParsons 2006 at Appendix 3). Smaller gyres that run counter to the main gyres may also develop during periods of variable winds (Mills & Brady 1985). Under typical conditions of wind and tide, the residence time of Harbour waters (before exchange with oceanic waters) is about 10 to 20 days (D'Adamo et al. 1992). Stratification in Princess Royal Harbour is generally weak, and is readily susceptible to vertical mixing by wind stress (EPA 1990a).

5.2.2 Water quality

Historical water quality in Princess Royal Harbour

No rivers discharge into Princess Royal Harbour and the only freshwater input comes from groundwater, surface runoff and direct rainfall. Due to the low level of freshwater input (about 10% of total Harbour volume per year; D'Adamo et al. 1992) the waters of Princess Royal Harbour are essentially marine (salinity 31–37 parts per thousand (ppt) compared with marine salinities of ~35 ppt; Atkins et al. 1980).

The catchment of Princess Royal Harbour is very small (~8350 ha) and includes the town and port of Albany (~235 ha). The volume of surface runoff annually is estimated to be 6140 ML or 7% of the total volume of the harbour (ATA Environmental 2000). A drainage network collects surface runoff from agricultural land, the local rubbish tip (the Hanrahan Refuse Site) and effluent from local industrial and light industrial areas and a cattle saleyard. The drainage network coalesces into a small number of drains that discharge into the north-western end of the Harbour (Mills 1987).

The water quality of Princess Royal Harbour deteriorated in the 1970's and 80's, largely due to the disposal of waste water from the woollen mills, fertiliser factory, fish processing and vegetable processing factories that had been set up along the shoreline.

Historic sources of contamination of Princess Royal Harbour include (EPA 1990a):

- potato processing factory: washing and cooking effluent
- abattoir: effluent from the killing floor and the stock holding yards
- fish processing factory: effluent from fish washing and scaling
- wool processing factory: effluent from the dyeing process (included heavy metals such as zinc and chromium)
- fertiliser factory runoff with high levels of nitrogen and phosphorous, as well as heavy metals (lead and mercury)
- groundwater inputs with high nutrient loadings from point sources such as piggeries and septic tanks.

In 1984, the western end of Princess Royal Harbour was closed to fishing due to contamination with heavy metals (it has since been re-opened). The direct discharge of effluent from CSBP stopped in 1984 and changes were made to the dyeing process at the woollen mill to reduce contaminant outputs (EPA 1990a). Since this time, the water quality in Princess Royal Harbour has improved.

The water quality of Princess Royal Harbour has been studied since the early 1980's. Historical water quality monitoring in Princess Royal Harbour has focussed on nutrient-related effects, especially the growth of phytoplankton, measured as chlorophyll a levels. The chlorophyll a concentrations measured in Princess Royal Harbour since 1980 show that water quality appears to have improved (Table 5).

Table 5 Changes in chlorophyll a 1980 to 2006

Study	Sampling regime	Chlorophyll a mean average (µg/L)	Chlorophyll a maximum (µg/L)
Atkins et al. 1980	24 sites sampled monthly Dec 1978 to Nov 1979	1.4	3.8 (Dec 1978) 2.5 (Feb 1979
Albany Harbours Environmental Study (AHES) (EPA 1990a)	5 sites sampled monthly in summer and twice- monthly in winter Dec 1987 to Feb 1989	<1	
Hillman et al. 1991 re-analysed data from the AHES for comparison with Atkins et al. 1980	Dec 1987 to Nov 1988	0.6	
Hillman et al. 1990	16 sites Feb 1988	0.4	
Water & Rivers Commission in Helleren & Pearce 2000	5 sites, Mar to Dec 1997	<1	
Oceanica 2008	5 sites sampled monthly Aug 2005 to Jul 2006	0.6	1.0

By 1987/88, the chlorophyll a concentrations in Princess Royal Harbour had decreased significantly (Table 5) and were only slightly higher than concentrations in King George Sound. This change has been attributed to the strategies adopted to improve water quality during the intervening period (Hillman et al. 1990, 1991).

Recent sampling (Oceanica 2008 at Appendix 1) during the period from August 2005 to July 2006 recorded average chlorophyll a concentrations of 0.6 µg/L, similar to the 1987/88 measurements (Hillman et al. 1991). However, between 1988 and 1995, estimated nitrogen inputs to Princess Royal Harbour have decreased significantly from 61.8 tonnes in 1988 to 21.9 tonnes in 1995 (Table 6) and total phosphorus load decreased from 17.7 tonnes to 2.98 tonnes (Water and Rivers Commission, unpublished data).

Chlorophyll a concentrations were already low by 1988 even though nutrient loads were still high. It is likely that the nutrients were being taken up by the macroalgae accumulations close to the shore, which effectively scavenge nutrient inputs before water-borne phytoplankton (indicated by chlorophyll a concentrations) have the opportunity to utilise them. Therefore, decreases in the nutrient loads since 1988 are likely to have decreased macroalgae growth in Princess Royal Harbour.

Table 6 Changes in nitrogen loads to Princess Royal Harbour

Nitrogen source	1988 nitrogen load (tonnes)	1995 nitrogen load (tonnes)
Vital Foods	3.4	2.8
Metro Meat	14.3	-
CSBP	10.0	2.0
Princess Royal Seafoods	2.5	1.2
Albany Woollen Mills	2.3	0.6
Industry Total	**32.5**	**6.6**
WAWA Treatment Plant	6.4	0.5
Urban catchment runoff	1.0	5.3
Rural catchment runoff	15.8	3.3
Total groundwater	6.1	6.1
Total other sources	**29.3**	**15.3**
TOTAL	**61.8**	**21.9**

Source: Water and Rivers Commission (unpublished data)

Present day water quality in Princess Royal Harbour

Nutrient inputs to Princess Royal Harbour are now predominately from catchment runoff and groundwater. A catchment runoff of 6140 ML/year (ATA Environmental 2000) equates to 9.2–12.3 tonnes/year nitrogen if modest concentrations of 1.5–2 mg/L nitrogen are assumed, while groundwater nitrogen loads are probably similar to 1995 (6.1 tonnes/year). The contribution from industrial discharges is relatively small.

Water quality monitoring for the preparation of this EPS was undertaken collaboratively with the DoW at the five sites originally used in the Albany Harbours Environmental Study in 1997 (Figure 11). The same monitoring methods used in the Albany Harbours Environmental Study were employed in this recent monitoring program from August 2005 to July 2006, including monthly surveys of secchi depths, light attenuation, profiles of salinity, temperature and oxygen and depth-integrated chlorophyll a levels.

The results of the 2005/6 sampling program are summarised in Table 7. Key findings from the sampling are:

1. There was very little difference in water quality between the five sampling sites.
2. Chlorophyll a levels are similar to marine water quality in King George Sound.
3. The nitrogen:phosphorous ratio was approximately 2:1. Phytoplankton growth typically requires about seven parts nitrogen to one part phosphorous. Therefore, phytoplankton growth is strongly limited by inorganic nitrogen inputs.
4. Salinity and temperature results indicated that there was very little stratification of the water column.
5. Dissolved oxygen levels were generally above 80%. Site 2 at the western end of the Harbour had the greatest variation in dissolved oxygen, with a minimum of 50% in January. This is likely to be caused by the decomposition of the macroalgal accumulations that occur in this area.
6. Water clarity at all sites and seasons was good, and the secchi depth exceeded water depth at all times except Site 1 which has a water depth ~12 m.

Table 7 Water quality in Princess Royal Harbour 2006

Parameter	Measured value
Dissolved inorganic nitrogen (µg/L)	10-15
Orthophosphate (µg/L)	5-8
Dissolved oxygen (August to April)	80-85 %
Dissolved oxygen (May to July)	5-125 %
Total suspended solids (mg/L)	1-4
Secchi depth	>5 m (water depth)
Chlorophyll a (µg/L)	0.6

Water quality at the project site

Water quality at the project site is similar to other parts of Princess Royal Harbour. Chlorophyll a levels at Site 1, which is representative of the project area, were very similar to Sites 2, 3 and 4, all of which were of slightly lesser water quality than Site 5 near the entrance to Princess Royal Harbour (Figure 11).

Nutrient inputs to waters at the project site are a result of groundwater discharge and catchment runoff through stormwater drains. ERM (2006) estimated that 81 m^3/day of groundwater would discharge into the project area (most likely scenario based on a hydraulic conductivity of 6 m/day). Based on groundwater quality data (ERM 2006), these groundwater flow rates give an associated inorganic nitrogen flux of 0.225 kg/day into waters within the project area (most likely scenario, with a best case to worst case range of 0.036–0.580 kg/day).

Figure 11 Water quality monitoring sites, 2005 to 2006

Stormwater discharge from Albany is predominately into waters west of the Albany Town Jetty through the York Street drains. There is one major existing stormwater discharge point (900 mm diameter pipe) into the protected harbour just west of the Duyfken Shed. This has a catchment of approximately 18 ha and will also service the Albany Foreshore Redevelopment. There is also one minor (450 mm diameter) existing stormwater discharge which picks up some of Princess Royal Drive and the Westnet rail marshalling yard.

The stormwater flow into the project area under conditions of low to moderate runoff is expected to be approximately 29 m^3/day with around 0.51 mg/L nitrogen (ERM 2006). This equates to an associated inorganic nitrogen flux of approximately 0.017 kg/day into the proposed marina during stormwater events, which is much less than that anticipated from groundwater.

A risk assessment of potentially toxic substances in groundwater and stormwater to the marine environment was undertaken based on sampling by ERM (2006). The risk assessment (Oceanica 2006b at Appendix 2) concluded that:

1. The foreshore adjacent to the proposed Protected Harbour is not a major source of contaminants to groundwater or stormwater.
2. Groundwater and stormwater discharging into waters adjacent to the project site are likely to undergo considerable dilution within a very short distance (10 m) of the shoreline.
3. Based on data for groundwater bores within 25 m of the shoreline and opportunistic sampling of stormwater drains during a period of low to moderate runoff, only zinc in groundwater and copper and zinc in stormwater exceed relevant environmental guidelines, which are for chronic effects. The level of nearshore dilution of these discharges is sufficient to ensure that those guidelines are rapidly met under most conditions, as the groundwater enters the marine environment. Even in occasional periods of low dilution (e.g. heavy stormwater runoff), the concentrations of zinc in groundwater and copper and zinc in stormwater are not likely to cause acute toxicity effects.
4. The level of groundwater dilution is sufficient to ensure that relevant guidelines for the protection of marine biota (ANZECC/ARMCANZ 2000) are met even if the extreme case is taken that localised contamination in bores up-gradient of the shoreline bores represent groundwater quality that might discharge to the marine environment at some time (these areas involve lower volumes of groundwater discharge, so the potential for dilution is also greater).
5. The levels of copper and zinc in surface sediments adjacent to the project area are well below ANZECC/ARMCANZ (2000) guidelines, indicating little risk due to partitioning of these metals from groundwater/stormwater to marine sediments.

5.3 LEGISLATIVE AND POLICY CONTEXT

5.3.1 National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Environment Conservation Council (ANZECC) together with the Agriculture and resource management Council of Australia and New Zealand (ARMCANZ) released a set of water quality guidelines for the protection of marine and freshwater ecosystems (ANZECC/ARMCANZ 2000).

The framework for applying the guidelines involves the following:

1. Define primary management aims which may be a statement of environmental values (EVs: particular uses or values of the environment) and level of protection (water quality necessary to protect values) to maintain these values.
2. Determine appropriate water quality guidelines (concentration of substances) tailored to local conditions.
3. Define water quality objectives to indicate the water quality to be achieved; may be concentrations of substances or a descriptive statement.
4. Monitoring and assessment program – to determine whether water quality objectives are being achieved.
5. Management response – to attain or maintain water quality objectives.

The guidelines recognise a number of EVs and assign “trigger values” for each value for substances that may impair water quality. The triggers do not demarcate the point at which adverse environmental effects occur, rather they are precautionary values that , as the name suggests , ‘trigger’ further investigation to see whether a problem exists or not.

5.3.2 EPA Environmental quality management framework for coastal waters of Western Australia

EPA Environmental Quality Management Framework

The EPA has developed an Environmental Quality Management Framework (Government of Western Australia 2004, based in turn on the National Water Quality Management Strategy) for marine waters which involves the development of the following hierarchy:

1. Environmental Values (EVs) using the five EVs prescribed by the national guidelines relevant to Exmouth Gulf – ecosystem health, recreation and aesthetics, cultural and spiritual, fishing and aquaculture, industrial water supply.
2. Environmental Quality Objectives (EQOs) are the outcomes required – equivalent to the management goals in ANZECC/ARCANZ (2000).
3. Level of ecological protection - maximum, high, moderate or low (relevant to ecosystem health value only).
4. Environmental Quality Criteria (EQC), which are numerical values (e.g. concentrations of substances) or statements by which to gauge whether the EQOs have been met.

There are four different levels of ecological protection each representing a different environmental quality condition and an associated limit of acceptable change that would apply across all areas including those areas where existing social uses have been recognised:

1. Maximum – no contaminants (pristine no change from background conditions) and no detectable change from natural variation of biological indicators.
2. High - very low levels of contaminants and no detectable change from natural variation of biological indicators.
3. Moderate – elevated levels of contaminants and moderate changes from natural variation of biological indicators
4. Low – high levels of contaminants and large changes from natural variation.

Princess Royal Harbour

Water quality objectives and criteria have not previously been set for Princess Royal Harbour. The Environmental Quality Management Framework (EQMF) for Princess Royal Harbour has been assumed to be similar to that developed for the waters of Cockburn Sound. The EQMF for Cockburn Sound is established in a State Environmental (Cockburn Sound) Policy (SEP), released by the Minister for Environment to declare, protect and maintain the EVs of Cockburn Sound (Government of Western Australia 2005). The SEP is consistent with the State's Water Quality Management Strategy (Government of Western Australia 2000) and is viewed by the EPA as a template for the management of Western Australian's coastal waters.

The EQC designated for Cockburn Sound, or the protocols used to derive them, have been adopted for Princess Royal Harbour in this document.

The EVs that apply to Princess Royal Harbour were:

- ecosystem health
- seafood safe for eating
- recreation and aesthetics
- cultural and spiritual
- industrial water supply.

Under the SEP for Cockburn Sound, the 'ecological' EVs of ecosystem health has different EQC for designated zones of high, moderate and low ecological protection, whereas the 'social' EVs (safe seafood, aquaculture, recreation and aesthetics, cultural and spiritual and industrial water supply) have the same EQC applied throughout the Sound. In accordance with the national water quality guidelines (ANZECC/ARMCANZ 2000), where two or more EVs are defined for a water body, the more conservative of the associated guidelines should become the water quality objectives as these define the level of environmental quality or water quality necessary to maintain all values. Therefore, as the protection of ecosystem health has the most conservative values, this value will be used for the establishment of water quality objectives in Princess Royal Harbour for this assessment.

The SEP for Cockburn Sound uses a risk based approach to environmental management, with two types of EQC, Environmental Quality Guidelines (EQGs) and Environmental Quality Standards (EQSs), that demarcate three levels of environmental risk as follows (EPA 2005):

- data below EQGs indicate a high degree of certainty that an EQO is met
- data above EQGs indicate a degree of uncertainty whether the EQO is met or not, and trigger a more comprehensive and sophisticated assessment against EQSs (if the EQSs are met, it signifies a low risk that the EQO isn't met, and routine monitoring against EQG continues)
- data above EQSs indicate a significant risk that the EQO has not been met, and management action may be required.

EQG are relatively simple measures of water quality whereas EQSs are more direct measures of biological effects such as seagrass health and phytoplankton blooms.

Based on precedents in the Cockburn Sound SEP, it has been assumed that the waters of Princess Royal Harbour will be classified a High Protection Zone and the waters within the Protected Harbour a

Moderate Protection Zone. Protocols established in the Cockburn Sound SEP have also been followed to derive potential EQC for key aspects of water quality.

Recent water quality monitoring undertaken to support this EPS has established that nutrient-related water quality in Princess Royal Harbour is very good. The 'reference' site chosen to derive EQC was Site 5 (Figure 11), and as water quality varied little year-round (as expected because no rivers discharge into Princess Royal Harbour), EQGs and EQSs were derived using the entire year's data set. This approach was not possible for secchi depth EQGs, which exceeded site depth at all sites except site 1 (the deepest site), and so Site 1 data were used for this purpose. Table 8 outlines the water quality EQC that have been developed for this assessment.

Table 8 Protocols for establishing water quality EQC and derived values

Parameter	High Protection Zone (outside Protected Harbour)			Moderate Protection Zone (within Protected Harbour		
	Protocol	EQG	EQS	Protocol	EQG	EQS
Nutrient enrichment						
Chlorophyll levels (µg/L)	80th percentile of data from suitable reference site	0.6 µg/L	n/a	95th percentile of data from suitable reference site	0.8 µg/L	n/a
Secchi depth (m)	20th percentile of data from suitable reference site	7.8 m	n/a	5th percentile of data from suitable reference site	6.6 m	n/a
TSS (mg/L)	80th percentile of data from suitable reference site	2.1 mg/L	n/a	95th percentile of data from suitable reference site	2.6 mg/L	n/a
Phytoplankton biomass						
Chlorophyll levels (µg/L)	3 times the median value from a suitable reference site	-	1.5 µg/L	3 times the 80th percentile from a suitable reference site	-	1.8 µg/L

5.3.3 Waterways Conservation Act 1976

The waters of Princess Royal Harbour come under the provisions of the *Waterways Conservation Act 1976*. All reclamation, excavation, construction of retaining walls, boat ramps and dewatering within or affecting Princess Royal Harbour is subject to licence approval under the *Waterways Conservation Act 1976*. The DoW is the lead agency with regards to this Act.

Section 48 of the *Waterways Conservation Act 1976* covers control of pollution, and use of these waters, which makes it an offence if polluting activities are undertaken. The *Waterways Conservation Act*'s pollution powers are currently addressed by DEC under the EP Act.

5.3.4 Sea Dumping Act 1981

The waters of Princess Royal Harbour do not come under the jurisdiction of the *Sea Dumping Act 1981*, as they are classified as waters within the limits of the State. No permit for dumping of dredged material is required as there will be no dumping of excavated material outside of Princess Royal Harbour.

5.4 IMPACT ASSESSMENT AND MITIGATION

5.4.1 Environmental aspects and potential impacts

The construction of solid breakwaters to create the Protected Harbour will alter the current water movement and reduce the water exchange within the sheltered harbour area. The reduction in water exchange is expected to cause some reduction in water quality through the lesser dilution of nutrient and contaminant inputs (boats, groundwater and stormwater) and the accumulation of nutrients and contaminants in the sediments of the Protected Harbour. Altered water circulation patterns may result in erosion and increased turbidity in some areas.

During the construction phase, there is also the potential for short term water quality impacts through increased turbidity, mobilisation of sediment and discharge of contaminants. Sediment contaminant levels in the area to be excavated meet relevant marine guidelines (Section 8.1), indicating a low risk of adverse effects on marine biota due to the release of contaminants during excavation and discharge of return water from the reclamation site.

The main aspects of the Protected Harbour that may affect water quality in adjacent areas of Princess Royal Harbour are:

- **Construction of the main breakwater and cut-off breakwater** will potentially cause localised, temporary increases in turbidity and potentially affect nearby seagrass
- **Dumping of excavated sediment** in the fishing industry reclamation area may affect water quality through stormwater runoff from sediment stockpiles
- **Anti-foulants, fuel usage and sullage may result in spills** from boats within the Protected Harbour may affect water quality
- **Presence of breakwater** will reduce water exchange which could potentially lead to reduced quality water within the boat harbour which could in turn affect the water quality in the adjacent waters of Princess Royal Harbour on an ongoing basis.

Potentially minor water quality impacts in Princess Royal Harbour that may result from the development include altered circulation patterns and any maintenance dredging required for navigational safety.

The sequence, timing and duration of construction activities are anticipated to be as follows:

1. Construction of main breakwater to commence in June 2008, expected duration 16 to 20 weeks
2. Construction of cut-off breakwater to commence in September 2008, expected duration 8 to 12 weeks
3. Marina revetment construction to commence in January 2009, expected duration 8 weeks
4. Excavation of a small portion of the marina basin using temporary sand platforms to provide access for the land based excavators. Works to commence in March 2009, expected duration 4 weeks
5. Fishing Industry area revetments and reclamation to commence in April 2009, expected duration 8 weeks.

