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Metropolitan Region Scheme

Amendment No. 1010/33

PORT CATHERINE
ENVIRONMENTAL REVIEW

SUMMARY

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Report No. R97062
July 2001

INVITATION TO MAKE A SUBMISSION

The Western Australian Planning Commission (WAPC) invites people to make a submission on this Environmental Review.

The Port Catherine project proposes an urban renewal concept for industrial land at Coogee, to provide a marina and a marine oriented residential community with commercial and recreational facilities. This Environmental Review describes and assesses proposed amendments to the Metropolitan Region Scheme which are required to enable the development to proceed. The Environmental Review has been prepared, in accordance with the requirements of the Environmental Protection Act, by Port Catherine Developments Pty Ltd on behalf of the Western Australian Planning Commission who is the Responsible Authority for the proposed Amendment. The Environmental Review describes the proposal and its likely impacts on the environment. .

Submissions received by the WAPC will be forwarded to the Environmental Protection Authority (EPA) to assist the EPA in its assessment of the amendment.

The environmental review document will be available for comment for a period of 101 days, commencing on **20 November 2001** and closing on **1 March 2002**.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you may have to improve the strategic plan.

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

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

Developing a submission
You may agree or disagree with, or comment on, the general issues discussed in the strategic review document. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific proposals in the strategic review document:
- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind
By keeping the following points in mind, you will make it easier for your submission to be analysed:
- attempt to list points so that the issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the strategic review document;
- if you discuss different sections of the strategic review document, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:
- your name;
- address;
- date; and
- whether you want your submission to be confidential.

THE CLOSING DATE FOR SUBMISSIONS IS: 1 MARCH 2002.

Submissions should be addressed to:

Western Australian Planning Commission
Albert Facey House
469-489 Wellington Street
PERTH WA 6000
Attention: **The Secretary**

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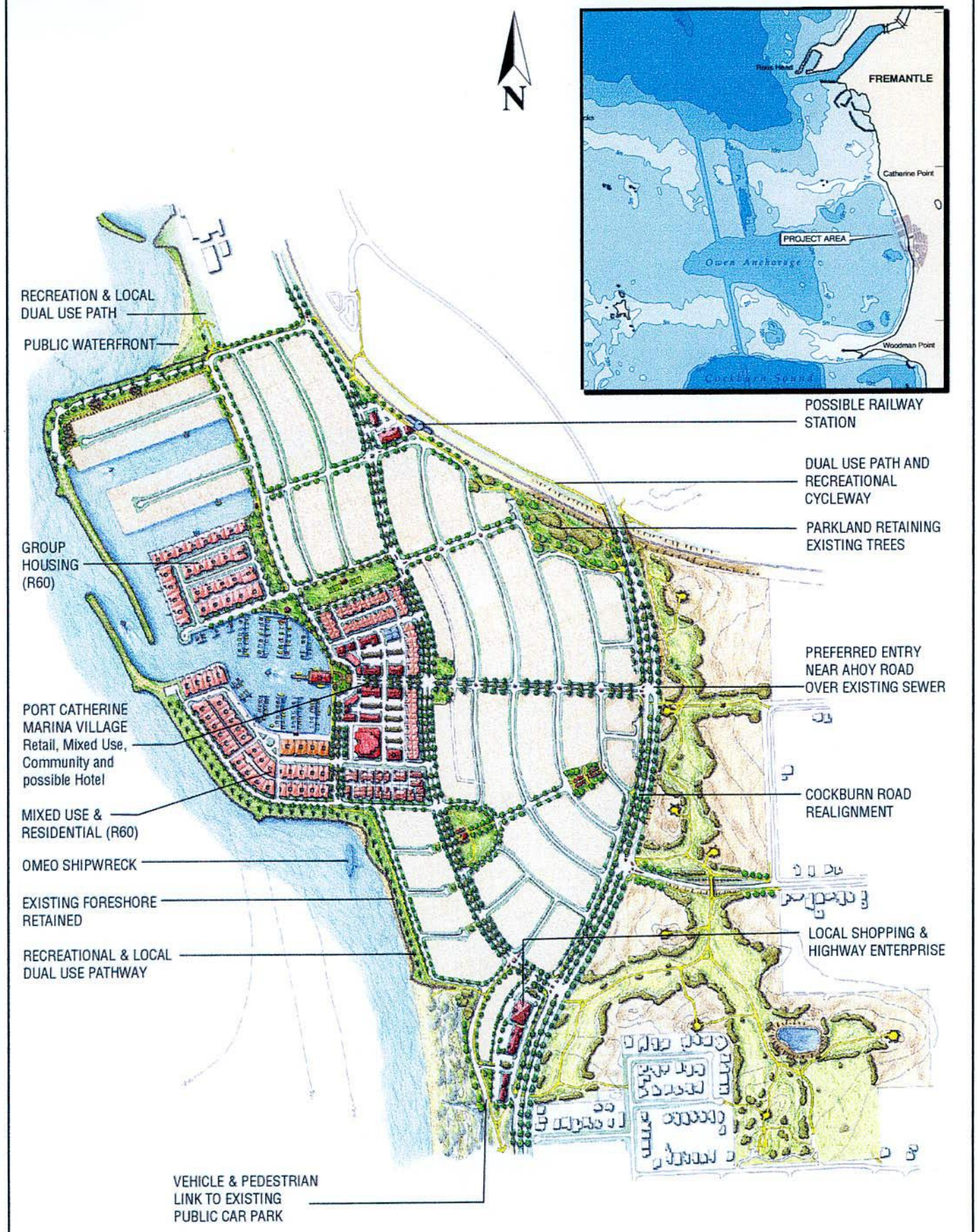


Figure 1

Port Catherine Concept Plan

Source : Taylor Burrell

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

R01003-SU-FIG-1-12 06 01

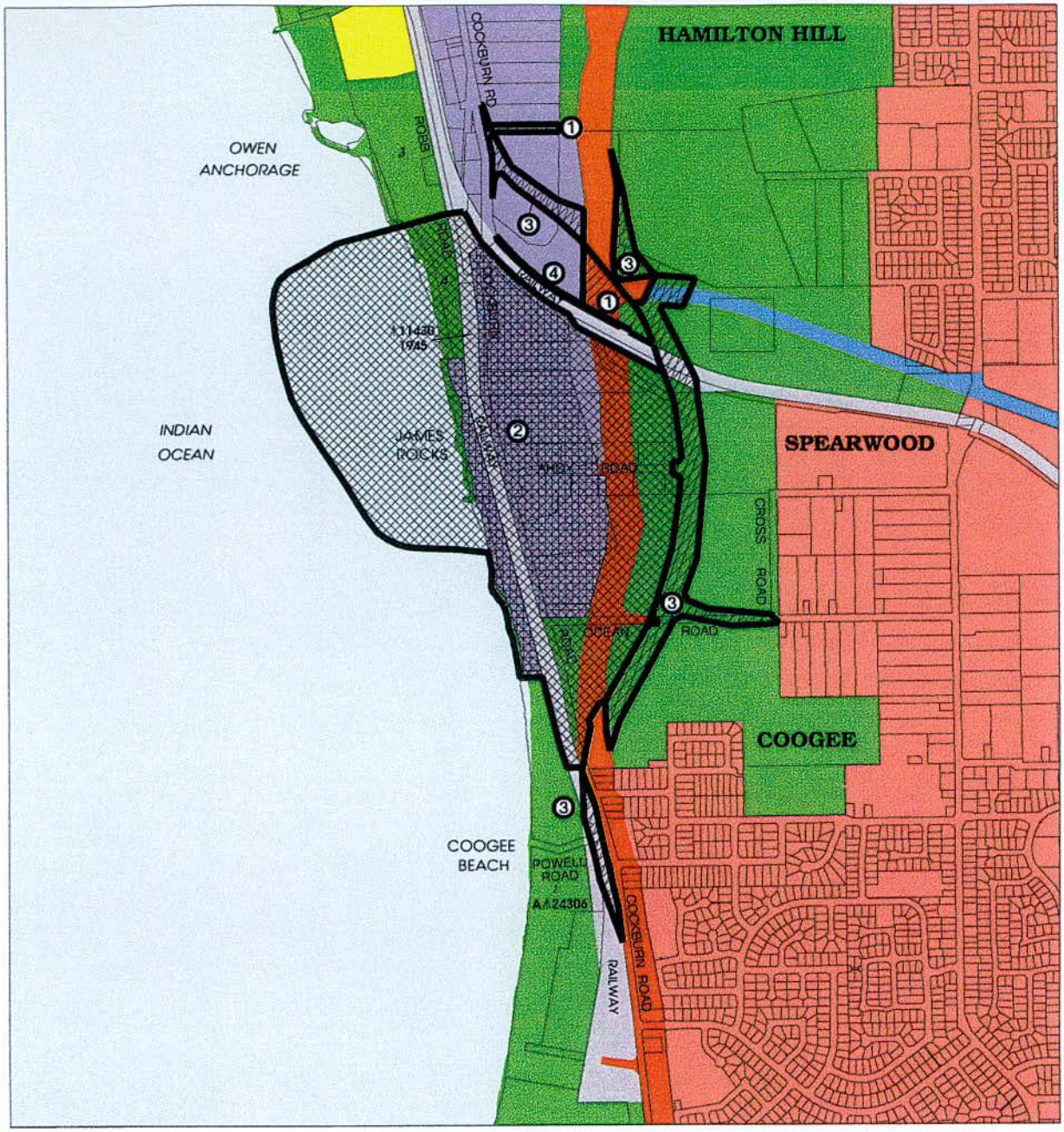
INTRODUCTION

The Port Catherine development is a proposal for urban renewal of derelict industrial land at Coogee, immediately to the south of the old South Fremantle Power Station. It is intended to develop a marina and marine-oriented residential community with commercial and recreational facilities that will create a new regional community attraction and focal point.

The Concept Plan for the Port Catherine project is provided on Figure 1.

The Port Catherine Project represents the culmination of State and Local Government initiatives which commenced in the late 1980s, to re-locate the noxious industries from South Coogee. Historically, these industries denuded and polluted the land, discharged untreated effluent to Owen Anchorage and reduced the amenity of surrounding areas due to odour emissions. The State Government is committed to cleaning-up the land to accommodate urban renewal.

Residential development of the site was first proposed in the 1980s and has evolved in response to State Government initiatives and agreements with the City of Cockburn and other stakeholders that date back to 1988. The proposed redevelopment is consistent with the Coogee Master Plan (1993) and the Western Australian Planning Commission's Improvement Plan No. 26 (1994).



LEGEND

PROPOSED

- ① Industrial Zone
- ② Urban Zone
- ③ Primary Regional Roads Reserve
- ④ Parks and Recreation Reservation

EXISTING

- Public Purposes (SEC) Reservation
- Special Industrial Zone
- Industrial Zone
- Urban Zone
- Parks and Recreation Reservation
- Primary Regional Roads Reservation
- Railways Reservation
- Waterways Reservation
- Other Regional Roads Reservation

N

0 300 metres

Source : Statutory Mapping Section, Land Information Branch, Ministry for Planning

RS7062.ER.FIG1-3.17.01.01

Figure 2

Existing and Proposed MRS Amendments

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ENVIRONMENTAL MANAGEMENT CONSULTANTS

PLANNING AMENDMENTS AND THE ENVIRONMENTAL REVIEW

Amendments to the Metropolitan Region Scheme (MRS) are required to provide for residential and marina use at Port Catherine (Figure 2). The amendments include rezoning land from Industrial and a small portion of Parks and Recreation to Urban and an offshore area to Urban to enable development of the Port Catherine development, and moving the Primary Regional Road reserve to allow for the deviation of Cockburn Road around the development area. A small area of land on the northern side of the railway line is also proposed for rezoning from Road Reserve and a small portion of Parks and Recreation to Industrial.

The MRS amendments require formal environmental assessment by the Environmental Protection Authority (EPA). The Western Australian Planning Commission (WAPC) has been designated under the Environmental Protection Act as the Responsible Authority for the Environmental Review (ER) and will ensure subsequent implementation of environmental conditions.

The State Government currently owns the majority of land within the amendment area and plans to clean up that part of this land which is subject to contamination from previous industrial use. The proposed clean-up strategy for the Government land was described in a separate Consultative Environmental Review proposed by the WAPC and approved with conditions by the Minister for the Environment in April 2000.

Once the Government land is cleaned to residential standards, Port Catherine Developments Pty Ltd (PCD) is contracted to purchase the land then implement the Port Catherine project. PCD is responsible for cleaning-up residual contamination on the six allotments in the amendment area that are within private ownership.

Any development proposal put forward by PCD must go through extensive environmental and planning scrutiny to ensure that it complies with current regulatory standards and provides sufficient community benefit. Legal agreements between PCD and WAPC will also ensure that PCD fulfils all relevant obligations for environmental management in its development proposal.

PURPOSE OF THIS SUMMARY

This summary to the ER is designed to provide enough basic information to enable informed review of the environmental aspects of the proposed amendments, without needing to read the major reports.

The full ER comprises three volumes:
Volume 1 – main text
Volume 2 – technical appendices
Volume 3 – site contamination assessment and management report.

The summary is a distillation of the outcomes of extensive and detailed investigations described in the ER and Appendices. For brevity, the summary describes only the conclusions and not the substance nor the authority of that research. The reader should refer to the full reports and appendices if further particulars are required.

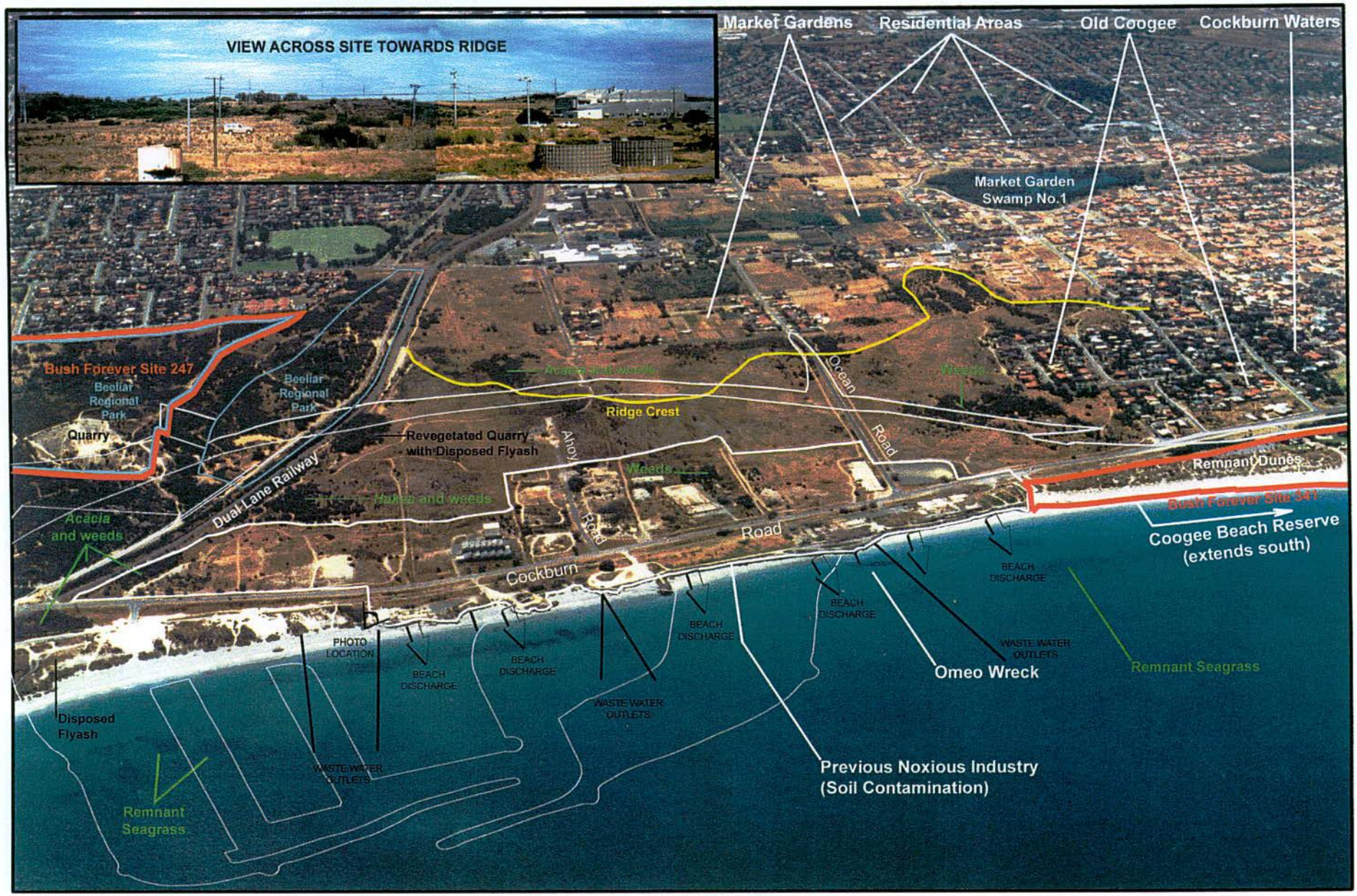

Figure 3
Existing Environment

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EXISTING ENVIRONMENT

Terrestrial Ecology

The terrestrial environment at Port Catherine has been severely degraded following almost 40 years of continuous use by noxious industries and other land disturbing activities.

As is evident from Figures 3 and 4, there is little native vegetation remaining within the amendment area. To the south of the railway, the small patches of vegetation that occur are mostly regrowth following previous clearing. They are full of weeds and generally devoid of native species in the understorey. They have low conservation value for protection of flora or as fauna habitat.

Remnant shrubland, including an area of mixed open heath requiring special protection, occurs immediately east of the amendment area on the northern side of the railway (F' in Figure 4). This area is contiguous with a larger remnant area to the north and east that is conserved within Bush Forever Site 247.

Landscape

The Port Catherine site lies on the western slope of a 35m high limestone ridge comprising the first north-south line of the Spearwood Dunes landform and has a distinctive landscape character and scenic quality, a result of its elevated ridge topography and its location adjacent to the coastline (Figure 3). However it has been denuded of its original vegetation and does not present landscape diversity. It is affected by derelict industry, high voltage transmission lines, roads and a railway cutting.

