Halpern
Glick
Maunsell

Norman Hope Nominees Pty Ltd

Redevelopment of Mandurah Marina Lot 11 Old Coast Road Mandurah

Consultative Environmental Review

Prepared by -

Halpern Glick Maunsell Pty Ltd

and

The Planning Group Pty Ltd

December 1992

CONSULTATIVE ENVIRONMENTAL REVIEW

REDEVELOPMENT OF MANDURAH MARINA

ERRATA

The public review period for the above document is from 15 December 1992 to 25 January 1993, not 14 December 1992 to 22 January 1993 as mentioned in the introductory pages of the CER.

INVITATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Consultative Environmental Review (CER) covers the proposed redevelopment and upgrading of existing facilities at the Mandurah Marina. In accordance with the Environmental Protection Act a CER has been prepared which describes this proposal and its likely effects on the environment. The CER is available for a public review period of 6 weeks from 14.12.92 closing on 22.01.93.

Following receipt of comments from government agencies and the public, the EPA will prepare an assessment report with recommendations to the government, taking into account issues raised in public submissions.

Why write a submission?

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

All submissions received by the EPA will be acknowledged. Submissions may be fully or partially utilised in compiling a summary of the issues raised or, where complex or technical issues are raised, a confidential copy of the submission (or part thereof) may be sent to the proponent. The summary of issues raised is normally included in the EPA's assessment report. Submittors would not be identified to the proponent without the submittor's permission.

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 CER or the specific proposals. 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 environmentally more acceptable.

When making comments on specific proposals in the CER:

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

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

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

Remember to include:

- your name
- your address
- date.

The closing date for submission is 22.01.93.

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
38 Mounts Bay Road
PERTH WA 6000

Attention: Ms Gabby Corbett

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1. SUMMARY

Norman Hope Nominees Pty Ltd proposes to redevelop and upgrade the existing facilities of the Mandurah Marina. The site is 9.404ha in area and consists of two basins and an associated commercial area. The redevelopment will extend the southern basin, upgrade the commercial area, create residential housing lots and formalise the public foreshore reserve.

A 41 dwelling unit housing precinct and a 13 unit group housing lot will be designed in accordance with Residential Planning Code R40. A detached housing precinct in conventional subdivision format will contain 56 lots and be built in accordance with R20 provisions. The commercial precinct will comprise boat hire and repair facilities, chandlery, a tavern and restaurant, refuelling facilities and a selection of small commercial tenancies.

The southern basin will be enlarged to 11,000m^2 in area (an increase of 7,000m^2) with a minimum bed depth of 2.7m below mean sea level at the southernmost point. The new basin will be excavated with a mildly sloping bed with the depth steadily increasing towards the entrance to the Mandurah Channel. The level of the basin will be set above that of the bed of the channel to ensure no dense, poor quality water can be trapped within the development.

This Consultative Environmental Review describes the physical, biological and social environments of the project area, places these in a regional context, discusses the likely impacts arising from the development and proposed management of these impacts.

The site is located within the Peel-Harvey estuarine system on the west bank of the Mandurah Channel. This channel limits the interaction of waters inside the estuary with those of the ocean. Oceanic wave action is restricted to the outlet of the channel and marine sedimentation is confined to the region north of the Pinjarra Road traffic bridge. Tidal range is restricted to about 0.5m. Water quality in the channel is variable and related to seasonal changes in the water quality of the Peel-Harvey Estuary. Flushing time of the redeveloped southern basin will be in the order of one day and hence water quality within the basin will reflect water quality in the adjacent channel.

The biological environment of the redevelopment area consists of three ecosystems:

- The estuarine/marine ecosystem of the Mandurah Channel consists of basin assemblages dominated by macroalgae, seagrass-vegetated shallow assemblages dominated by two main species of seagrass and unvegetated shallow assemblages dominated by benthic invertebrates. Impacts on estuarine/marine biota will be restricted to a short term increase in turbidity during construction.

- The terrestrial ecosystem has been extensively modified and little understorey remains. Some isolated *Casuarina obesa* and *Eucalyptus rudis* occur.

- The tidal/wetland ecosystem is represented by two areas of samphire wetland consisting of five samphire vegetation assemblages. The development will result in the loss of 2.24ha of samphire wetland that has already been damaged by previous activities such as stormwater compensation and human disturbance. This vegetation type is well represented in the study area.

Groundwater effects will be negligible in the long term. A short term reduction in groundwater levels will be expected during excavation of the southern basin.

No sites of archaeological or ethnographic significance occur in the study area. Redevelopment of the site will have positive social impacts through modernisation and upgrading of facilities.

Prior to construction activities commencing a Foreshore Management Plan and a Waterway Management Plan will be developed. These plans will address issues relating to stability of foreshore areas, preservation of remnant vegetation, public access, basin construction, management and operation of a stilling basin, oil and fuel contingencies and maintenance of water quality. A hydrographic, water quality and sediment quality monitoring programme will be implemented by the proponent for the first five years of operation. A long term management agreement with the City of Mandurah will also be formalised.

In conclusion, it is anticipated that the proposed redevelopment will have minimal detrimental impact on the environment. A list of specific management commitments are provided which, when implemented, will ensure the long term acceptability of the project.

2. INTRODUCTION

2.1 THE PROPONENT

The proponent for the redevelopment of the Mandurah Marina is Norman Hope Nominees Pty Ltd of PO Box 1264, Mandurah, WA 6210, a Western Australian company that has been in the same ownership for over 20 years.

There are five directors of Norman Hope Nominees Pty Ltd and in all twenty-six shareholders, all of whom are resident in Mandurah. Norman Hope Nominees Pty Ltd purchased the land in 1987 for the purpose of carrying out the redevelopment of the site in accordance with the proposals embodied within this Consultative Environmental Review (CER) document.

2.2 LOCATION

This project proposes to redevelop and upgrade the existing marina facilities of the Mandurah Marina, Lot 11 Old Coast Road, Mandurah. The redevelopment site is located on the western side of the Mandurah Channel just south of the Pinjarra Road traffic bridge (Figure 2.1).