5.4.2 Assessment and management of breakwater and seawall construction, excavation and reclamation

Breakwater construction

The main breakwater and cutoff breakwater will be constructed using ferricrete or granite. In relative terms, construction of the main breakwater core may potentially generate the greatest turbidity during the construction phase, although this will be less of a risk as limestone will not be used. The fines content of material supplied for breakwater construction will be limited by the engineering specifications that require that no more than 20% of the core material used in the construction of the breakwaters will have a diameter less than 0.1 m. The expected impact would be intermittent shading of seagrass up to about 50 m from the breakwater construction. Turbidity plumes are typically densest closest to the construction area and rapidly dissipate with both distance and time. No long-term impacts on nearby seagrass meadows due to breakwater construction are anticipated. This conclusion is supported by recent information obtained during a breakwater extension at Hillarys marina which involved the use of limestone over a nine week construction period in winter 2006, with the breakwater extending into Marmion Marine Park, potentially affecting seagrass meadows 150 m away. Seagrass health was intensively monitored during and after construction, but there were no evidence of short-term or long-term impacts on seagrass health and no exceedances of monitoring criteria (Oceanica 2006a).

Marina edge wall construction, reclamation and excavation works

The shallow parts of the marina basin will be deepened to between 2.3 to 2.8 m below AHD, using a land-based excavator working from a series of temporary sand platforms. A total of about 15,000 m^3 of sediment will be excavated and will be used as compacted fill to create the hardstand area in the fishing industry hardstand reclamation area (Figure 4) if it meets geotechnical criteria. All excavation will be undertaken behind a silt curtain.

Material that is not clean, cohesionless, free draining sand and is not free of all silty, organic or other deleterious inclusions is unsuitable for use as reclamation fill and will be transported off site for disposal in a licensed landfill site. All sand that is to be retained on site shall have not more than 8% of fractions finer than 0.075 mm. Care will be taken during excavation to ensure that materials that are suitable for use on site are kept separate from those that are unsuitable.

Detailed investigation of the sediment contaminant levels and acid sulphate soil potential has been undertaken (Section 8.1) within the proposed area for excavation to confirm that the material is suitable for reclamation works, with regard to contaminant levels (Oceanica 2008). The sampling sites were named according to the water depths at the site (0.5 m to 2.0 m) and position in the proposed excavation area; e.g. ranging from A at the eastern end to E at the western end.

Turbidity is mainly created by the suspension of fine particles. The particle size analysis of the sediments indicated that they are fine to medium sands, and the silt plus clay fraction in most of the sediments to be excavated, is minor (<10%, Table 9), indicating a reduced risk of persistent high turbidity due to suspended sediments due to excavation or in return water from the reclamation area.

The main risk associated with turbidity is smothering and reduction in light reaching nearby seagrass. However, no seagrass death or permanent impact on seagrass is expected due to turbidity generated during construction activities (either excavation, seawall or breakwater construction). Research undertaken during the 1988-1989 Albany Harbours Study established that notwithstanding the productivity of seagrasses in Princess Royal Harbour was affected by shading, they recovered within a year (EPA 1990a). These studies involved the use of screens to reduce the amount of light reaching seagrass by 80–99% for five months, which represents an impact of far greater duration and intensity than anticipated during construction of the marina.

Table 9 Particle size composition of sediments tested

Site and sediment layer to be tested	Fines content	Main size fraction/s*
0.5A: surface 0–0.5 m layer	0%	Fine/medium sand
0.5A: 0.5–1 m layer	2.46%	Fine/medium sand
0.5A: 1–1.5 m layer	8.11%	Fine/medium sand
0.5B: surface 0–0.5 m layer	1.41%	Fine/medium sand
0.5B: 0.5–1 m layer	17.56%	Fine sand
0.5B: 1–1.5 m layer	3.19%	Fine/medium sand
0.5C: surface 0–0.5 m layer	0%	Medium sand
0.5C: 0.5–1 m layer	21.18%	Fine sand
0.5D: surface 0–0.5 m layer	1.14%	Fine/medium sand
0.5D: 0.5–1 m layer	15.32%	Fine/medium sand
0.5E: surface 0–0.5 m layer	0%	Fine/medium sand
0.5E: 0.5–1 m layer	14.41%	Fine/medium sand
1.0A: surface 0–0.5 m layer	10.37%	Fine/medium sand
1.0A: 0.5–1 m layer	2.64%	Fine/medium sand
1.0B: surface 0–0.5 m layer	3.34%	Fine/medium sand
1.0B: 0.5–1 m layer	5.88%	Fine/medium sand
1.0C: surface 0–0.5 m layer	5.99%	Fine/medium sand
1.0D: surface 0–0.5 m layer	0-1.28%	Fine/medium sand
1.0E: surface 0–0.5 m layer	0%	Medium sand
1.5A: surface 0–0.5 m layer	23.05%	Fine/medium sand
1.5B: surface 0–0.5 m layer	14.97-25.4%	Fine/medium sand

*Fine sand (particle diameter 62–250 µm), medium sand (particle diameter 250–500 µm), coarse sand (particle diameter 500–2000 µm) or gravel (particle diameter 2000–10000 µm)

Mitigation measures

Mitigation measures proposed for construction impacts on water quality are as follows:

1. Construction of the marina edge wall, excavation for the marina basin and construction of the fishing area revetments and reclamation area will commence following completion of the two breakwaters. This construction phase will be carried out within the semi-confined area behind the breakwaters, providing a barrier and increased distance between active works and the seagrass west of the development area.
2. Installation of a silt curtain surrounding the excavation area to reduce any turbidity plume caused by the excavation and installation and removal of the sand access platforms.
3. Water quality and seagrass health will be monitored throughout the construction period and establishment of management response triggers.
4. Management of quarry practices to reduce fines content of material used for breakwater core

5. Breakwater construction and reclamation activities will be in accordance with management measures outlined in the CEMP (e.g. management of quarry practices to control fines content of breakwater material and contingency measures that include temporary cessation of construction activities).

Monitoring and contingencies

Monitoring during construction will focus on temporary changes in site-specific water turbidity, to safeguard against potential effects on nearby seagrass meadows. Monitoring for turbidity will be established and criteria set to act as triggers to initiate management action. These triggers are addressed in the CEMP. Visual monitoring using digital photography will be used to monitor movement and extent of the sediment plume daily during construction. Monitoring will also include logging of light attenuation as detailed in the CEMP.

If the established criteria are exceeded during construction, one or more of the following contingencies will be triggered according to the CEMP:

- Investigate and modify quarry practices to ensure selection of core material with low fines content, and/or washing of core material (only feasible for ferricrete)
- modify material selection and placement methods
- cease construction of the breakwater until conditions are more favourable
- install a silt curtain between the breakwater and the potentially affected seagrass beds.

The monitoring criteria and contingencies have been developed in consultation with the DoW and DEC and are addressed in the CEMP (Appendix 8).

Maintenance dredging

The bathymetry of the Protected Harbour slopes down to the deeper waters of Princess Royal Harbour so sediment is unlikely to accumulate in the marina. Also, the degree of longshore sediment transport in the vicinity of the Protected Harbour is minimal (Section 7). Therefore, minimal or no maintenance dredging is expected to be required.

5.4.3 Assessment and management of Protected Harbour and Princess Royal Harbour water quality

Water quality within any harbour is predominately determined by any contaminant inputs and how well it is ‘flushed’ with marine waters. Flushing times affect the dilution of nutrient and contaminant inputs, and therefore a variety of ecological processes (e.g. plant growth rates, toxicity responses) that depend on the concentrations of these substances.

The Protected Harbour will be calmer and less well flushed than adjacent waters. The calmer waters will encourage the accumulation of fine organic particles (e.g. dead plankton and plant material), and so will be more organically enriched than shallower/more exposed areas. Contaminants discharged to marine environments also typically accumulate in the sediments, especially in sheltered, relatively deep areas. As the requirement for deepening the Protected Harbour has been minimised and the proposed harbour is shallower than adjacent waters, there should be minimal accumulation of sediments in the Protected Harbour relative to other marinas.

Contaminants from stormwater and groundwater

Contaminants in the groundwater and stormwater discharging to the site do not represent a significant ecological risk to the marine waters of Princess Royal Harbour (Oceanica 2006b at Appendix 2). This is unlikely to change with the proposed development due to both the flushing characteristics and small scale of the development.

Stormwater from the Albany Foreshore Development and from within the Protected Harbour development (fishing hardstand areas, car parking) will be collected in the existing stormwater drains that discharge to the Protected Harbour area near the Duyfken Shed. As part of this project, gross pollutant traps will be installed on both stormwater drains to reduce the input of course material to the Protected Harbour. In addition, all drains in the carparking areas will have sediment traps to help minimise sediment outputs from the drainage system.

The existing fishing and boat ramp hardstand areas currently discharge directly into the harbour. Facilities will be updated and improved as part of this development, and a proper stormwater collection system installed with the stormwater treated onsite with a gross pollutant trap before being discharged to the Protected Harbour. This will improve the quality of the water from the parking and hardstand area discharging into the Protected Harbour area.

Fuel and sullage spills and anti-foulant

Any impact on water quality due to contaminants is expected to be largely associated with the concentration of boats within the Protected Harbour. The combination of reduced flushing, deeper waters and the concentration of boats has the potential to result in some build up of contaminants in sediments within the Protected Harbour.

Boats within the Protected Harbour are potential sources of hydrocarbons (released from engine emissions and accidental fuel spills), and heavy metals from anti-foulants (leaching from boat hulls), and sullage and other waste discharges (e.g. fish cleaning waste, debris and litter). The depth of the Protected Harbour is such that sediment re-suspension due to propeller wash or dragging of boat hulls is unlikely, and therefore any associated turbidity and release of contaminants from sediments should be minimal.

Mitigation measures proposed to address these potential impacts include:

1. Installation of improved refuelling facilities within the Protected Harbour.
2. Containment and clean up fuel spills within the Protected Harbour that may occur during re-fuelling. The configuration of the Harbour facilities offers better containment opportunity than the current situation.
3. Installation of sullage pump-out facilities, to minimise informal (and illegal) disposal of sewage wastes (this will also have regional benefits on water quality).
4. Decommissioning of the slipway and boat maintenance facility west of the tug boat harbour, currently a source of contamination, and covering most of this site with fill to create the hardstand area around the fishing industry precinct.
5. Review of performance.

Change to circulation patterns in Princess Royal Harbour

The Protected Harbour will result in altered circulation patterns within the project area itself, and also has the potential to alter circulation patterns in the broader Princess Royal Harbour.

The potential for the Protected Harbour to alter water circulation patterns in broader Princess Royal Harbour was investigated using the Danish Hydraulics Institute Mike3 flexible mesh model, a high quality model of proven performance in estuarine and coastal ecosystems both internationally and within Australia. A detailed description of the model setup is provided in Appendix 3, which presents results for an outdated marina design. The predicted flushing times for the final boat harbour design are presented in Appendix 4. The model simulates three dimensional free surface flows, and its flexible mesh makes it particularly useful in assessment of coastal circulation and mixing in complex water bodies, such as Princess Royal Harbour, where a variety of spatial scales are important.

The effect of the Protected Harbour on circulation characteristics was determined by relative comparison of model results between the existing conditions and the proposed development, and this was modelled for the three distinct hydrodynamic regimes identified for circulation patterns and flushing: 'summer', 'autumn' and 'winter-spring'. The model was qualitatively calibrated by comparison to results obtained by earlier studies (Mills 1987, Mills & D'Adamo 1993) and demonstrated good agreement with their results (Appendix 3).

A floating breakwater option for the internal cutoff breakwater was also modelled and showed slightly faster flushing times than the proposed development (Appendix 4). However the maximum design wave for commercially available floating breakwater systems is up to 1.0 m. The design wave for the site is about 1.2 to 1.3 m and therefore floating breakwaters are not a practical solution at present. Conventional rubble mound breakwaters are the appropriate approach for this site. (Mick Rogers, pers comm. 2007).

The Protected Harbour will have little effect on circulation patterns within Princess Royal Harbour (Appendix 3). This is probably because the Protected Harbour is a small-scale development compared to Princess Royal Harbour and is built around existing structures (the Albany Town Jetty and Tug Boat harbour breakwater), and only involves relatively minor extension of breakwater structures out into the main body of Princess Royal Harbour.

The potential Albany Port Authority upgrade associated with Grange Resources magnetite proposal (Grange Resources 2006) is likely to result in the entrance channel from King George Sound into Princess Royal Harbour becoming narrower and deeper. It is understood that potential impacts on the flushing and circulation of Princess Royal Harbour are being investigated by detailed modelling, with the intention of ensuring that narrowing of the channel due to reclamation is offset by increased depth due to dredging to allow analogous flow and flushing.

Protected Harbour flushing

Flushing of the Protected Harbour was estimated using the Danish Hydraulics Institute Mike3 flexible mesh model, by relative comparison of model results between the existing conditions and the proposed development (WorleyParsons 2006 at Appendix 3). Flushing times were estimated using the rate at which a dye (in the model) was diluted and dispersed in the Protected Harbour, and recording the time taken for the concentration to reduce to 37% of the initial concentration (commonly termed the 'e-folding time'). Changes to flushing times of the existing tug boat harbour (which will form the eastern side of the Protected Harbour) were also examined.

Under current conditions the e-folding time for the project area (open water) was predicted to be approximately 1 day, and 1–2 days for the Tug Boat Harbour. The post- development flushing times for the Tug Boat Harbour represent the time taken for water to flush out into the Protected Harbour. The Protected Harbour is predicted to flush within 3.4 to 6 days throughout the year, and the Tug Boat Harbour to have an independent flushing time of 1.2 to 3.3 days, an increase of approximately one day on present conditions (Table 10 and Appendix 4).

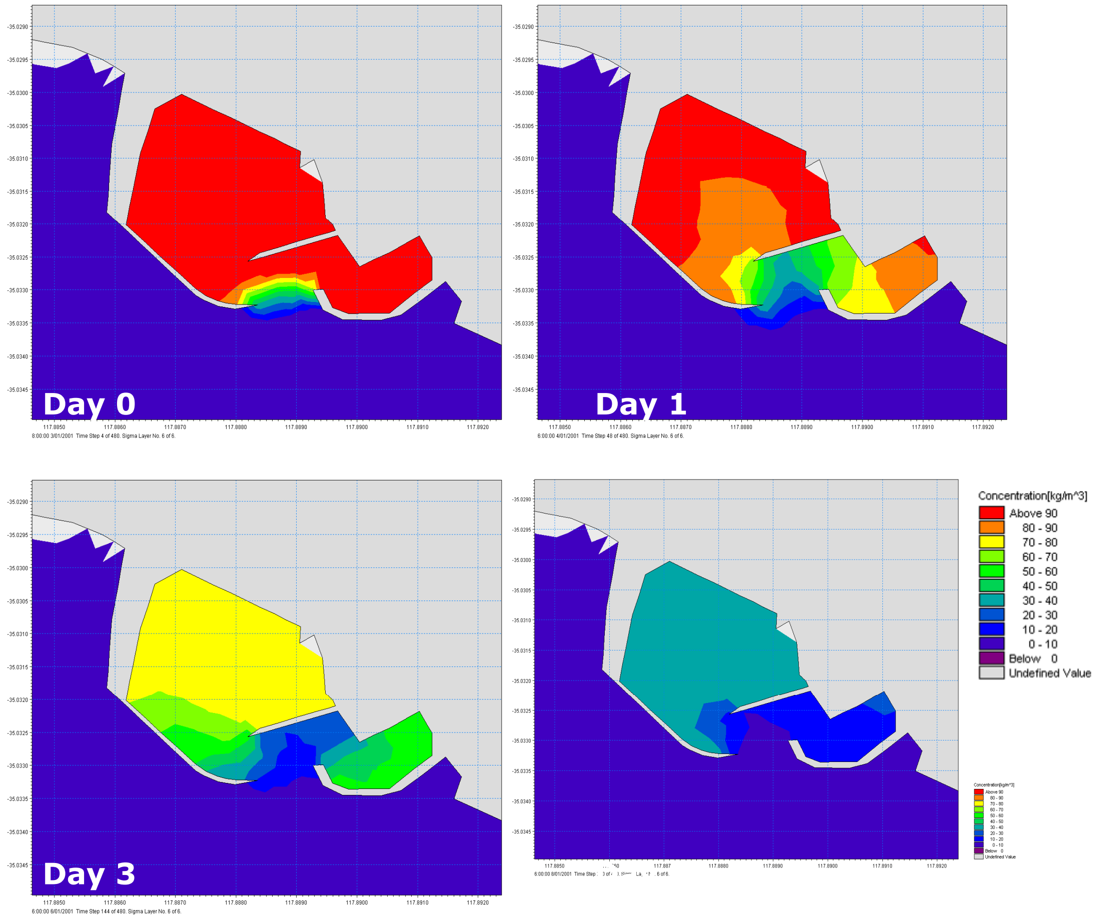
Table 10 Predicted flushing times (e-folding times) for waters within the Protected Harbour

Time of year and conditions during modelling	Post-development e-folding time (days) for entire Protected Harbour*	Post-development e-folding time (days) in Tug Boat Harbour
January		
1. Typical summer conditions with predominantly south-easterly winds with speed generally of 4 to 7 m/s. Tidal range varies between 0.5 m to 1.0 m	5.2	3.2
2. Southerly winds for first two days (speed 2 to 5 m/s) and then changing to stronger easterly winds (up to 10 m/s). Low tidal range of 0.4 m to 0.7 m.	5.4	2.5
3. Easterly winds for first two days (speed 3 to 9 m/s) and then after varying direction between east and southwest. Tidal range of ~ 1.0 m.	6.0	1.3
April		
1. Winds varying between north and west (speed up to 7 m/s) for first three days, and then winds between south and east with speed up to 9 m/s. Tidal range of 0.4 m to 0.6 m.	5.1	3.3
2. Dye simulation started in the middle of simulation 1. Wind direction varying between south and east for first three days. Wind constantly from the south day 4 to day 6, and thereafter constantly from the east. Wind strength typically between 3 to 8 m/s. Tidal range of approximately 0.5 m.	3.6	1.2
3. For first five days constant easterly winds (3 to 8 m/s), ending with a half day storm with wind speed up to 13 m/s. After storm, wind direction is southeast. Tidal range varies from 0.3 to 0.6 m.	5.3	2.0
July		
1. North-westerly winds (typical for winter) with speed of 5 to 7 m/s, and tidal range of approximately 0.8 m.	3.7	2.0
2. Predominantly north-westerly winds with speed of 4 to 6 m/s. Simulation starts with wind speed up to 10 m/s. Tidal range 0.7 m.	3.8	1.7
3. First three days North-westerly winds (3 to 9 m/s) and low tidal variation of 0.4 m. Then, winds are lighter (2 to 3 m/s) and vary between southeast and northeast, and tidal variation increases to 1.0 m.	3.4	1.7

* Including Tug Boat Harbour

There is little variation in flushing results between the seasons, presumably due to wind speeds and tides remaining similar in magnitude throughout the year (Table 10). The estimates are considered to be conservative, as density-driven effects (e.g. diurnal heating and cooling, groundwater discharge) were not included in the modelling.

Some parts near the entrance of the Protected Harbour flush in less time than suggested by the overall e-folding time. The impact on water quality outside the Protected Harbour will be minimal (Figure 12), and should effectively be below limits of detection for chlorophyll a levels (assuming chlorophyll levels within the harbour meet relevant EQC, and therefore are 1.8 μg/L or less) within 10–25 m of the harbour entrance.



Source: WorleyParsons 2006

Figure 12 Flushing sequence of Protect Harbour for an autumn period (April - case 1)

The predicted flushing times for the Protected Harbour were used in simple equilibrium 'box model' calculations to estimate potential chlorophyll a levels in the Protected Harbour, using dissolved inorganic nitrogen (DIN) as the modelled constituent (Appendix 5). This modelling was based on the assumption that phytoplankton growth is limited by DIN supply, and so incorporation of DIN into phytoplankton biomass was used to provide a conservative estimate of potential phytoplankton growth. The ratio of chlorophyll a to carbon, and of carbon to nitrogen in phytoplankton is relatively uniform (50C:1Chl a, and 5.7C:1N; by mass). If it is conservatively assumed that all available DIN is utilised by phytoplankton as new growth within the marina, the chlorophyll a concentration will be approximately 0.117 times the predicted DIN concentration. This approach provides a highly conservative guide to potential water quality (in terms of chlorophyll a levels).