Land Uses

Land uses near the amendment area are shown in Figure 3 and include:

Industrial and Infrastructure Uses. There is a mix of industrial uses to the north, with the most notable feature being the decommissioned and derelict South Fremantle Power Station, the railway and an old limestone quarry. The railway traverses the north-eastern sector of the amendment area and is used for freight haulage (currently two trains per week).

Market Gardens. There are small areas of market gardens east of the ridge (Figure 3), however these are mostly no longer used. This land is zoned Urban in the MRS and will gradually be developed for residential purposes.

Residential. The residential area of Old Coogee is located on the ridge slopes and ridge to the south of the site. Further south is the more recent housing estate of Cockburn Waters.

Reserves. The ridge land to the east and northeast of the amendment area is largely undeveloped and was set aside in 1963 to provide an odour buffer between residential areas and the (then existing) noxious industries on Cockburn Road. Existing MRS zonings showing reserved lands are shown on Figure 2.

South of the railway line, the ridge is encompassed in Coogee Regional Open Space. This area is severely degraded (Figure 3). However, it is proposed to rehabilitate part of the reserve (east of the amendment area) as a linear parkland, in concert with the Port Catherine project (Figure 1).

North of the railway line, the remnant vegetation is in better condition and is nominated for conservation as part of Bush Forever Site 247 and Beeliar Regional Park (Figure 3).

LEGEND

Vegetation Units

A : Beach and Coastal Dune Vegetation, with few *Callitris preissii*.
B : Alien Vegetation with few remnant patches of Tuart, *Callitris preissii* and native shrubs.
C : *Acacia rostellifera* Closed Tall Scrub to Closed Heath.
D : *Petrophile serruriae* and *Hakea prostrata* shrubs, and weeds.
E : *Acacia rostellifera* Closed Tall Scrub. (Floristic community 29b)
F : Mixed Low Open Shrubland to Closed Scrub, commonly with *Leptospermum laevigatum*, *Dryandra sessilis*, *Acacia cyclops* and *A. rostellifera*.
F' :*Melaleuca systena* Mixed Open Heath.(Floristic community 26a)
S : *Leptospermum laevigatum* (alien) Shrubland to Heath to Scrub.
S/T : *Leptospermum laevigatum* (alien) and *Acacia rostellifera* shrubs, with alien trees.
T : Alien Trees, mainly pines and *Eucalyptus*, mainly open forest.
W : Weedy vegetation, mainly alien grasses and forbs, with few native species, and disturbed areas that are mainly bare.

Vegetation Condition

1 Pristine; no obvious signs of disturbance.
2 Excellent; some disturbance; weeds non-aggressive.
3 Very Good; obvious signs of disturbance and weeds.
4 Good; significant disturbance, alteration and weeds.
5 Degraded; severe impacts and alterations.
6 Completely Degraded; "parkland cleared"; few natives.
7 Without plants or totally alien; very few, if any, natives.

MRS Amendment Area

Figure 4

Vegetation Map

Source : Dr. Arthur S. Weston, 2001

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R97062 ER FIG-4 09.07.01

The area of Beeliar Regional Park that is immediately north of the railway (Figure 3) was not nominated as requiring protection in Bush Forever.

The Coogee Beach Recreation Reserve extends south along the coast from the southern end of the amendment area, and adjoins the Woodman Point Recreation Reserve further south. The Coogee Beach Caravan Park is located within the Reserve, about 200 metres south of the amendment area.

Groundwater

Groundwater is present beneath the site in an unconfined aquifer in the Tamala Limestone. A notable feature of the groundwater in this locality is the presence of elevated concentrations of nitrogen, derived from past market gardening and unsewered residential areas. Investigations beneath and inland of the area have defined a groundwater plume containing an average of up to 4.4mg/L of dissolved inorganic nitrogen (DIN) that extends from approximately 2.5km inland (coincident with Rockingham Road) to the coast. Inland of Rockingham Road, the concentrations of DIN in the groundwater average up to 1.0mg/L, representing background.

Other than nitrogen, the regional groundwater is of good quality – the chemical concentrations in groundwater flowing into the amendment area comply with water quality guidelines for both drinking water and irrigation.

There are small areas within the amendment area where soil contamination due to past industrial activities, if left in place, has the potential to unacceptably impact on the groundwater and the marine environment. However, as described subsequently, it is proposed to clean up this contamination to ensure permanent protection of public health and the environment.

Heritage

Archival research and field survey did not reveal any archaeological material within the site, however two Aboriginal ethnographic sites have been identified:

- The Indian Ocean, a mythological site that encompasses the ocean between the mainland and Rottnest, Carnac and Garden Islands.

- A site referred to as Jervoise Bay Ethnographic #1, which has not yet been listed on the register of Aboriginal sites but is a mythological site associated with the limestone ridge and the creation of Lake Coogee and other nearby lakes.

No places of European historical and cultural significance occur within the amendment area. The wreck of an iron barque, the Omeo, lies a short distance off the beach to the south of the amendment area (Figure 3). The wreck is protected under the terms of the *Historic Shipwrecks Act, 1976* and will not be affected by the proposed development.

The Marine Environment

The coastline at Port Catherine mostly comprises low (3 metres) limestone cliffs or artificial breakwaters, with very narrow intertidal zones of bare sand. There are also areas of sandy beach backed by foredunes, generally degraded.

The marine habitats within and near the amendment area are mapped in Figure 5.

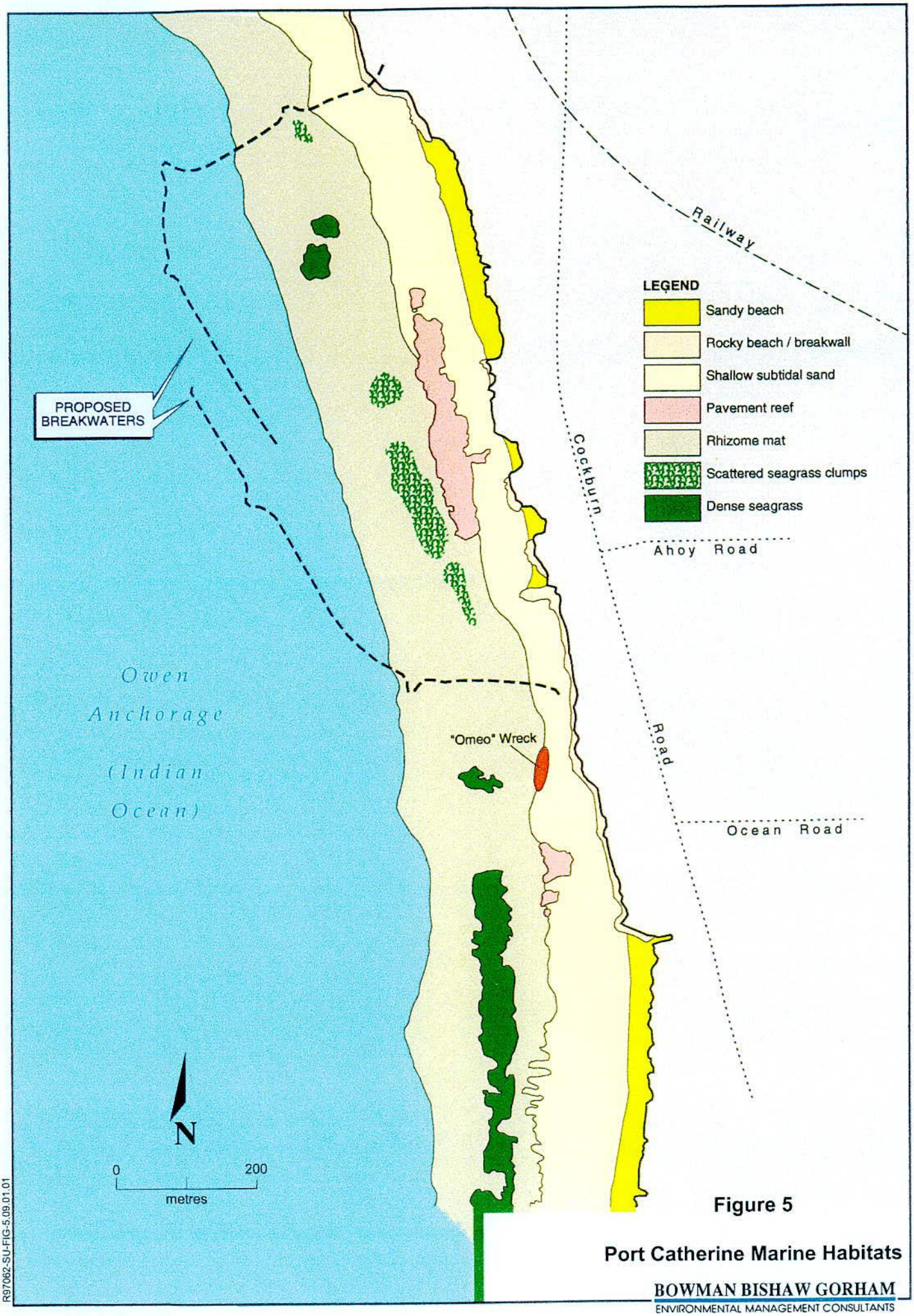

Figure 5

Port Catherine Marine Habitats

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R97062-SU-FIG-5.09.01.01

Small remnant meadows of *Posidonia sinuosa* seagrass occur in the northern central parts of the amendment area. These meadows cover a total area of 0.3ha and have low plant diversity, low biomass and large epiphyte loads (i.e. the leaves are covered by algae).

South of the amendment area, a larger seagrass meadow of dense *P. sinuosa* occurs as a narrow (50 metres wide) band approximately 200 metres off the beach (Figure 5). Recent investigations have shown that Owen Anchorage has not generally suffered the significant historical decline in seagrass habitat that befell Cockburn Sound.

Most of the shallow offshore seafloor within the amendment area is covered by extensive mats of dead *P. sinuosa* seagrass roots and rhizomes, probably killed due to historical wastewater discharges (Figure 3). These mats have no potential to regrow and will erode and eventually disappear. They have low habitat value.

The other marine habitats within and near the amendment area comprise bare sand and exposed limestone pavement. The limestone pavement has a variable cover of algae but appears to be periodically inundated by sand and does not support a well-developed animal or plant assemblage.

The coastal stability along the shoreline of Owen Anchorage has not been in a natural state for many decades. Sand arrives at Catherine Point, about 1.5km north of the Port Catherine site (Figure 1 inset), at a rate of about 40,000 cubic metres per annum (m^3/a). This sand is moved along the shore in the wave breaking zone, to the north with the seabreeze in summer and to the south with storms from the northwest and west in winter.

The South Fremantle Power Station was built immediately north of the Port Catherine site in the 1940s. The groynes at the Power Station and subsequent groynes that were built further to the north at Catherine Point and Robb Road effectively stopped littoral drift of sediment in this part of Owen Anchorage. In recent years about 33,000 m^3/a of sand has been trapped by these groynes in combination. This has lead to the recession of the northern end of Coogee Beach, immediately to the south of the Port Catherine site. Coogee Beach has realigned and can now cope with little sand feed from the north.

The Robb Road and Power Station groynes are now nearly saturated with sand on their northern sides and in coming years they would become less of an impediment to the movement of sand from Catherine Point to Coogee Beach. It is anticipated that the movement of sand towards the Port Catherine project area from the north will gradually return to historical levels, approximately 33,000 m^3/a. This is the estimated annual figure of net movement; there will be seasonal and inter-annual variations.

Long-term records (1942 to 1994) show that Coogee Beach has remained essentially stable - the present shoreline is now within two metres of its 1942 position - despite having been starved of sand supply from the north due to the existing Robb Road and Power Station groynes. There have been significant winter erosion events at various times but these have not remained over the longer term.

PRINCIPAL ENVIRONMENTAL ISSUES

The EPA's Instructions for the Environmental Review issued in May 1999 included a comprehensive listing of 22 site-specific factors requiring environmental assessment, as listed in the Table at the rear of this Summary. Both the amendment area and the proposed Port Catherine project have been modified as a result of consultations on planning and environmental matters since 1999, when the initial Port Catherine amendment was part of a larger regional MRS amendment. The improved environmental outcomes from this consultative strategy include protection of Coogee Beach, avoidance of dense seagrass meadow, retention of remnant foredunes which form part of the Woodman Point system, avoidance of the Omeo wreck, reduction of the marina size and modification to the marina construction techniques to avoid the need for dewatering and substantial dredging.

As a result of the evolution of the development plan and the proposed MRS amendment, the key environmental issues that are addressed in this Summary are as follows:

- site contamination clean-up to remedy past industrial use and ensure protection of human health and the environment;

- marina water quality, particularly the risk of excessive algal growth due to nutrient inputs from the groundwater.

- coastal stability, to be managed to ensure that Coogee Beach to the south of the marina will remain stable;

- seagrass loss from the offshore rezoning for a marina and residential waterways, however the reduced marina size will now only affect 0.3ha in an area previously depleted by industrial discharges;

- disturbance to ecological values, which are very low across most of the site, although a small area of Bush Forever Site 247 and Beeliar Regional Park will be affected by re-alignment of the Primary Regional Road reservation;

- protection of landscape and amenity; and

- potential noise and vibration nuisance from road and rail traffic impacting upon future residents.

The EPA has emphasised the contamination clean-up and the maintenance of marina water quality as being the most significant issues to the environmental acceptability of the project. It is with respect to these issues that the Environmental Review has given the most detailed assessment and for which the summary position is outlined below. The additional issues identified in the EPA's instructions are addressed thereafter.

The comprehensive list of 22 environmental factors identified by the EPA and addressed in the Environmental Review are summarised in the Table at the rear of this Summary.

CONTAMINATION REMEDIATION

Introduction

Historical industrial activities at Port Catherine have left a legacy of metals, hydrocarbons and pesticides within the soils of the amendment area. Industrial activity within the site has ceased, however residual contamination identified in onsite soils is a concern for human health and the environment.

The State Government currently owns the majority of land within the amendment area and defined a clean-up strategy for its land in a separate Consultative Environmental Review proposed by the WAPC and approved with conditions by the Minister for the Environment in April 2000. The WAPC has committed to clean up all material to conservative criteria (ANZECC B) over its entire landholding. There is one exception to this where contamination at depth is to be further assessed by a human health and ecological risk assessment.

PCD proposes that 3,050m^3 of contaminated soils within its six lots of land will be cleaned-up for the protection of human health, 227m^3 to protect site amenity, and 5,000m^3 of uncontrolled fill within the northern portion of the amendment area. The PCD clean-up program has been defined and tested through detailed investigations and risk assessment involving the following elements:

- Soil and Groundwater Sampling and Analysis Programs to characterise contaminant concentrations in soil and groundwater at PCD owned land, the government owned rail reserve 11430 and the northern amendment area.
- A Human Health Risk Assessment (HHRA) to identify contamination on PCD owned land that requires remediation to protect future site residents and users.
- A Contamination Transport and Fate Assessment (CTFA) for all land within the amendment area to assess the impact of contamination on groundwater and its discharge into the proposed marina and Owen Anchorage.
- A Contamination Management Plan (CMP) for areas identified as requiring remediation on PCD owned land and the northern amendment area.

Site History

Historical industrial activity and associated materials and waste management practices were determined through a detailed review of historical literature and aerial photographs, title searches and consultations with past site owners and workers.

Industrial development at the site commenced about 90 years ago. The majority of the amendment area was used for a variety of animal-based industries including abattoirs, fellmongers, woolscourers, tanneries, fish processing and edible oil refining. A chemical plant (Coogee Chemicals) was also located at the site.

Lot locations are shown in Figure 6. Figure 7 shows those areas where potential contamination was identified as a result of historical land use.