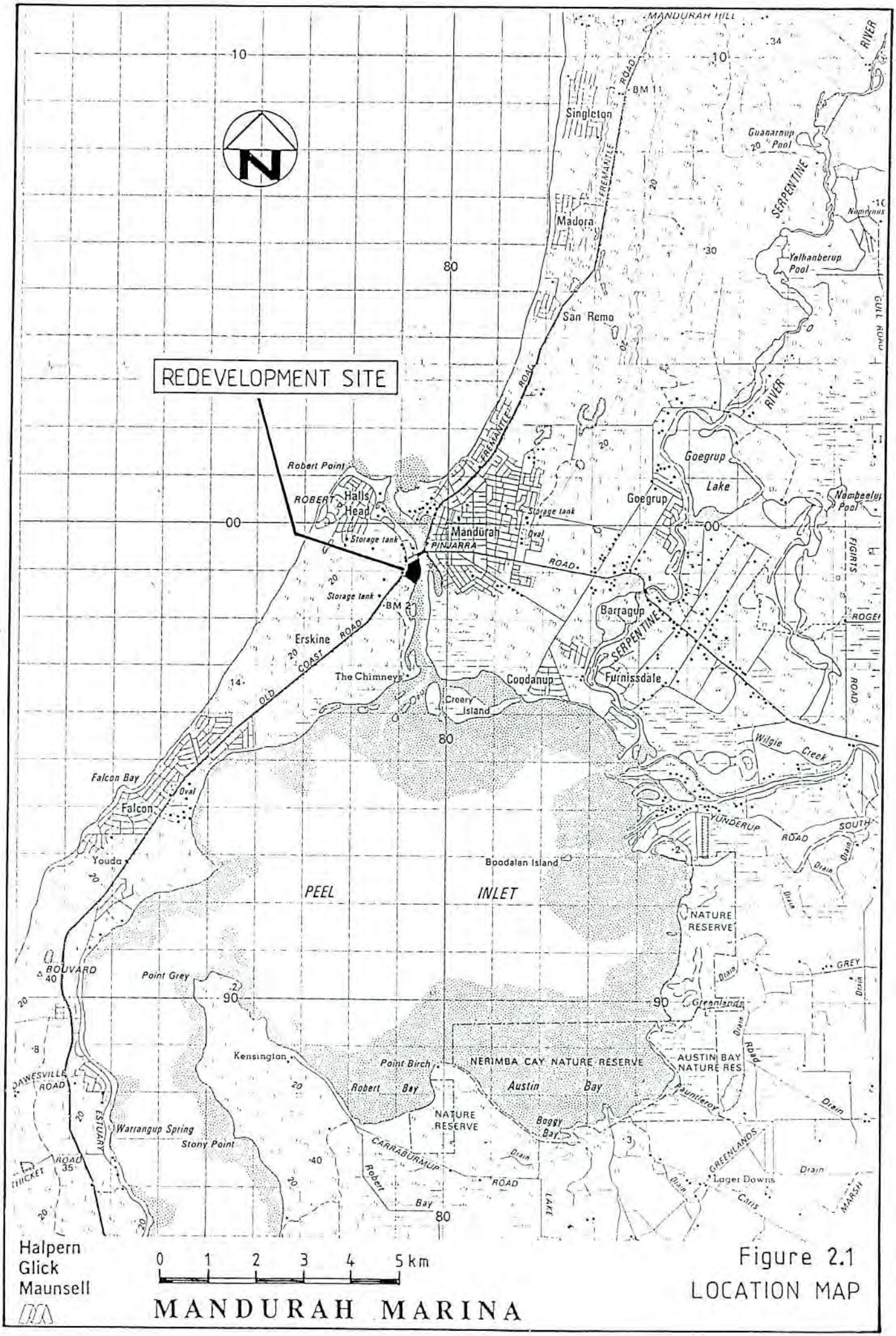
The site has two existing marina embayments of approximately 2,200m^2 (northern basin) and 4,000m^2 (southern basin) each in area, boat storage sheds and a small commercial area. Redevelopment will involve:

- extension of the southern marina basin;
- upgrade of the commercial area;
- creation of residential housing lots;
- formalisation of the public foreshore reserve.

The various components of the redevelopment proposal are described in more detail in Section 4.

2.3 PLANNING CONTEXT

Lot 11 is currently zoned "Future Urban" under the City of Mandurah District Zoning Scheme No. 1A. As part of the Mandurah Marina redevelopment proposal, the land is being rezoned as "Canal". Appendix 7 to the zoning scheme incorrectly categorised the site as tourist zoned prior to rezoning and specifically commented on the planning intent for this site.



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MANDURAH MARINA

Figure 2.1
LOCATION MAP

> "The tourist zone base to this precinct allows a variety of commercial, residential and recreational land uses based on artificial water areas. The Council anticipates that a core of commercial tourist facilities be established in association with the existing marina or a new core elsewhere in the precinct or both. Provided there are environmental safeguards, the Council considers that the commercial tourist core facilities should have boat access and the land uses should emphasise the need for boat mooring and servicing private recreational facilities, hotel or motel accommodation, restaurants and the like. The Council considers that because of its prime waterfront location and main road access the development of the precinct should not be limited."

The redevelopment proposal is consistent with Council's policy statement by providing a mix of residential and tourist/commercial land uses within the precinct. It is intended by the proponent that the redevelopment concept adopt the principle of developing a centralised area of water based activity. This design principle aims to establish a strong core of activity with applied urban design techniques to avoid activity conflicts or loss of amenity to the proposed residential precincts.

2.4 LEGISLATIVE REQUIREMENTS AND APPROVALS

In addition to obtaining approval from the State's Minister for the Environment, the proposal will have to comply with various other legislation including:

- Environmental Protection Act 1986,
- Conservation and Land Management Act 1984,
- Aboriginal Heritage Act 1972,
- Water Authority Act 1984.

This CER is intended to provide Government and the public with an understanding of the proposal, its potential impacts and the steps taken to offset them. After submission to the Environmental Protection Authority (EPA), the CER is made available for public review. Written submissions from interested or involved groups are sought during a six week review period. The proponent is then given an opportunity to respond to the issues raised in submissions. Both the public submissions and the proponent's responses are then incorporated into the EPA's assessment of the proposal.

The EPA's Assessment Report provides advice to the Minister for the Environment who then sets ministerial conditions based on the EPA's recommendations.

3. EXISTING ENVIRONMENT

3.1 INTRODUCTION

The Mandurah marina redevelopment site is 9.404ha in area, located on Lot 11, Murray Location 58, situated on the Old Coast Road, Mandurah (Figure 3.1). The eastern boundary of the site is the foreshore adjacent to the Mandurah Channel.