The results obtained for the most likely scenario of groundwater nutrient inputs (see Appendix 5 for full set of scenarios modelled) and source water chlorophyll a levels (i.e. 'background' levels) are shown in Table 11, Table 12 and Table 13. The model results suggest that the chlorophyll concentrations in the Protected Harbour will increase by around 3.3 to 3.8-fold (assuming full conversion of DIN to phytoplankton growth), with values of 1.7–2.8 µg/L during most conditions (flushing times 3–4 days), and 1.9–3.2 µg/L in calmer conditions (6 days) (Appendix 5).

The efficiency with which DIN is converted to new growth (expressed as chlorophyll) depends on a range of other factors such as availability of other nutrients, light, temperature, and the phytoplankton species involved. The scientific literature indicates 10–50% of gross DIN uptake may be excreted as dissolved organic nitrogen (e.g. Diaz & Raimbault 2000, Flynn & Berry 1999, Pujo-Pay et al 1997, Slawyk et al, 1998). Nor does the model take into account uptake of DIN by sediment microalgae, or loss of phytoplankton due to grazing. For these reasons results have also been modelled for 75% utilisation of DIN (Table 12) – which is considered more realistic, and 50% utilisation of DIN (Table 13).

Table 11 Predicted increases in chlorophyll for waters within the Protected Harbour, assuming 100% utilisation of DIN by phytoplankton within marina

Flushing time	Chl a. level in 'source' water (µg/L)	Chl a. level in Protected Harbour (µg/L)	Relative increase
3.4 days	0.6	2.0	3.3
4 days	0.6	2.1	3.5
5 days	0.6	2.2	3.7
6 days	0.6	2.3	3.8

Table 12 Predicted increases in chlorophyll for waters within the Protected Harbour, assuming 75% utilisation of DIN by phytoplankton within marina

Flushing time	Chl a. level in 'source' water (µg/L)	Chl a. level in Protected Harbour (µg/L)	Relative increase
3.4 days	0.6	1.7	2.8
4 days	0.6	1.7	2.8
5 days	0.6	1.8	3.0
6 days	0.6	1.9	3.1

Table 13 Predicted increases in chlorophyll for waters within the Protected Harbour, assuming 50% utilisation of DIN by phytoplankton within marina

Flushing time	Chl a. level in 'source' water (µg/L)	Chl a. level in Protected Harbour (µg/L)	Relative increase
3.4 days	0.6	1.3	2.2
4 days	0.6	1.3	2.2
5 days	0.6	1.4	2.3
6 days	0.6	1.5	2.4

The results for 75–100% utilisation of DIN are reasonably consistent with data for other marinas:

- data for 1999/2000 summer in Hillary's Boat harbour, modelled flushing time ~4 days, chlorophyll a values ~3.4 times those of 'outside' waters (BBG 2001)
- data for 1999/2000 summer in Success Harbour, modelled flushing time ~1 day, chlorophyll a values ~2.1 times those of 'outside' waters (BBG 2001)
- data for 2005/2006 summer in Jervoise Bay Northern Harbour in Cockburn Sound, modelled flushing time of 10–11 days (BBG 2001), and recorded chlorophyll a levels of ~2.0–2.2 µg/L in summer 2005/2006, about 3.7 times those of outside waters (Oceanica 2006a).

Modelled flushing times for the Protected Harbour in Albany are intermediate between those of Hillary's Boat harbour and the Jervoise Bay Northern Harbour. On the basis of data for these Perth metropolitan locations, chlorophyll a levels in the Protected Harbour could be ~3 times those of outside waters. This is considered a conservative view because Hillary's Boat harbour has greater groundwater inputs of DIN, while Jervoise Bay Northern Harbour has a longer flushing time, and its groundwater nitrogen inputs/unit area are almost two orders of magnitude greater (0.7 tonnes/hectare) than for the Protected Harbour (0.011 tonnes/hectare) (Appendix 5). Predictions for Albany are also conservative because Perth coastal waters are more favourable for phytoplankton growth. as they experience far more hours of sunshine than Albany (annual average of 126 clear days in Perth versus 45 days in Albany; http://www.bom.gov.au/climate/averages/) and warmer water temperatures than Albany (17–24°C range versus 13–21°C; EPA 1990a). .

Water quality monitoring will include measurement of chlorophyll a levels, secchi depths and total suspended solids (TSS). Potential environmental quality criteria for these parameters have been established following the protocols for the Cockburn Sound SEP (Table 8).

The modelling results described above indicate that EQGs and EQSs (Table 8) for chlorophyll a levels in the High Protection Zone outside the Protected Harbour will easily be met. Hence, it is concluded that there is likely to be no significant impact on the water quality of Princess Royal Harbour from the existence and operation of the marina.

The EQGs for chlorophyll a levels in the Moderate Protection Zone within the Protected Harbour itself are not met by the modelling results, irrespective of the efficiency of DIN utilisation by phytoplankton (Table 12 and Table 13). More importantly, it is anticipated that the EQS for phytoplankton biomass for a Moderate Protection Zone (1.8 µg/L, equivalent to 3 times the 80th percentile from a suitable reference site, see Table 8) will be met within the Protected Harbour under most conditions, given that modelling of flushing times is conservative, and that a more realistic scenario for DIN utilisation is less than 100%.

It is proposed that the following management objectives are appropriate for the project, and are expected to be met by the proposed design:

- maintenance of water quality within the Protected Harbour such that the EVs of 'ecosystem health' (moderate level of protection), 'seafood safe for eating', 'industrial water supply', 'cultural and spiritual' and 'recreation and aesthetics' are protected (this will capture aspects of phytoplankton blooms, water clarity, faecal bacteria, potentially toxic species of phytoplankton and contaminants)
- maintenance of sediment quality within the Protected Harbour to protect the EV of 'ecosystem health' (moderate level of protection)
- maintenance of water quality within the Protected Harbour such that all EVs of 'ecosystem health' (high level of protection), 'seafood safe for eating', 'recreation and aesthetics' are protected in the adjacent waters of Princess Royal Harbour.

Other potential impacts of decreased water exchange or altered circulations within the Protected Harbour

The predicted increase in phytoplankton growth (and therefore higher chlorophyll levels in the water and lesser water clarity) due to reduced flushing of nutrient inputs to this area will encourage some build up of nutrients in sediments due to both increased phytoplankton growth and the increased depth and calmer water in the area (which facilitates more settling of organic material). Decreased water exchange and surface current velocities within the Protected Harbour have the potential to result in a decrease in vertical mixing. In very calm conditions, the wind may be insufficient to drive the vertical mixing and replenish oxygen supplies in bottom waters. This in turn may lead to increased rates of nutrient release from sediments and affect water quality.

Although vertical mixing within the Protected Harbour has not been directly modelled, the risk of very low oxygen conditions occurring is considered slight due to the shallow depth of the Protected Harbour, its orientation to prevailing wind directions and the absence of any major nutrient inputs that might lead to the development of organic-rich sediments. A comparative assessment was also made with the Jervoise Bay Northern Harbour in Cockburn Sound, which has similar flushing times to the Protected Harbour. Recent monitoring data for the Jervoise Bay Northern Harbour (Oceanica 2006a) do not indicate any periods of low oxygen. As the Protected Harbour experiences a similar wind climate, is much shallower and has far lower nutrient input per unit area than the Jervoise Bay Northern Harbour, it is not anticipated that it will experience low oxygen levels.

There is also some potential for altered circulation patterns which may cause drift seagrass and macroalgal material (commonly termed 'wrack') to accumulate within the Protected Harbour. The risk of this is low for the following reasons:

1. Wind-driven accumulations of wrack occur mainly on the north-west and south-east ends of Princess Royal Harbour, under the influence of the circulation patterns driven by strong south-west winds (EPA 1990a). The Protected Harbour is not in either of these areas of natural seagrass wrack accumulation.
2. Wind-driven wrack in the vicinity of the Protected Harbour is largely trapped on the western site of the Albany Town Jetty, with little evidence of accumulations east of the Albany Town Jetty.
3. The position of the Protected Harbour relative to the entrance to King George Sound, the prevailing circulation patterns (Appendix 3), the bathymetry of the Protected Harbour (i.e. sloping down to the deeper waters of Princess Royal Harbour) and the orientation of the breakwater are such that wrack is more likely to be directed past the breakwater on an outgoing tide, or accumulate in deeper waters offshore of the Protected Harbour on an incoming tide.

There may be some potential for the Protected Harbour to collect floating wrack (and other rubbish and suspended material) during an incoming tide under the circulation patterns that prevail with northwest winds (Figure 3.4 in Appendix 3).

Monitoring

Detailed monitoring measures during construction are addressed in the CEMP that has been developed for the proposal in consultation with the DoW and DEC ((Appendix 8) and includes:

- baseline monitoring of water quality and seagrass health at agreed sites
- ongoing monitoring of water quality and seagrass health at agreed sites
- agreed reporting requirements, management triggers for water quality and seagrass health, and required actions if management triggers are exceeded
- post-construction monitoring of seagrass health.

During operation, monitoring of water quality and sediment quality will be undertaken to ensure that the Ministerial Conditions are met. Recommended conditions are included in the EPA Report and these have been developed in consultation with the proponent as well as the relevant agencies.

The operational monitoring will include routine monitoring of water quality (salinity, temperature, dissolved oxygen, light attenuation, nutrients, chlorophyll and bacterial indicators) and sediment quality (metals, hydrocarbons) at sites within and outside the marina, and seagrass health (shoot density) at sites outside the marina.

Mitigation

If water or sediment quality monitoring indicates that pre-determined triggers are being exceeded as a result of the operation of the marina, contingencies will be implemented based on the cause of the water or sediment quality issues. Contingencies for water quality may include artificially enhancing mixing (e.g. pumping), nutrient stripping using macroalgae, and further investigations (e.g. phytoplankton community composition) to see if water quality is actually such that EQOs aren't being met. Contingency measures for sediment quality may include management of contaminant sources, removal of sediment or sediment amendment.

Although it is not anticipated that the water quality EQS for chlorophyll will be exceeded in the marina waters, some simple modelling was undertaken to examine the potential impact on marina flushing times by pumping, to confirm that mitigation is likely to be effective. For the purpose of this exercise, pumps capable of moving 5,000 m^3/day were examined, as such pumps are commonly used for site dewatering and so are readily available. The approach to modelling is described in Appendix 5, and the potential impact of 1–3 pumps is shown in Table 14.

Table 14 Predicted change in flushing times with pumping

Original flushing time	Flushing time with 1 pump	Flushing time with 2 pumps	Flushing time with 3 pumps
3.4 days	3.2 days	3.0 days	2.8 days
4 days	3.7 days	3.4 days	3.2 days
5 days	4.5 days	4.1 days	3.8 days
6 days	5.3 days	4.8 days	4.3 days

The results in Table 14 indicate that the use of 2–3 pumps will result in flushing times of 3–4 days under almost all conditions, providing an effective contingency measure. It should also be noted that pumps would be placed in the most stagnant part of the marina and therefore would cause the greatest change by directly causing water exchange in these areas.

Performance Review

The proponent shall submit a Performance Review report five years after the start of operation to the CEO. The review will determine whether the project has met the following objectives:

1. Water and sediment quality:
   - 1.1. The operation of the boat harbour has not affected water quality within the Protected Harbour such that the environmental values of 'seafood safe for eating', and 'recreation and aesthetics' are adversely affected.
   - 1.2. The operation of the boat harbour has not affected sediment quality within the Protected Harbour such that the environmental value of 'ecosystem health' is adversely affected.
   - 1.3. The operation of the boat harbour has not affected water quality within the Protected Harbour such that the environmental values in the adjacent waters of Princess Royal Harbour

('ecosystem health', 'seafood safe for eating', 'recreation and aesthetics') are adversely affected.

2. Seagrass rehabilitation:

   2.1. survival and growth of rehabilitated seagrass is sufficient to attain 0.4 ha of seagrass of 75% average cover within 10 years of planting (as per Section 6.4.2)

3. Coastal processes:

   3.1. Changes to the beach alignment west of the Albany Town Jetty are as anticipated (Figure 20).

If the above objectives are met at the time of performance review, this will constitute closure of the monitoring and reporting requirements for the project.

5.5 OUTCOME

The proposal has been designed to reduce potential impacts on water quality. The impact of construction activities will be monitored and compared with management triggers for contingency actions to ensure no permanent adverse effects on seagrass adjacent to the Protected Harbour. Once constructed, the Protected Harbour is expected to flush within acceptable timeframes and the operational impacts of the Protected Harbour are anticipated to be small. No adverse effects on social and ecological environmental values of the broader waters of Princess Royal Harbour or the Protected Harbour are anticipated.

The EQG for chlorophyll a for a Moderate Protection Zone will not be met within the proposed marina. It is noted that even a marina with a flushing time of 1.5 days would not meet the chlorophyll EQG, and it is considered that no marina designed to shelter water would be able to meet the chlorophyll EQG. More importantly, it is anticipated that the EQS for phytoplankton blooms for a Moderate Protection Zone will be met within the proposed marina, and therefore EQOs will also be met.

The following management objectives have been applied to the project in this assessment and are expected to be met by the proposed marina design:

- maintenance of water quality within the Protected Harbour such that the EVs of 'ecosystem health' (moderate level of protection), 'seafood safe for eating', 'industrial water supply', 'cultural and spiritual' and 'recreation and aesthetics' are protected (this will capture aspects of phytoplankton blooms, water clarity, faecal bacteria, potentially toxic species of phytoplankton and contaminants)
- maintenance of sediment quality within the Protected Harbour to protect the EV of 'ecosystem health' (moderate level of protection)
- maintenance of water quality within the Protected Harbour such that all EVs of 'ecosystem health' (high level of protection), 'seafood safe for eating', 'recreation and aesthetics' are protected in the adjacent waters of Princess Royal Harbour.

Although operational impacts are expected to be minimal, they will be monitored and compared with management triggers for contingency actions to ensure the environmental values of the broader waters of Princess Royal Harbour or the Protected Harbour are protected.

6. MARINE ECOSYSTEM

6.1 EPA OBJECTIVE

The preliminary EPA objective for the marine environment is:

To maintain the abundance, diversity, geographic distribution and productivity of seagrass species and the ecological values supported by seagrass.

6.2 DESCRIPTION

6.2.1 Benthic habitat

Seagrass beds are of considerable ecological importance in coastal and marine ecosystems, as they provide food, shelter and breeding grounds for fish and other marine animals (EPA 1990a). Seagrasses also act to reduce the velocity of water movement at the base of the plant, stabilising sediments (Mills & D'Adamo 2000). In Princess Royal Harbour the seagrass meadows support abundant and diverse populations of benthic invertebrates (Hutchings et al. 1991), as do the macroalgal stands, although this has not been quantified. The fauna of the unvegetated areas are far less abundant and diverse than the vegetated areas (Hutchings et al. 1991). The importance of vegetated areas as nursery habitat for juvenile fish lies in both the abundant food supply available, and protection from predators.

Historic decline in seagrass

Extensive loss of seagrass in Princess Royal Harbour and Oyster Harbour was first reported in 1986 (EPA 1990a). Between 1962 (when the seagrass meadows were considered to be in pristine condition) and 1984, 66% of the seagrass meadows in Princess Royal Harbour had been lost. By 1988 the loss increased to 90% (EPA 1990a). The two year intensive study coordinated by the EPA concluded that since 1962 about 90% of the seagrass meadows in Princess Royal Harbour and about 80% of the seagrass meadows in Oyster Harbour had been lost (Bastyan et al. 1996).

The appearance of dense macroalgal accumulations also dates from some time between 1981 and 1984 (Bastyan 1986). The presence of macroalgae was noted in 1979 and 1981, but not in nuisance proportions (Atkins et al. 1980, Bastyan 1986). Prolific growth of algae during that time was identified as the likely cause of seagrass loss through smothering and light attenuation. The biomass of macroalgae in Princess Royal Harbour in the late 1980s was calculated as about 13 times greater than the above-ground seagrass biomass. The algal growth was attributed to high levels of nutrients in the harbour (Section 5.2).

A variety of management measures were recommended including control of point sources of nutrient, and harvesting of the macroalgae (EPA 1990a). Most of these were implemented, and water quality has improved and macroalgal accumulations have declined. The most recent estimate of macroalgal biomass is that of Bastyan et al. (1996), which indicated that by 1996 macroalgal biomass was about seven times greater than above-ground seagrass biomass, and had declined across the majority of Princess Royal Harbour, particularly in the western and eastern regions.

Present day seagrass distribution

Water quality improvements and a reduction in macroalgal accumulations in Princess Royal Harbour since the 1980s have enabled a gradual recovery of seagrass meadows. Seagrass mapping or Princess Royal Harbour was carried out as a collaborative exercise between LandCorp and the DoW (Figure 13, Oceanica 2006c at Appendix 6). The study was designed to prepare 'baseline' maps of seagrass and macroalgae in Princess Royal Harbour and Oyster Harbour with standardised methods that could be repeated in future exercises to assess and interpret any changes. As the DoW study overlapped with LandCorp requirements for the Albany Waterfront Project, the study was conducted collaboratively. The study enabled an updating of the changes in seagrass cover in Princess Royal Harbour since the 1960s.

The extent of seagrass has increased considerably since the 1980s, particularly the areas of dense seagrass with 45% cover or more (Table 15). In 2006, the total area of seagrasses appeared to decrease compared to 1996, even though the area of dense seagrasses (>45 %) increased. This result is attributed to the differences in methods and level of effort used for ground-truthing in the 1996 and 2006 mapping exercises (Appendix 6). Due to the methodological differences in detection of sparse seagrass, any apparent trends in areas of sparse seagrass cover between 1996 and 2006 are not reliable, especially as the changes are small. For this reason, trends in areas of dense seagrass (>45% cover), which are easier to map accurately, are considered a better indication of changes in conditions for seagrass growth between 1996 and 2006.

Table 15 Estimated changes in seagrass area (hectares) in Princess Royal Harbour

Seagrass cover	Seagrass area (hectares)							
	1962*	**1981**	**1984**	**1988**	**1991**	**1992**	**1996**	**2006**
>75% cover	2176*	290	104	68.5	69	69	185	234
45–75% cover	0	272	228	108.5	121	112	102	140
15–45% cover	0	220	227	278	267	240	526	371.5
<15% cover	0	99	99	852.5	984	1021	842.5	784
<2%	0	705	0	0	0	0	19	n/a
Total seagrass	**2176***	**1586**	**658**	**1307.5**	**1441**	**1442**	**1674**	**1529**

* Note: seagrass cover in 1962 was inferred rather than confirmed by ground-truthing, and it is not certain that the entire area of Princess Royal Harbour was covered by seagrass at a density of >75%.

Detailed seagrass mapping of the Protected Harbour project area was also carried out, and indicates that the main species of seagrass are *Posidonia sinuosa* and *Posidonia australis*. The shallow waters west of the Albany Town Jetty have extensive areas of seagrass of varying cover, while in the waters of the Protected Harbour there is one small patch (0.111 hectare) of dense seagrass and 1.259 hectares of sparse seagrass (<15% cover) (Figure 14).

The phototones evident in the aerial photograph further offshore from the seagrass meadows (Figure 14) are due to macroalgal accumulations, not seagrass meadows (as ground-truthed by Geoff Bastyan, pers. comm., 27th November 2007).