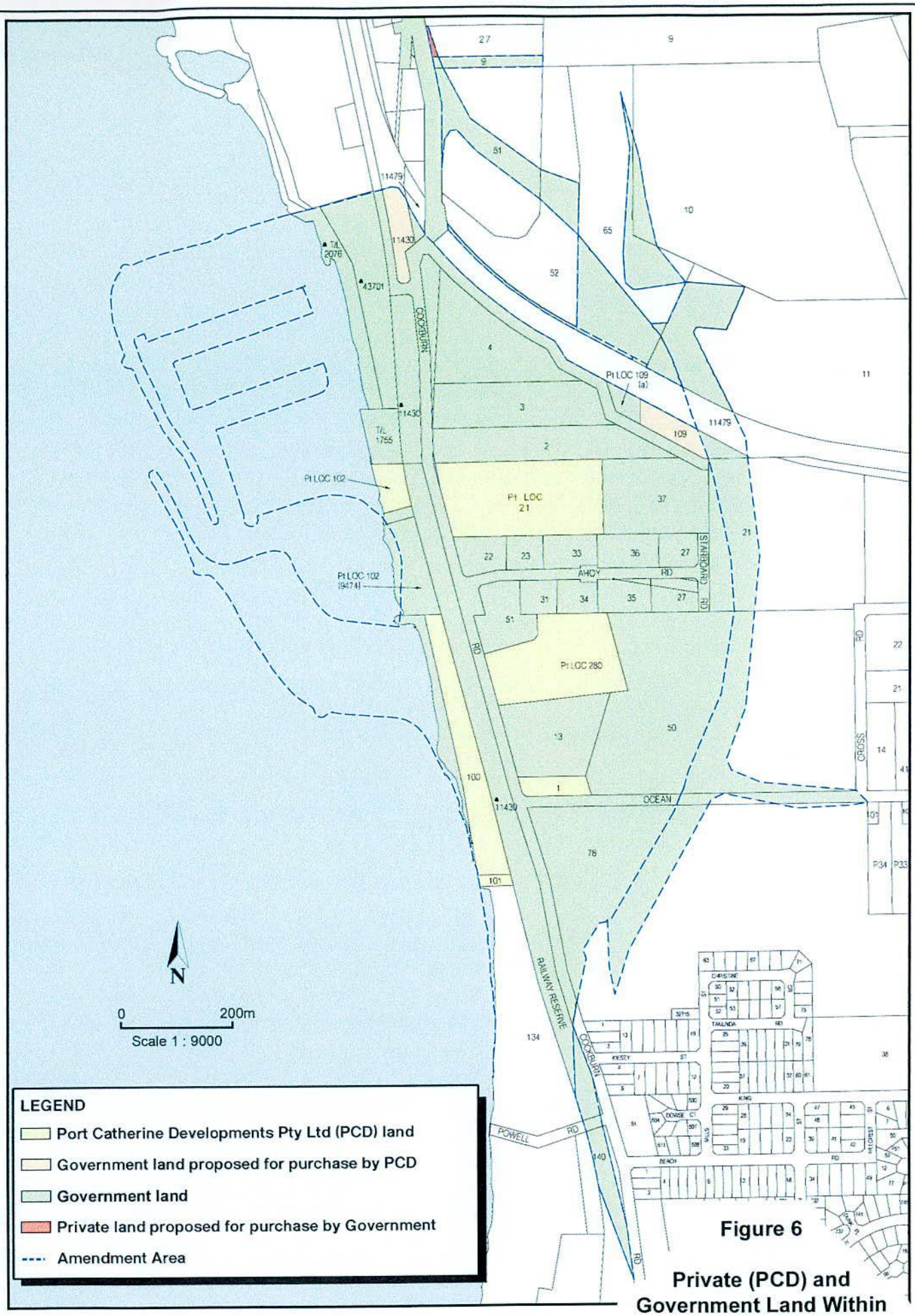

Figure 6

Private (PCD) and Government Land Within the Amendment Area

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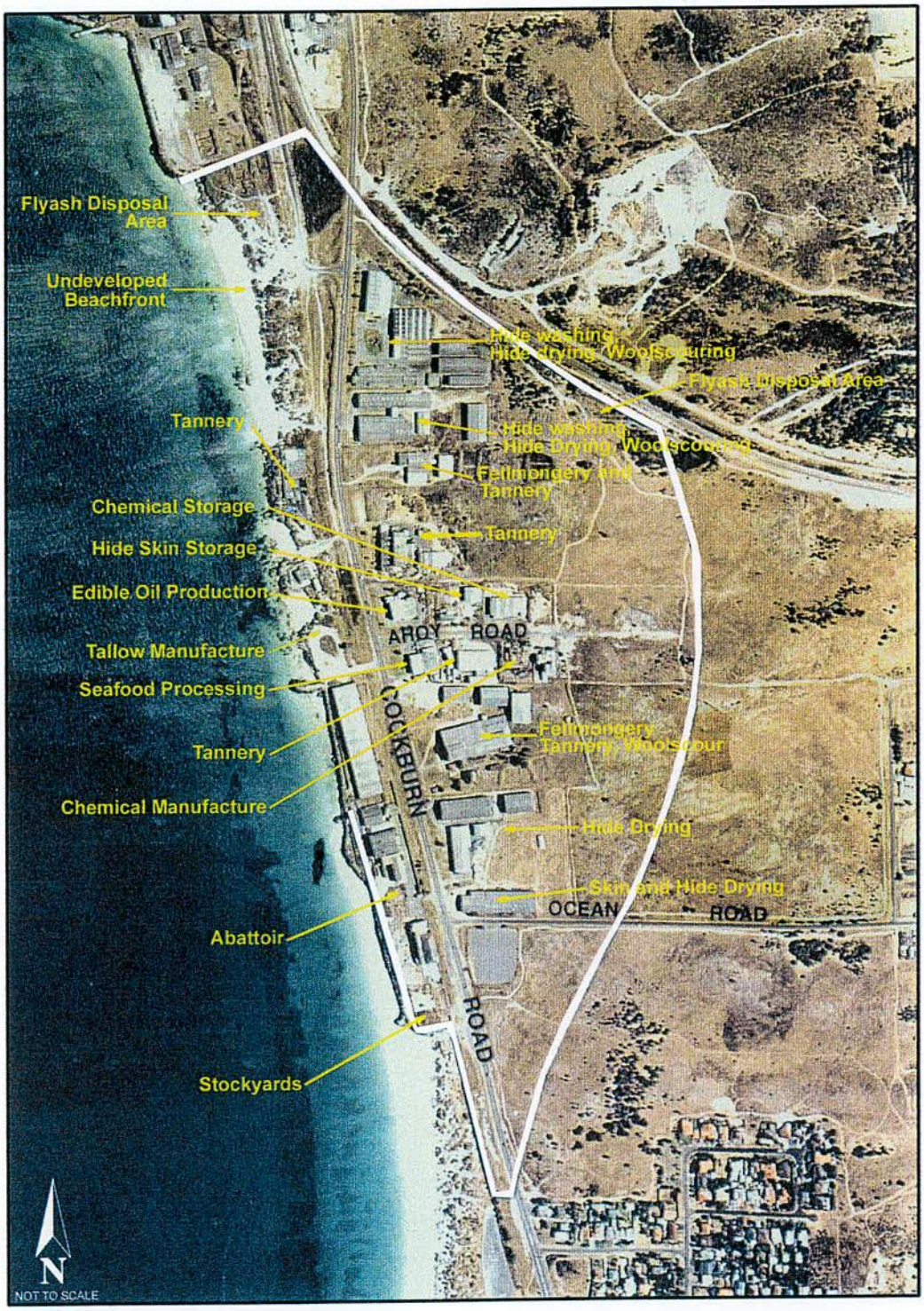

Figure 7

Potentially Contaminating Historical Activities

BOWMAN BISHAW GORHAM
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R97062.SU FIG-7 13.06.01

N

Scale 1:10,000 approx

LEGEND

- Soil Sampling Locations
- Groundwater Sampling Locations
- Existing Cadastral Boundaries

Figure 8

Soil and Groundwater Sampling Locations

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ENVIRONMENTAL MANAGEMENT CONSULTANTS

R97062.SU.FIG-8 10.05.01

Residual Contamination

Sampling and analysis programs that were undertaken to investigate residual contamination within the development area, are as follows:

- *Soils*: A total of 1,967 soil samples and 10 deep cores were collected from 1,059sampling locations to investigate potential soil contamination across the site.

- *Groundwater*: The groundwater sampling programs involved the construction and monitoring of 86 groundwater monitoring bores across the site.

- *Marine Sediments*: The marine sediment-sampling program involved the collection of 68 samples from offshore locations to investigate potential sediment contamination within the offshore area proposed for the marina.

- *Marine Groundwater:* Groundwater was sampled at 17 offshore locations to investigate the quality of groundwater seeping into the near shore coastal zone at the location of the proposed marina.

- *Coastal Groundwater and Sediments:* Eleven bores were installed and sampled along the coast to investigate the quality of groundwater discharging to the proposed marina and the quality of deep sediments that will be excavated to create canals and construct peninsulas.

The sampling and analysis strategy was designed to determine the presence, nature, magnitude and extent of contamination within the development area. Figure 8 shows the soil and groundwater sampling locations.

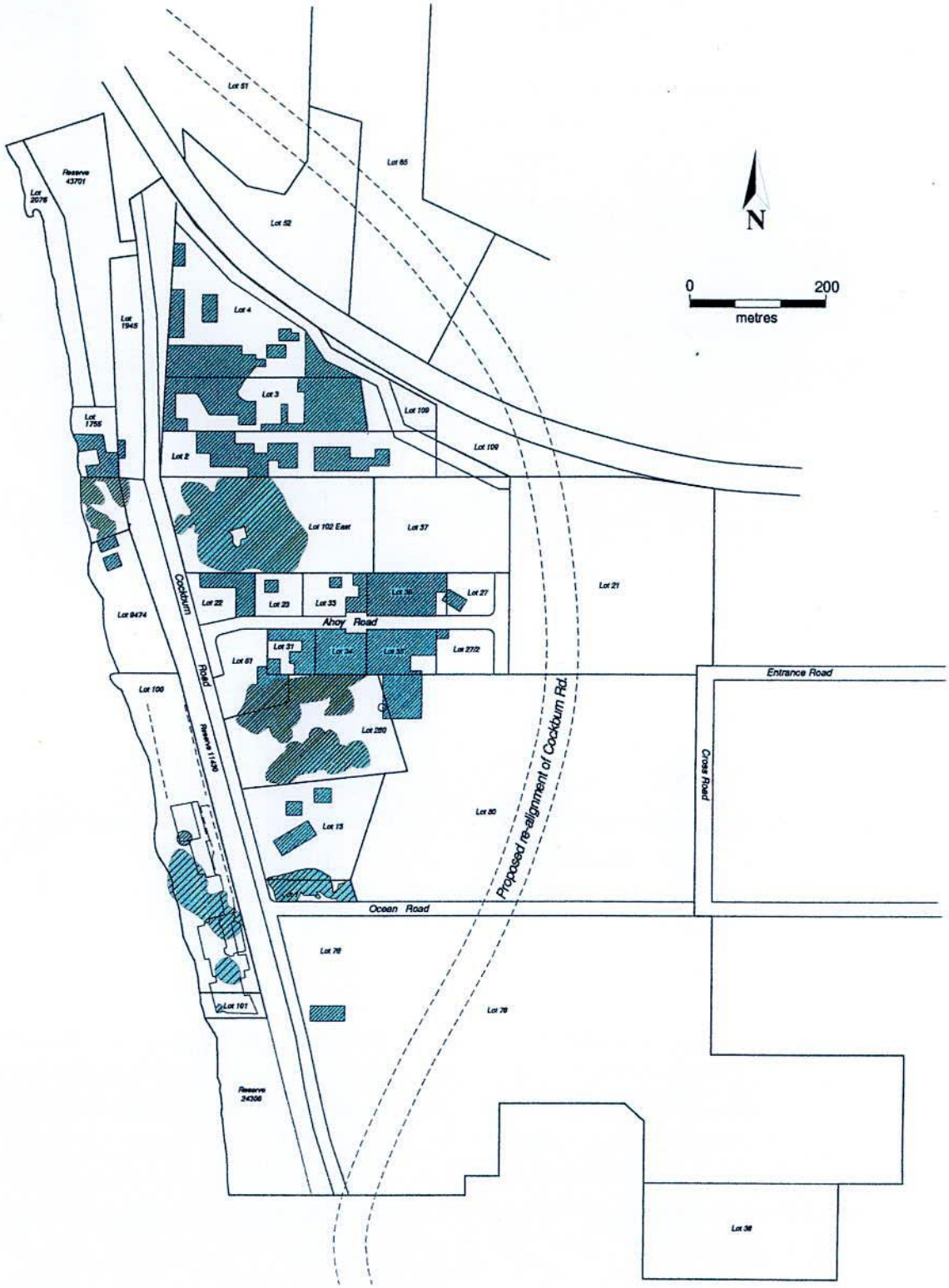
Figure 9 shows those areas where measured soil contaminant concentrations required investigation and assessment. The contaminants that were identified within the development area are as follows:

- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Zinc
- Barium
- Polycyclic aromatic hydrocarbons (PAH).
- Total petroleum hydrocarbons (TPH).
- Organochlorine and organophosphorus-based pesticides.
- Monocyclic aromatic hydrocarbons (MAH) including:
  - Phenols
  - Benzene, Toluene, Ethylbenzene and Xylene (BTEX).
- Fluoride.
- Boron.
- Sulphate.

Most of the soil contamination is found within the surface 1m of soil profile. Isolated pockets of low-level groundwater and aquifer sediment contamination were identified at the old Coogee Chemicals site (Lot 34 Ahoy Road). Only very minor amounts of marine sediment contamination were identified, located adjacent to former wastewater discharge outlets (Figure 10).

Public Health and Environmental Risks

The objective of the contamination management strategy was to select a socially acceptable and cost effective management plan for site contamination that ensures permanent protection of public health and the environment.



LEGEND

Soils Exceeding Investigation Guidelines

Figure 9

Areas Subject to Soil Contamination Management

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R97052 SU FIG-9.10.05.01

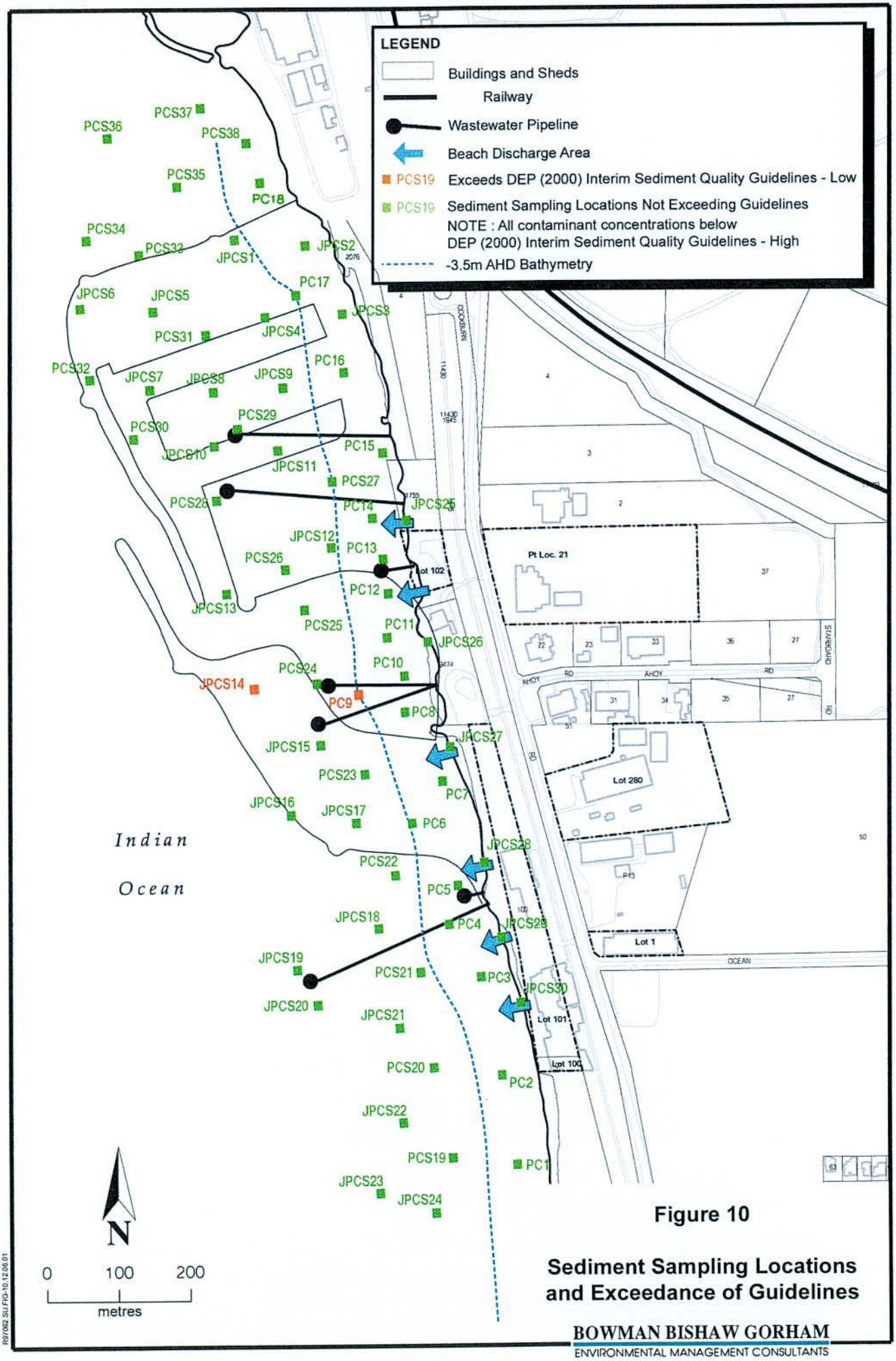

Figure 10

Sediment Sampling Locations and Exceedance of Guidelines

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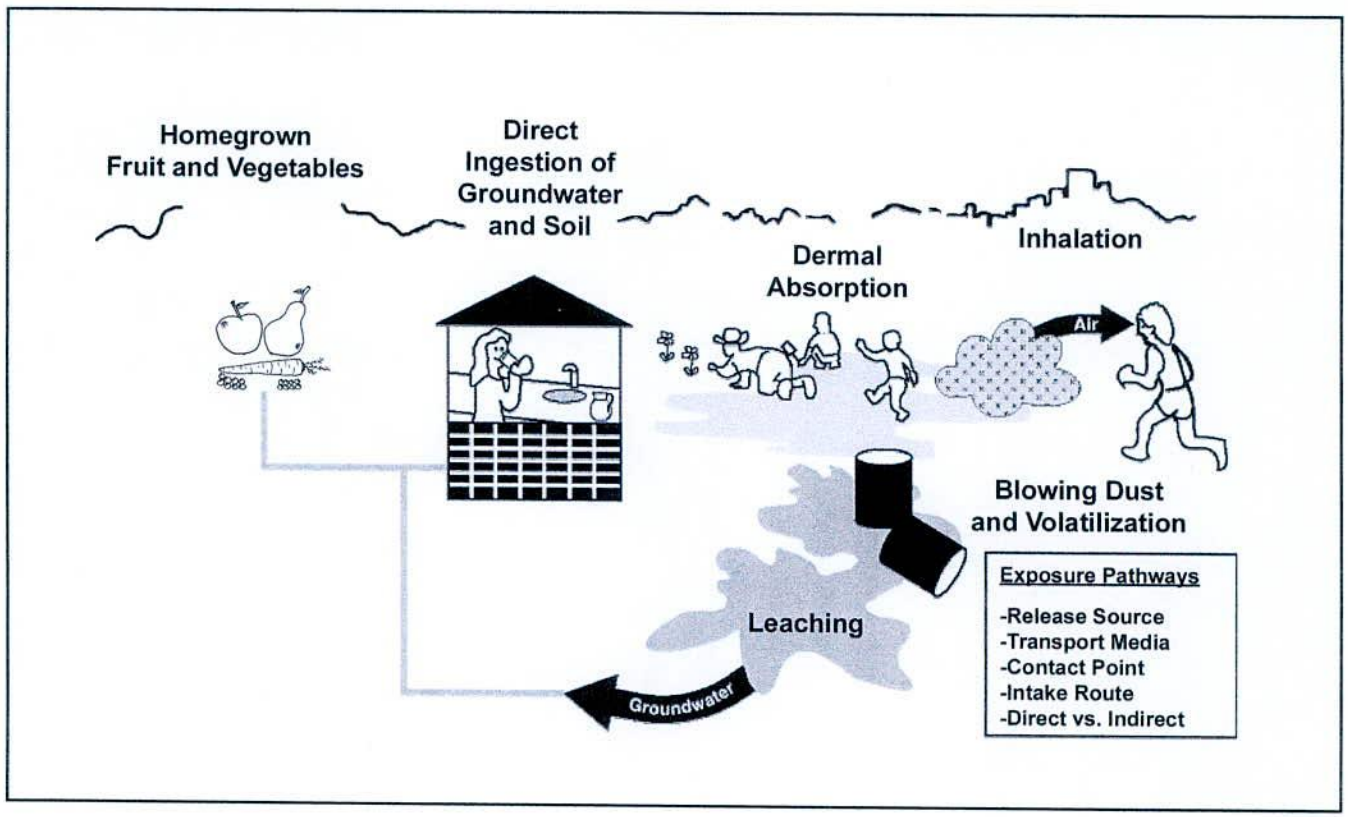
R97062 SU FIG-10.12.06.01



Source : Environmental Protection Agency

Figure 11

Exposure Pathways

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R97062 SU FIG-11 10/05/01

The public health and environmental risks from soil and groundwater contamination identified at the site have been addressed through the following processes:

- WAPC has committed to cleaning up all surface soils in government land so that contaminant concentrations are reduced to less than the ANZECC/NHMRC Environmental Investigation Guidelines.