The following sections describe the salient physical, biological and social features of the local environment and establishes the spatial and temporal setting of the development site to place its environmental significance into a regional context.

3.2 REGIONAL CHARACTERISTICS

3.2.1 Climate

The Department of Conservation and Environment (DCE, now EPA) undertook a comprehensive meteorological survey at Robert Bay during 1976-1979 to supplement the historical data collected from the Bureau of Meteorology Station at Mandurah Post Office since 1889. Data from both these sources have been used in this assessment.

The Swan Coastal Plain in the vicinity of Mandurah has a "Mediterranean-type" climate similar to that of Perth, 60km to the north, with long (November to March) dry, hot summers, and short (May to August) mild wet winters.

Average rainfall is 896mm with 71% falling in the May to August winter months. Evaporation exceeds precipitation in all but the four wettest months of the year. Storms with a fall of up to 50mm in 24 hours are recorded about once a year.

The average daily temperature ranges from 18^{o}-25^{o}C in summer to 10^{o}-15^{o}C in winter. The yearly average is around 18^{o}C. The highest mean monthly maximum is recorded in February (30^{o}C) and the lowest mean monthly minimum recorded in August (9^{o}C). Wind systems affecting the area include both anticyclone/cyclone winds and a land breeze system.

Winds are predominantly from the southerly sectors during spring and summer, with a strong south-easterly component during autumn. The period with the highest mean wind speeds occurs during December to February with a mean speed of more than 3m/sec.

During the winter months the winds are predominantly from the northern and western sectors.

Superimposed on this large scale wind pattern is the more localised land breeze/sea breeze system which gives rise to easterly breezes in the morning and south to south-westerly sea breezes in the afternoons (Feilman, 1981).

3.2.2 Regional Geomorphology

The proposed site is located within the Peel-Harvey estuarine system which is situated on the Swan Coastal Plain. The coastal plain has developed by the accumulation of a parallel series of aeolian (wind), marine, lacustrine (lake) and fluvial (river) sediments, forming identifiable geomorphic units (MacArthur and Bettenay, 1960) known as:

- Pinjarra Plain: fluviatile deposits occurring as a broad strip extending west from the foothills of the Darling Plateau, along the main river courses.

- Bassendean Dunes: a degraded dune landform composed of grey/ yellow quartz sand.

- Spearwood Dunes: calcareous sands which have been largely cemented to form coastal limestone hills and ridges.

- Quindalup Dunes: unconsolidated dune and beach deposits forming much of the present coastline.

Frequently occurring along the junction of the above units are discontinuous chains of wetland systems which include swamps, lakes, lagoons and inlets (Feilman, 1981).

Marine inundation of river systems and interdunal depressions following the most recent post-glacial sea level rise (Holocene) has generated a number of coastal estuaries and lagoons (Feilman, 1981). One such example, the Peel-Harvey estuarine system, covers an area of approximately 300km^2 located on the Pinjarra Plain, Bassendean Dunes and Spearwood Dunes. This system is largely the result of the sea level rise flooding this pre-existing terrain. The Harvey estuary developed on an interdune depression at the junction of the Spearwood and Bassendean units, while marine flooding of the pre-Holocene confluence of the Murray, Serpentine and Harvey Rivers gave rise to the Peel Inlet.

Wind waves generated within the estuaries are a major factor in developing estuarine geomorphology and sedimentary units (Feilman, 1981). Within the broad regional geomorphic units, a number of smaller geomorphic units occur in the Peel-Harvey estuarine system (Feilman, 1981) as follows:

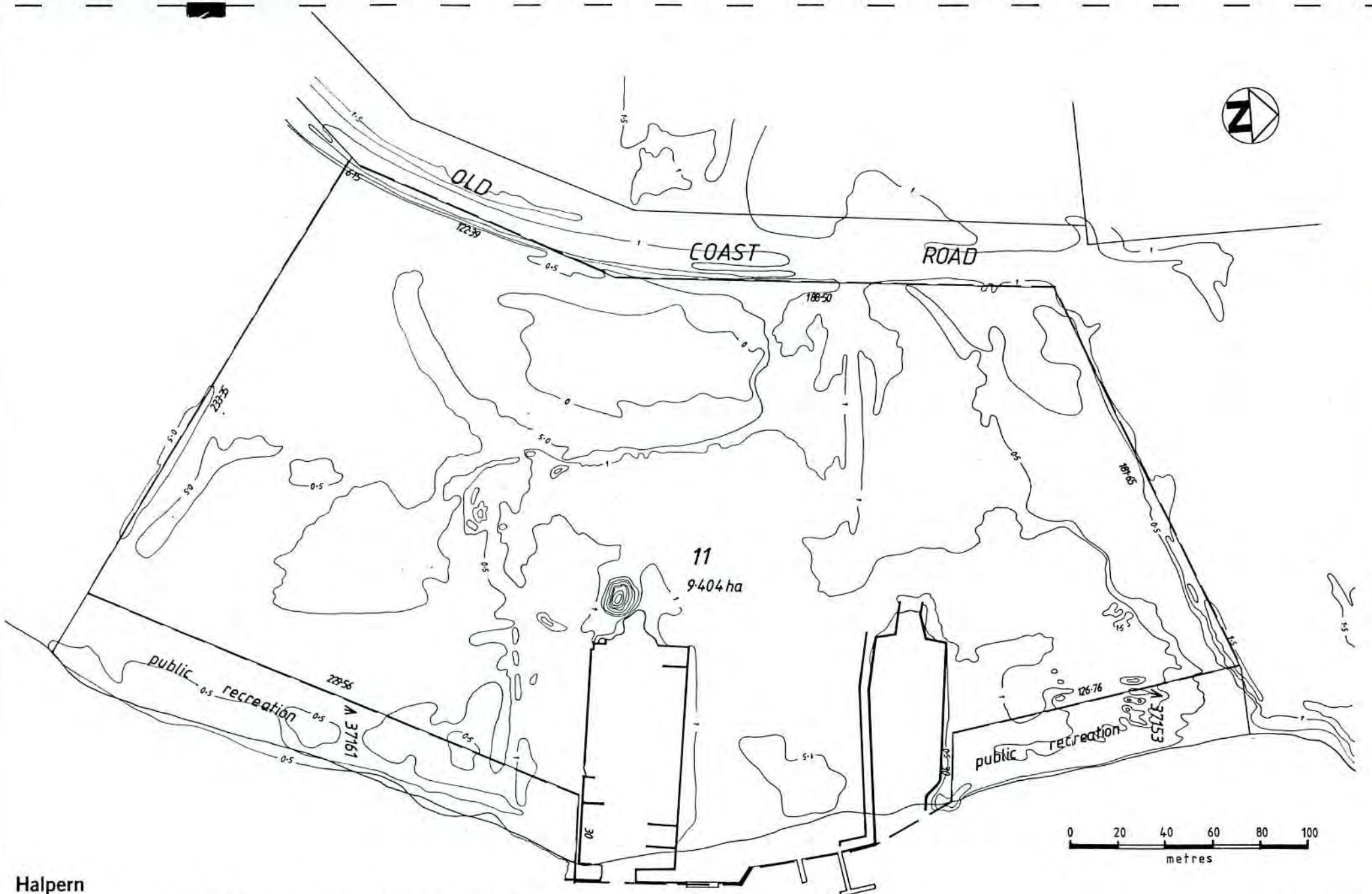
- A barrier ridge of Spearwood Dunes separating the estuaries from the ocean.