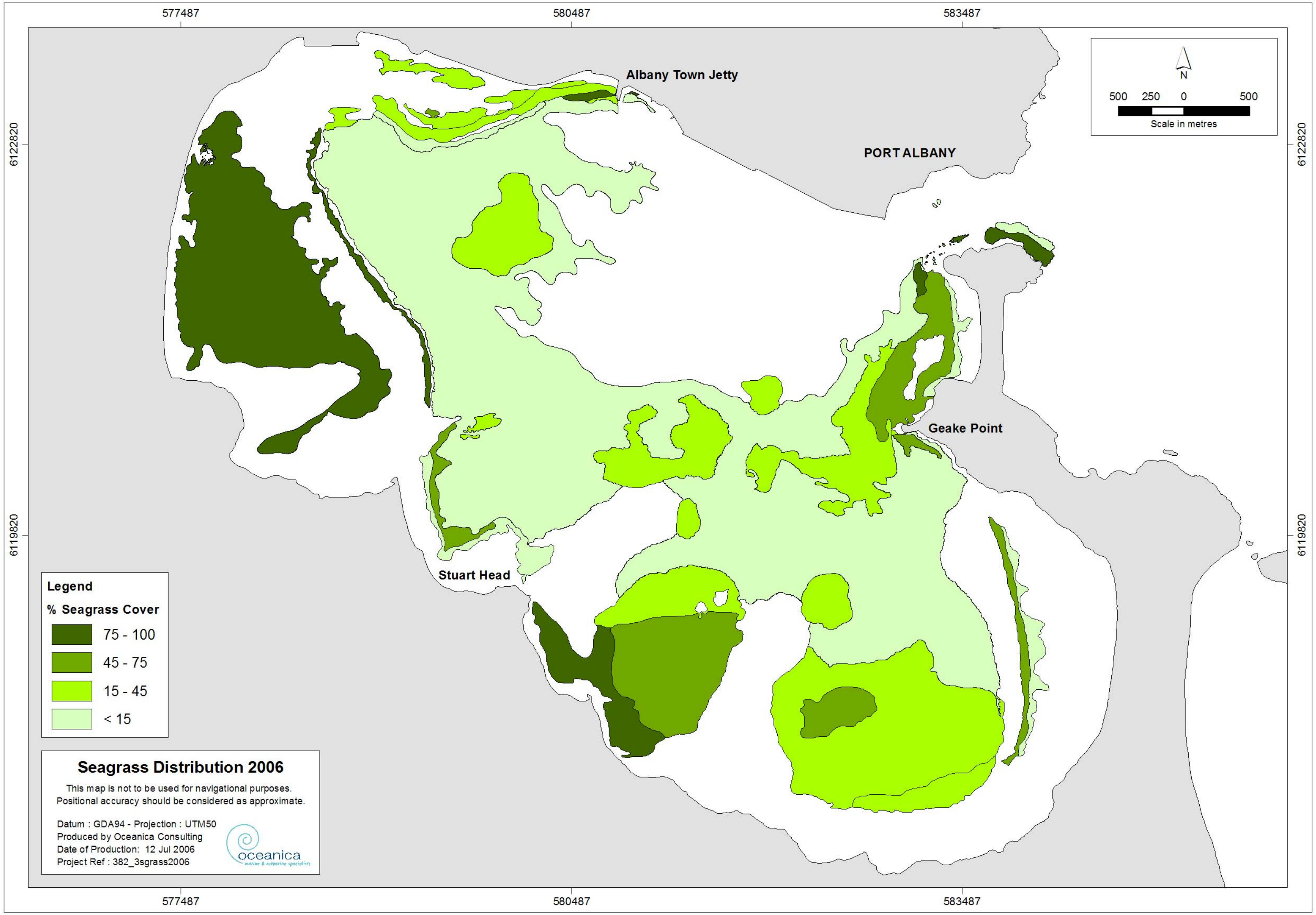


Figure 13 Seagrass distribution in the Princess Royal Harbour in 2006

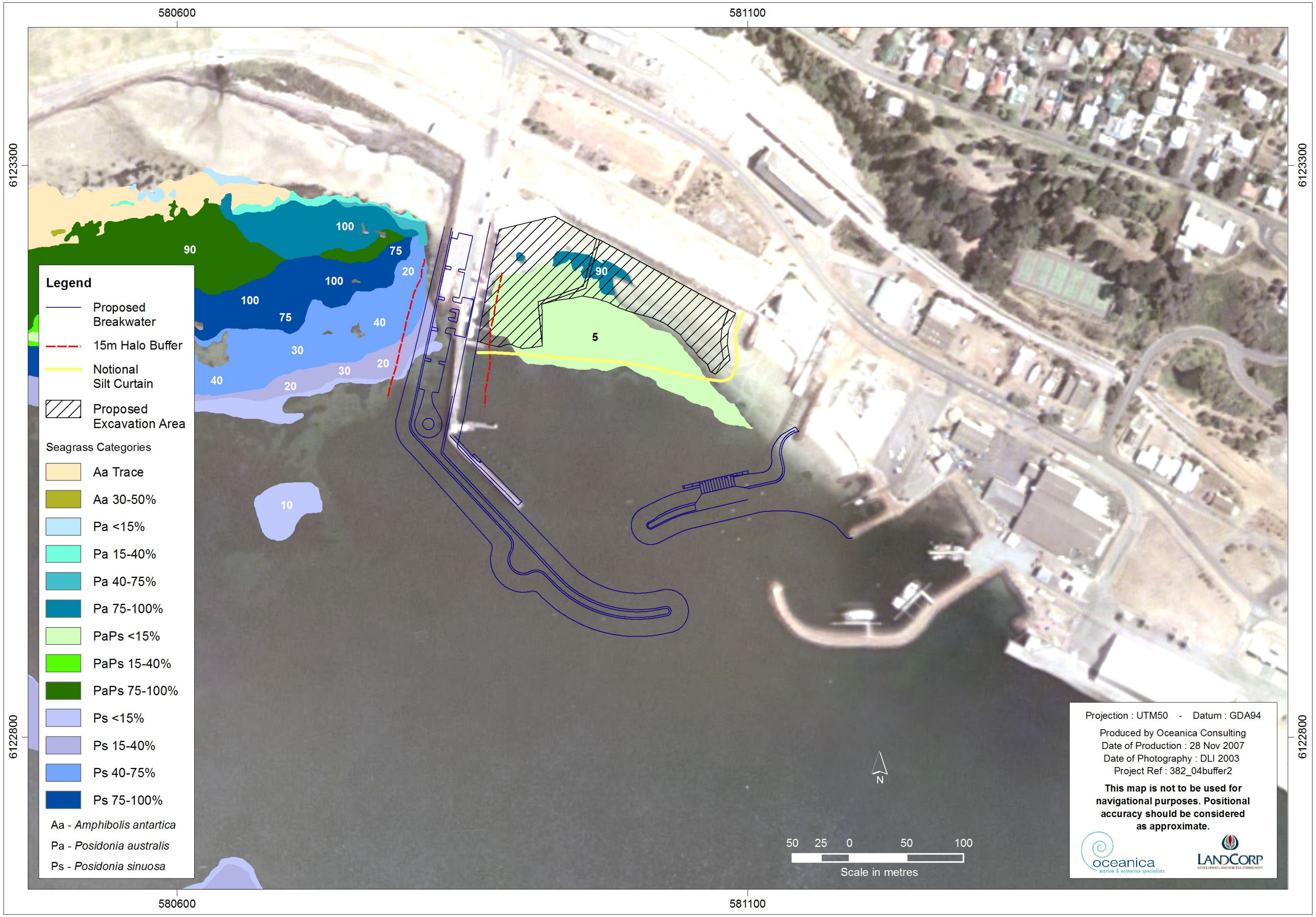


Figure 14 Seagrass species and density (%) in the project area

6.2.2 Marine fauna

Seagrass meadows and macroalgal stands in Princess Royal Harbour provide habitat for a wide range of fauna, including invertebrates and fish. The seagrass meadows support abundant and diverse populations of benthic invertebrates, mainly molluscs, amphipods, polychaete worms, ascideans and echinoderms (Hutchings et al. 1991, Kirkman et al. 1991). The invertebrate fauna of macroalgal stands has not been quantified, but is also known to be both abundant and relatively diverse (Dr Tom Rose, DEC, pers. comm.). In comparison, the unvegetated areas are depauperate of fauna, having less than 10% of the biomass and 20% of the species richness of seagrass meadows, a finding consistent with many other local and interstate studies (Hutchings et al. 1991).

The waters of Princess Royal Harbour support large numbers of juvenile fish (particularly in the seagrass meadows and macroalgal stands), and commercially and recreationally important species such as cobbler, flathead, King George whiting, leatherjackets, sea mullet, yelloweye mullet, squid, garfish, blue manna crabs and king prawns (EPA 1990a, Bastyan, personal observations). Sandy patches within the seagrass meadow or areas of degraded meadows support different fauna including stingrays, seastars, solitary ascidians, razor shell, gastropod molluscs, sponge colonies and mussels.

6.3 LEGISLATIVE AND POLICY FRAMEWORK

6.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval is required from the Federal Environment Minister if an action has, will have, or is likely to have a significant impact on a matter of national significance.

Humpback and Southern Right whales are regularly sighted in the King George Sound and Southern Right whales to a lesser extent in Princess Royal Harbour (Section 3.3), and are listed as Migratory Species under the EPBC Act. The Protected Harbour is a small-scale development that builds on existing structures and does not impinge on migratory routes and the DEH has determined that the action is not a 'Controlled Action' under the EPBC Act.

6.3.2 EPA Guidance Statement No 29

EPA Guidance Statement No. 29, *Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment* (EPA 2004), provides a set of principles to be applied by proponents and the EPA when considering development proposals that may result in removal or destruction of, or damage to, marine benthic primary producer communities (e.g. seagrasses, coral reefs) or the habitats which support them.

Principles

Guidance Statement No. 29 identifies that the EPA expects a hierarchy of principles to be followed in assessing proposals that could damage BPPH (EPA 2004). The first three of these four principles need to be demonstrated prior to evaluating the loss of BPPH against the management unit framework specified in the final principle of the Guidance. These first three principles are addressed below.

1. All proponents should demonstrate consideration of options to avoid damage/loss of BPPH.

The Protected Harbour development proposal has been designed to complement the adjacent Albany Foreshore Development project and to build on the capacity and safety of an existing boat mooring area. Other sites were considered early in the planning process, however the proposed site was chosen on the basis that it is adjacent to the foreshore development and the Albany CBD and that it is an area currently used for boating purposes and would expand on existing structures.

2. Where avoidance of BPPH is not possible, then design should aim to minimise damage/loss of BPPH and proponents will be required to justify the need for damage/loss of BPPH.

The project area is to the east of the Albany Town Jetty where only a small area of seagrass occurs. As the seagrass is adjacent to the existing jetty structure that has been incorporated into the project design, the seagrass loss cannot be further minimised as much of the dense seagrass occurs next to the jetty and close to the shore in the area to be excavated. It has also been conservatively assumed that the other sparse seagrass within the marina will be lost due to boat shading and disturbance.

3. Proponents will need to demonstrate 'best practicable' design, construction methods and environmental management aimed at minimising further damage/loss of BPPH through indirect impacts.

The management of construction in order to minimise affects on water quality and seagrass are outlined in the CEMP (Appendix 8). Potential impacts and management are described in Sections 1 and 6.4. All seagrass loss will be offset through rehabilitation of seagrass within Princess Royal Harbour.

Management unit framework

A series of six categories of marine ecosystem protection (category A to category F) are defined in the guidelines and used to define the cumulative percentage loss threshold for benthic primary producer habitat (BPPH) within any defined management unit.

The guidelines require:

- the natural ecosystem boundary to be defined (i.e. the 'management unit')
- the quantity of previous habitat loss or damage to be determined
- the additional loss or damage as a result of the proposal to be calculated.

The proposed loss and previous habitat loss are totalled to determine a cumulative impact that is assessed in light of the ecosystem's level of protection. Management units are usually in the order of 50 km^2, and are defined taking into account key physical and biological ecosystem attributes, such as bathymetry, position of offshore reefs/islands, water circulation patterns, and habitat/substrate types.

Princess Royal Harbour is a recognised management unit within EPA Guidance Statement No. 29 (EPA 2004), and is designated 'Category F', which includes areas where cumulative loss thresholds have been significantly exceeded, and therefore proposals must not cause any net loss of seagrass.

6.4 IMPACT ASSESSMENT AND MITIGATION

6.4.1 Environmental aspects and potential impacts

The aspects of the Protected Harbour proposal that have the potential to affect the marine ecosystem are:

- excavation will result in the direct removal of seagrass
- construction of the breakwater may alter sediment movement and flows and shear or smother benthic habitat adjacent to the breakwater creating a 'halo' effect
- breakwater and seawall construction, drainage from excavated sediment used as fill in the reclamation area may all cause turbidity that will result in a sediment plume that may affect nearby seagrass areas.

The construction of the Protected Harbour will cause both direct losses due to the development footprint, and potential indirect losses of seagrass through the development of a bare sand halo adjacent to the proposed breakwater. Habitat may be smothered by longshore sediment transport adjacent to the breakwater, and/or eroded bottom shear stresses due to wave shoaling and reflection in front of the breakwater. Due to the low energy environment of Princess Royal Harbour, the "halo" effect around the existing Albany Town Jetty breakwater is narrow, and dense seagrass meadows occur within 10 m of the current jetty. The "halo" effect around the proposed breakwater is likely to be similar to that occurring around the existing jetty.

Direct (development footprint) and potential indirect (halo effect around development breakwaters) losses of seagrass due to the Protected Harbour are estimated to be 0.111 ha of dense seagrass (*Posidonia australis*) and 1.436 ha of sparse seagrass (*Posidonia sinuosa* or mixed *Posidonia australis and Posidonia sinuosa*). A detailed breakdown of seagrass loss is provided in Table 16. The majority of the losses are areas of sparse (<10% density) seagrass, and so for the purpose of seagrass rehabilitation Table 16 also shows the estimated losses in terms of an equivalent area of seagrass meadow with 75% seagrass cover. This approach has been taken because seagrass of moderate to high density has greater value in terms of ecological function (particularly in terms of habitat for fauna) than sparse meadow.

The area of seagrass as 75% seagrass cover 'equivalent' is calculated as follows:

Area of 75% seagrass cover 'equivalent' = (Area of seagrass (ha) * Density of seagrass (%)) /75

For example:

0.111 ha of 90% cover = (0.111 * 90) /75 = 0.133 ha of 75% cover

Table 16 Direct and indirect seagrass loss (hectares) associated with the Protected Harbour Princess Royal Harbour

Category of seagrass cover	Seagrass area (hectares)			
	Direct loss, marina footprint	**Direct loss, breakwater footprint**	**Indirect loss, breakwater halo***	**Total loss**
90% cover *P. australis*	0.111	0	0	0.111
20% cover *P. sinuosa*	0	0.036	0.113	0.149
<15% cover *P. sinuosa***	0	0.017	0.011	0.028
5% cover *P. australis / P. sinuosa*	1.259	0	0***	1.259
Total area (varying density of cover)	**1.370**	**0.053**	**0.124**	**1.547**
Total area, as 75% cover 'equivalents'	**0.217**	**0.011**	**0.031**	**0.259**

* Note: assuming a 15 m halo around the breakwater

** Note: for calculation of 75% cover equivalents, a value of 75% cover was used

*** Note: losses on west side of breakwater included under direct loss due to marina footprint

No indirect losses of seagrass are expected due to turbidity generated during construction activities due to the following (Section 5.4):

1. Design and management measures applied to the construction of the proposal (Section 5.4)
2. Seagrass health and water quality will be monitored during construction and if pre-determined criteria (set out in the CEMP Appendix 8) are exceeded, contingency measures will be implemented to avoid permanent impacts
3. Seagrass extent will be monitored for two years (every 6 months for the first year in summer and winter, then annually) after construction to determine the total direct and indirect losses from the project and halo effect. Seagrass extent will be monitored through high resolution vertical digital imagery (captured from a plane).
4. Research undertaken during the 1988-1989 Albany Harbours Study established that although the productivity of seagrasses in Princess Royal Harbour was affected by shading, they recovered within a year (EPA 1990a). These studies involved the use of screens to reduce the amount of light reaching seagrass by 80–99% for five months, which represents an impact of far greater duration and intensity than anticipated during construction of the marina.

No indirect losses of seagrass are expected due to the outflow of lesser quality water from the Protected Harbour once it is constructed (Section 5.4.3) as modelling indicates that all environmental quality criteria will be met outside of the Protected Harbour.

Cumulative seagrass losses

Other projects that may affect seagrass within Princess Royal Harbour are:

- Albany Foreshore Redevelopment Project, LandCorp
- Anzac Peace Park, City of Albany
- Albany Port Expansion, Grange Resources (Ecologia 2007).

The cumulative seagrass losses of known projects in Princess Royal Harbour are outlined in Table 17.

Table 17 Cumulative seagrass losses in Princess Royal Harbour

Project	Predicted seagrass loss (ha)	Approval status
Albany Foreshore Redevelopment Project, LandCorp	0.061	Approved
Anzac Peace Park, City of Albany	0.004	Approved
Albany Port Expansion, Grange Resources	0.4 (maximum permanent loss, Ecologia 2007)	Assessment in progress
Albany Protected Harbour, LandCorp	1.547	Assessment in progress
Cumulative total	**2.012 ha**	

6.4.2 Seagrass rehabilitation offset

All the seagrass loss caused by the Protected Harbour project, both direct and potentially indirect, will be offset by the replanting of 0.4 ha of seagrass in other areas of Princess Royal Harbour. This 0.4 ha of seagrass is to be planted at a density to ensure 75% seagrass cover is achieved within 10 years. This is more than the area (equivalent to 0.259 ha of 75% seagrass cover) that may be lost (directly and indirectly) due to the proposed development. Potential sites for seagrass rehabilitation close to the project area have been selected (Figure 15).

A comprehensive seagrass rehabilitation plan will be developed that describes the rehabilitation sites, the seagrass species to be used, transplanting units and techniques, spacing of planting units, and the proposed monitoring for transplanted seagrass. Rehabilitation criteria will be developed in consultation with the DoW and DEC (regional offices and head offices). It is proposed that completion criteria for any seagrass rehabilitation program be linked to a specific % survival of planting units for at least two years (with infill planting undertaken if required) and ongoing monitoring of indicators of ecological function (shoot density, seagrass production, fauna production, habitat function) for a total of four years.

All donor material will be sourced from within the Albany Protected Harbour site from the seagrass beds that will be lost due to the development. This will be undertaken prior to construction affecting the seagrass. If ‘top up’ planting is required in subsequent years as a contingency measure, suitable donor material will need to be sourced from within Princess Royal Harbour. If this is required, appropriate donor sites and donor bed monitoring requirements will be identified in consultation with DEC and DoW.

This approach has been taken because seagrass rehabilitation studies in the Albany region (see next section) have established that the first one to two years are critical in the life of transplants; if they survive for the first two years, their ongoing survival is virtually assured. Furthermore, the growth of transplants accelerates at around the three to four year mark, with the individual transplants coalescing at around the four year mark, and subsequently reaching the densities of healthy natural meadows within 8 to 10 years. Completion criteria for seagrass rehabilitation therefore involve confirmation that survival and growth meet required performance indicators within four years.

Implicit in this approach is that planting units are spaced at intervals that allow attainment of shoot densities similar to adjacent natural meadows within ten years. This process will be informed by the considerable body of research undertaken in Princess Royal and Oyster Harbours to date (Bastyan & Associates 2006). Performance indicators will include % survival of sprigs and seagrass shoot density; the latter has been chosen as it is the DEC's preferred indicator of seagrass health (EPA 2005).