- Bowman Bishaw Gorham on behalf of PCD has undertaken a comprehensive quantitative HHRA for the PCD land. The HHRA includes:
  - Toxicity assessment.
  - Exposure assessment including exposure scenarios.
  - Risk characterisation.
  - Derivation of response levels (RLs).
  - Background exposure from water, air and food.
  - Exposure from home grown fruit and vegetables.

- Bowman Bishaw Gorham on behalf of PCD has also undertaken a detailed CTFA for the site, including comprehensive three-dimensional, saturated/unsaturated groundwater flow and contaminant fate and transport modelling, to predict the long-term future groundwater quality beneath the site and discharging into the ocean and proposed marina. The CTFA applied to the entire site, including both the PCD and government land.

- The remediation strategy for PCD land has been developed to comply with the RLs.

Human Health Risk Assessment

HHRA is used to evaluate the harmful effects to human health that may result from exposure to toxic contaminants in onsite soils or groundwater. Figure 11 shows the assessed exposure pathways.

It was determined from the HHRA that 3,050m^3 of contaminated soils covering an approximate area of 7,000m^2 within the PCD land will require to be clean-up to comply with the RLs for human health protection.

Soil and Groundwater Contaminant Transport and Fate Modelling

PCD has assessed the transport and fate of soil and groundwater contaminants at the site using a three dimensional computer model that simulates the leaching of contaminants from the soil into the groundwater and the transport within the underlying saturated aquifer sediments (Figure 12).

All contaminant concentrations measured in soils throughout the amendment area (including both the government and the PCD land), were used in the model. It was assumed that the government land had been cleaned-up in accordance with the WAPC commitments in the approved Consultative Environmental Review. The CTFA focussed upon ensuring that the respective contamination clean-up programs will result in groundwater flowing across the shoreline to Owen Anchorage always meeting current marine water quality guidelines for toxicants.

The input parameters for the model were selected on the basis of field and laboratory testing, supported by literature sources and calibration exercises. All model input parameters and assumptions were conservative so as to simulate reasonable worst-case scenarios. A sensitivity analysis was undertaken to determine the effect of a range of parameter values on predicted groundwater flows and contaminant concentrations.

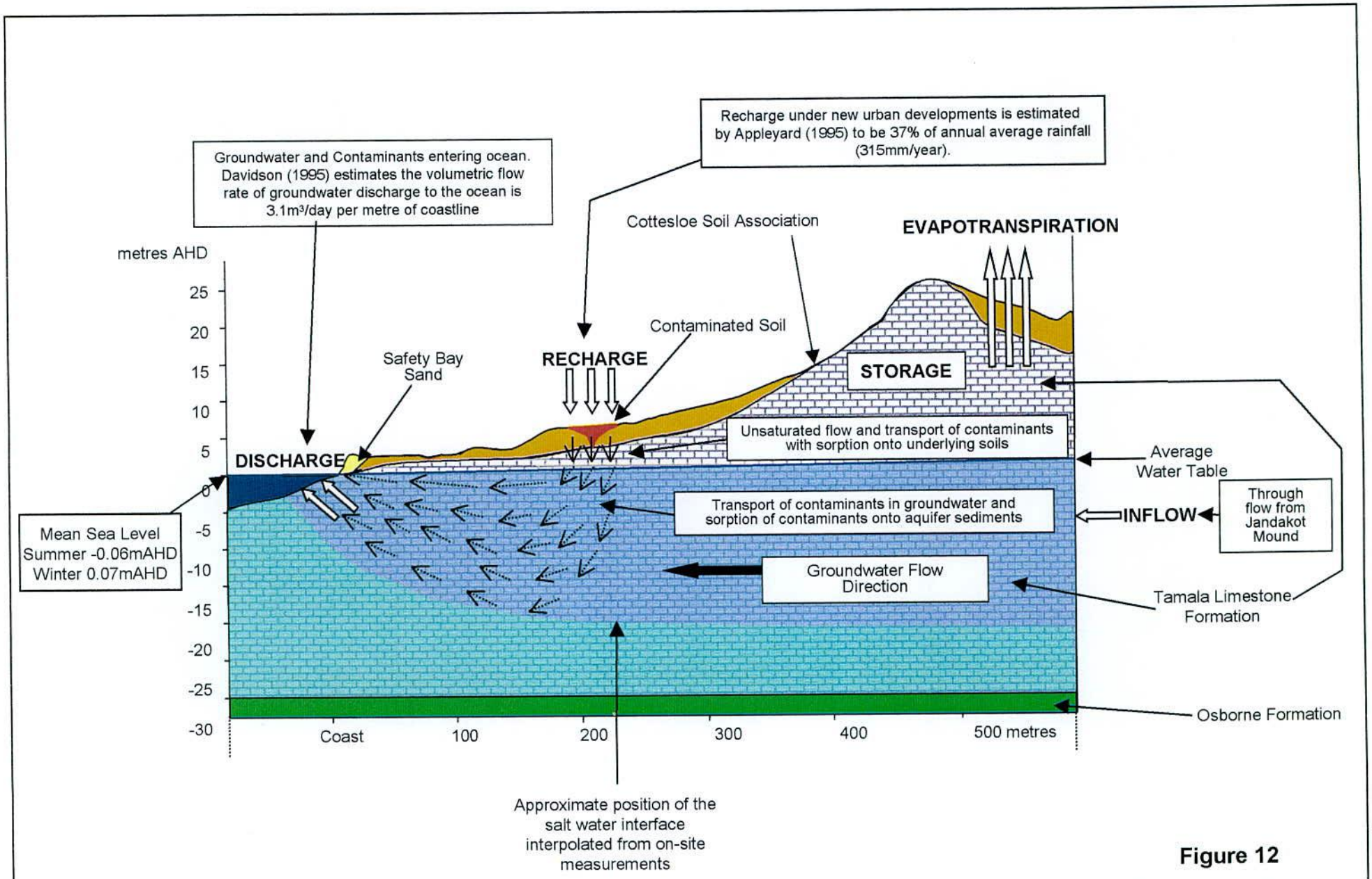

Figure 12

Conceptual Model

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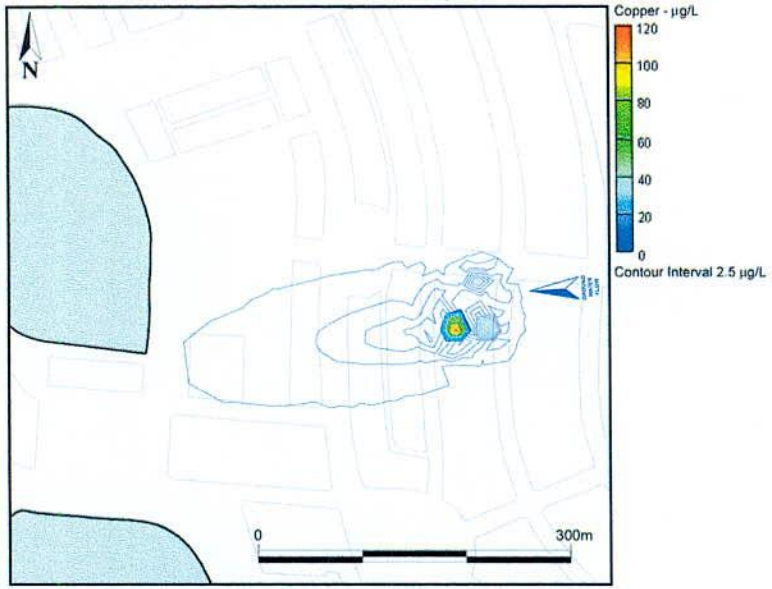

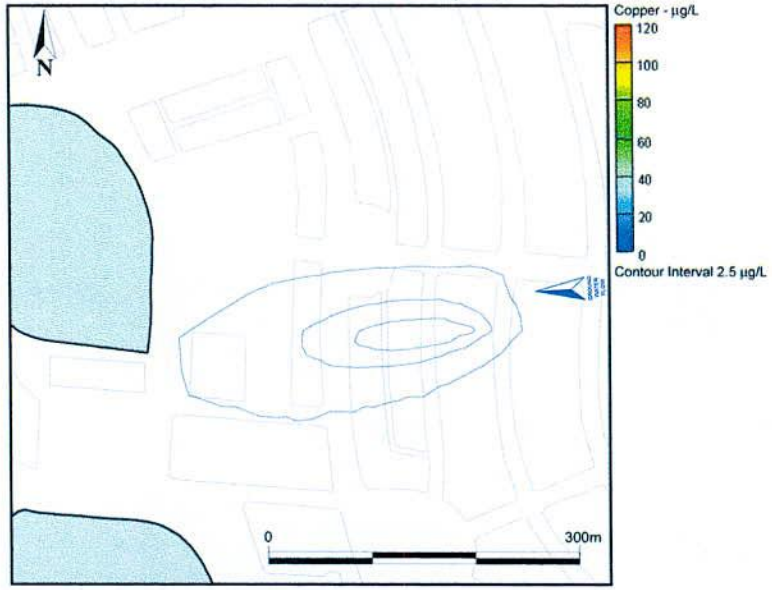

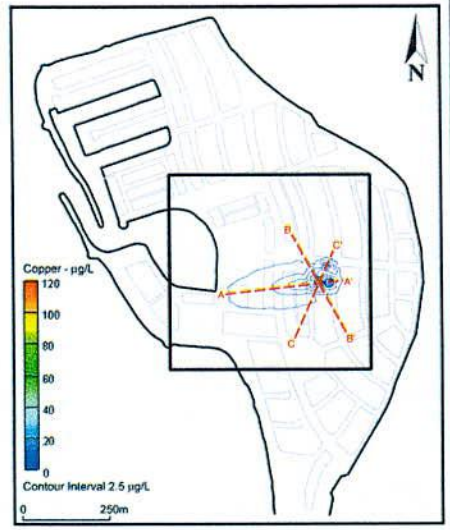

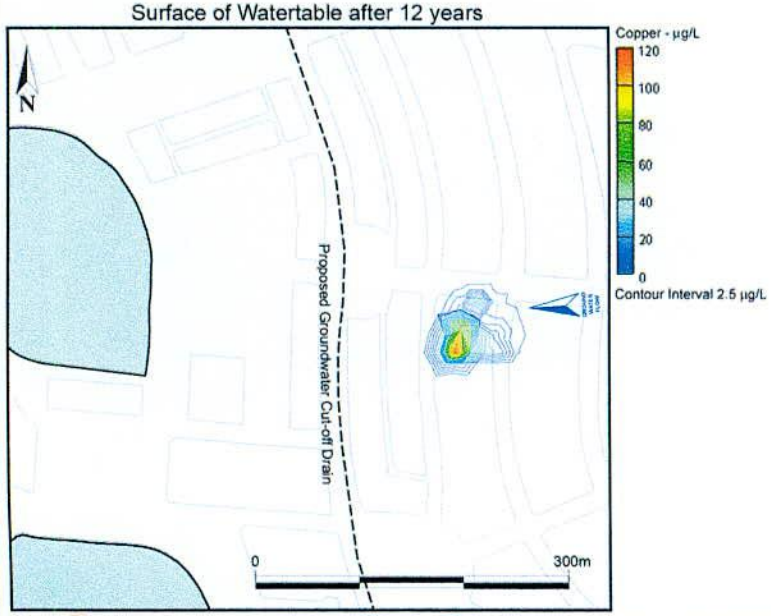

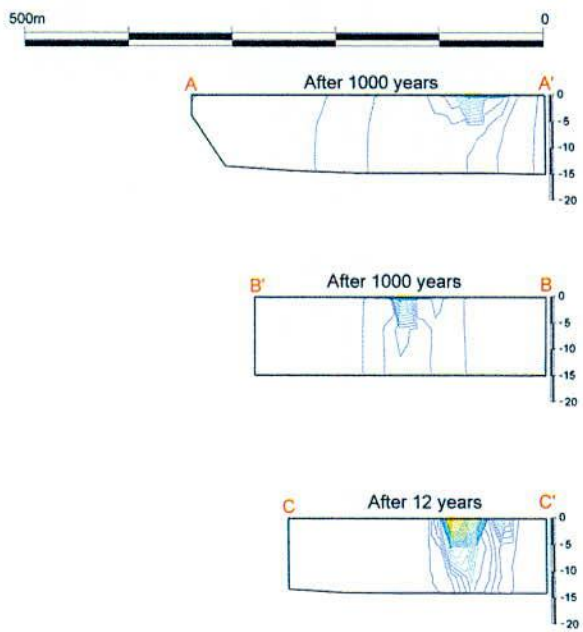

The outer contour is the extent of the predicted copper plume above a background concentration assumed to be 2.5µg/L.

The source of the copper plume is the former chemical manufacturing plant at Lot 34 Ahoy Road.

Copper concentrations are predicted to exceed the DEP (2000) Irrigation Water Quality Guideline (IWG) after 40 years. The predicted maximum concentration occurs after 100 years and exceed the IWG by 1.2 fold. After 210 years the concentration is predicted to fall below the IWG. This is a result of ongoing leaching of residual copper from contaminated soils at Lot 34, Ahoy Road.

The maxiumum predicted copper concentration at the coast occurs after 1000 years. Predicted copper concentrations at the proposed location of the groundwater cut-off drain and at the coast comply with the DEP, (2000) Marine Water Quality Guideline of 5 µg/L at all times during the 1000 year simulation.

Figure 13

Predicted Copper Concentrations in Groundwater

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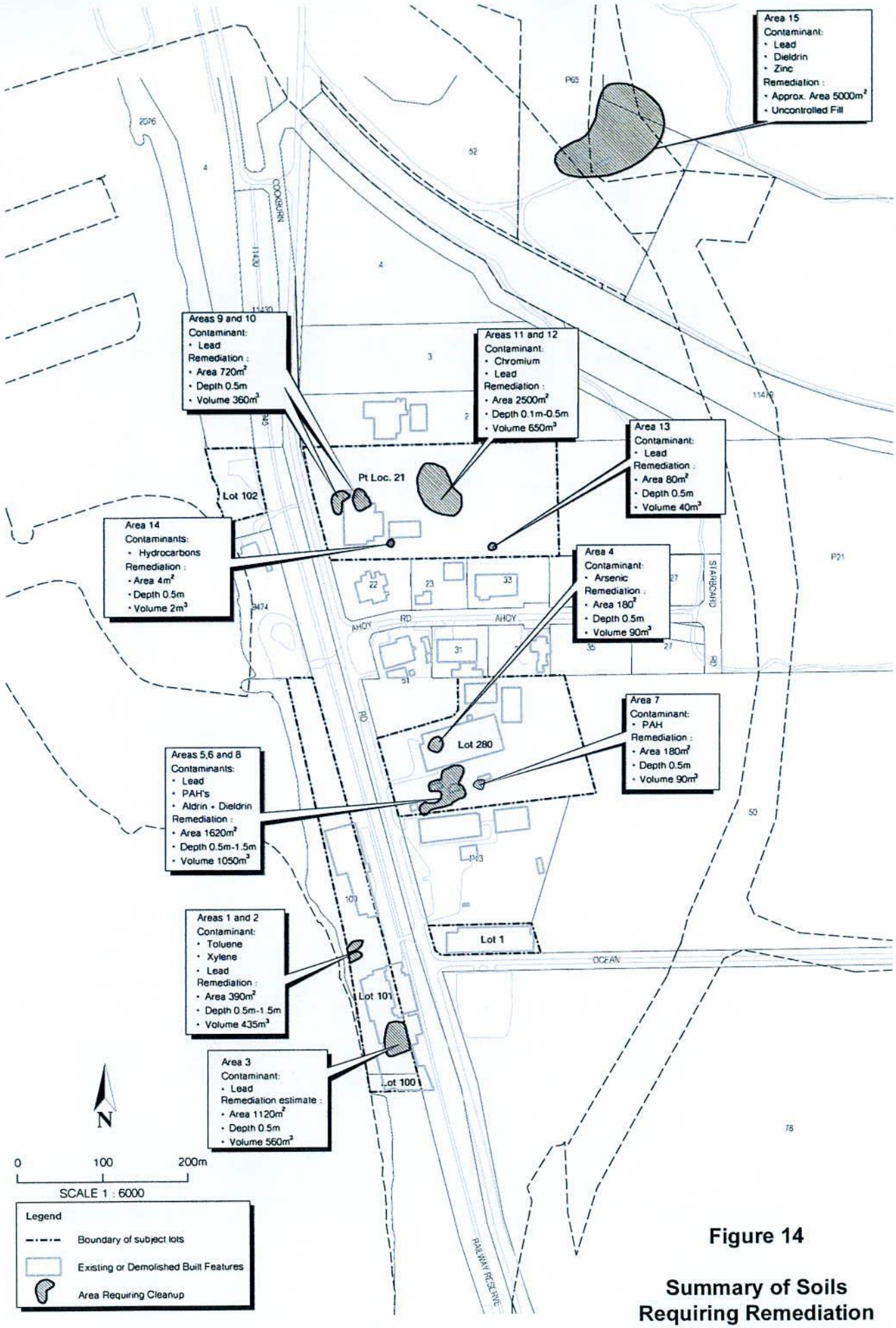

Figure 14

Summary of Soils Requiring Remediation

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R97062.SU.FIG-14.28.08.01

The modelling results defined three dimensional plumes showing the concentrations and extent of any contamination that might reach and advect with the groundwater over the next 1000 years, for all contaminants where soil concentrations exceeded investigation concentrations. As an example, Figure 13 shows a two-dimensional representation of the groundwater plumes for copper after 1000 years – copper being the contaminant that was of greatest potential ecological concern.