- A lowland of Bassendean Dunes.

- A riverine lowland of Pinjarra Plain sediments.

- A wetland and aquatic environment comprised of:

  - Peel Inlet tidal channel system (Mandurah Channel)
  - shoreline cheniers (sand ridges built on swamp deposits) and beach ridges
  - sub-tidal platforms and sills which skirt the margins of the system
  - shallow basins (1-2m deep) in central parts of the water body
  - riverine basins.



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MANDURAH MARINA

Figure 3.1
EXISTING SITE CONFIGURATION

- A lowland of Pleistocene estuarine deposits bordering the tidal channel known as the Yoongarrillup Plain.

The proposed redevelopment area abuts the Mandurah Channel.

3.2.3 Geology and Soils

The soil of the area is predominantly humic quartz sand which occurs as a sheet overlying the Pleistocene deposits. Calcrete occurs as a widespread layer shallowly underlying the surface soil, it occasionally outcrops on the surface. It commonly attains a thickness of 20-30cm in the lowland areas but is thinner (10-15cm) in ridge areas. The calcrete overlies estuarine deposits of shelly sand and silty sand which extend to a depth of 5m below AHD (Feilman 1981).

Tamala limestone occurs immediately beneath the estuarine sediments achieving a thickness of more than 5m in the development area. Further to the west, it forms a limestone ridge of height 25m above AHD, giving it a total thickness of more than 35m. The Tamala limestone overlies the Leederville Formation which occurs 10m below AHD throughout the development site.

3.2.4 Hydrogeology

The major regional aquifers are the superficial Quaternary deposits and sandstone beds within the deeper Leederville and Yarragadee Formations. Table 3.1 summarises the stratigraphic relationships of these hydrological units. The following discussion has been sourced from Feilman (1981).

- **Confined Aquifers**

  - The Yarragadee Formation comprises a sequence of non-marine, interbedded sandstone, siltstone and shale. This Formation is relatively thin (100m in thickness in the Mandurah area) and lies between about 350m and 450m below mean sea level. This aquifer is confined. Beneath the development site the sandstone contains saline water unsuitable for either domestic or irrigation use.

  - The Leederville Formation consists of a sequence of predominantly non-marine sandstone, siltstone and shale. Groundwater in this Formation is confined by the siltstones and shales and water levels rise to within 10-15m of ground surface. At Mandurah the Formation contains predominantly brackish water (1,000 to 2,500mg/l TDS), although limited supplies of fresher water (less than 1,000mg/l TDS) are reported at some localities.

    At nearby Halls Head three bores situated at the Mandurah Golf Course and the Glencoe Primary School pump brackish water from sandstone beds within the Leederville Formation for irrigation purposes.

TABLE 3.1

STRATIGRAPHIC RELATIONSHIP OF HYDROLOGICAL UNITS
(from Feilman, 1981)

Age	Hydrological Unit	Maximum Thickness (m)	Aquifer Type
	Quindalup Sand	10	Unsaturated
	Estuarine Sediments	2	Unsaturated
	Safety Bay Sand	8)	
Quaternary	Cooloongup Sand	12)	Shallow unconfined aquifer
	Karrakatta Sand	10)	
	Tamala Limestone	35)	
	UNCONFORMITY		
Cretaceous	Leederville Formation	250	Confined artesian aquifer
	UNCONFORMITY		
	Yarragadee Formation		Confined artesian aquifer

Shallow Unconfined Aquifers

The shallow unconfined aquifer overlies the Leederville Formation and is made up of saturated Quaternary deposits known as the Safety Bay, Cooloongup, Karrakatta Sand and Tamala Limestone. These deposits are in hydraulic continuity and behave as one unconfined aquifer system.

- The Tamala Limestone lies between 7.5m and 16m below mean sea level and slopes very gently to the west. In the development area it consists of interbedded fawn to light brown calcarenite and calcareous sandstone. Layers and pinnacles of hard caprock occur. The limestone is very permeable and porous and yields good supplies of water.

- The Karrakatta Sand is a grey to deep yellow, permeable quartz sand of moderate permeability and porosity overlying pinnacles of hard caprock developed in the Tamala Limestone. This Formation achieves greatest saturated thickness, up to 5m below the water table, in interdunal lows between the main dune ridges.

- The Cooloongup Sand consists of grey, very coarse grained permeable quartz sand containing shell fragments interbedded with hard layers of calcareous sandstone. This Formation occurs north of the development area. It has moderate to high permeability and porosity, due to its coarse grain size and sorting.

- The Safety Bay Sand is a dark grey, silty calcarenite composed mainly of shell detritus and with hard cemented layers of limestone. Its permeability and porosity is low to moderate due to its fine, angular, poorly sorted lithology.

Within the Quaternary deposits water levels generally stand 0.3m to 0.4m above mean sea level. The system recharges primarily via infiltration of rainfall.

Groundwater movement in the shallow aquifer is generally away from the central area of Halls Head, towards the Peel Inlet and the Indian Ocean. Groundwater discharges along these boundaries and also via evapo-transpiration in low lying areas.

Preliminary estimates of the rate of groundwater flow in the unconfined aquifer suggest the annual throughflow from Halls Head is in the order of 200,000m^3 per annum, or 550m^3 per day. This corresponds to a recharge coefficient of about 8% of average annual rainfall.