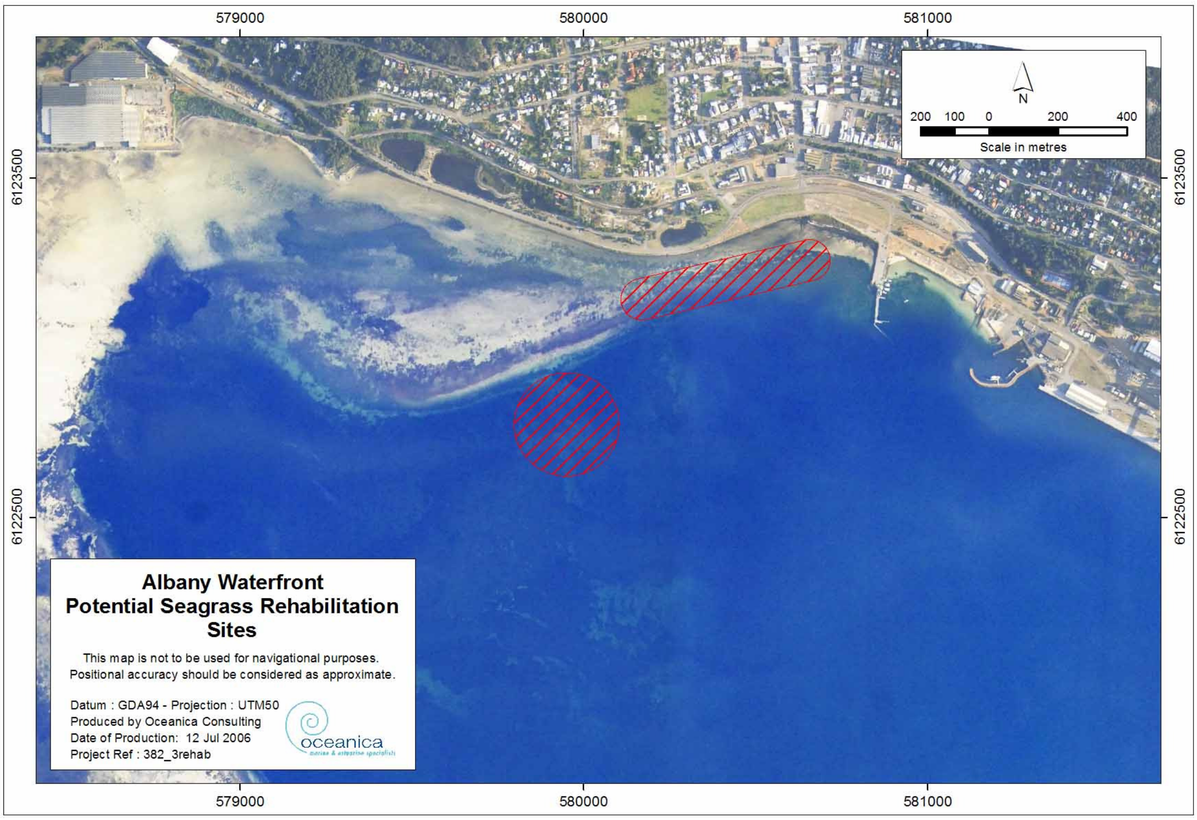


Figure 15 Potential sites for seagrass rehabilitation

Previous rehabilitation at Albany

Seagrass rehabilitation using manual techniques has an established track record for successfully transplanting species of *Posidonia* in the sheltered marine embayments of Princess Royal Harbour and Oyster Harbour at Albany (Bastyan 2001, 2004, Bastyan & Associates 2006). These trials were independently conducted between 1994 and 1997 and involved transplanting of 'sprigs', a section of underground rhizome about 10 cm long containing one to four leaf-bearing shoots. The most comprehensive planting has taken place in Oyster Harbour and have achieved outstanding success with anchored sprigs resulting in 95% success over six years for plantings in 1994, >94% success over four years for sprigs planted in 1997. In overall terms, sprigs planted 1 m apart began to merge during the fourth year, and by the end of the fifth year a complete meadow was established, with plant density similar to adjoining natural meadows in Oyster Harbour. Similar trials in Princess Royal Harbour were less successful, with this being attributed to currents sufficient to scour/deposit sediments at one site (14% survival over four years), and intense activity of sand-dwelling worms at two other sites (86% survival over four years).

Seagrass rehabilitation in Princess Royal Harbour and Oyster Harbour has also been undertaken as part of a large, collaborative seagrass research and rehabilitation plan (SRRP) by Cockburn Cement Limited and the Department of Industry and Resources. Seagrass rehabilitation trials have been undertaken using sprigs of *P. australis*, and to a lesser extent, *P. sinuosa*. A survey of a 0.8 ha rehabilitation plot planted in January 2003 indicates a survival rate in excess of 90%. There is no indication of detrimental changes in meadows at donor beds after the limited removal of donor material, such as core or plug removal and of the removal of the leading edge on both *P. australis* and *P. sinuosa* meadows (DAL 2005, Oceanica 2006a, Bastyan & Associates 2006).

SRRP research in the Albany region has included the collection of *P. australis* seeds in December 2003, and 'grow out' in an aquarium before transplantation in February 2004. In March 2004, seedlings growing naturally were collected from the field and transplanted. The survival rate for the transplanted seedlings after one year was 60% for the aquarium-raised seedlings and 80% for wild seedlings.

Survival and spreading of transplants using sprigs in the Albany area continues to be excellent (DAL 2005, Oceanica 2006a, Bastyan & Associates 2006). SRRP research in the Albany region also includes examination of a range of ecological functions (primary production, secondary production, biogeochemical cycling and storage, habitat function, physical setting) in areas where *P. australis* has been transplanted and successfully growing for four, five and eight years. As noted earlier, work to date strongly indicates that the first 2 years are critical for survival (if the plants survive the first 2 years, their successful establishment is almost certain), and also indicates that ecological function in seagrasses is established for many indicators within four years (Kenna et al. 2005, DAL 2005, Oceanica 2006a, Bastyan & Associates 2006).

Offset principles

The proposed seagrass rehabilitation offset has been developed based on the principles included in the EPA Position Statement on environmental offsets (EPA 2006). The principles and how they addressed in this offset proposal are shown in Table 18.

Table 18 Description of how the offset principles are addressed

Offset Principle	How addressed
Environmental offsets should only be considered after all other reasonable attempts to mitigate adverse impacts have been exhausted	The Protected Harbour Development is proposed in an area that is already used for boat moorings and within an area of water that is already partially protected by breakwaters. Locating the project in an already modified environment that is already used for boat mooring has minimised the potential impact of the proposal.
An environmental offset package should address both direct offsets and contributing offsets	The predicted seagrass losses will be addressed completely by direct offsets (seagrass rehabilitation). This is considered to be the optimal outcome in an area that has suffered extensive historical seagrass loss.
Environmental offsets should ideally be 'like for like or better'	The proposed seagrass rehabilitation will be within the same area of Princess Royal Harbour (within 1km) and include rehabilitation with the same seagrass species. The area of seagrass lost is mostly sparse and is likely to support far less ecological function than moderate to dense meadow. Undertaking the offset at a greater density (75%) will increase the likelihood that the rehabilitation project will support significant ecological function within 5-10 years and therefore be a better environmental outcome than replacing the seagrass at a lower planting density.
Positive environmental offset ratios should apply where risk of failure is apparent	Even assuming a 60% success rate, the rehabilitation will result in 0.32 ha of established seagrass (75% equivalent) which will more than offset the predicted loss of 0.259 ha (75% equivalent).
Environmental offsets must entail a robust and consistent assessment process	Seagrass rehabilitation using manual techniques has an established track record for successfully transplanting species of Posidonia in the sheltered marine embayments of Princess Royal Harbour and Oyster Harbour at Albany (Bastyan 2001, 2004, Bastyan & Associates 2006). Geoff Bastyan has undertaken much of the seagrass rehabilitation work in Albany and has agreed to undertake the seagrass rehabilitation for LandCorp for this project in collaboration with Oceanica.

Offset Principle	How addressed
Environmental offsets must meet all Statutory requirements	Not applicable
Environmental offsets must be clearly defined, transparent and enforceable	The seagrass rehabilitation of 0.4 ha of seagrass is clearly defined. Monitoring results will be reported annually to DEC. The seagrass rehabilitation offset is expected to be a condition of approval for this project (Appendix 7).
Environmental offsets must ensure a long lasting benefit	It is proposed to monitor the seagrass rehabilitation for four years following completion of planting. Previous studies have shown that the first 12 months are the high risk periods for transplanted seagrass. Once established, transplanted seagrasses have been shown to continue to spread. Therefore, four years is considered an adequate timeframe for monitoring. If completion criteria are not met within this time frame, additional seagrass rehabilitation and monitoring will be undertaken.

6.4.3 Impact on marine fauna

Loss of seagrass meadows due to direct or indirect effects will result in a loss of habitat for marine life. However, the majority of the seagrass potentially affected by the proposal has a density less than 15% and is likely to have more limited habitat value: for example the 0.9 ha of sparse seagrass east of the Albany Town Jetty is little more than bare sand with the occasional small clump of seagrass (G. Bastyan, pers. comm.). The seagrass rehabilitation to offset seagrass loss will also ensure that there is no net loss in seagrass habitat in Princess Royal Harbour, and the completed development, particularly the proposed breakwater, will provide additional habitat for marine fauna in the project area.

Princess Royal Harbour is not on the migratory route for Humpback whales or Southern Right whales. Humpback whales and Southern Right whales do regularly appear in King George Sound - the former in spring and autumn, and the latter in winter/early spring. Humpback whales tend to occur further offshore than Southern Right whales - the mothers and calves of Southern Right Whales are found closest to shore. Sometimes Southern Right whales do appear close to Middleton Beach in King George Sound, but typically they are further offshore.

Pile driving for jetties and pens is likely to take place from mid-September 2008 to early January 2009, largely outside the main time for Southern Right whales (June to early September). Furthermore, it is not anticipated that whales will be disturbed because:

- the piles involved in the Protected Harbour are small and the noise source would be stationary (rapidly approaching or rapidly increasing noise, or noises which are erratic and involve many sharp changes in level over short time scales are more likely to cause adverse behavioural reactions from whales; McCauley et al 1996)
- noise rapidly attenuates with distance (particularly in shallow, soft-bottom environments such as Princess Royal Harbour) and the noise source is several kilometres from King George Sound and Middleton Beach (the nearest places likely to be frequented by whales).

6.5 OUTCOME

The construction of the Protected Harbour will potentially result in the loss of about 0.111 ha of dense seagrass and 1.436 ha of sparse seagrass, which is equivalent to 0.259 ha of seagrass meadow with 75% seagrass cover. This loss will be offset by rehabilitation of 0.4 ha in Princess Royal Harbour resulting in no net loss of seagrass in Princess Royal Harbour in the medium to long term. As most of the seagrass to be lost is of low density and all losses will be offset with seagrass rehabilitation there is not expected to be any significant impact on marine fauna.

The impact of the project on water quality is not expected to cause any loss of seagrass and the implementation of the CEMP (Appendix 8) will ensure that monitoring criteria and contingencies are in place to address unexpected impacts.

7. COASTAL PROCESSES

7.1 EPA OBJECTIVE

The EPA objective for the marine environment is:

To maintain the integrity, ecological functions and environmental values of the soil and landform.

7.2 DESCRIPTION

Coastal engineers M P Rogers & Associates Pty Ltd have completed an investigation of the coastal processes influencing the small pocket beach located immediately to the west of the town jetty. The impact of the Albany Foreshore Redevelopment on these processes was determined and used to predict the alignment and stability of the beach west of the Albany Town Jetty.

7.2.1 Nearshore Processes

The Protected Harbour is situated on the northern shore of Princess Royal Harbour in a low energy marine environment that is sheltered from the open ocean swells. The dominant process influencing the sediment transport at the site is from wave driven currents as a result of locally wind generated seas from within Princess Royal Harbour. The summer months have a large component of east to south easterly winds while the winter months are dominated by the west to south westerly winds (Figure 8). This seasonal imbalance drives the changes in the magnitude and direction of the longshore sediment transport at the site.

Longshore currents capable of transporting sediment parallel to the shoreline are created when waves arrive at oblique angles to the shoreline. This longshore transport can result in changes to the shoreline position due to differential rates of sediment transport caused by factors such as beach alignment and sheltering. Storm waves can also result in cross-shore sediment transport which can also change the position of the shoreline. For this site the focus was on the longshore sediment transport as this is most important in the long-term changes to the beach alignment.

7.2.2 Existing Beach

The beach on the western side of the town jetty currently consists of a very narrow strip of sand backed by a seawall. The beach is partly sheltered by the Town Jetty to the east and the Princess Royal Drive seawall to the west, thus forming a small pocket beach approximately 200 m long. The nearshore region is a gently sloping, shallow sand terrace extending to a depth of around -1m chart datum approximately 150 m from the shore. The beach is very narrow and the waterline is close to the seawall (Figure 16).

7.2.3 Long-term Changes

An analysis of aerial photographs from 1957 to 2001 established the seasonal and long-term changes to the beach (Figure 17 and Figure 18). Over this period the size and alignment of the beach has remained reasonably constant with a maximum width of around 20 m. The sediment in the area is believed to originate from the offshore seagrass meadows and also from the drainage outlets located along the foreshore area. Seagrass wrack from the seagrass meadows adjacent to the beach accumulates on the beach at times (Figure 16).

The beach is confined by the town jetty breakwater to the east and by the Princess Royal Drive seawall to the west, making the beach partly trapped between these two structures. The seasonal changes in the wave climate, and thus the changes in longshore sediment transport, result in the beach rotating towards the direction of the dominant waves. Most of the aerial photographs were taken in summer so the seasonal rotation of the beach could not be accurately determined, however it is likely to be in the order of 5 to 10 degrees. This is supported by the photograph taken at the end of summer in April 1998 showing the beach rotated further to the east than the other photographs taken earlier in summer during January (Figure 18).

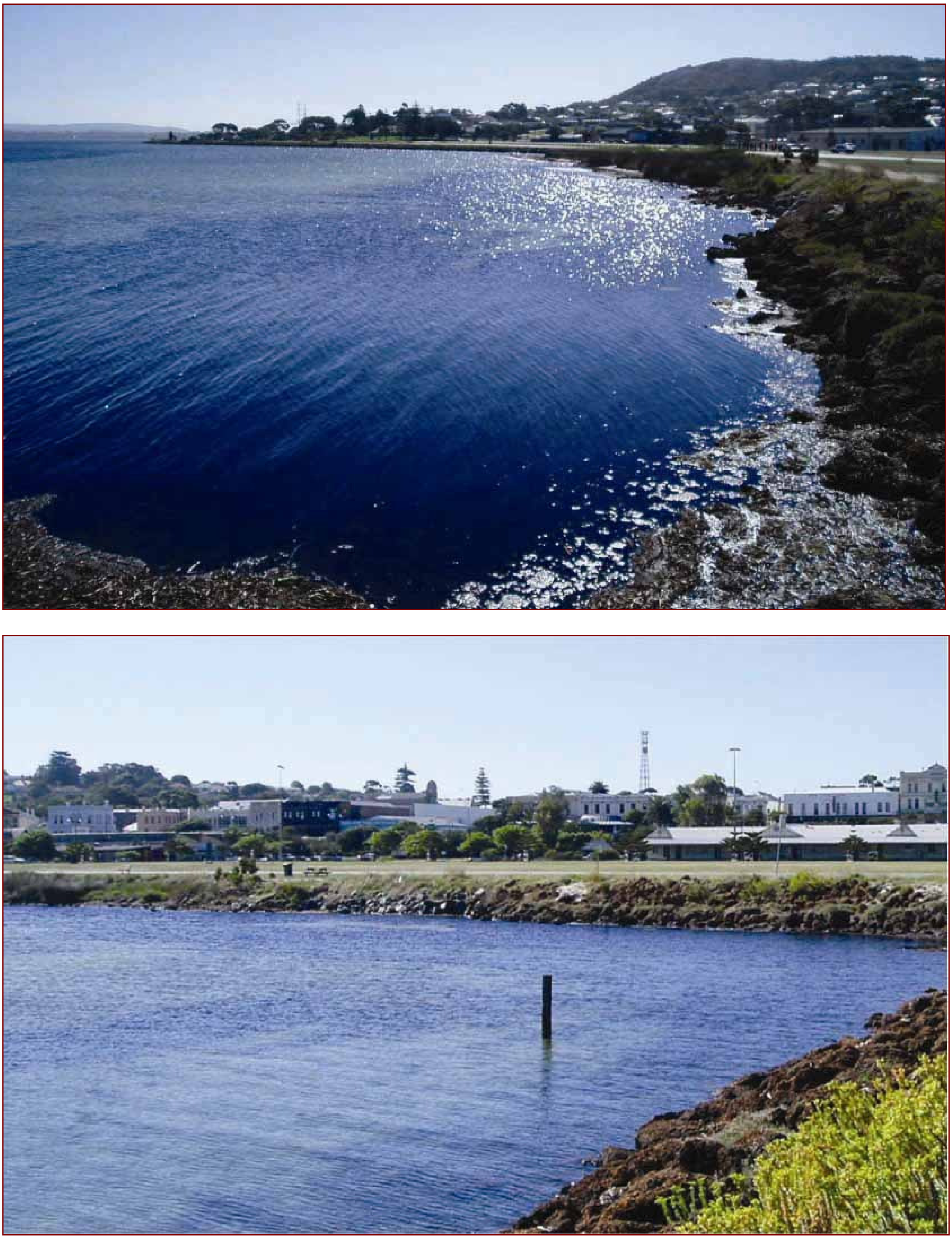
7.3 LEGISLATIVE AND POLICY FRAMEWORK

Statement of Planning Policy No. 2.6 State Coastal Planning Policy

Statement of Planning Policy No. 2.6 provides guidance on:

- public interest
- coastal foreshore reserves
- coastal strategies and management plans
- environmental considerations
- development and settlement planning considerations
- physical processes setbacks.

The coastal environment in the project area is already cleared and modified with seawalls and jetty structures, so coastal setbacks and foreshore reserves are not applicable to the site. The environmental guidance includes "Avoid any significant and permanent negative impacts on the environment and coastal processes, either on or off site." The following section discusses the potential impact of the project on coastal processes.



Note: Photographs taken on 7 March 2006 at 3:20pm

Figure 16 Photos of existing shoreline west of the town jetty

Figure 17 Aerial photos 1957-1981

Figure 18 Aerial photos 1988 – 2001

7.4 IMPACT ASSESSMENT AND MITIGATION

7.4.1 Environmental aspects and potential impacts

The construction of the breakwater has the potential to alter the magnitude and direction of the longshore sediment transport to the west of the Albany Town Jetty. This in turn may alter the beach alignment.

7.4.2 Prediction of changes to longshore sediment transport

The magnitude and direction of the longshore sediment transport is controlled by the height and direction of the wind generated waves. An assessment of the longshore sediment transport has been conducted using local wave hindcasting and bulk sediment transport calculations (CERC 1977).

Wind data were obtained from the Bureau of Meteorology for the Albany Airport between April 1965 and July 2006. The data was presented in tables as a percentage frequency for four wind speed bands against the eight main compass directions (Table 19). Only the wind directions influencing the sediment transport at the site were included in the wave hindcast calculations (i.e. those on the seaward side of the Protected Harbour; east through south and west).

The wave heights and periods adjacent to the study site in a water depth of -1.8 m AHD were hindcasted using the Bretschneider and Reid (1953) method described in the Shore Protection Manual (CERC 1977). Effective fetch lengths were determined using the method described in the Shore Protection Manual (CERC 1977) and these were used in the wave hindcasting calculations (Figure 19).