The results of the modelling confirmed that, at all times, the contaminant concentrations in groundwater reaching the coast will always (over the next 1000 years) comply with the DEP (2000) Water Quality Assessment Criteria - Aquatic Ecosystems - Marine Waters, so will not affect aquatic life or its suitability for human consumption.

Proposed Clean-up of PCD Land

The Contamination Management Plan (CMP) delineates the locations and depths of soils requiring remediation to ensure the protection of human health and the environment. The proposed clean-up and management of contamination within PCD land is summarised as follows:

Soils

Approximately 3,050m^3 of soils within PCD land will require management to comply with the RLs. A further 227m^3 will be cleaned up for aesthetic reasons and 5,000m^3 of uncontrolled fill within the quarry located in the northern portion of the amendment area for geotechnical reasons. It is proposed to clean-up these soils by excavating and disposing them to an approved landfill (Figure 14).

PCD will prepare and implement a Remedial Works Management Program (RWMP) for the clean-up operations on PCD land. The RWMP will satisfy the WAPC's and EPA's requirements on advice from the DEP, the Health Department, the Water and Rivers Commission and the City of Cockburn and will comprise the following plans:

1. Site Remediation Integration Plan
2. Public Safety Plan
3. Occupational Health and Safety Plan
4. Noise and Vibration Management Plan
5. Groundwater Monitoring and Management Program
6. Contaminated Material Transport Management Plan
7. Dust Management and Monitoring Plan
8. Contaminated Stormwater Management Plan
9. Site (soil and groundwater) Remediation Validation Plan
10. Detailed staging and planning of works.

Groundwater

Elevated contaminant concentrations in groundwater collected at various locations across the site were identified including:

- Trace metals.
- Free petroleum product.
- Dissolved hydrocarbons.

The petroleum product is restricted to beneath land controlled by the WAPC. WAPC has previously committed (in its separate Consultative Environmental Review proposed by the WAPC and approved with conditions by the Minister for the Environment in April 2000) to recovering free petroleum product floating on the groundwater table beneath its land. It is anticipated this will involve the selective recovery of the free product using skimmer bores. The WAPC has commenced the remediation of groundwater by recovering white spirit floating on the groundwater surface.

The most effective option for long-term groundwater contamination management is source removal i.e. removal of the contaminated soils. Following source removal, natural renovation will occur with time. The contaminant transport and fate assessment that has been undertaken has identified the time frame required for natural renovation to occur.

Marina

The CTFA shows that the groundwater discharging into Owen Anchorage and the proposed marina will, even in the very long term, always comply with the marine water quality guidelines (DEP 2000), so will not affect aquatic life or its suitability for human consumption.

Predicted maximum contaminant concentrations in the groundwater reaching the marina and/or Owen Anchorage are shown in Table 1.

A marina-monitoring program will be implemented to confirm the conclusions of the CTFA. The monitoring program will be designed and implemented to the satisfaction of the WAPC and the EPA on advice from the City of Cockburn and the DEP.

Table 1. Predicted maximum concentrations of contaminants in the groundwater reaching the coast over time, compared with marine water quality criteria for protection of marine organisms.

Contaminant	Year from present when predicted maximum concentration will occur	Predicted maximum concentration in groundwater (µg/L)	Marine water quality criteria (µg/L)
Chlorpyrifos	100	0.0007	0.0007[1]
Dieldrin	210	0.0008	0.002
DDT	920	0.0005	0.001
Arsenic	460	2.9	50
Cadmium	1000	0.26	2
Chromium	1000	2.1	50
Copper	1000	2.6	5
Mercury	790	0.03	0.1
Nickel	390	3.4	15
Lead	1000	2.9	5
Zinc	1000	2.3	50
Naphthalene	80	1.0	3[2]

Notes:
All values in µg/L.
[1] denotes ANZECC/NHMRC (2000) trigger level 2 and interim guideline values for chlorpyrifos as DEP (2000) provides no guidance for these chemicals.
[2] denotes guideline value for total PAHs - naphthalene is the only PAH predicted to reach the watertable.
Marine denotes DEP (2000) Water Quality Assessment Criteria - Aquatic Ecosystems Marine Waters.

MARINA WATER QUALITY

Introduction

A key issue that has been addressed in the environmental planning for the project is managing the potential impact of the groundwater-borne nitrogen from historical market gardening on water quality in the marina. Groundwater with elevated nitrogen (up to 4.4mg/L of DIN) currently extends to about 2.5km inland of the coast at Port Catherine.

Nitrogen in the groundwater is a concern to water quality in the proposed marina because, unless appropriately managed, it has the potential to stimulate excessive algal growth. For example, nitrogen in groundwater inflows appears to have caused significant phytoplankton blooms in the northern harbour of Jervoise Bay, 4km south of Port Catherine.

As distinct from persistent metals and hydrocarbon contaminants that were considered for the contamination management strategy, dissolved nitrogen in the groundwater moves at essentially the same rate as the groundwater itself. Groundwater modelling and soil testing have shown that it will take until 2012 for the nitrogen plume to pass. The plume will be followed by groundwater containing background concentrations of nitrogen.

Other than nitrogen, the regional groundwater entering the Port Catherine amendment area is generally of good quality. In particular phosphorous, also a nutrient for plant growth, is present at relatively low concentrations (0.05mg/L).

Groundwater Interception and Reuse Scheme

It is proposed to manage the groundwater inflow to the marina at Port Catherine until 2012 by installing a subsurface cut-off drain immediately inland of the marina, to reduce the groundwater inflow to the marina. The extracted groundwater will be used to irrigate nearby parklands, with the surplus to be reinjected back into the aquifer north of the project, away from the marina. The quality of the water intercepted will always exceed current irrigation water quality criteria, even in the long term.

The proposed scheme is shown conceptually in Figure 15 and will comprise the following elements:

1. A buried permeable drain, located in a road reserve immediately inland of the marina, will be used to extract sufficient groundwater so as to lower the local water table and thereby reduce the groundwater flow to the marina. The groundwater extraction will be controlled to maintain a residual flow of 300m^3 (10% of existing) to the marina and thereby prevent any inflow of salt water to the drain.

2. The extracted groundwater will be pumped to a lined lake, located to the southeast of the amendment area and landscaped to meet aesthetic and recreational design criteria defined in consultation with the City of Cockburn and the Ministry for Planning.

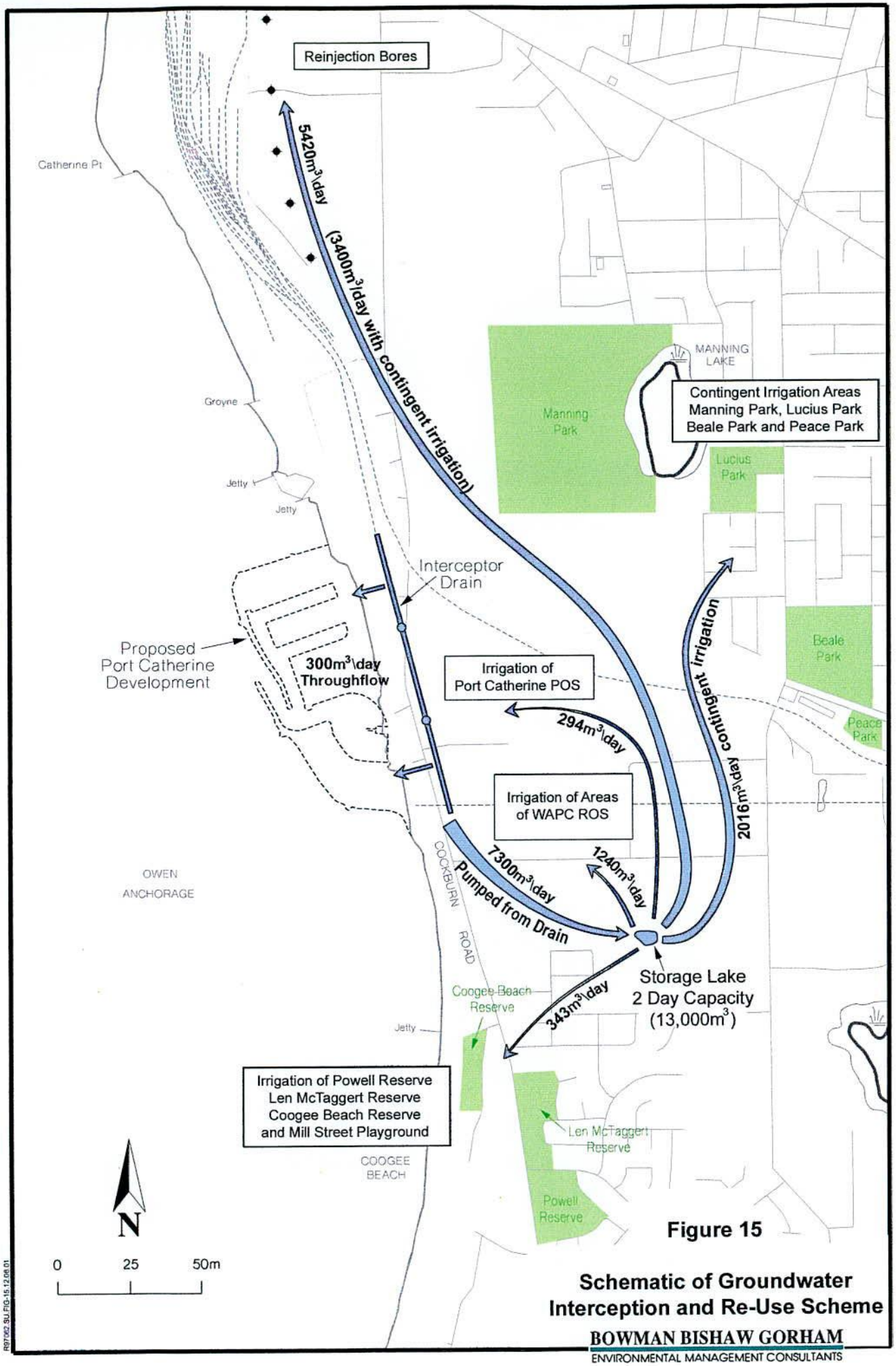

Figure 15

Schematic of Groundwater Interception and Re-Use Scheme

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R97062.SU.FIG-15.12.06.01

3. The groundwater will be used to irrigate nearby parks and gardens as follows:
   - Public Open Space areas within the Port Catherine development 4.2 ha
   - Regional Open Space to the east of the Port Catherine development 17.7 ha
   - City of Cockburn parks, replacing existing bore irrigation up to 33.8 ha

     Total area up to 55.7 ha

4. The excess groundwater will be re-injected back into the shallow groundwater aquifer using a series of injection bores located north of the project area.

Management Responsibilities

PCD will be responsible for the installation of all facilities and infrastructure comprising the groundwater interception and reuse scheme, and for the ongoing management and monitoring responsibilities associated with operating the scheme for the first five years following marina completion. Ongoing operational responsibility will devolve to the City of Cockburn, coincident with the City accepting responsibility as the Waterways Manager for the Port Catherine Marina.

Funding for the City to accept ongoing management responsibility will be established with seed capital from PCD. This arrangement will be similar to arrangements commonly applied at marinas and canal estates at Mandurah and elsewhere in Western Australia.

It is predicted that the groundwater interception scheme will be required to operate until 2012, by which time the nutrient concentrations in the groundwater will have reduced to background levels. Thereafter it would probably be maintained as a convenient and economical source of good quality groundwater, but would not be critical to the management of the marina water quality.

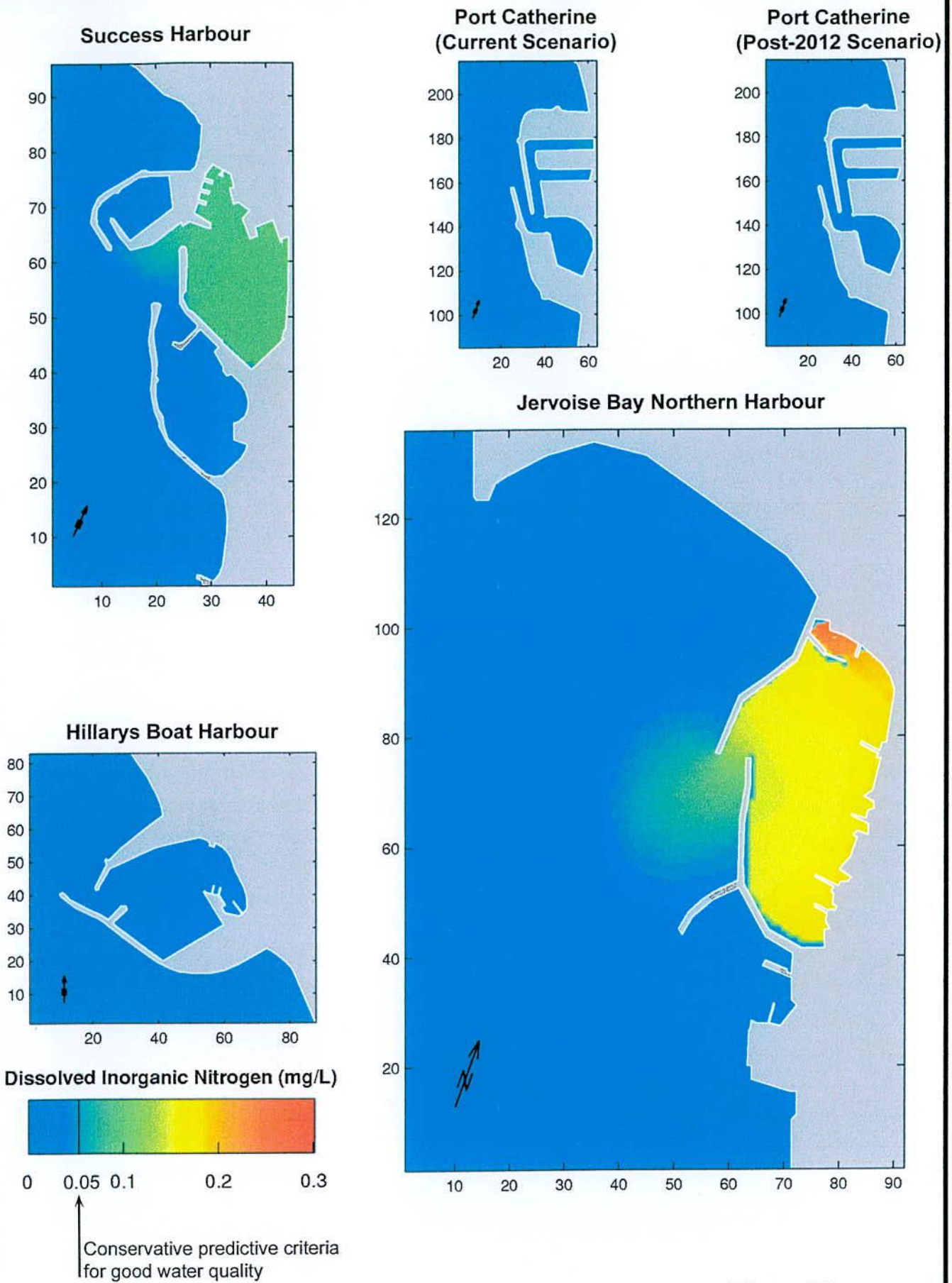
Benefit to Owen Anchorage from Groundwater Interception and Reuse.

The design purpose of the groundwater interception and reuse scheme is to manage the nitrogen load entering the marina and thereby avoid unacceptable algal growth in the marina waterway. An ancillary but very significant environmental benefit that will derive from the scheme is that it will reduce the groundwater nitrogen load currently flowing into Owen Anchorage by approximately 10%. The high amount of epiphytic algae covering the leaves of seagrasses in nearshore Owen Anchorage indicates that the current nitrogen load to Owen Anchorage may be affecting seagrass growth and vitality.

Marina Water Quality Management

Additional elements of the water quality management for the proposed marina include:

1. The configuration and alignment of the marina waterways have been refined based on computer modelling results, to maximise water exchange with the ocean.
2. There will be no direct discharge of stormwater to the marina waterway, except in extreme storm events.
3. The design and management of marina developments, particularly site drainage, will aim to minimise the potential for nitrogen runoff to the marina waterway.



Scale 1 : 25,000

Source : MP Rogers and Associates

Figure 16

Spatial Plots of the Modelled DIN Concentrations in each of the Modelled Marinas

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R07062.SU FIG-16.10.05.01

4. Contingency measures will provide opportunities to subsequently augment marina water circulation and/or further reduce groundwater inflow, in the event that incidents of reduced water quality ever occur.

A Waterways Environmental Management Plan will be prepared prior to the advertising of a TPS amendment to the requirements of the WAPC and EPA on advice from the City of Cockburn and the DEP, to ensure that acceptable environmental quality is maintained.

Potential for Algal Growth

Water quality in the marina waterway has been assessed using three-dimensional hydrodynamic and transport-dispersion modelling. Two scenarios were modelled. The first represented the groundwater and nutrient inflow towards the marina during the period to 2012 and incorporated the proposed groundwater extraction and reuse/recharge system. The second scenario represented the groundwater and nutrient inflow after 2012, once the plume of nutrient enriched groundwater has passed through and groundwater nutrient concentrations have reduced to background. The second scenario was modelled without any groundwater interception, to simulate conditions post-2012 if the groundwater extraction system is turned off.

Additional investigations to support and interpret the modelling work included the following:

- Comparative three-dimensional modelling of the water circulation and quality was undertaken at Success Harbour, Hillarys Boat Harbour and Jervoise Bay Northern Harbour, to assist interpretation of the Port Catherine modelling results.
- Water quality was monitored in Owen Anchorage at the location of the proposed Port Catherine marina, and inside and outside each of the other marinas that were modelled, to derive water quality input and calibration values for the modelling.
- Historical data and other information describing the water quality at each marina were reviewed, to enable interpretation of the modelling results in light of the water quality achieved elsewhere.
- The modelled water quality at Port Catherine was interpreted and assessed based on the foregoing, to confirm that the proposal satisfies the EPA's objectives for water quality.