Groundwater quality in the unconfined aquifer is variable and fresh water is closely associated with both brackish and saline water. A thin lens of fresh water lies within the central portion of Halls Head. Wedges of saline water extend inland from the ocean and the Mandurah Channel in association with the seawater interface. Groundwater near the interface zone is brackish to saline, ranging from 1,000-44,000mg/l TDS. A thin layer of brackish water (less than 10,000mg/l TDS) is also situated near the base of the aquifer. Beneath the development area, groundwater is predominantly brackish to saline.

The throughflow indicates that safe yield from the unconfined aquifer at Halls Head is likely to be quite low. The quantity of water available is certainly insufficient to allow widespread pumping from the aquifer without drawing in saline water.

3.2.5 Regional Hydrology

The following discussion was taken from Feilman (1981). The open coastal system about Mandurah is wave-dominated and wind-influenced and is typical of the shorelines developed along the Swan Coastal Plain. Within the Peel-Harvey estuarine system the oceanographic/limnologic processes are distinct from the oceanic system and are characterised by:

- tides which are microtidal and diurnal with a range of about 0.5m;
- a broad area of shallow water (<2m deep) which is protected from oceanic processes;
- wind waves generated on the water bodies produce mixing and turbidity, develop wave-built structures and transport sediment;
- a tidal channel providing exchange of water with the ocean and generating tidal currents;
- periodical flooding of rivers which carry substantial quantities of fresh water and sediments into the system;

- high evaporation rates during summer causing localised fields of hypersalinity; and

- some ocean wind and swell waves depositing marine-derived sediments in the channel entrance thereby generating shoals and sand bars.

The Peel-Harvey estuary system is separated from the ocean by a 5km long entrance channel. This entrance channel (known as the Mandurah Channel) limits the interaction of the waters inside the inlet with those of the ocean.

Ocean wave action does not penetrate any significant distance into the entrance channel and marine sedimentation is confined to the region north of the Pinjarra Road traffic bridge (refer Section 3.3.2 for tidal and current details). Only normal sea level variations which can be about ±0.5m occur both in the ocean, the entrance channel and the Inlet.

From the available evidence it appears that the major factors causing exchange of water between the Peel Inlet and the sea are in order of importance:

- the long term sea level variations
- flooding of one or more of the rivers
- wind mixing at the head of the tidal inflow.

3.3 MANDURAH CHANNEL

3.3.1 Hydrography

The existing marina development utilises two excavated basins, the northern basin is approximately 2,200m^2 in area while the southern basin is approximately 4,000m^2 in area (Figure 3.1).

Both basins are rectangular in plan form and average approximately 2.5m deep below chart datum. The depth of the Mandurah Channel opposite the two basins ranges up to 4.7m below chart datum. The depth of the channel along its full length (5km) between the ocean and Sticks Channel in Peel Inlet generally varies from around 2m to 4m below chart datum. At its deepest point adjacent to the Pinjarra Road traffic bridge, the channel has a depth of 6.8m.

The Mandurah Channel measured at the traffic bridge has a cross sectional area of approximately 700m^2. The mouth of the Mandurah Channel is dredged by the Department of Marine & Harbours to keep it open at a depth of about 1.5m for the duration of the fishing season.

Hydrographic surveys of the Mandurah Channel were undertaken by the Public Works Department (now Water Authority of Western Australia) in 1971, 1979 and 1981.

. **Sedimentation**

The south-north moving sediment along the coast undergoes complex changes when it reaches the entrance to the Mandurah Channel. The entrance is stabilised by retaining walls and this coupled with dredging maintains a safe navigable passage from the channel to the ocean.

Sediment movement has been monitored by hydrographic surveys and aerial photographs and characterised as follows. Sediment which is trapped in the entrance by ingoing and outgoing tides moves up the estuary along the Fairbridge Road sandbar in the form of a very long sandwave. The front moves an average of about 40m per year, overtaking older seaweed-covered areas. The volume of sand in the sandwave moving past any one point was calculated to be 1,000 - 2,000m^3 per year. Sedimentation has not moved further south than the traffic bridge (Feilman, 1981).

Other sedimentation in the Mandurah Channel is negligible. The Mandurah Channel delta was probably formed at the last sea level stabilisation about 5,000 - 6,000 years ago. There have been no significant changes for the last forty years (Feilman, 1981).

3.3.2 Tide, Current and Wave Data

The Peel-Harvey Estuarine Environmental Study (1976-80) conducted an intensive measurement programme to determine the tide and currents in the Mandurah Channel, Peel Inlet and Harvey Estuary in 1977 and 1978.

. **Tides**

The highest and lowest recorded tide levels are +0.9m AHD and -0.5m AHD. For 98% of the time, the levels vary between +0.5m AHD and -0.35m AHD. Daily variation is in the range of 0.2-0.4m and occasionally up to 0.6m.

Tidal range at Chimney Spit (situated at the southern end of the Mandurah Channel) is approximately 85% of that at the traffic bridge. Tidal peaks occur at Chimney Spit approximately 30 minutes after the peak at the traffic bridge.

Changes in the tidal amplitude in the Peel-Harvey system resulting from construction of the Dawesville Channel have yet to be finalised by the Department of Marine and Harbours. Once this information is available recalculation of minimum building block levels will be undertaken and incorporated into the design of the development.

. **Long Period Water Level Variations**

In addition to normal daily/twice daily tides there are long period water level variations attributed to the rise and fall of sea levels in response to low and high pressure atmospheric conditions, shelf waves, storm systems and large scale eddies that travel down the west coast of Australia.

Density Currents

Distinct differences in the salinity of the water in the inlet and ocean are likely to occur in summer and winter which result in daily and seasonal patterns of movement. A saline wedge has been traced up into the Sticks Channel at the inlet end of the Mandurah Channel (Black and Rosehr, 1980).

3.3.3 Flood Data

During floods the area of the proposed waterways development acts as a flood plain to store flood waters. There have been two major floods recorded at Mandurah in 1862 and 1926. However the condition of the estuary entrance would have a significant effect on flood discharge and it has changed considerably since those times (Feilman, 1981). An earth bund constructed on the southern edge of the site would also restrict the area that is potentially affected by flooding. A discussion on minimum building block levels is given in section 4.4.1 and an analysis of the engineering components of the project is provided in Appendix 4.

3.3.4 Water Quality

The Peel-Harvey system is a eutrophic, or nutrient enriched, water body that periodically displays very poor water quality due to excessive algal growth. The system has been extensively studied by both Government and private programmes aimed at understanding and managing the system.