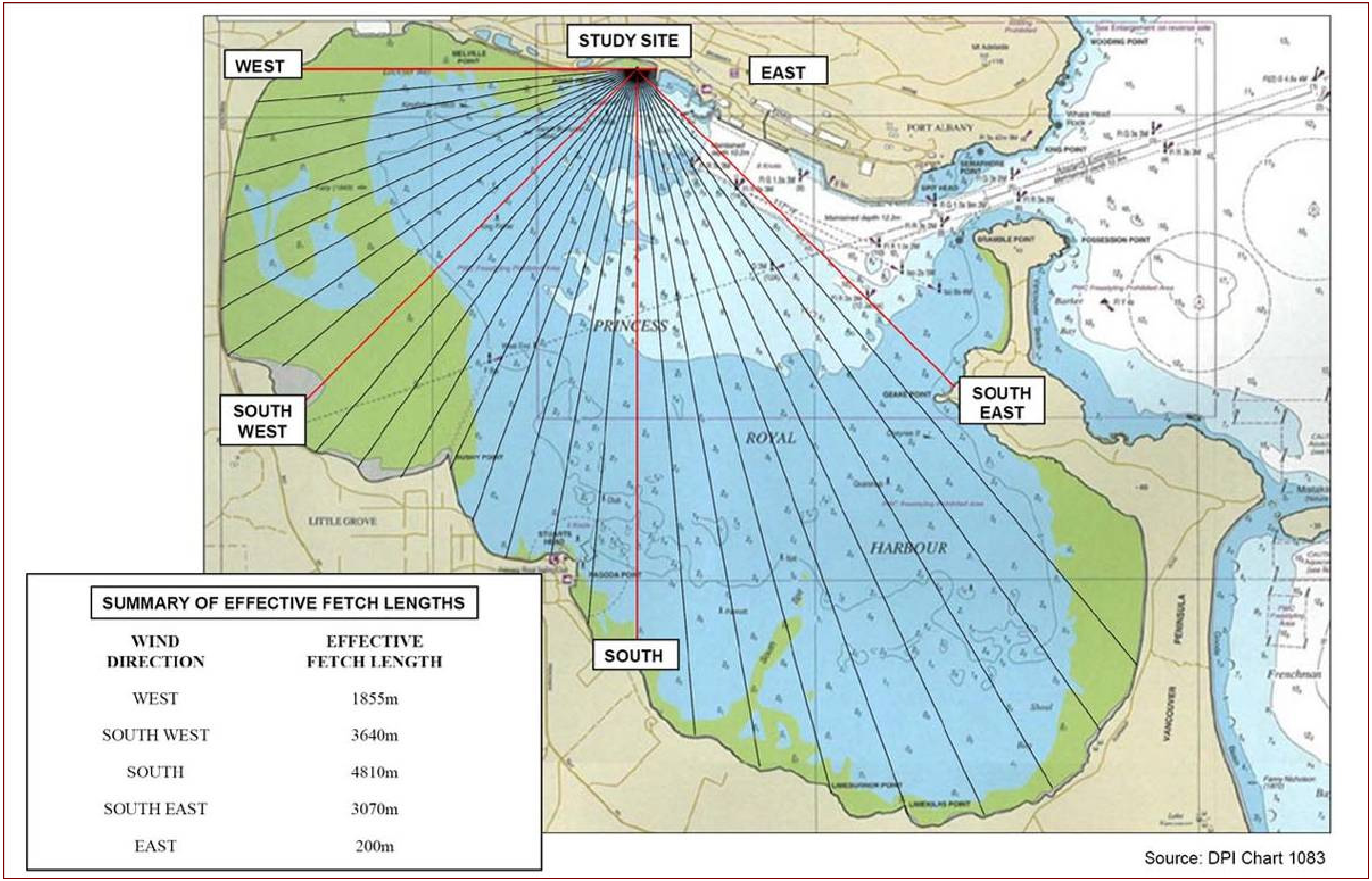
The resulting hindcasted wave heights and periods at a point adjacent to the study site in a water depth of -1.8m AHD are presented in Table 19 and Table 20.

Table 19 Current significant wave height (m) in -1.8m AHD water depth

Wind Speed Range	E	SE	S	SW	W
0-10km/hr	0.01	0.03	0.04	0.04	0.03
10-20km/hr	0.05	0.14	0.16	0.15	0.10
20-30km/hr	0.08	0.25	0.30	0.26	0.15
>30km/hr	0.12	0.37	0.43	0.37	0.20

Table 20 Current wave period (s) in -1.8m AHD water depth

Wind Speed Range	E	SE	S	SW	W
0-10km/hr	0.43	0.74	0.79	0.76	0.66
10-20km/hr	0.77	1.45	1.57	1.46	1.17
20-30km/hr	0.99	1.90	2.06	1.89	1.47
>30km/hr	1.17	2.25	2.43	2.22	1.70



SUMMARY OF EFFECTIVE FETCH LENGTHS

WIND DIRECTION	EFFECTIVE FETCH LENGTH
WEST	1855m
SOUTH WEST	3640m
SOUTH	4810m
SOUTH EAST	3070m
EAST	200m

Figure 19 Calculation of effective fetch lengths

The predicted waves were then refracted and shoaled from the point in -1.8 m AHD to the breaker point using linear wave theory. The longshore sediment transport rate was determined for each season using the CERC bulk sediment transport rate formula described in Kamphuis (2000). Due to the low energy environment experienced at the site, the longshore sediment transport fluxes were determined to be small. It was estimated that less than 1000 m^3 of sediment is transported west during the summer months when the east and south-easterly winds dominate and this sediment is returned to the site by the westerly and south-westerly winds experienced in the winter months. Therefore, the beach alignment was determined based on a predicted net annual longshore sediment transport of 0 m^3/yr. This investigation indicated that the average annual beach alignment should face a compass bearing of approximately 190 degrees. This is consistent with the beach alignment in the historical aerial photographs.

Potential impacts of project

The nearshore coastal processes at the study site will be altered by the construction of the town jetty breakwater, which will increase the sheltering from the east and south-east. This will result in less westerly sediment transport during the summer months. The longshore sediment transport was again calculated taking into account the effects of proposed breakwater. The extended breakwater reduced the fetch lengths for the east and south easterly directions. This was accounted for by removing all waves from the east. The waves from the south east had to be transformed due to the effects of diffraction from the new breakwater. It was calculated that these waves would be reduced to 60% of the incident wave height and the angle of the incident waves would shift from 135º to 150º due to diffraction (Goda 2000). The wave periods were not changed by the diffraction around the new breakwater.

The new wave heights and periods calculated adjacent to the site in a water depth of -1.8 m AHD are presented in Table 21 and Table 22.

Table 21 Significant Wave Height (m) in -1.8m AHD water depth after project implementation

Wind Speed Range	E	SE	S	SW	W
0-10km/hr	0.00	0.02	0.04	0.04	0.03
10-20km/hr	0.00	0.08	0.16	0.15	0.10
20-30km/hr	0.00	0.15	0.30	0.26	0.15
>30km/hr	0.00	0.22	0.43	0.37	0.20

Table 22 Wave Period (s) in -1.8m AHD water depth after project implementation

Wind Speed Range	E	SE	S	SW	W
0-10km/hr	-	0.74	0.79	0.76	0.66
10-20km/hr	-	1.45	1.57	1.46	1.17
20-30km/hr	-	1.90	2.06	1.89	1.47
>30km/hr	-	2.25	2.43	2.22	1.70

These predicted waves after breakwater construction were transformed to the breaker point using linear theory accounting for shoaling and refraction. As before, the CERC formula was used to determine the bulk longshore sediment transport rates. From this analysis, it was determined that the beach is likely to rotate by approximately 10 to 20 degrees clockwise. This new alignment is illustrated in Figure 20.

After the construction of the new breakwater the beach will still experience seasonal fluxes and rotations like the existing beach, although these will be of a slightly reduced magnitude. The width of the beach will be dependent on the volume of fill placed during the foreshore redevelopment. The seasonal changes in the longshore sediment transport and effects of cross shore storm erosion will alter the beach width as before.

Seagrass wrack

Seagrass and algae wrack currently accumulates to the west of the Albany Town Jetty under certain conditions. This will continue following construction of the breakwater. The location of the wrack accumulation may alter with the beach alignment but the amount generated is not expected to be affected. This foreshore area will be established as City of Albany public open space. This existing issue will be the responsibility of the City of Albany to manage. The City of Albany has stated its intention to manage this ongoing issue.

7.4.3 Monitoring

High resolution vertical digital imagery (captured from a plane) is proposed to monitor seagrass extent for two years after construction (summer and winter in the first year and then annually). These photos will also be used to monitor the beach width following construction. In addition, field inspection of the beach width will be monitored in autumn and winter and after any major storm event.

The implementation of the project will be reviewed after five years of operation. This review will determine whether changes to the beach alignment have been as anticipated.

7.5 OUTCOME

The nearshore coastal processes will alter with the construction of the breakwater as an extension of the existing Albany Town Jetty. The change is expected to increase the build up of sand to the west of the Albany Town Jetty and the beach is likely to rotate by approximately 10 to 20 degrees clockwise as shown in Figure 20. This change is not expected to cause any significant change to the environmental or social values in the area.

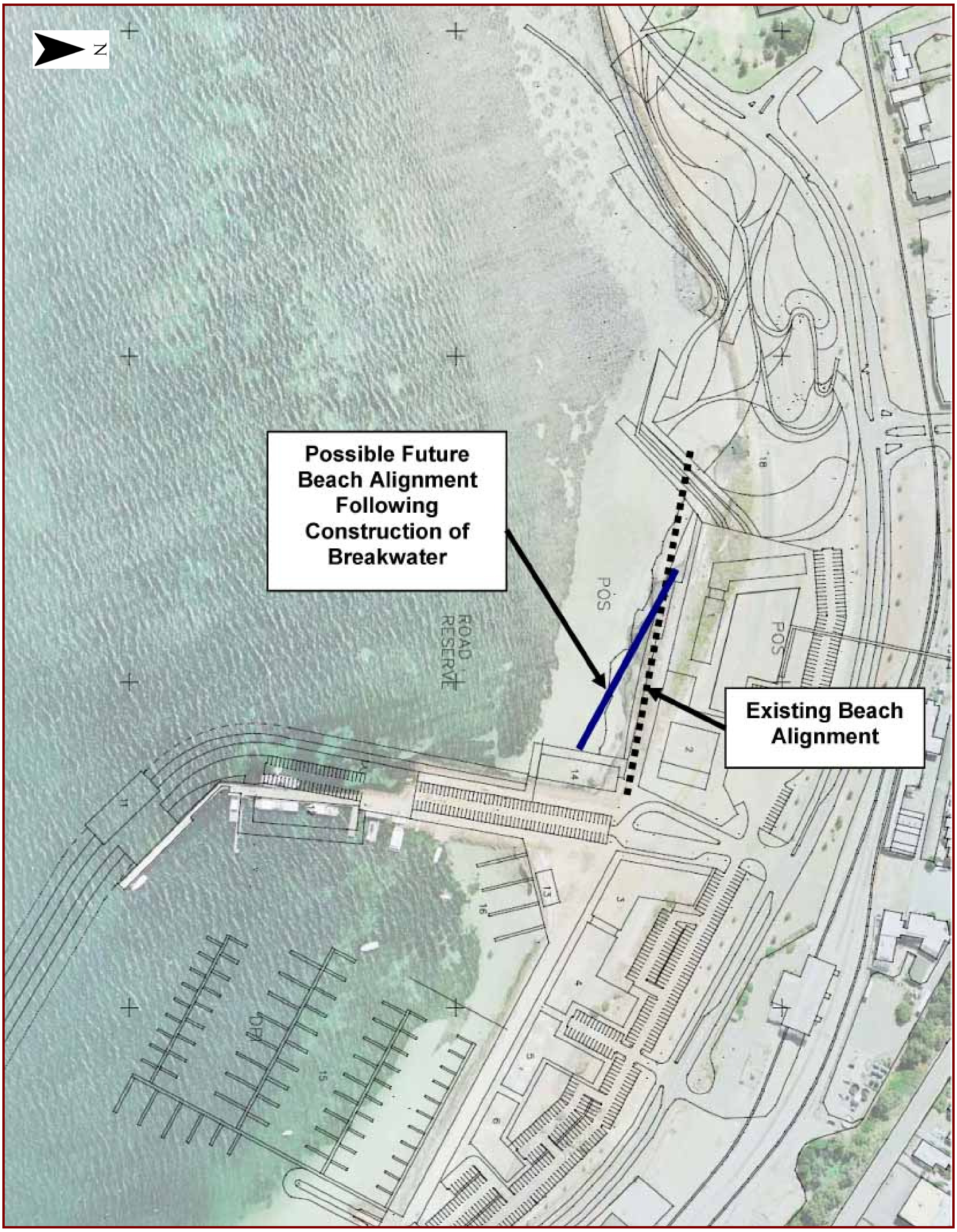


Figure 20 Current and predicted beach alignment west of the Albany Town Jetty

8. ASSESSMENT AND MANAGEMENT OF OTHER ENVIRONMENTAL FACTORS

8.1 SEDIMENT CONTAMINATION

8.1.1 EPA objective

The EPA objective for soil quality is considered applicable to sediment contamination:

> *To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use and consistent with appropriate criteria.*

The marine water quality objective is also relevant:

> *To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.*

8.1.2 Sediment investigation

The Protected Harbour requires excavation of approximately 15,000 m^3 of sediment and it is proposed to use this material to create a 0.85 ha hardstand area around the fishing industry precinct to the east of the Albany Town Jetty (Figure 4). Previous designs of the Protected Harbour required dredging of 45,000 m^3 and detailed investigation of the sediment characteristics and contaminant levels were undertaken to confirm that the material was suitable for reclamation works (Oceanica 2008 at Appendix 1). The excavation will result in some suspension of sediment into the water column, and there is potential for dissolved and particulate contaminants in the excavated material to come into contact with the marine environment. There is also some potential for dissolved and particulate contaminants in the sediment to enter the harbour through reclamation runoff. The sediment investigations also served the purpose of assessing the potential contamination in the area to be excavated.

Sediment samples were initially collected on two separate occasions, firstly in February 2004 and secondly in March and April 2006 (Oceanica 2008 at Appendix 1). The latter sampling was more comprehensive and included the sites, sampling depths and analyses shown in Table 23 and Figure 21. The choice of sites was guided by the national guidelines for the assessment of dredged material (Commonwealth of Australia 2002), with 12 sites required for the original dredging volume of 45,000 m^3, sampled to the full depth of dredging and split into layers of approximately 0.5 m for analysis. The 2006 sampling included nine sites east of the Albany Town Jetty (Figure 21), and used data from three sites from the 2004 survey. The sites west of the Albany Town Jetty were sampled to assess risks to the marine environment due to any accumulation of contaminants from the York Street stormwater drains.

The 2004 and 2006 data indicated low level lead and mercury contamination in some of the sediments to be excavated for the Protected Harbour. As a result, further sampling of lead and mercury levels in sediments was undertaken in February 2008, to more fully characterise the environmental risks associated with these trace metals. Again, the choice of sites in 2008 was guided by the national guidelines for the assessment of material to be dredged (Commonwealth of Australia 2002), and samples were collected from 13 sites within the proposed area of excavation. Sediments in the breakwater footprints of the proposed development were also examined to assess the potential risk of lead and mercury mobilisation due to sediment suspension during placement of breakwater material. In addition, several sites outside the development area were sampled to confirm whether the low level of mercury contamination evident in some of the sediments to be excavated was part of a broader scale legacy of historic mercury contamination in the 1960s to early 1980s (EPA 1990).

Table 23 2004 and 2006 sediment survey details including sites, depths and analyses

Site and sediment layer	Analyses undertaken					
	Metals[1]	Organics[2]	Nutrients[3]	Particle size[4]	TBT[5]	ASS[6]
YS1: surface 2 cm	✓	✓	✓	X	✓	✓
YS2: surface 2 cm	✓	✓	✓	X	✓	✓
YS3: surface 2 cm	✓	✓	✓	X	✓	✓
0.7W: surface 0–1 m layer		2004 survey		✓	✓	✓
0.7W: 1–2 m layer	✓	✓	✓	✓	✓	✓
0.7M: surface 0–1 m layer		2004 survey		✓	✓	✓
0.7M: 1–2 m layer	✓	✓	✓	✓	✓	✓
0.7E: surface 0–1 m layer		2004 survey		✓	✓	✓
0.7E: 1–2 m layer	✓	✓	✓	✓	✓	✓
1.5W: surface 0.65 m layer		2004 survey		✓	✓	✓
1.5W: 0.65–1.25 m layer	✓	✓	✓	✓	✓	✓
2.0W: surface 0–0.375 m layer	✓	✓	✓	✓	✓	✓
2.0W: 0.375 –0.75 m layer	✓	✓	✓	✓	✓	✓
2.0M: surface 0–0.375 m layer	✓	✓	✓	✓	✓	✓
2.0M: 0.375 –0.75 m layer	✓	✓	✓	✓	✓	✓
2.0E: surface 0–0.375 m layer	✓	✓	✓	✓	✓	✓
2.0E: 0.375 –0.75 m layer	✓	✓	✓	✓	✓	✓
2.5M: surface 0.25 m layer	✓	✓	✓	✓	✓	✓
2.5E: surface 0.25 m layer	✓	✓	✓	✓	✓	✓
SY: surface 2 cm	✓	✓	✓	X	✓	✓

1 Arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, zinc

2 Total petroleum hydrocarbons, standard suite of Polycyclic aromatic hydrocarbons – Total PCB's, BTEX (Benzene, Toluene, Ethylbenzene, Xylene), standard suite of organochlorine pesticides, total organic carbon.

3 Total nitrogen and total phosphorus

4 Particle size analysis

5 Tributyltin (boat anti-foulant)

6 Acid sulphate soil potential

Source: Oceanica 2008

Analysis of all sediments in 2008 included assessment of total lead and total mercury, and, as per Commonwealth of Australia (2002), for bioavailable lead and mercury, and elutriate levels of lead and mercury to determine potential release of bioavailable metals into the water column due to suspension of sediments (during excavation, or placement of breakwater material). Sediment from the area to be excavated was also analysed for leachate metals (as per DoE 2001) to assess the potential for release of lead and mercury into drainage (groundwater, stormwater) from the site. The sites, sampling depths and analyses for the 2008 survey are shown in Table 24 and Figure 22.

Table 24 2008 sediment survey details including sites, depths and analyses

Site and sediment layer	Analyses undertaken					
	Total lead & total mercury[1]	Bioavailable lead & mercury [2]	Total organic carbon	Particle size analysis	Elutriate lead & mercury[3]	Leachate lead & mercury[4]
0.5A: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
0.5A: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
0.5A: 1.0–1.5 m layer	✓	✓	✓	✓	✓	✓
0.5B: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
0.5B: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
0.5B: 1.0–1.5 m layer	✓	✓	✓	✓	✓	✓
0.5C: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
0.5C: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
0.5D: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
0.5D: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
0.5E: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
0.5E: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
1.0A: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.0A: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
1.0B: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.0B: 0.5–1.0 m layer	✓	✓	✓	✓	✓	✓
1.0C: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.0D: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.0E: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.5A: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
1.5B: surface 0.5 m layer	✓	✓	✓	✓	✓	✓
2.0A: surface 0.25 m layer	✓	✓	✓	✓	✓	✓
EB1: surface 0.25 m layer	✓	✓	✓	✓	✓	X
EB2: surface 0.25 m layer	✓	✓	✓	✓	✓	X
EB3: surface 0.25 m layer	✓	✓	✓	✓	✓	X
MB1: surface 0.25 m layer	✓	✓	✓	✓	✓	X
MB2: surface 0.25 m layer	✓	✓	✓	✓	✓	X
MB3: surface 0.25 m layer	✓	✓	✓	✓	✓	X
MB4: surface 0.25 m layer	✓	✓	✓	✓	✓	X
O1: surface 0.25 m layer	✓	✓	✓	✓	✓	X
O2: surface 0.25 m layer	✓	✓	✓	✓	✓	X
O3: surface 0.25 m layer	✓	✓	✓	✓	✓	X

1 Strong acid extraction

2 Dilute acid extraction.

3 One volume of sediment shaken with four volumes of seawater for half an hour, , as per Commonwealth of Australia (2002)

4 ASLP test, as per DoE (2001)

Source: Oceanica 2008

The results of the sediment surveys are addressed in Section 8.1.4.

Figure 21 Sediment sampling sites for 2004 and 2006 surveys

Figure 22 Sediment sampling sites for February 2008 survey

8.1.3 Legislative and policy framework

Environmental management framework for coastal waters in WA

As discussed in Section 5.3.2, the environmental management framework developed for the waters of Cockburn Sound has been used for Princess Royal Harbour. The EV relevant to sediment contamination is Ecosystem Health, and relevant environmental quality criteria have been used to assess sediment quality. Sediment environmental quality criteria comprise two types:

- an EQG 'Value' equivalent to the ANZECC/ARMCANZ (2000) interim sediment quality guideline - low (ISQG - low)
- an EQG 'Re-sampling trigger' equivalent to the ANZECC/ARMCANZ (2000) interim sediment quality guideline – high (ISQG - high).

Protocols established for the Cockburn Sound SEP require the median value of sediment contaminants within an area to comply with the EQG Value, and no single site to exceed the EQG Re-sampling trigger.