To simulate worst-case conditions, each scenario was modelled using weather and tidal data from the summer of 1997-98, at a time when Jervoise Bay Northern Harbour suffered a large-scale algal bloom.

Figure 16 shows spatial plots of the modelled equilibrium DIN concentrations in each of the modelled marinas (note that the marinas are all depicted at a common scale to show their relative sizes). Table 2 describes the mean and range of modelled DIN concentrations within each marina and compares them with the measured DIN concentrations during the summer of 1999-2000.

The modelling results demonstrate that water quality in the Port Catherine marina will be similar to both Hillarys and Success Harbours and very much better than at Jervoise Bay Northern Harbour.

Table 2 Average and range of modelled DIN concentrations within each marina, compared with measured DIN concentrations during summer 1999-2000

Waterway		Modelled DIN (mg/L)	Measured DIN (mg/L)
Jervoise Bay Northern Harbour			
	mean	0.161	0.138
	range	0.072-0.239	0.081-0.216
Hillarys Boat Harbour			
	mean	0.029	0.022
	range	0.019-0.034	0.006-0.064
Success Harbour			
	mean	0.041	0.011
	range	0.035-0.048	0.006-0.019
Port Catherine: current scenario			
	mean	0.041	n.a.
	range	0.036-0.045	
Port Catherine: 2012 scenario			
	mean	0.038	n.a.
	range	0.033-0.041	

The mean and maximum nitrogen concentrations within the proposed Port Catherine marina remained low: the mean DIN concentration (0.041 mg/L) is similar to (only 65% higher than) the background concentration in the near shore Owen Anchorage. This compares favourably with Hillarys Boat Harbour, where the mean measured concentration of DIN within the marina was 60% higher than in external waters. In comparison, the mean measured concentration of DIN within the Jervoise Bay Northern Harbour was 475% higher than the external concentration.

The maximum concentration of DIN within the proposed Port Catherine marina (0.045mg/L) was exceeded by 10% of measured DIN concentrations recorded at Hillarys Boat Harbour and is only one-third of the long-time average DIN concentration (measured over two years) in Jervoise Bay Northern Harbour.

The modelled DIN concentrations at Port Catherine were also within a conservative predictive criterion that was derived from monitoring data for Hillarys and Success Harbours, that the DIN concentration should remain less than 0.050 mg/L.

The flushing time of a marina is an important secondary determinate of water quality. As well as affecting the dilution of groundwater nutrients, efficient flushing with clear ocean water increases the water clarity and reduces the rate at which phytoplankton settle out to enrich the sediments.

A comparison of harbour flushing times for the modelled marinas supported the estimates of good water quality at Port Catherine.
The water quality modelling for the proposed marina estimated that the eastern end of the northern-most canal has a flushing time of around 4 to 5 days. The main marina area has an estimated flushing time of 2 to 3 days.

This compares with the modelled flushing times of approximately 1 day at Success Harbour and approximately 4 days at Hillarys Boat Harbour. The flushing time at Hillarys Boat Harbour has previously been measured at approximately 5 days. In contrast, the modelled flushing time at Jervoise Bay Northern Harbour was 10 – 11 days.

Monitoring data and historical records support the generally held perception that Success Harbour and Hillarys Boat Harbour meet ecological and social objectives for acceptability of water quality with respect to nutrients and algal productivity. Using DIN concentration and flushing efficiency as indicators of the propensity of a waterway to support nuisance algal growth, the predicted water quality at Port Catherine marina will remain well within the range experienced at Success and Hillarys.

Key Conclusion – Marina Water Quality

The proposed groundwater interception and reuse scheme and associated marina design and management strategies will ensure that the marina will maintain high water quality.

Owen Anchorage will derive a net environmental benefit by the 10% reduction in groundwater nitrogen load.

The water quality modelling and assessment has concluded the following:

1. The proposed marina design and a reduction of groundwater inflow to the marina (to approximately 10% of normal flow) will ensure that the water quality in the marina will remain similar to Success and Hillarys harbours and should not result in algal blooms.

2. The extent of elevated nitrogen concentrations in soils and groundwater indicates that the proposed interception and use/disposal of groundwater will be required for up to twelve years, until the groundwater nutrient plume has passed.

3. After the groundwater extraction and irrigation system is no longer used, the return of groundwater inflow to the marina to 100% of normal flow would continue to ensure that the water quality in the marina will remain similar to Success and Hillarys harbours and should not be of a nature that provides for algal blooms.

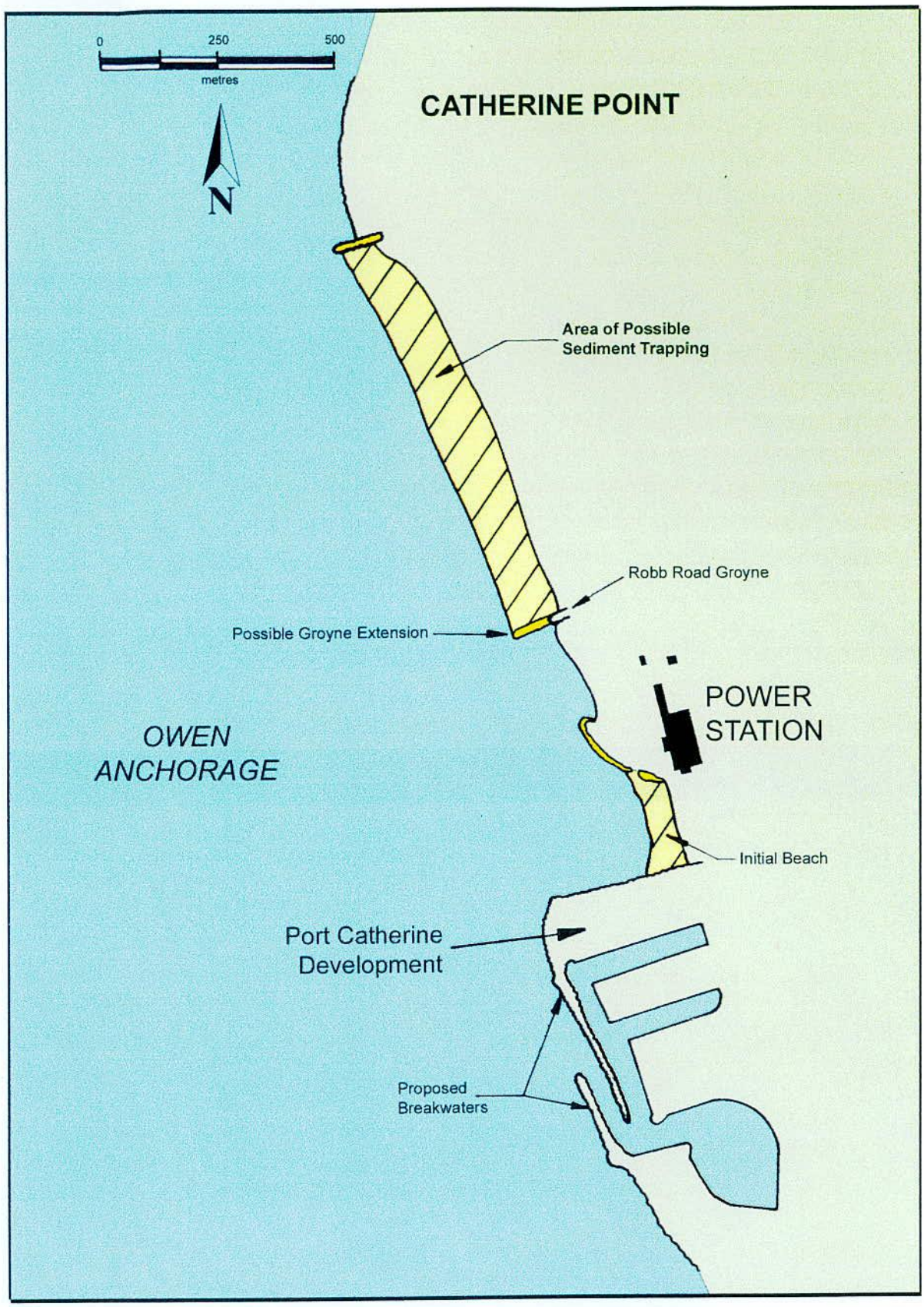

Figure 17

Anticipated Sand Accumulation North of Development

Source : MP Rogers and Associates

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R9/002.SU.FIG-17.10.05.01

DISCUSSION OF OTHER ISSUES

Coastal Stability

As described in "The Marine Environment" above, coastal processes along the shoreline at Port Catherine marina have not been in a natural state for many years.

Historically, an estimated 33,000m^3 of sand was transported south towards the amendment area each year. However, from the 1970s until the 1990s, the Robb Road and Power Station groynes trapped most of this sand and only 5,000m^3 of sand reached the amendment area each year.

These two groynes are now nearly saturated with sand on their northern sides and in coming years the natural movement of sand towards the Port Catherine project area from the north will gradually return to historical levels.

Following completion of the Port Catherine marina, the beach north of the proposed northern breakwater will accumulate approximately 120,000m^3 of sand, resulting in the formation of a beach around 50m wide over a period of about four years. This new beach (Figure 17) will be protected from the sea breeze and is likely to become a valuable recreation resource.

The proposed development will create a barrier to the flow of sand in the surf zone from the north to Coogee Beach. At the rate of 33,000 m^3/a, it will take many decades for the marina groyne to become saturated with sand.

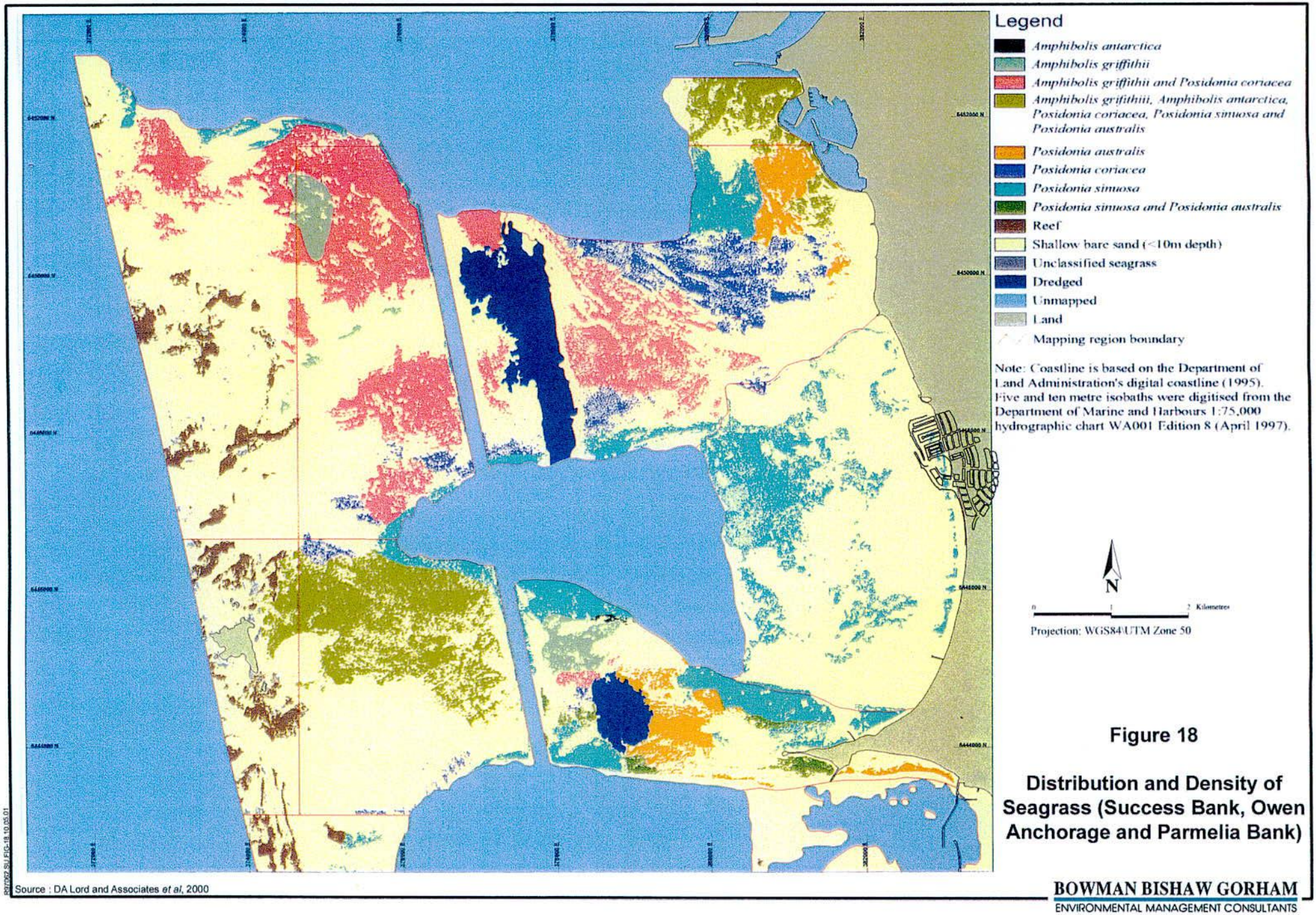
However in the longer term, ongoing sand accumulation around the northern breakwater to the marina will need to be managed to prevent the silting up of the harbour entrance.

Extending Robb Road groyne could accommodate around 900,000m^3 of sediment, providing twenty to thirty years of sediment control under the estimated sediment transport rate (Figure 17). Other possible long-term strategies for sediment management have been identified and are summarised in the ER. The ultimately preferred strategy would be selected and designed to the satisfaction of the Department of Transport.

Following development, the foreshore within the amendment area will be permanently protected by the outer breakwaters and will mostly comprise retaining walls with some areas of stable beach.

To the south of the marina, Coogee Beach has remained essentially stable in the past according to long-term records (1942 to 1994) despite having very low sand supply from the north throughout this period, due to the Robb Road and Power Station groynes. Short and medium term changes in erosion or accretion rates have occurred and will continue to occur. For example, between 1980 and 1987 the shoreline at Coogee Beach eroded by approximately five metres (O'Brien Planning Consultants, 1996). Annual fluctuations are also common.

The wave shadow from the proposed marina could impact the northern end of Coogee Beach as sand could be moved into the shadow under the action of the seabreeze and storms from the southwest. As this area is sheltered from waves from the northwest, sand will tend to accumulate near the wreck of the Omeo with minor (reciprocal) erosion further to the south.



Source : DA Lord and Associates *et al*, 2000

Figure 18

Distribution and Density of Seagrass (Success Bank, Owen Anchorage and Parmelia Bank)

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

Coogee Beach has ample width to accommodate the variable regime of minor accretion and erosion. Possible changes to the beach profile are considered manageable – sand accumulating at the groynes to the north of the marina could be bypassed to Coogee Beach if needed at any time.

Seagrass and Marine Fauna

Construction of the marina will result in the direct loss of a small (0.3ha) area of *Posidonia sinuosa* seagrass. This area is equivalent to 0.014% of the total seagrass habitat and 0.05% of the *P. sinuosa* habitat within eastern Owen Anchorage (Figure 18). The current status of seagrass habitat in Owen Anchorage appears to be generally very healthy. Recent mapping from aerial photographs has indicated that total seagrass cover in Owen Anchorage has increased by approximately 500ha since 1965.

The location and design of the proposed marina have specifically been reconfigured to minimise disturbance to seagrass habitat located further to the south (Figure 3). In addition, the proposed management of groundwater entering the marina will mean that the project will derive a net benefit to seagrass habitat by achieving a 10% reduction in the dissolved inorganic nitrogen loading that flows annually into Owen Anchorage in the groundwater.

The benthic habitats for marine fauna in the amendment area are well represented elsewhere in Owen Anchorage, so the proposed development will not affect the abundance, species diversity or species distribution of marine fauna.

It is concluded that the proposed amendment and marina construction will not compromise the EPA objective for marine flora or fauna.

Terrestrial Vegetation, Flora and Fauna

Historical clearing and use of the land have rendered much of the amendment area, particularly the area south of the railway line, as essentially devoid of ecological value.

South of the railway, the land proposed for Urban and Primary Regional Road (PRR) reservation does not contain any native vegetation communities or fauna habitats of significance (Figure 3).

The proposed re-alignment of the PRR reservation and the Industrial rezoning on the northern side of the railway encroaches within Bush Forever Site 247 and Beeliar Regional Park, as shown in Figure 19 and discussed below.

Bush Forever Site 247.

The proposed PRR rezoning north of the railway includes 1.57ha of Bush Forever Site 247 (Figure 19). This area comprises 0.59ha of regrowth shrubland and 0.98ha that is a derelict quarry or has been otherwise substantially disturbed. It is devoid of remnant vegetation although has patches of regrowth.

Beeliar Regional Park.

The proposed PRR rezoning north of the railway also includes 1.64ha that is within part of Beeliar Regional Park that was not nominated for protection in Bush Forever Site 247 (Figure 19). Of this area, 0.54ha contains regrowth *Acacia* shrubland with reduced plant diversity and significant weed infestation. The other 1.10ha is essentially devoid of remnant vegetation.

LEGEND

- Bush Forever Site 247 and 341
- Beeliar Regional Park
- Conservation Category Wetland

N

0 100 200 300 400 500

metres

Figure 19

Bush Forever Site 247, 341 and Beeliar Regional Park Showing Area Affected by Proposed PRR Zoning

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R0702.BU.FIG-19.10.05.01

The proposed Industrial rezoning north of the railway includes 0.57ha that is similarly included within Beeliar Regional Park but excluded from Bush Forever Site 247 (Figure 19). This area is essentially devoid of remnant vegetation.

No reasonable alternative exists for rerouting the PRR through the south-western corner of Bush Forever Site 247 and Beeliar Regional Park. The location of the land that is then excised by the PRR reservation and proposed for rezoning to Industrial, between the deviated PRR and the railway, deems it unsuitable for inclusion within Beeliar Regional Park and unsuitable for conservation as functional remnant bushland.

Some of the vegetation within the PRR reserve to the north of the railway will be retained by aligning the roadway within the reserve so that vegetation disturbance is minimised. In addition, it is proposed to compensate for any necessary clearing of remnant vegetation within Bush Forever Site 247 or Beeliar Regional Park through rehabilitation of currently disturbed Bush Forever land adjoining the amendment area.