Current thinking suggests that the combination of widespread catchment farming involving fertiliser applications, and soils poorly suited to phosphorus retention, have led to phosphorus loading in excess of the system's ability to cope without detrimental change. Thus nutrients, particularly phosphorus, have leached from the catchment to the estuaries where they stimulate algal growth and internal cycling.

The recent decision to proceed with the Dawesville Channel highlights the importance of marine flushing in controlling water quality in the Peel-Harvey system. Rapid phosphorus retention and the germination of *Nodularia* blooms in the Peel Inlet and Harvey Estuary are in part due to the poorly flushed nature of the water body.

Water quality in the Mandurah Channel is variable throughout the year and is related to seasonal changes in the water quality of the Peel Inlet/Harvey Estuary. Unlike these upstream estuarine areas the Mandurah Channel is well flushed and strongly affected by tidal regimes. The summer phytoplankton blooms common in the upper reaches do not develop in the channel and are infrequently seen near the redevelopment area other than as parts of upstream blooms flushed from the system.

3.4 REGIONAL BIOLOGY

3.4.1 Habitats

Within each of the regional geomorphic units of the Peel-Harvey estuary system are smaller scale geomorphic units. The distinct landforms, groundwater regimes, geomorphic processes and natural history of each unit combine to form habitats within the Peel Inlet/Mandurah Channel area for the biological components of the environment. The elements of the development area have been described by LeProvost Semeniuk & Chalmers (1981) as:

- **Mandurah Channel**

  The Mandurah Channel environment is tidally dominated. Elongated sediment accumulations, or shoals, form parallel to the tidal flow, and are preserved in their progressive stages. Protected lagoons are developed parallel to the shoal trend when shoals are colonised and fixed by samphires, and then continue to shoal by the trapping/binding ability of this vegetation.

  The main habitat types recognised in this channel unit are deep channels, subtidal shoals, tidally exposed shoals and protected lagoons.

- **Tidal Delta and Pleistocene Estuarine Lowlands**

  The modern tidal delta is an active depositional system formed by tidal currents entering the large expanse of quiet water within the Peel Inlet from the Mandurah Channel and depositing the sediment load. There are several habitat types within the tidal delta, including subtidal sand shoals, vegetated intertidal/ emergent shoals, salt flat-capped shoals, sand ribbons and deep water channels.

  The Pleistocene estuarine lowlands are a modern wetland complex, forming a wetland plain flanking Peel Inlet.

- **Terrestrial Environment**

The terrestrial biota associated with the Peel-Harvey estuary system are typical of those found elsewhere on the Swan Coastal Plain, and have been described by a range of authors, in particular Speck (1952), Seddon (1972), Erikson et al. (1973) and Heddle (1979). The most conspicuous element of the terrestrial biota is the flora, which forms recognisable assemblages on the various geomorphic units of the plain.

- **Estuarine Environment**

Compared to other estuaries in the south-west of Western Australia, such as the Swan River estuary, the Peel-Harvey estuarine system has a less diverse plant and animal population. Two factors which are thought to contribute to this low diversity are:

- large variations in salinity, greatly constraining the number of species which can inhibit the estuary, and

- a relatively homogeneous sand and mud floor of the estuary which offers few hard surfaces to which organisms can attach, thus habitat diversity is low.

The relatively few species that have adapted to the estuary conditions generally experience less competition than species in wholly marine or fresh water environments and the biological community consequently often experiences rapidly fluctuating population sizes.

The Mandurah channel is a tide-dominated environment. The range of benthic biota within the channel is limited as it is neither wholly marine- nor freshwater-dominated. The relatively few species which do occur may be present in very large numbers.

Wetland habitats peripheral to the Mandurah Channel and Peel Inlet support a fringing paperbark and salt marsh vegetation, and a variety of avifauna utilise the estuarine habitats as feeding, breeding and residing grounds. The Peel-Harvey region is recognised as one of the most important estuarine bird habitat areas in south-western Australia (DCE, 1981a).

3.4.2 Regional Biota

. Terrestrial Biota

The following discussion is taken from Feilman (1981). Agricultural development has modified the natural environment to the extent that only modified remnants of the original biotic assemblages remain. The majority of the region is vegetated by Marri (*Eucalyptus calophylla*) woodland peripheral to wetland areas, with some Tuart (*E. gomphocephala*). The Tuart woodland originally present on the ridges and more elevated parts of the estuarine lowlands is now represented by a small number of mature Tuarts retained for shade purposes, scattered through the developed pasture areas.

The more elevated area to the south of the development area comprises pastureland with more extensive shade trees, predominantly Marri, plus some partially drained freshwater paperbark (*Melaleuca*) swamplands.

The wetter parts of the estuarine lowland and the inter-ridge depressions have been extensively modified to pasture. Typically this assemblage has been modified by grazing and drainage controls and as a result the understorey has few plant species.

. Tidal Wetland Assemblages

The present channel shoreline is greatly modified from the original shoreline, particularly north of the traffic bridge. Most of the channel is now bounded by limestone retaining walls, except for the sandy foreshore on the western side between the traffic bridge and Carter Street. This area was originally a samphire marshland which was filled and grassed for use as a recreation area.

South of the traffic bridge further shoreline modification has occurred, particularly on the western bank extending as far south as the southern end of the existing marina. Beyond the marina, the shoreline is naturally vegetated and comparatively undisturbed.

The following information is taken from LeProvist Environmental Consultants (LEC), (1990).

Kirke (1986) has recorded the dominant components of the vegetation of the tidal delta region and neighbouring Mandurah Channel. These include a samphire community made up of at least five species, a sedge community, paperbark thickets (four species), and open woodland of Swamp Sheoak (*Casuarina obesa*), Flooded Gum (*Eucalyptus rudis*) or Tuart.

Fringing vegetation of the salt flats is dominated by salt-tolerant rush and samphire species. Rushes (*Juncus kraussii*) vegetate the open areas of shoreline in dense interlocking tufts providing an effective barrier to erosion and protection to the species which grow behind (Schwinghammer, 1978). Fringing vegetation has been degraded along the shoreline of the development area. Two species of trees (*Casuarina obesa* and the salt water swamp paperbark, *Melaleuca cuticularis*) dominate the salt water affected areas of the foreshore.

Many invertebrate species have been recorded in the tidal wetlands (Kirke, 1986). These are an important food source for the many species of waterbirds which frequent the estuary. The tidal wetland supports significant numbers of bird species that are not commonly found elsewhere in south-western Australia.