Relevant guidelines and policies

Other relevant policies include:

- *Australian New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)*
- *National Ocean Disposal Guidelines for Dredged Material (Commonwealth of Australia 2002)*
- *Contaminated Sites Regulations (Government of Western Australian 2006)*
- *Contaminated Sites Management Series (developed by the DoE).*

Note that ANZECC/ARMCANZ (2000) ISQG - lows and ISQG - highs are also used as screening guidelines and maximum permissible levels, respectively, in the National Ocean Disposal Guidelines (Commonwealth of Australia 2002). At the State level, the ISQG - lows and ISQG - highs are used in contaminated site assessment (DoE 2003), and as Environmental Quality Guideline (EQG) Values (= ISQG – lows) and EQG Re-sampling Triggers (= ISQG – highs) for sediment quality assessment under the environmental management framework established for Cockburn Sound.

Protocols established for sediment quality assessment under these policies and guidelines are more typically based on the 95% upper confidence level (95% UCL) of the mean (i.e. average) concentration of the sediments in question.

Data from elutriate tests and leachate tests are compared to ANZECC/ARMCANZ (2000) guidelines for marine waters, using the 95% upper confidence level (95% UCL) of the mean (i.e. average) concentration in elutriate or leachate waters.

8.1.4 Impact assessment and mitigation

Environmental aspects and potential impacts

The aspects of the Protected Harbour proposal that have the potential to disturb or release any sediment contamination are:

- excavation of sediment to deepen the marina
- return of the marine water drainage from the reclamation area has the potential to cause turbidity and release contaminants
- placement of the excavated sediment (if contaminated) in reclamation has the potential to affect environmental values or public health.

Sediment contamination results

Sediment data have been compared to both marine EQG Values and EQG Re-sampling triggers (to assess environmental health) and with Ecological Investigation Levels (EILs) and Health Investigation Levels (HILs) for soils, as defined by DEC (DoE 2003). HILs for 'E' (parks, recreational open space and playing fields, includes secondary schools) and 'F' (commercial/industrial, includes premises such as shops and offices as well as factories and industrial sites) were deemed the most appropriate to use, given the proposed use of excavated material for hardstand.

The results of the sediment sampling and analysis are presented in full in Appendix 1 (Oceanica 2008), and may be summarised as follows:

1. The sediments within the area to be excavated did not exceed any EIL or HIL.
2. West of the Albany Town Jetty, sites YS1, YS2 and YS3 did not exceed EQG Values for metals, organics or TBT. Where no guidelines were available, the contaminants were below laboratory detection limits. For two organic chloride pesticides (dieldrin and endrin), the laboratory detection limit was slightly above the EQG Value. Therefore, compliance was inferred rather than confirmed, based on levels being below detection limits.
3. East of the Albany Town Jetty, no site exceeded EQG Values for PAHs and TBT and most metals. Where no guidelines were available, the contaminants were below laboratory detection limits. For two organic chloride pesticides (dieldrin and endrin) the laboratory detection limit was slightly above the EQG Value. Therefore, compliance was inferred rather than confirmed, based on levels being below detection limits.
4. Nutrient and total organic carbon levels were within the range commonly recorded for fine marine sediments from the coastal waters of Western Australia.
5. The Titratable Peroxide Acidity (TPA – net acidity) and Chromium Reducible Sulphur (S_{CR}) were determined for the sediments to be excavated. There were no exceedances of TPA, but several exceedances of oxidisable sulphur. However excess acid neutralising capacity at all sites was high, and it is unlikely the sediments would become acid generating.
6. Particle size analysis indicated that the majority of sites in the area to be excavated comprised either fine – medium sands or coarse sands – gravel, with only small percentages of silts and clays
7. Low level mercury contamination was evident at some sites both within and outside the proposed development area, confirming the most likely source as re-distribution of sediments from the

western end of Princess Royal Harbour (by wind and wave action over several decades) that were contaminated with mercury in the 1960s to early 1980s.

As some sediment layers at some sites exceeded marine guidelines for lead and mercury, a more detailed assessment was undertaken. Two approaches can be taken for the assessment of data for marine sediment, and both were used. Both approaches require measurement of bioavailable metals and use the same guideline values, but differ in their statistical treatment of data. Approach 1 is that used under the Cockburn Sound SEP, and requires the median value of sediment contaminants within an area to comply with the EQG Value (= ISQG – low), and no single site to exceed the EQG Re-sampling trigger (= ISQG – high). Approach 2 is that used for contaminated site assessment, and requires the 95% UCL of the mean concentration within an area to comply with the ISQG – low.

With respect to **lead**:

- data for total lead obtained from eight sites (16 sediment samples, taken at depth intervals from 0.5 to 2.0 m) in the 2004/2006 surveys indicated that the sediments to be excavated complied with both assessment Approach 1 and 2, indicating a low risk to marine biota due to lead contamination of sediments
- data for bioavailable lead obtained from 13 sites (22 sediment samples, taken at depth intervals from 0.25 to 1.5 m) in the 2008 survey indicated that the sediments to be excavated complied with both assessment Approach 1 and 2, indicating a low risk to marine biota due to lead contamination of sediments
- elutriate tests for sediments in the area to be excavated (2008 data) were below the marine water quality guideline, indicating a low risk to marine biota due to mobilisation of lead during suspension of sediments during excavation
- leachate tests of sediments in the area to be excavated (2008 data), were below the marine water quality guideline, indicating a low risk to marine biota due to leaching of lead from landfill.
- in the breakwater footprint area, elutriate tests for lead in sediments (2008 data) were below the marine water quality guideline, indicating a low risk to marine biota from lead mobilised due to suspension of surface sediments during placement of breakwater material

With respect to **mercury**:

- data for total mercury obtained from eight sites (16 sediment samples, taken at depth intervals from 0.5 to 2.0 m) in 2004/2006 indicated non compliance with assessment Approach 1 (the median value complied with the EQG Value, but one sample exceeded the EQG Re-sampling trigger), and non compliance with assessment Approach 2 (the 95% UCL of the mean exceeded the EQG Value). These results indicated potential risk to marine biota due to mercury contamination, but were based on total mercury not bioavailable mercury, and non-compliance in both cases was due a sample from one sediment layer at one site taken in 2004. This result triggered further assessment in 2008.
- data for bioavailable mercury obtained from 13 sites (22 sediment samples, taken at depth intervals from 0.25 to 1.5 m) in 2008 indicated that the sediments to be excavated complied with both assessment Approach 1 and 2, indicating a low risk to marine biota due to mercury contamination of sediments
- elutriate tests for sediments in the area to be excavated (2008 data) were below the marine water quality guideline, indicating a low risk to marine biota due to mobilisation of mercury during suspension of sediments during excavation

- leachate tests of sediments in the area to be excavated (2008 data), were below the marine water quality guideline, indicating a low risk to marine biota due to leaching of mercury from landfill.
- in the breakwater footprint area, elutriate tests for mercury in sediments (2008 data) were below the marine water quality guideline, indicating a low risk to marine biota from mercury mobilised due to suspension of surface sediments during placement of breakwater material

The bioavailable lead and mercury levels that will be left in the excavated area after construction, based on the 2008 sediment data, also complied with assessment Approaches 1 and 2, indicating a low risk due to lead and mercury levels in the sediments that will be exposed after excavation.

Excavated material from the project area will be suitable for reclamation from a contamination point of view and no further testing for contamination is required. The level of contaminants in sediments presents negligible risk to the marine biota of Princess Royal Harbour in situ or when sediments are disturbed by construction. In making this assessment greater weight was given to the 2008 data because it more thoroughly characterised the sediments to be excavated (both in terms of the number of samples taken and analyses performed), and because non-compliance with screening guidelines for mercury in the 2004/2006 data was due to total mercury levels (not bioavailable mercury) in one sample taken in 2004.

Particle size data also indicate a low percentage of fine particle in material to be excavated, which lowers the potential for excavation activities to result in persistent turbidity (Section 5.4, Table 23).

Finally, it is noted that seagrass rehabilitation is required as an offset for the proposed development, and the risks that this activity poses to human health and marine biota were assessed. The risks were considered low for the following reasons:

- Planting of seagrass is designed to disturb the substrate as little as possible so that the plants have the best chance of establishing a root system.
- Planting of seagrass is done in sandy substrate (i.e. minimal fines content and less potential for sediment re-suspension and therefore turbidity), as silty areas are not desirable for rehabilitation. Sandy sediments with low organic matter do not tend to be associated with elevated mercury levels
- The rehabilitation method creates very little disturbance to the sediments so it is unlikely that there will be a risk to divers undertaking the planting
- Sampling within the area proposed for use in seagrass rehabilitation found sediment concentrations of lead and mercury, and elutriate tests, that were well below relevant guidelines.

Risk assessment due to contamination of seafood

The sediment results discussed above address risks to human health due to contact with excavated sediments used for reclamation, but do not address one other potential pathway of exposure; the effects on human health due to the consumption of seafood (locally-caught fish, molluscs and crustaceans) contaminated by mercury mobilised during construction of the Protected Harbour. Further assessment of this risk was undertaken because of the potential risks due to methylmercury, a highly toxic form of mercury that can form in marine sediments, that is known to bioconcentrate in fish. There are no specific sediment or water quality guidelines for methylmercury. The full risk assessment is presented in Appendix 1 (Oceanica 2008).

Methylmercury typically forms in anaerobic[4] sediments (ANZECC/ARMCANZ 2000), and tends to bind very strongly to organic matter. In the historic area of mercury contamination at the western end of Princess Royal Harbour, methylmercury was primarily associated with the organic fraction of sediments (EPA 1987). This fine organic matter forms the base of food chains as it is food for many invertebrates (worms, tiny crustaceans, shellfish) that in turn are the preferred food of most commercially and recreationally important fish. Mercury biomagnifies along the aquatic food chain in Princess Royal Harbour because the proportion present as methylmercury accumulates and is retained in the flesh much more efficiently than inorganic mercury. In fish, over 90% of the mercury present is in the form of methylmercury. The half life of methyl mercury in fish (it is stored mainly in the muscle tissue) is about 50 days (OPHA 2004). Methylmercury in fish is slowly excreted via their faeces - where it adds to organic matter in the sediments, becoming available to enter the food chain again.

Suspension of fine organic matter is considered the main pathway by which methylmercury could potentially contaminate seafood, as any methylmercury present in sediments is likely to be, and remain, strongly adsorbed to the fine organic matter when it is suspended during excavation or placement of breakwater material.

The provisional tolerable weekly intake (PTWI) for methylmercury set by the Joint FAO/WHO Expert Committee is 1.6 µg/kg body weight/week to take account of the most sensitive population subgroup (pregnant women) (JECFA 2003). A PTWI of methylmercury for human consumers of 1.6 µg/kg body weight/week (JECFA 2003) equals 96 µg/week for a 60 kg adult, or 198 µg/week for the previous PTWI set by the JECFA of 3.3 µg/kg body weight/week (which does not consider pregnant women). Given Australian fish consumption ranges from a median of 70 g fish/day (490 g/week) to high consumption of 321 g fish/day (2,247 g/week), the fish consumed would need to have an average maximum methylmercury concentration of 196 µg/kg for a typical fish consumption rate and 42 µg/kg for a high consumption rate (or 0.196 and 0.042 mg/kg, respectively) for the new PTWI. The previous PTWI equates to an average maximum methylmercury concentration of 404 µg/kg for a typical fish consumption rate and 85 µg/kg for a high consumption rate (or 0.404 and 0.085 mg/kg, respectively).

In addition to fish caught from Princess Royal Harbour, the population of Albany has access to local commercially and recreationally caught seafood (lobster, crabs, shark, snapper, dhufish, emperor, herring) from Oyster Harbour, King George Sound and further offshore, as well and frozen and tinned fish from a variety of sources. Due to (i) the likely rapid dispersion throughout Princess Royal Harbour of fine suspended matter generated during excavation, (ii) the mobility of fish (which would also avoid the area during construction), plus (iii) the various sources of fresh fish available for consumption by the population of Albany (and any frozen and canned fish consumed), it is difficult to directly assess the risk to human health posed by seafood contamination due to the small amount of bioavailable mercury in suspended sediments generated during excavation of the proposed development. For this reason a simpler approach was used, based on the additional burden of methylmercury that the proposed development will contribute, relative to that already present due to the historic contamination of the western end of Princess Royal Harbour with an estimated 400 kg of mercury (see Section 3.3.2). This risk assessment concluded (Appendix 1):

- Breakwater construction will not result in any incremental mercury exposure for seafood consumers. Construction of the breakwaters will actually lessen the degree of mercury exposure for seafood consumers, as it will 'cap' an area of about 30,000 m^2, resulting in the effective

[4] No oxygen present.

removal of an estimated 1.349 kg of bioavailable mercury, and 2.202 kg of total mercury from the food webs of Princess Royal Harbour.

- The incremental mercury exposure for consumers of fish and crustaceans due to the excavation of sediments (via suspension and dispersion of fine sediments) and use for landfill on-site (via leachate into the marine environment) is negligible
- Uncontrolled excavation (i.e. no silt curtain used) of the most contaminated sediments coinciding with a period of calm conditions could potentially result in any mussels on existing pylons around the proposed development area exceeding the provisional tolerable weekly intake for methylmercury set by the Joint FAO/WHO Expert Committee (JECFA 2003, and set to be protective of pregnant women), assuming consumption of 70 g of mussels (about 25 small or 10 average sized mussels) by a 60 kg person in one week. This risk is considered low because
  - this represents the worst case scenario
  - sustained harvesting of mussels at this rate would not be possible, and
  - there would be no public access to the site during construction
- There is not expected to be any incremental mercury exposure for seafood consumers after construction because
  - the sediment surface left exposed after excavation has levels of bioavailable mercury that comply with sediment screening guidelines
  - where sediments are used for reclamation fill there will be no infiltration as the area will be covered by hardstand, and much of the material will be above the water table. Therefore the potential for leaching from sediments in the landfill site is considered to be less than experienced by the sediments in situ at present
  - The breakwaters for the Protected Harbour will gradually become colonised by algae and invertebrates, and the fish they attract will be targeted by recreational fishers. Breakwater plants and invertebrates will provide water-column based food rather than sediment-based food, and so the food available to fish from this source is expected to have little or no mercury contamination. As such, the breakwaters are not expected to add to the mercury burden of fish targeted by recreational fishers
  - As noted earlier, the breakwaters will also lessen the degree of mercury exposure for seafood consumers, as they will 'cap' an area of about 30,000 m^2 that has existing low-level mercury contamination

The risks to the marine environment and to seafood consumers due to the construction of the Protected Harbour are low, but will be reduced even further as follows:

1. A silt curtain will be deployed around the excavation area to minimise the dispersion of suspended fines generated during excavation.
2. The drainage from excavated sediments will be discharged into the Protected Harbour behind the silt curtain.
3. LandCorp will monitor contaminant levels in mussels within the Protected Harbour before, during and for two months post construction to determine whether contaminant levels are affected and whether the mussels are safe for human consumption. Both naturally occurring mussels on the existing jetty and specifically deployed 'sentinel' mussels will be sampled. The sampling is further described in the CEMP (Appendix 8).

4. Sediments with the higher levels of fine organic matter will have the highest concentrations of mercury. These sediments will not meet the geotechnical criteria for use as fill in the reclamation area so will be taken offsite to a licensed landfill site. These sediments easily meet leachate guidelines for Class 1 landfill for lead and mercury (Appendix 1).

The CEMP outlines the management and monitoring program in more detail (Appendix 8).

8.1.5 Outcome

Contaminant levels in the sediment to be excavated and used for reclamation are such that ecological values in the vicinity of the project area will not be affected as no EILs or HILs are exceeded, no marine guidelines for sediment are exceeded, and no marine water quality guidelines are exceeded in sediment elutriate waters or leachate waters. Therefore, the EPA objectives to protect environmental values in marine waters and to ensure sediments are of an acceptable standard for the intended land use will be met.

Elutriate testing of sediments in the breakwater footprints meet marine water quality guidelines. Therefore, the EPA objectives to protect environmental values in marine waters will be met during any suspension of sediments during placement of breakwater material.

Risk assessment indicates that there will be no incremental mercury exposure for seafood consumers during or after construction. The proposed development will actually lessen the degree of mercury exposure for seafood consumers, as its breakwaters will ‘cap’ an area of about 30,000 m^2 that has existing low-level mercury contamination. Therefore, the EPA objectives to protect environmental values in marine waters and ensure no adverse effects on the health and welfare of human consumers of locally caught seafood will be met.

8.2 DUST, NOISE AND ODOUR

8.2.1 EPA objectives

The relevant EPA objective for noise and air quality (dust and odour):

- **Noise:**

  To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

- **Air quality:**

  To ensure that emissions do not adequately affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

8.2.2 Description

The main existing sources of noise near the project area are the Albany Port and road traffic along Princess Royal Drive. The Protected Harbour development is outside the Albany Port Noise Buffer Area that was established in 2000. Odour is sometimes generated by the seagrass wrack that currently accumulates to the west of the Albany Town Jetty.

8.2.3 Legislative and policy framework

The *Environmental Protection (Noise) Regulations 1997* will apply to the project.

8.2.4 Impact assessment and mitigation

The key aspects of the proposal with the potential to generate dust, noise and odour during construction are:

- vehicle movements and machinery operation including earth moving machinery, trucks and small vehicles may generate noise
- earthworks and vehicle movement
- dust lift-off from stockpiled material
- excavation may disturb anoxic sediments that cause odour.

Construction

Approximately 15,000 m^3 of sediment will be excavated to deepen the north western corner of the Protected Harbour, with the material then to be used for reclamation in the fishing industry area. The excavation will be undertaken 'wet', so it is expected that the material to be excavated and any stockpiles will still be wet and not generate dust.

The material to be excavated has been sampled as described in Section 8.1.2 and results show that the material is predominately sand with low levels of finer material. This material would not be expected to cause odour problems when exposed to air.

Dust and noise will be managed in accordance with the CEMP that has been prepared in consultation with DEC (Appendix 8).

Operation

During operation, negligible dust would be expected to be generated from the boat harbour as there will be no ground-disturbing activities and vehicle movements will be restricted to sealed areas. Low levels of noise would be expected to be generated from boat traffic during operation of the boat harbour. The noise generated during operation of the boat harbour would not be expected to be significant as:

- there are no residential areas in proximity to the boat harbour
- boat speeds within the boat harbour will be restricted.

Mitigation

Management of dust and noise is outlined in CEMP (Appendix 8).

8.2.5 Outcome

The EPA objectives are expected to be met as there is a low potential for odour, dust and noise that would affect the amenity of nearby residents. Dust and noise will be managed according to the CEMP.

8.3 HERITAGE AND CULTURE

8.3.1 EPA objective

The EPA objective for heritage is:

> *To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

8.3.2 Description

Aboriginal

The South West Region has a population of about 4000 Aboriginal people. In March 2003, the City of Albany signed an Accord with its Noongar community to involve aboriginal people in employment, training, cultural and social activities.

There are no Aboriginal Heritage sites recorded on the Department of Indigenous Affairs Register System within the project area (DIA 2006).

European

The Albany Town Jetty is registered as site 3607 on the State Register of Heritage Places. The jetty was first built in 1862 as a timber and iron finger jetty with a landing and steps on each side of the jetty head. The jetty and the sea bed under and adjacent to it has cultural significance for the following reasons (Heritage Council of Western Australia 2006):

- it is believed to be the oldest jetty site in Western Australia in continuous use
- the place was the gateway port to Australia for international passenger ships arriving from Europe via Cape Leeuwin between 1862 and 1900. During this period it was also the principal landing place in Western Australia for migrants, imports and exports, and international mail
- the place is associated with the development of mail and steamship services to and from Western Australia in the nineteenth century, and with the development of port facilities in Western Australia
- the place is representative of the importance of shipping in communication, and in the provision of commercial services, in the mid and late nineteenth century
- the place is a landmark on the Albany foreshore and contributes to the community's sense of place as a place of recreation
- the place has maritime archaeological importance for its deposits of artefact material on the sea bed which date from the early 1860s.

LandCorp undertook a project in 1995/96 to refurbish the existing structure and replace some parts of the jetty that were structurally unsound and beyond practical repair. Most of the jetty is now in sound condition.

Little remains of the original jetty structure (pre 1900) however, the original form of the place is discernible despite reclamation. The current use of the place as a jetty to service the Port of Albany and for recreational purposes is compatible with the cultural heritage significance of the place.