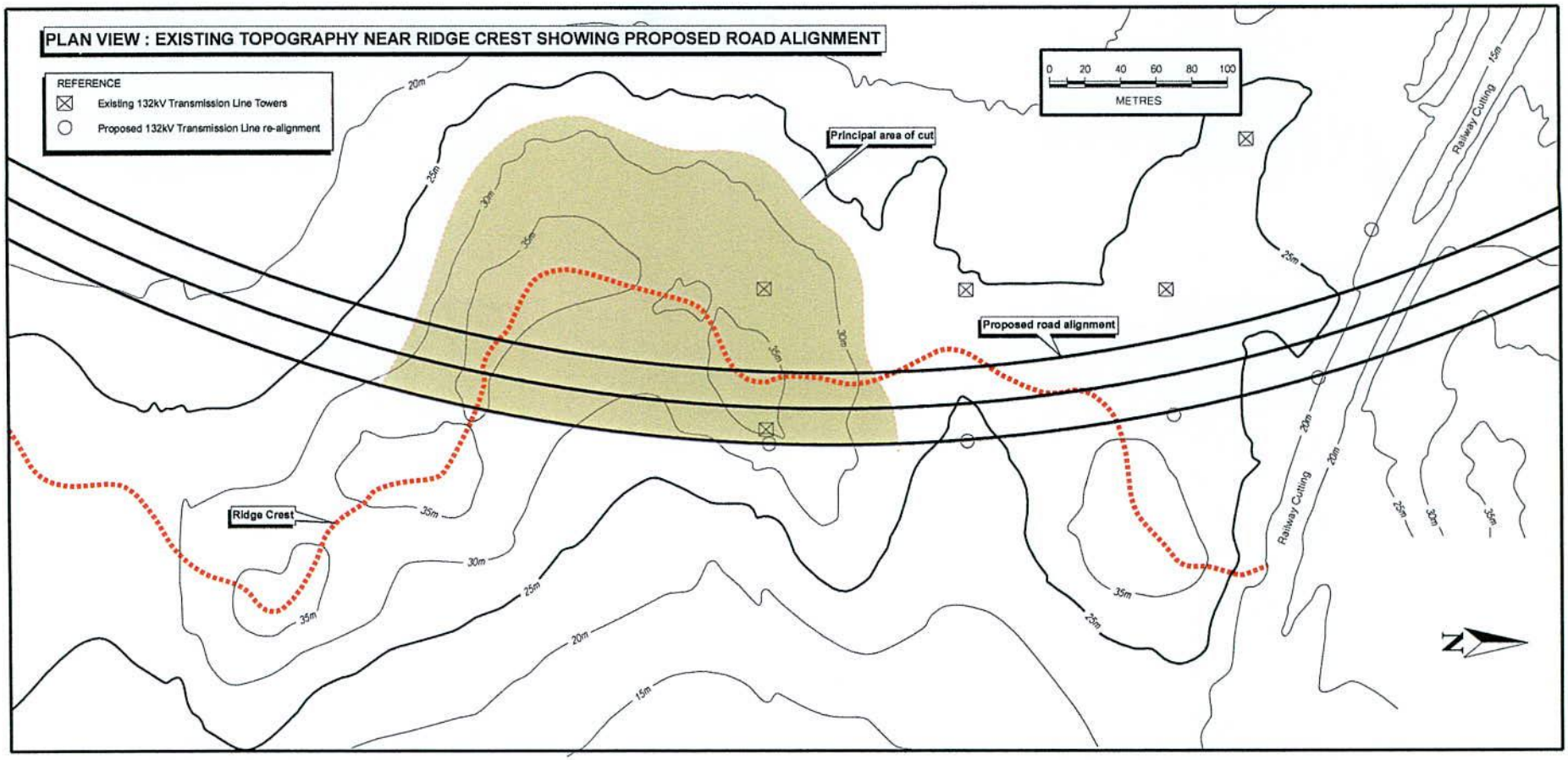
These management measures will be defined in a Remnant Vegetation Management Plan to be prepared prior to construction disturbance of the affected areas to the requirements of the WAPC and the EPA on advice from the City of Cockburn, the DEP and the Department of Conservation and Land Management.

The 2.21ha reduction to the area of Beeliar Regional Park that is not included in Bush Forever Site 247 (comprising 1.64ha proposed from realignment of the PRR reserve and 0.57ha proposed for Industrial rezoning) will be compensated by rehabilitating and landscaping the area of presently barren land within the Regional Open Space reserve on the eastern side of the Port Catherine project area, as shown in Figure 1. The proposal will significantly enhance the amenity of the eastern flank of the ridge and assist in achieving the north-south linkage concept promoted by the Beeliar Regional Park proposals for this locality. The proposal also conforms to the City of Cockburn's aspirations for a network of recreational trails through the ridge area.

The proposed rehabilitation of nominated areas of cleared or disturbed vegetation will offset the loss of small areas of Acacia shrubland associated with the amendments and thereby ensure that the development does not compromise the EPA's objectives for protection of terrestrial vegetation, flora and fauna habitat.

Landscape and Amenity

The prominent limestone ridge along the east of the amendment area provides distinctive landscape character and scenic quality. Earthworks for the realignment of Cockburn Road onto the PRR reservation will modify a part of the ridge, reducing the topographic variation for an overall distance of 230m (Figure 20). In order to protect the landscape function of the modified ridge, earthworks have been designed to ensure that residential development will not be visible from the east (i.e. the development and road will be cut into the hillside).



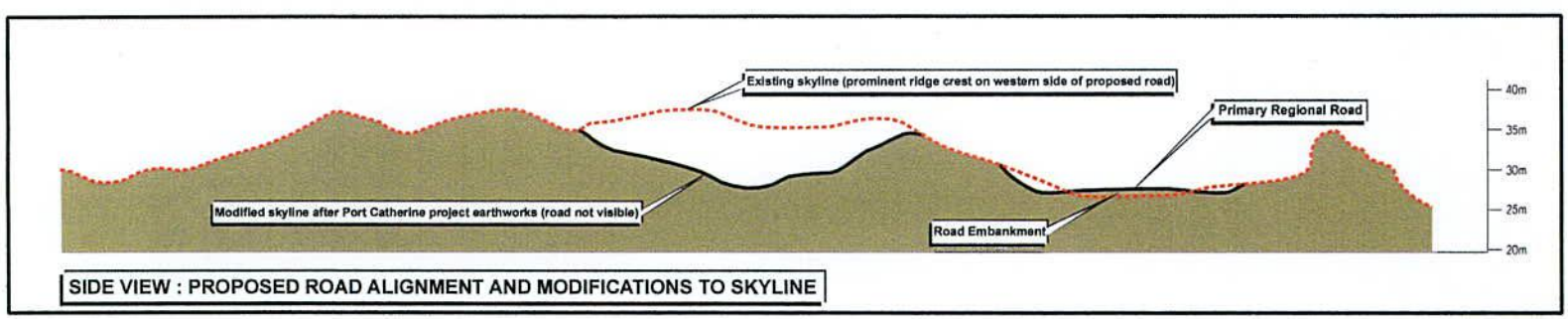


Figure 20

Existing Topography with Proposed Primary Regional Road Alignment and Proposed Modifications to Skyline

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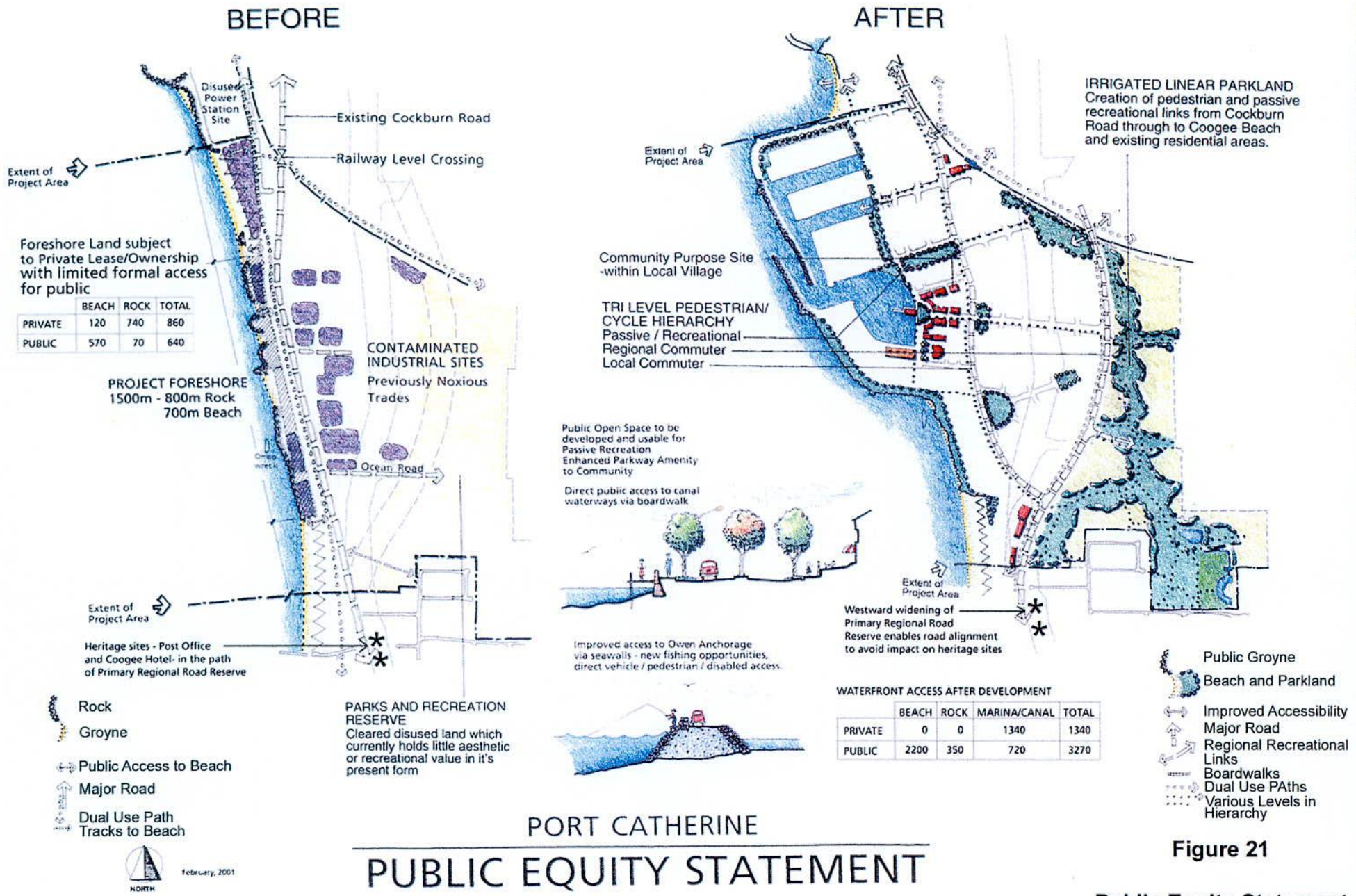

PORT CATHERINE

PUBLIC EQUITY STATEMENT

Figure 21

Public Equity Statement

Source : Taylor Burrell

R01062.SU.FIG-21.12.06.01

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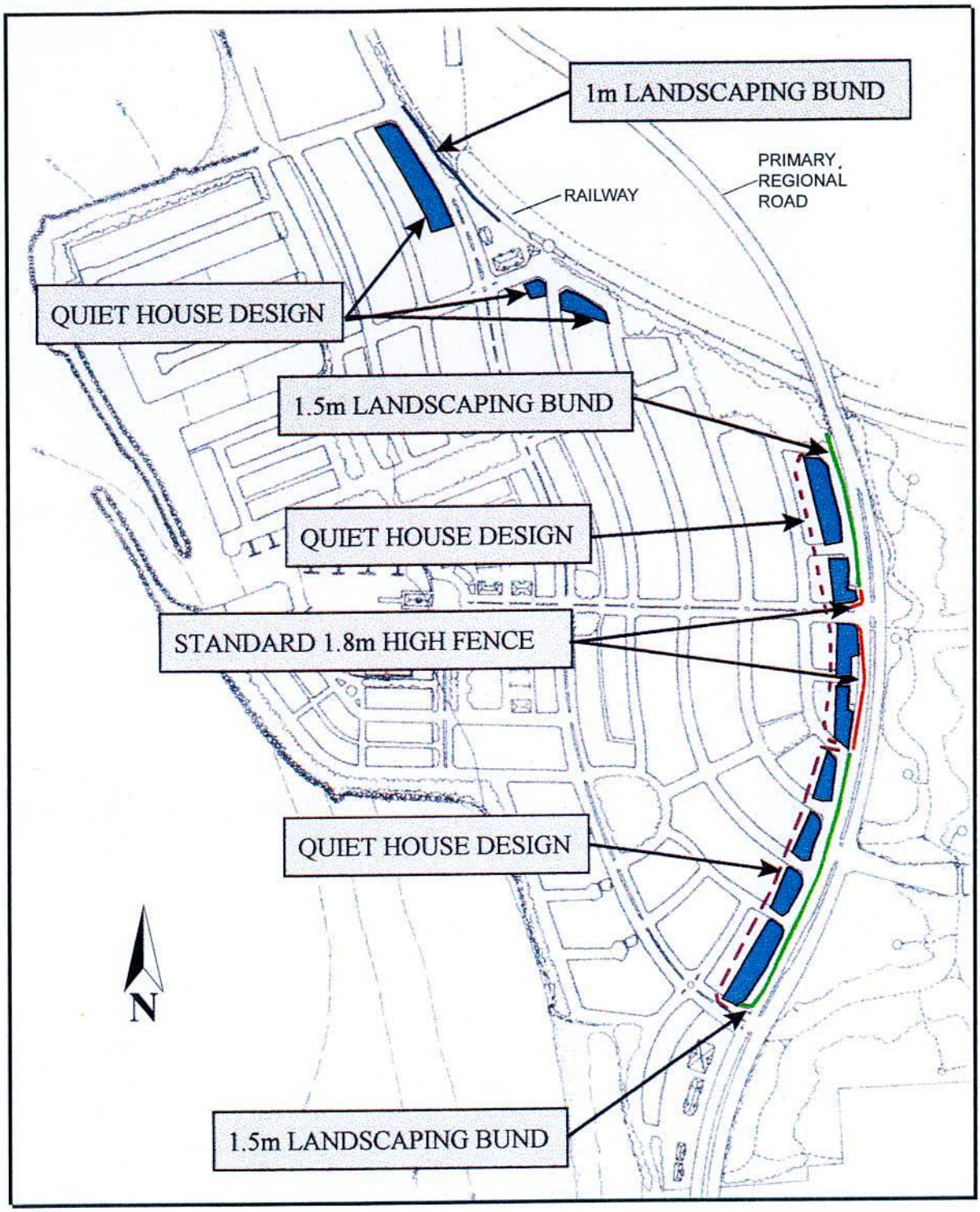

Figure 22

Noise Management Proposals Adjacent to Railway and Primary Regional Road

Source : Herring Storer Acoustic

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097092 SU FIG-22 10.05.01

On the western side of the ridge, the landscape will change to a built landscape. This will be of a similar scale to the nearby Cockburn Waters and is therefore consistent with the locality.

Public amenity will be provided through broadly accessible public facilities. A Public Equity Statement highlighting the differences between the existing situation and the proposed development is schematically illustrated on Figure 21.

Noise and Vibration

Construction noise and vibration will be mostly remote from residential areas, so should cause no adverse impacts to nearby residents. Traffic management measures (e.g. route selection, operating hours), to reduce truck nuisance on local roads during breakwater construction, will be prepared to the requirements of the WAPC and the EPA on advice from the City of Cockburn and the DEP.

Road noise assessments for the PRR reserve have shown that it is practicable to avoid traffic noise nuisance to future residents at Port Catherine by the construction of noise barriers at the locations shown on Figure 22 (either a 1.5 metre high earth landscaping bund or a standard 1.8 metre high fence). Titles of noise-affected allotments will stipulate that "quiet house" designs should be used.

Railway noise impacts upon future residents were assessed on the basis of an average of two trains per day (current use is two trains per week) but the results were found to apply equally for up to eight trains per night (and a much greater number of trains during the day). The assessment showed that it is practicable to avoid rail traffic noise nuisance to future residents at Port Catherine by the construction of noise barriers (a 1 metre high earth landscaping bund at the edge of the railway reserve) adjacent to approximately twelve of the proposed residences to be within approximately 50 metres of the railway line (Figure 22). Titles of noise-affected allotments will stipulate that "quiet house" designs should be used.

Vibration from road and railway traffic was assessed as having no adverse effect to nearby future residents.