Estuarine/Marine Assemblages

Five main assemblages, named according to their broad habitat types, have been identified in the estuarine/marine environments of the Mandurah Channel and Peel Inlet. The following description is taken from LEC (1990).

- **Basin Assemblages**: The deeper water (1-2m) of the Peel Inlet basin is the main growth area for macroalgal beds, which support small animals such as amphipods and shrimps, while sheltering fish and crabs from predation (Kinhill, 1988).

- **Seagrass-Vegetated Shallow Assemblages**: The shallow, sandy, marginal flats support two main species of seagrass, *Ruppia megacarpa* and *Halophila ovalis*, which grow mostly in spring and summer. The seagrasses support small crustaceans, such as amphipods, copepods, shrimps and mysids (Kinhill, 1988).

- **Unvegetated Shallow Assemblages**: The faunal assemblages within the sandy sediments of the shallows vary in composition depending on the salinity regime. Approximately 90% of the biomass of benthic invertebrates of the Peel-Harvey estuary is made up of four species of molluscs, three species of worms and three species of amphipods (Hillman, 1985).

- **Nektonic Assemblages:** The fish fauna of the Peel-Harvey estuarine system have been comprehensively documented by Potter et al. (1983) and Lenanton et al. (1984). These studies identified 55 species of fish from 29 families. In addition, the western school prawn, the western king prawn and blue manna crab occur in the estuary, the latter two of which combine with the yellow-eye mullet, sea mullet, King George whiting and cobbler to form the basis of the commercial and recreational fisheries of the estuarine system.

- **Planktonic Assemblages:** Zooplankton populations are dominated by a single species of estuarine copepod (*Gladioferens imparipes*) during the winter flow period, whereas in summer and abundance of other crustacea exists (Lukatelich, 1987). The phytoplankton community is dominated for most of the year by diatoms, while *Nodularia spumigena* dominates the planktonic blue-green algal flora (Lukatelich, 1987).

Macrophytes recorded in the channel are more typically marine than further upstream and include the seagrasses *Zostera, Heterozostera* and *Halophila* as well as a limited range of marine/estuarine algae. Near the channel entrance rock walls and wooden pilings support a number of attached marine species, frequently *Ulva* and *Enteromorpha.*

Benthic fauna includes very large numbers of polychaete worms plus molluscs and crustaceans such as amphipods, small crabs and shrimps. The nektonic fauna, including the fishes, Blue Manna crabs and prawns utilise the channel as a migratory pathway and an opportunistic feeding area. It has insufficient area to support large resident populations (Feilman, 1981).

3.5 LOCAL ECOSYSTEMS

The ecological relationships of the major components within the development area are discussed below. They are based on general ecological principles and available local information. Each of the terrestrial, tidal-wetland and estuarine/marine systems has both physical and biological links to the other systems.

3.5.1 Estuarine/Marine Ecosystem

The only estuarine component adjacent to the redevelopment site is the Mandurah Channel. The biological components of the channel have been described earlier and are typical of a well flushed marine system subject to only limited wave energy. The redevelopment area includes two existing marina excavations, which would be expected to provide environmental conditions similar to the modified channel areas outside their entrances. Water quality within the marina is currently maintained by regular flushing driven by tidal exchange. The existing marina receives no direct effluent discharge and trash or wind-blown macroalgal accumulations are infrequent.

3.5.2 Terrestrial Ecosystem

The terrestrial component of the redevelopment area has been extensively modified by previous development and clearing for pasture. Little woodland remains on the development area other than isolated *Casuarina obesa* and *Eucalyptus rudis*. Little remnant understorey exists following clearing, grazing and the introduction of exotic species.

The parts of the development area fringing the channel retain more of the natural plant species, consisting mainly of samphires and some Casuarina. This vegetation is salt and flood-tolerant and has endured in the absence of pasture and weed species despite modifying influences such as grazing and permanently compacted vehicle tracks.

3.5.3 Tidal-Wetland Ecosystem

The Peel-Harvey system represents an important resource of large salt-marsh areas. These communities are a productive source of organic detritus and bacteria. The role of these communities within the estuarine food web is described by DCE (1984b).

Within the redevelopment area two samphire wetland areas remain (Figure 3.2). These are a foreshore area at the south-eastern edge of the site and a tidal and drainage discharge area at the northern boundary of the study area. While these two areas have been largely modified by previous development, remnant samphire communities remain. Botanical field surveys identified five distinct samphire assemblages covering both the southern and northern wetland areas. These different associations can be characterised as follows:

- **Association 1**
  Halosarcia indica ssp bidens
  Frankenia pauciflora
  Suaeda australis/Threlkeldia diffusa

- **Association 2**
  Sarcocornia quinqueflora

- **Association 3**
  Halosarcia halocnemoides
  Sarcocornia quinqueflora
  Halosarcia syncarpa

- **Association 4**
  bare sand

- **Association 5**
  Halosarcia indica ssp bidens
  Suaeda australis/Threlkeldia pauciflora

A more detailed description of species present and their distribution is contained in Appendix 2 of this document.

In general terms both wetland areas have been significantly modified by weed invasion from adjacent pasture areas, vehicle passage and previous filling. The "levee" shown in the southern wetland (Figure 3.2) represents an earth bund, approximately 1.5m high, presumably positioned to limit flooding as part of historical filling activities. The northern wetland area currently receives drainage discharge from adjacent road reserves and low lying areas prepared for development to the west.

3.5.4 Problem Biota

. Mosquitoes

Two species of biting mosquitoes are prevalent in the Mandurah region, *Aedes camptorhynchus* and *Aedes vigilax* (LEC, 1990). Control is important to reduce the likelihood of mosquitoes acting as vectors for diseases such as Ross River Virus.

Important breeding sites exist in the delta/channel area for both species of mosquito, where breeding takes place throughout the year, depending on the extent of high tide inundation. Filling of depressions and aerial spraying of ABATE are presently undertaken to reduce mosquito breeding in the area. It is also believed that vehicle access through tidal areas aids mosquito breeding by providing water-filled depressions ideal for juvenile development.

Large numbers of mosquito larvae were observed in water-filled areas of the southern wetland area on the redevelopment site during field surveys.