Available studies

A maritime archaeological assessment of the area was conducted by the Western Australian Museum and funded by LandCorp in 1995 as part of a previous development plan (Garratt et al. 1995). The assessment found that much of the earliest (pre 1870's) part of the Albany Town Jetty and its associated artefact layers lie under the reclaimed areas of the Albany foreshore. These reclaimed areas do not form part of the Protected Harbour project area. However, some artefacts are expected to remain under the seabed around the Jetty (Heritage Council of Western Australia 1996). A key recommendation of the 1995 study was that "the entire west side of the existing jetty structures be left undisturbed by any future development".

A Heritage Impact Statement has been prepared for LandCorp by Tom Stevens, Heritage Consultant regarding the Albany Waterfront Structure Plan and Adam Wolfe and Associates prepared a heritage impact statement specifically on the Albany Town Jetty and Foreshore maritime heritage values (Stevens 2007, Adam Wolfe and Associates 2007). These reports recognised that any land reclamation, including the construction of a stone breakwater, would cover the artefact deposits and ensure their long term protection. The reports also recommended that planning and construction for the project was carried out with advice from a quality archaeological consultant.

8.3.3 Legislative and policy framework

The Albany Town Jetty and surrounding seabed has been determined to fall within the jurisdiction delegated to the Western Australian Museum by the Western Australian *Maritime Archaeology Act 1973*. There is the potential for maritime archaeological material related to the early settlement of Albany to be located on the seabed or within existing foreshore area.

The State Register provides official recognition of a place's cultural heritage significance to Western Australia, and assists the Heritage Council to identify, provide for and encourage the conservation of heritage places.

The State Register of Heritage Places legally protects a place's cultural heritage significance by ensuring that any proposed demolition, relocation, subdivision, amalgamation, alteration, addition or new development is in harmony with its cultural heritage values. Protection is achieved through the requirement under the *Heritage of Western Australia Act 1990* (WA Heritage Act) that all development proposals regarding a registered place be referred to the Heritage Council for advice.

8.3.4 Impact assessment and mitigation

The Protected Harbour Development will construct a breakwater adjacent to and extending the existing jetty structure. Some sections of the Albany Town Jetty are known to be in poor condition and will be removed. The new breakwater alignment has been chosen where possible to avoid the sections of Town Jetty that will be retained. The breakwater will however, encroach to some extent on the Town Jetty near the lookout due to the alignment of the Toll Place road reserve. The breakwater will be lowered in this section to provide for a ramp from the breakwater to the jetty / lookout and foundations will be constructed around the Town Jetty piles. Indicative sketches of how the breakwater will be constructed in relation to the jetty are included in Appendix 7.

Some excavation for the marina basin and marina edge wall construction will occur but the majority of earthworks will cover rather than remove seabed material.

Construction of the breakwater, harbour structures and excavation for the boat harbour also has the potential to disturb the seabed and any historical material that exists there.

The construction of the breakwater and excavation of the seabed will be referred to the Heritage Council for consideration under the Heritage Act and to the Western Australian Museum under the *Maritime Archaeology Act 1973*. An archaeological survey of the areas to be excavated and reclaimed will be undertaken prior to construction to:

- identify any visible artefacts,
- determine appropriate management of any artefacts identified
- determine the potential for disturbance of unknown artefacts during construction
- recommend methods to identify and preserve artefacts during excavation.

These measures and contingencies are being determined in consultation with the Heritage Council and the Western Australian Museum and will be outlined in the Heritage Management Plan.

8.3.5 Outcome

The Albany Town Jetty extension will be undertaken in accordance with the requirement of the Museum, WA Heritage Act and the *Maritime Archaeology Act 1973*.

8.4 TRAFFIC

8.4.1 Objective

The following objective is considered relevant to this project:

> *To ensure that the increase in traffic resulting from the proposal does not adversely impact on social surroundings or increase the risk to local public safety*

8.4.2 Description

The Protected Harbour Development will be directly serviced by Princess Royal Drive which is a key link to York St (Figure 3). Princess Royal Drive is a primary access road leading to the Albany Port, it falls under the control of Main Roads Western Australia and is currently constructed as a wide two-lane boulevard style road. Current daily traffic movements collected by Main Roads indicates 4600 vehicles per day (vpd) to the east of Carlisle Drive, 2400 vpd east of York Street and 1760 vpd west of Bolt Terrace (Figure 23).

York St is the main street of Albany, providing a focal shopping and tourist precinct and is constructed as a two-lane boulevard type road with on-street parking. Current traffic data supplied from the City of Albany indicates a daily flow of 4100 vehicles, split 2400 northbound and 1710 southbound per day (Figure 23).

8.4.3 Potential impacts

The future traffic flows for the area have been forecast for 2016 and 2026 and include predicted increases in Port exports (Figure 24 and Figure 25). The overall traffic growth assumed in the traffic forecasts was 3.27% per annum (Riley Consulting 2006).

In addition to any future growth, the anticipated traffic generation of the Albany Waterfront Project was predicted by Riley Consulting (2006) and is summarised in Table 25. The traffic generation directly associated with the Protected Harbour Development is only a small proportion (<10%) of the traffic generated by the overall Albany Waterfront Project. The Protected Harbour Development is anticipated to result in a <5% increase in 2006 traffic volumes along Princess Royal Drive and York St (Table 26).

Table 25 Albany Waterfront Project traffic generation

Land Use	Weekday	Weekend
Entertainment Centre	490	818
Commercial	660	200
Retail	620	620
Restaurants / Cafes	864	1,440
Accommodation	542	700
Marina / boat ramp	98	340
Total	**3,274**	**4,118**

Table 26 Albany Waterfront Project traffic impacts

Location	Development	2006	2016	2026
Princess Royal Drive west of York St	+492	4,459	6,069	8,070
Princess Royal Drive east of York St	+2,480	5,091	6,243	7,574
York St	+1,988	6,365	7,913	10,009

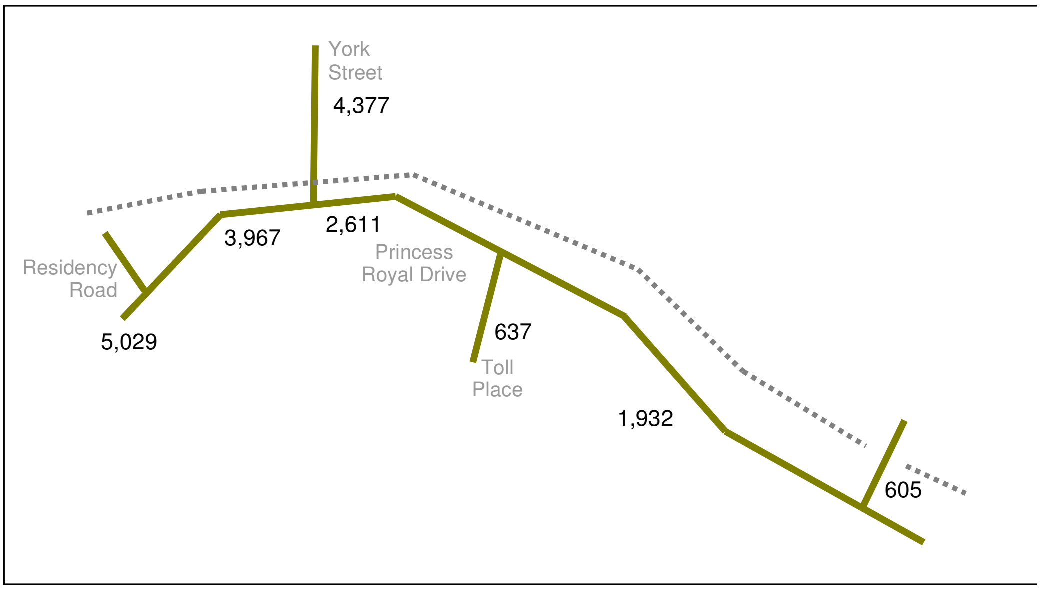


Figure 23 Traffic flows 2006

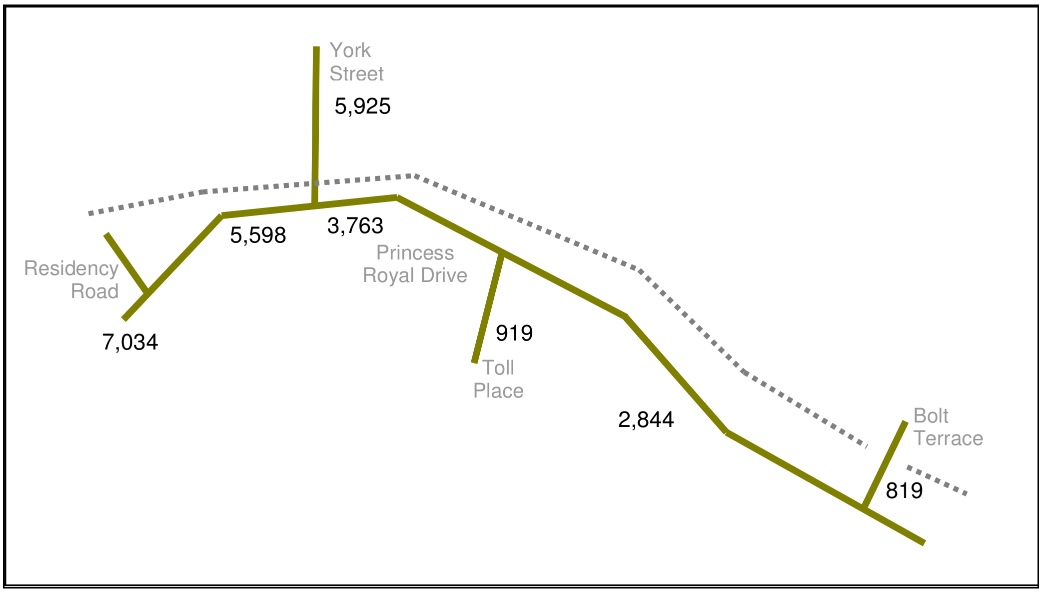


Figure 24 Projected traffic flows 2016

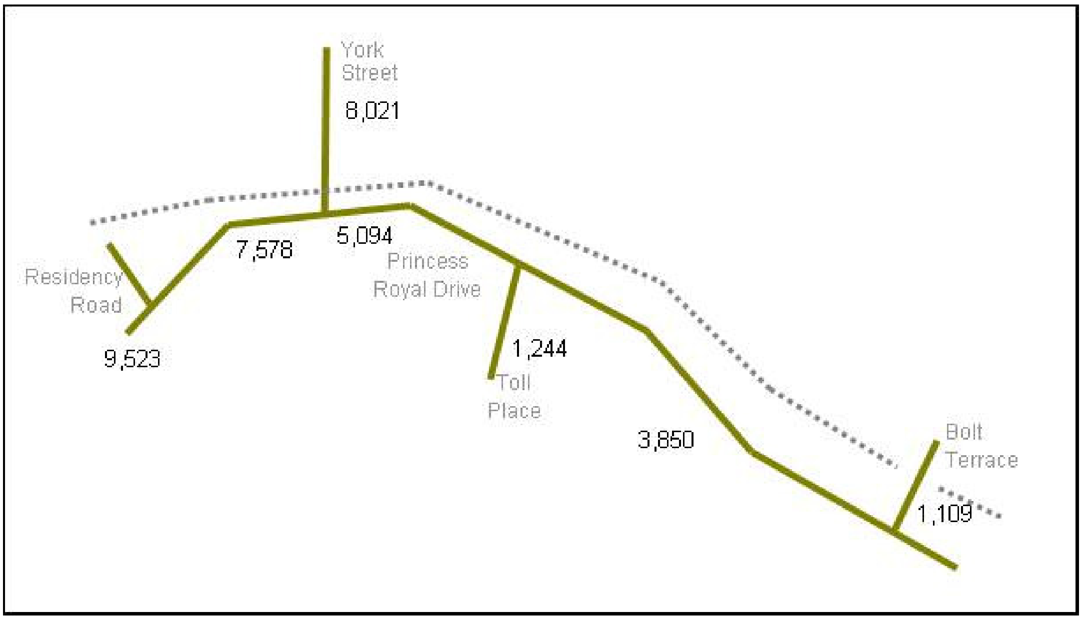


Figure 25 Projected traffic flows 2026

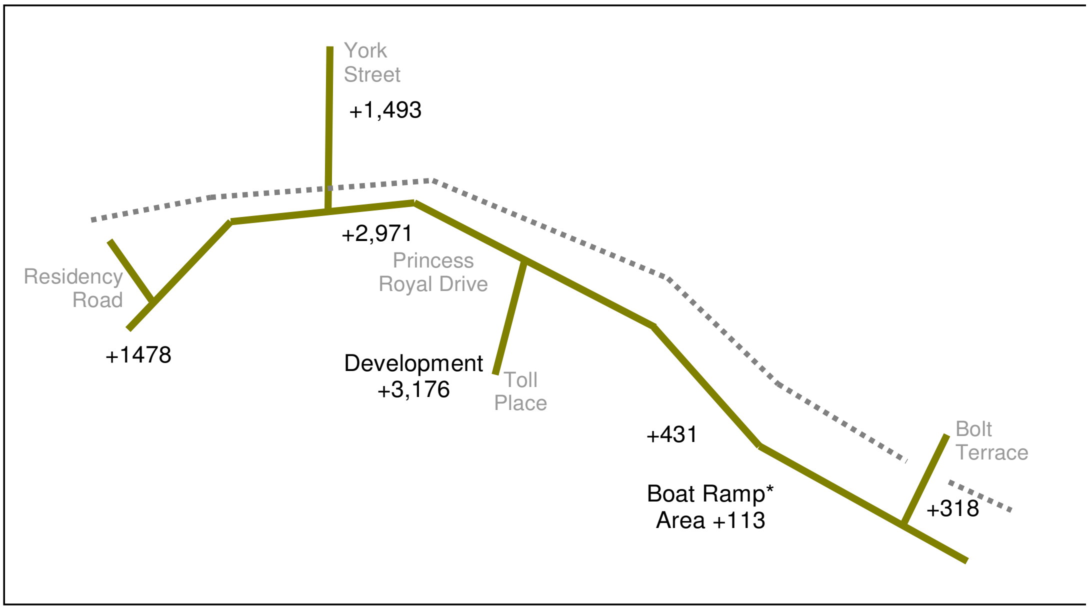


Figure 26 Forecast traffic flows resulting from the development

8.4.4 Outcomes

The key outcomes of the traffic assessment by Riley Consulting (2006) were:

1. From a daily traffic flow perspective, local roads can be expected to operate within acceptable levels of service with the full development of the Albany Waterfront Project for the next twenty years.
2. The forecast traffic volumes for 2016 suggest that the intersection of York St/Princess Royal Drive would require some form of control.

The Protected Harbour Development will result in a <5% increase in 2006 traffic volumes along Princess Royal Drive and York St and no specific management measures are proposed.

9. ENVIRONMENTAL OUTCOMES: COSTS AND BENEFITS

The key environmental factors identified by the proponent, Government agencies and other key stakeholders in regard to the development and operation of the Protected Harbour Project were:

1. Marine water quality – Turbidity generated by construction and potential reduced water quality both within the Protected Harbour and in adjacent areas of Princess Royal Harbour, through reduced water exchange in the project area.
2. Marine ecosystem – Direct and indirect seagrass losses due to the development footprint, 'halo' effects of erosion and smothering around the breakwater and potential for adverse effects on seagrass from construction turbidity. This will be offset by replanting seagrass elsewhere in Princess Royal Harbour.
3. Coastal processes – Erosion and accretion around the harbour structures and the beach to the west of the Albany Town Jetty.

The targeted consultation program indicated that the most important issue regarding this proposal related to marine water quality, primarily effects on marine water quality during and following construction.

9.1 ENVIRONMENTAL COSTS

The environmental costs of the proposal are as follows:

1. Localised, temporary reduction in water quality due to turbidity generated by breakwater and seawall construction, excavation, reclamation and potential runoff from reclaimed areas.
2. Reduction of water quality within the Protected Harbour due to decreased water exchange after breakwater construction.
3. The construction of the Protected Harbour will potentially result in the loss of about 0.111 ha of dense seagrass and 1.436 ha of sparse seagrass, which is equivalent to 0.259 ha of seagrass meadow with 75% seagrass cover.
4. The alignment of the beach west of the Albany Town Jetty may rotate between 10 to 20 degrees clockwise from the current situation.

9.2 ENVIRONMENTAL BENEFITS

A number of environmental benefits will arise from the implementation of this proposal and continued operation of the Protected Harbour:

1. The project has supported a joint study with DoW to map the seagrass extent and density in Princess Royal Harbour in 2006 (based on aerial photography and ground-truthing) showing a recovery in seagrass cover. The last seagrass mapping of Princess Royal Harbour was carried out in 1992.
2. Seagrass rehabilitation will be carried out west of the project area to more than offset any seagrass losses associated with the project.
3. Continued monitoring of water quality in Princess Royal Harbour.

4. The slipway that currently exists in the project area is a potential source of contamination. The slipway will be filled and capped as part of the reclamation for the fishing hardstand/parking area. This will effectively reduce exposure to the marine environment of any historic contamination.

9.3 ENVIRONMENTAL RISKS AND MANAGEABILITY

The approach taken in this environmental review has been based on a risk assessment approach to characterise environmental factors, identify environmental aspects, determine potential impacts and develop mitigation measures.

LandCorp has extensive experience in managing community and land development projects while the Department for Planning and Infrastructure (DPI) has extensive experience managing and designing boat harbours and this experience is anticipated to lead to a greater certainty in achieving desirable environmental outcomes.

The construction environmental aspects of the proposal will be primarily managed through the CEMP and the performance review, which will be prepared in consultation with the relevant agencies. The CEMP sets out the monitoring requirements, triggers and contingencies that will be the basis of the project management during construction.

Monitoring after construction will be undertaken in accordance with an Operation Environmental Monitoring and Management Plan to determine whether the boat harbour is having the predicted effects and whether a management response is required. The five year performance review will review the water quality within the Protected Harbour and in adjacent Princess Royal Harbour, the performance of the seagrass rehabilitation and any changes to the beach alignment as a result of the development.

Extensive consultation has been undertaken during the development of the project and during the preparation of the EPS in order to scope the environmental issues associated with the project and to determine their significance and the develop of mitigation measures. This process substantially increases the likelihood that all significant environmental issues have been identified, investigated, mitigated and offset as appropriate.

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11. SHORT TITLES AND ACRONYMS

Short title or acronym	Long title
µg/L	Micrograms per litre
Administrative Procedures	*Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002*
AHD	Australian Height Datum
ASS	Acid sulfate soil/s
BPPH	Benthic primary producer habitat
CALM	Department of Conservation and Land Management (now DEC)
CBD	Central business district
CEMP	Construction environmental management plan
CER	Consultative Environmental Review
CERC	Coastal Engineering Research Centre
CRG	Community Reference Group
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DIN	Dissolved inorganic nitrogen
DoE	Department of Environment (now DEC)
DoW	Department of Water
DPI	Department for Planning and Infrastructure
EIL	Ecological Investigation Level
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPASU	Environmental Protection Authority Services Unit
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPS	Environmental Protection Statement
EQC	Environmental quality criteria
EQG	Environmental quality guidelines
EQO	Environmental quality objective
EQS	Environmental quality standard
GSDC	Great Southern Development Commission
ha	Hectare/s
Heritage Act	*Heritage of Western Australia Act 1990*
HIL	Health Investigation Level
kg/day	Kilogram/s per day
km/hr	Kilometres per hour
km^2	Square kilometre/s
m	Metre/s
m/day	Metres per day
m/s	Metres per second
m^3	Cubic metre/s
m^3/day	Cubic metres per day
m^3/yr	Cubic metres per year
mg/L	Milligrams per litre
ML	Megalitre/s

Short title or acronym	Long title
mm	Millimetre/s
MOA	Memorandum of Agreement
No.	Number
PAH	Polycyclic aromatic hydrocarbons
ppt	Parts per thousand
SEP	State Environmental (Cockburn Sound) Policy
SRRP	Seagrass research and rehabilitation plan
SWALSC	South West Aboriginal Land and Sea Council
TBT	Tributyltin
TPA	Titratable peroxide acidity
tpa	Tonnes per annum
TSS	Total suspended solids
UWA	University of Western Australia
vpd	Vehicles per day