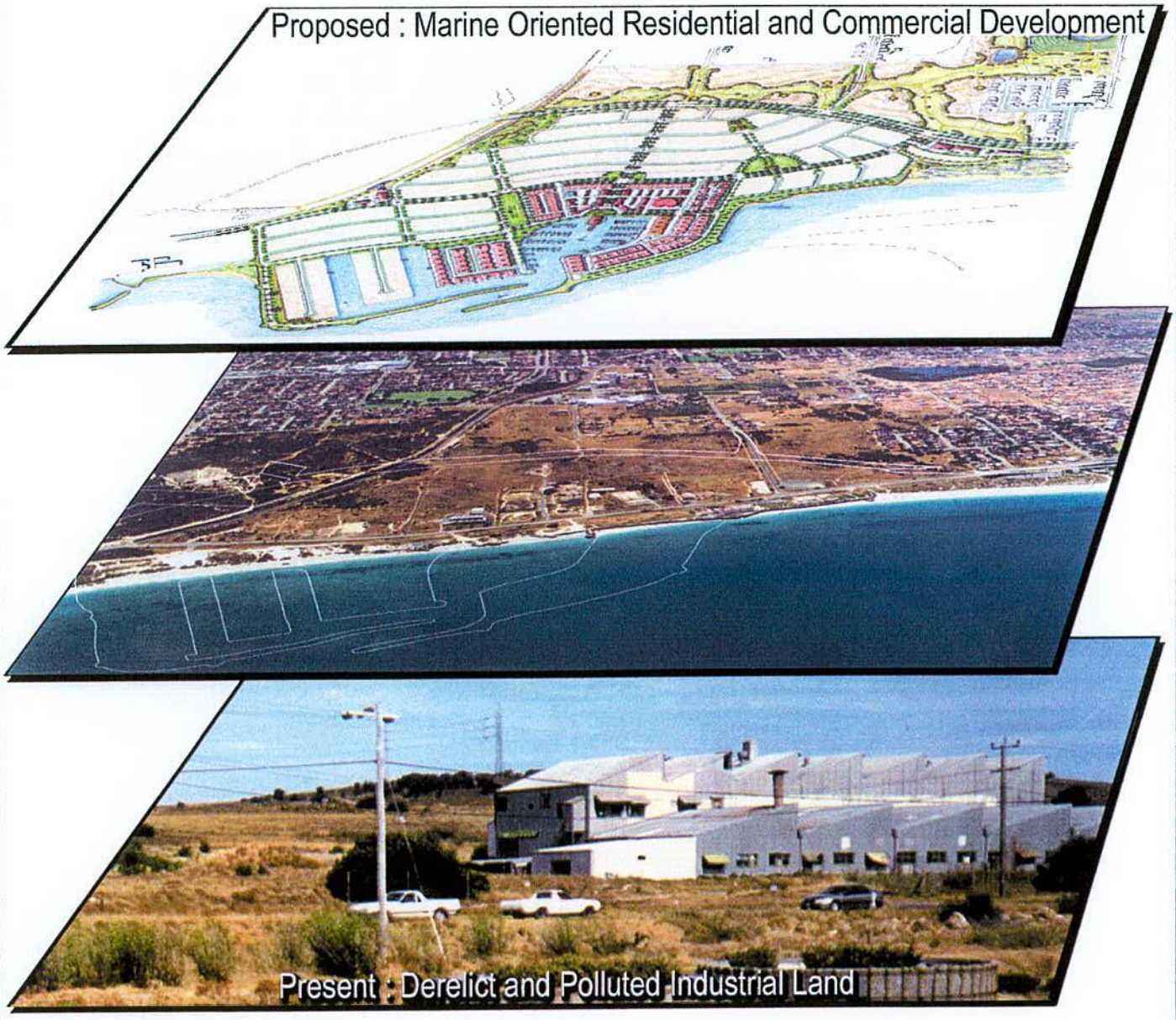

Figure 23

Port Catherine,
Present and Proposed

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R97062.SU.FIG-23.10.05.01

CONCLUSION

The Port Catherine project represents an opportunity to clean-up derelict and polluted industrial land and create a marine-oriented residential and commercial development that will become a regional community attraction and focal point. The project will introduce a broad range of new public amenities not presently available at the locality. Similarities with aspects of the Fremantle Esplanade and waterfront are envisaged.

The Environmental Review has shown that the proposed MRS amendments and the Port Catherine project can be implemented in accordance with EPA policies and objectives for each of the nominated environmental factors (Summary Table). Conditions will be attached to the MRS amendments to assure proper environmental management of the land uses allowed by the zonings. Environmental management obligations can be enforced by the WAPC through subsequent stages of the statutory town planning and development process.

Accordingly, it is submitted that the Environmental Review presents an environmentally acceptable proposal.

SUMMARY TABLE

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Vegetation Communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities	Site is mostly cleared of native vegetation. Small areas of regrowth coastal heath with weedy understorey and high degree of fragmentation.	Cockburn Rd realignment will impinge on 1.57ha of Bush Forever Site 247 (including up to 0.59ha of low diversity *Acacia* shrubland) and an additional 1.64ha of Beeliar Regional Park not part of Bush Forever Site 247 (including up to 0.54ha of low diversity *Acacia* shrubland). Industrial zoning north of Railway includes approx. 1ha of *Acacia* shrubland not nominated in Bush Forever nor contained in Beeliar Regional Park.	Minimise disturbance by sensitive alignment of road in road reserve. Compensate by rehabilitating adjacent disturbed Bush Forever land. Implementation of Beeliar Regional Park proposal on-going; CALM to prepare Management Plan. Compensate impingement on Beeliar Regional Park by landscaping Open Space to east of site to achieve linkage promoted in Park proposals.	No loss of remnant vegetation which could be considered to be a good representation of a regional vegetation type. Unavoidable loss of *Acacia* shrubland will be offset by rehabilitation.
Declared Rare and Priority Flora - Terrestrial	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act, 1950*	No species of declared rare or priority flora recorded or likely to occur on site.	No loss of Declared Rare and Priority Flora.	Environmentally acceptable without further management.	Proposals conform with *Wildlife Conservation Act, 1950.*
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna	Mostly very poor habitat for terrestrial fauna due to historical clearing and use for stock agistment.	Removal of approx. 2.2ha of low diversity coastal heath habitat north of railway line however this is unlikely to affect abundance, species diversity or geographical distribution of fauna.	Compensate by rehabilitating adjacent disturbed Bush Forever land. Enhance fauna habitat linkage between Beeliar Regional Park northern and southern precincts through landscaping in Open Space east of project area.	No loss of species diversity or abundance due to persistence of viable populations in adjacent habitat.
Specially Protected (Threatened) Fauna - Terrestrial	Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act, 1950*	Vegetated areas are potential habitat for Lined Burrowing Skink (*Lerista lineata*), a Priority 4 species.	Survey for *Lerista lineata* failed to locate any individuals. Removal of sparse remnant habitat will not affect conservation status of this animal. Viable populations able to persist in adjoining Beeliar Regional Park north of railway line.	Environmentally acceptable without further management.	No affect on conservation status of specially protected fauna. Proposals conform with *Wildlife Conservation Act, 1950.*

SUMMARY TABLE (Continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Marine Flora (seagrass)	Maintain the ecological function, abundance, species diversity and geographic distribution of seagrasses	Small patches of seagrass (0.3ha) in Amendment area is remnant of more extensive meadow probably reduced by past industrial discharges. Rhizome mat is dead; no regrowth potential.	Loss of seagrass limited to 0.3ha of *Posidonia sinuosa* meadow within Amendment area. Equivalent to 0.01% of seagrass habitat and 0.05% of *P. sinuosa* habitat in eastern Owen Anchorage.	Proposed extraction and reuse of nutrient enriched groundwater plume will derive net benefit to seagrass by achieving 10% reduction in DIN load to Owen Anchorage.	Proposal does not compromise EPA objective for marine flora.
Declared Rare and Priority Flora - Marine	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act, 1950*	No Declared Rare and Priority Flora recorded.	No adverse impact.	Environmentally acceptable without management.	Proposals conform with *Wildlife Conservation Act, 1950.*
Marine Fauna	Maintain the abundance, species diversity and geographic distribution of marine fauna	Existing benthic habitats comprise 0.3ha of seagrass, areas of dead rhizome mat, bare sand and limestone pavement.	Potential loss of benthic fauna is not considered significant due to low abundance and diversity of fauna. Each of the benthic habitats is well represented elsewhere in Owen Anchorage.	Environmentally acceptable without management.	Abundance, species diversity and geographic distribution of marine fauna will not be significantly affected.
Specially Protected (Threatened) Fauna – Marine	Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*	Two turtle species previously recorded in region, but are uncommon vagrants. Fairy Tern also previously recorded.	No adverse impacts due to very low potential for threatened fauna.	Environmentally acceptable without management.	Proposals conform with *Wildlife Conservation Act, 1950.*
Dunes	Maintain the integrity, function and environmental values of the dune system	Remnant foredunes in Amendment area occupy a distance of 400m (discontinuous). They are moderately to heavily degraded and, where vegetated, are very weedy.	Loss of approx. 4ha of remnant dune system with low conservation value. Project design specifically avoids disturbance of foredunes to the south, which are less degraded.	PCD to manage construction impacts at interface with Woodman Point dune system to the south, and provide for appropriate access pathways from residential area.	Proposal will not adversely affect the integrity, function and remaining environmental values of the Owen Anchorage foredune system.

SUMMARY TABLE (continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Foreshore (beach)	Maintain the stability of beaches	Historically, beach stability at the development site has been altered by groynes to the north of the site and at Woodman Point. Coastline has been relatively stable over the long term. Coogee Beach has adequate width to accommodate minor change.	Sand will accrete north of proposed marina to form a new and protected beach. Coogee Beach to south should remain relatively stable following construction of the breakwaters.	Stability of Coogee Beach to be monitored by the Waterways Manager. Contingency plans to be implemented if necessary.	Maintenance of beach stability readily manageable.
Seabed	Maintain the stability of beaches	Proposed development site is currently receiving sand via longshore drift from Success Bank - Point Catherine area.	Sediment will be trapped on northern side of breakwater for 3-4 years to form beach 50m wide. Subsequent extension of Robb Rd groyne will trap sediment for another 20-30 years. Thereafter, management may be required to prevent or remedy silting in the harbour entrance.	Sedimentation will be monitored by the Waterways Manager. Measures are proposed for long-term management by theWaterways Manager.	Frequent maintenance dredging of harbour entrance will not be required. Potential silting of harbour entrance is readily manageable.
Sea level	Development should not increase the potential impact on the environment of/from storm surge	Storm surge erosion events have occurred at Coogee Beach in the past and will occur again in the future.	Because Coogee Beach is in "near-equilibrium" with respect to sand supply, the presence of the development will not significantly affect the natural recovery potential of this beach.	Managed by the City of Cockburn as per current practice.	No significant change to current storm surge erosion risk.
Particulates/Dust	Ensure that the dust levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards	The development site is relatively isolated from densely populated areas with respect to potential dust nuisance. The exception is Old Coogee, which extends to within 60m from the south-east corner.	The potential for dust generation is highest in summer when soils are dry. Summer prevailing winds are east to south-easterly (no residential areas impacted) and south-westerly (600 metres to nearest residence). Therefore, the potential for dust nuisance is low.	Implementation of dust control in accordance with EPA Guidance N° 18 Prevention of Air Quality Impacts from Land Development Sites, to be defined in Construction Management Plan.	No adverse impacts on the health, welfare and amenity of surrounding community.

SUMMARY TABLE (continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Marine Water and Sediment Quality: Construction Phase	Maintain or improve the quality of marine water consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993a); and/or Maintain or improve marine water and sediment quality consistent with Environmental Quality Objectives (EQO's) and Environmental Quality Criteria (EQC's) defined in the Southern Metropolitan Coastal Waters Study (1996)	Seagrass is priority habitat requiring protection from turbidity. Nearest meadow is 130m south, with significant meadows extending southwards from 275m to south. Sediments in nearshore area are essentially uncontaminated.	Temporary turbidity from breakwater construction is unlikely to affect nearby seagrasses. Any sediments, nutrients and contaminants disturbed during dredging will be contained within the harbour and will not cause significant water quality impacts to external waters.	Monitoring of water turbidity is proposed throughout marina construction. A Construction Management Plan will be prepared stipulating turbidity control during dredging, monitoring and contingency responses.	No significant water or sediment quality impacts will occur outside the harbour during construction.
Marine Water and Sediment Quality: Operational Phase	Maintain or improve the quality of marine water consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993a); and/or Maintain or improve marine water and sediment quality consistent with Environmental Quality Objectives (EQO's) and Environmental Quality Criteria (EQC's) defined in the Southern Metropolitan Coastal Waters Study (1996)	Water quality within Owen Anchorage is generally good, having improved significantly since the industrial discharges ceased in the late 1980's. Sediments in nearshore area are essentially uncontaminated.	The proposed groundwater interception and reuse scheme and associated marina design and management strategies will ensure that the marina will maintain high water and sediment quality. It will also derive a net environmental benefit to Owen Anchorage by reducing the groundwater nitrogen load by 10%. Proposed contamination clean-up will ensure that groundwater quality always complies with marine water quality criteria.	Proposed groundwater interception and reuse scheme to operate for up to 12 years. Marina design and management strategies to prevent pollutant inputs and maximise seawater exchange. Water and sediment monitoring and management plan to be prepared and implemented.	Water and sediment quality in the marina will comply with EPA guidelines. Internal waterway will remain attractive and visibly healthy, the adjacent marine environment will not be adversely affected and the recreational and human health values will not be compromised.

SUMMARY TABLE (continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Contamination	To ensure that soil and groundwater quality at the site is acceptable from a human health perspective and in terms of potential environmental consequences for the near shore marine environment and marina	Detailed investigations have identified a range of contaminants in soils, groundwater and marine sediments as a result of historical industrial land uses and inadequate waste management practices. Government land to be cleaned-up to residential standard as per previous EPA approval. In PCD land, some residual substances occur at concentrations that may adversely impact upon the marine environment and the health of future site users, based upon current soil, water and sediment quality guidelines.	All land within amendment area to be cleaned-up to requirements of the Human Health Risk Assessment (HHRA) and Contaminant Transport and Fate Assessment (CTFA), to ensure that human health and ecological values are protected. The CTFA has confirmed that site clean-up to protect human health will ensure that the groundwater flowing across the shoreline to Owen Anchorage will always meet applicable marine water quality guidelines for toxicants.	Residual soil and groundwater contamination within the Amendment area will be cleaned-up to the levels specified by the HHRA and CTFA, with validation of clean-up to the satisfaction of the WAPC on advice from DEP, Health Department and WRC.	Amendment area to be cleaned-up to protect human health and the environment. Outcome to be confirmed via a comprehensive Validation Program.
Noise	Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards	Cockburn Road, which will be realigned to the eastern boundary of the site, currently carries approx. 17,000 vehicles per day, including 6% heavy vehicles. The railway line is a strategic freight link for Fremantle Port but currently experiences only two train movements per week. The extent of future usage is uncertain.	Construction noise mostly remote from residential areas but marginal increase in heavy vehicles on Rockingham and Cockburn Roads during construction. Noise assessments have shown that it is practicable to avoid road and railway noise nuisance within Amendment area by using low acoustic barriers and quiet house design.	Construction noise to comply with Environmental Protection (Noise) Regulations. Traffic management measures to be defined in consultation with City of Cockburn. PCD to construct noise barriers at locations defined by noise assessments. Titles of noise affected allotments to stipulate requirement for quiet house design.	Noise management techniques will ensure that the amenity of existing and future residents is protected.

SUMMARY TABLE (continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Vibration	Protect the amenity of nearby residents from vibration impacts resulting from activities associated with the proposal by ensuring that vibration levels meet statutory requirements and acceptable standards	The site is mostly limestone which is generally relatively soft at depth. Near surface horizons are hard in places and therefore potentially more transmissive of vibration, although solution cavities are common and would be a mitigating factor.	During the construction phase, heavy duty compaction will be required for the offshore peninsulas, which are generally remote from established residential areas. The potential for deep ripping and blasting for onshore earthworks, whilst low, cannot be discounted. Assessments of potential road and rail vibration showed no adverse effects from operation of railway or PRR on future residents.	PCD will notify neighbouring residences advising of impending construction activity (nature and extent) and contact personnel within the company, then will consult as necessary. Free structural inspections will be offered prior to construction to enable assessment of potential building damage. Operational vibration from railway and PRR acceptable without special management.	Significant vibration impacts are not anticipated. The amenity of current and future residents will not be adversely affected.
Visual Amenity (Landscape Impact)	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal	Tamala limestone ridge landform has landscape value associated with massive size and form, but reduced because denuded of vegetation and affected by transmission towers, tracks, quarries and a railway cutting. The ridge also has amenity as linking Market Garden Swamp and Manning Lake and for passive recreation.	Cockburn Rd realignment will retain view from east save for reduced topographic variation for overall distance of 230m. Residential development will not be visible from east. The landscape on western side of ridge will change from a derelict industrial area to a residential area. Linkage and passive recreation amenity of ridge will be retained and improved.	PCD to implement proposed landscape improvements to the ROS immediately east of Amendment area, to enhance the landscape values of the eastern flank of the ridge and achieve the ecological and recreational linkages	Area of Coogee Regional Open Space will be reduced however amenity and passive recreation values will be substantially improved. Landscape value of the ridge will not be significantly reduced.
Aboriginal Culture and Heritage	Ensure that the proposal complies with the *Aboriginal Heritage Act, 1972*. Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area	Survey by specialist consultants did not locate any archaeological material within the site. Two ethnographic sites occur; S02169, Indian Ocean and, Jervoise Bay Ethnographic #1.	Changes will occur to the biological and physical environments of parts of the mythological areas associated with the two ethnographic sites. No concerns were raised by the Aboriginal groups consulted that these changes would adversely affect their cultural association with these sites.	Protection of the eastern face of the limestone ridge is an important component of project planning and this is believed to be of benefit to site JBE#1 as the limestone ridge is associated with a creation myth for the western chain of the Cockburn wetlands. .	Project will comply with the *Aboriginal Heritage Act, 1972*. Project will not adversely affect Aboriginal spiritual associations with the area.

SUMMARY TABLE (continued)

RELEVANT ENVIRONMENTAL FACTORS, ASSESSMENT AND MANAGEMENT

Site Specific Factors	EPA Objective	Present State of the Environment	Impacts/Benefits of the Proposed Scheme Amendments	Proposed Management	Predicted Outcome
Non-Aboriginal Heritage	Comply with statutory requirements in relation to areas of cultural or historical significance	No heritage sites occur within the onshore areas to be rezoned. The Omeo shipwreck is situated outside the Amendment area and will not be affected.	Non-Aboriginal heritage will not be affected by the proposal.	Environmentally acceptable without management.	Project will conform with the *Heritage Act, 1990* and the *Historic Shipwrecks Act, 1976.*
Public Health and Safety	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety	The existing Cockburn Road and future PRR are preferred routes for road transport of dangerous goods. The railway may also be utilised for transport of packaged or containerised dangerous goods.	Explosives and Dangerous Goods Division of DME has advised that the risks from road and rail transport at current and foreseeable levels are acceptable without specific setback between future residences and the PRR/railway. Accident statistics indicate that the risk of a vehicle accident involving dangerous goods transport would be one in several million per year.	Current management is coordinated by the Explosives and Dangerous Goods Division of the Department of Minerals and Energy. Western Australia has a good emergency response system for accident management with respect to dangerous goods.	Public health and safety risk will meet the EPA's criteria for individual fatality risk off-site, which is one in one million per year or less.
Social Amenity	The amenity of Coogee Beach should not be unduly affected by the proposal	Coogee Beach is a popular recreational asset that is highly valued by the local community.	Redesign and the reduced scale of the proposed development has greatly reduced its potential impact on the recreational amenity of Coogee Beach. The beach and remnant foredune behind it will not be disturbed.	Environmentally acceptable without management.	The amenity of Coogee Beach will not be affected.