. Algae

While both macroalgae and phytoplankton (microscopic algae) cause considerable problems throughout the broader Peel-Harvey system, they represent little nuisance value in the Mandurah Channel environment. Occasional accumulations of macroalgae in "backwaters" and on the channel foreshores are minor compared to wind-blown accumulations in bays of the Peel Inlet. Similarly, *Nodularia* blooms have a transient occurrence in the Mandurah Channel as they are flushed from the Peel-Harvey system (Lukatelich and McComb, 1986).

3.6 THE HUMAN ENVIRONMENT

As part of this study programme McDonald, Hales & Associates were commissioned to conduct archaeological and ethnographic surveys of the study area in accordance with the EPA guidelines and the requirements of the Aboriginal Heritage Act 1972-80. The following discussion represents a summary of findings of the study which is presented in full in Appendix 3.

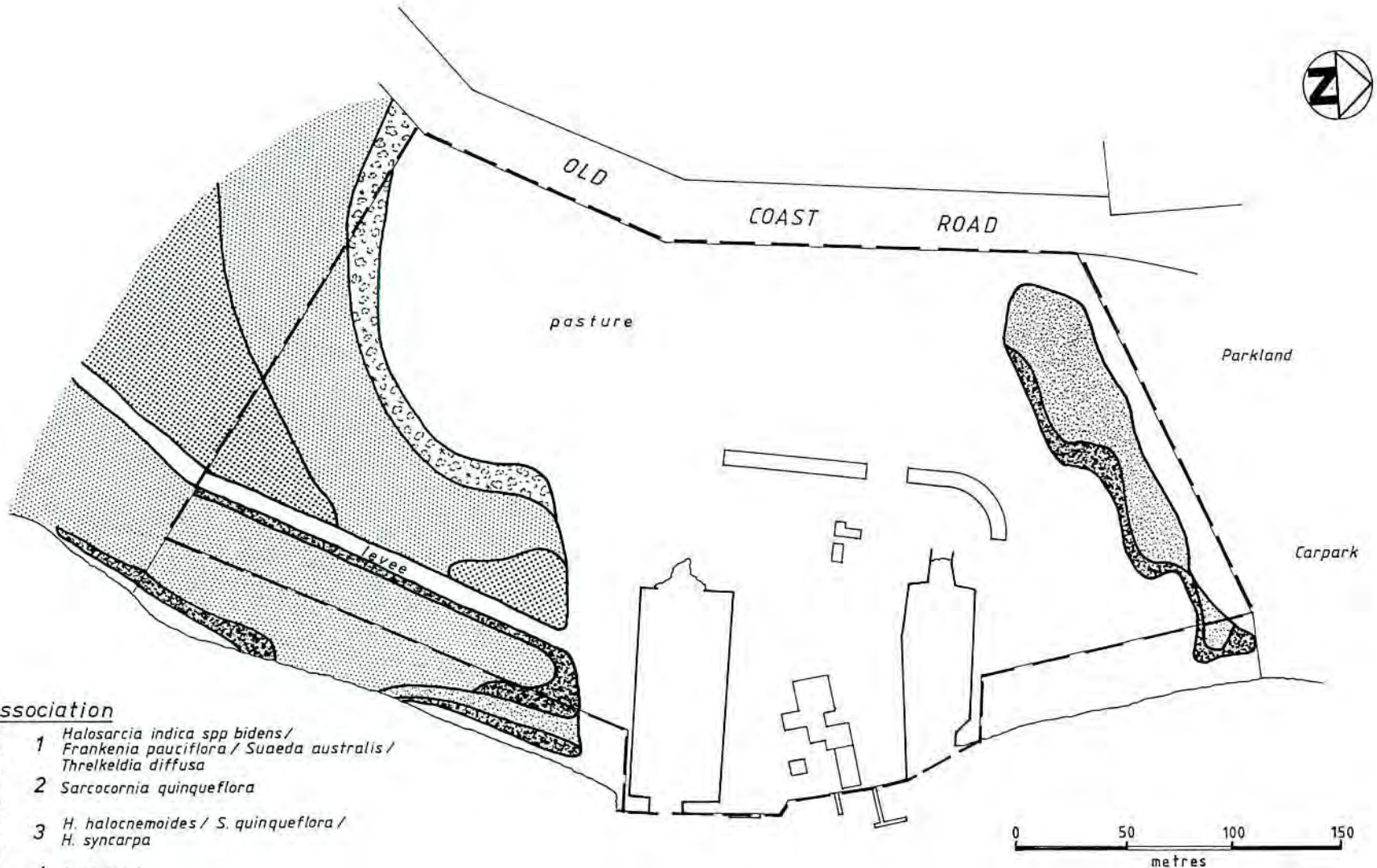

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Figure 3.2
VEGETATION ASSOCIATIONS

3.6.1 Aboriginal History

At the time of European colonisation, the south-west of Western Australia was occupied by thirteen socio-dialectical groups, known in more recent times as Nyungar. Berndt (1979:82) concluded that, in traditional Aboriginal terms, the area around Perth was part of the territory of the Whadjug.

The social organisation of the coastal Nyungar groups, encompassed matrilineal moieties, with four exogamous clans in each moiety. The names of these clans had totemic associations, connecting them with the physical and biological environment in which they were installed. However, ritual affiliations to sites occurred through an individual's father.

A basic unit of Nyungar local social organisations was the band or horde which characteristically numbered up to forty persons and which contained a number of families. From the Rockingham area, specifically from a line drawn due east of Mangles Bay, extending northwards to the foreshores of the Swan and Canning Rivers was the "territory" of the *Beerliar* Aboriginal group. This group included Aboriginal influentials *Midgegooroo* and his son *Yagan.*

The wetlands in this region were intensively occupied, given the availability of fresh water and food resources (waterfowl, turtles, kangaroos etc.) Wells were dug close to swamps in order to filter water and some swamp vegetation was consumed. Pads connected the wetlands and rivers and extended through this territory from the present-day Perth area south to Rockingham, Mandurah and the Murray River.

South of the *Beerliar* territory, according to Lyon (1983, cited in Green 1979:177) lay the territory of *Banyowla* of the Murray River or *Pinjarup (Bidjared)* tribe. In subsequent years, the area was described by Hammon (1933) as the domain of *Winjan,* a celebrated Aboriginal leader, who ranked in influence equally with *Midgegooroo* and *Yagan* but with somewhat less violent associations. The present ethnographic perspective is informed by an imputed direct line of descent from *Winjan.*

Ethnohistorical data suggests that there was a great deal of movement in these coastal groups. Individuals, families and bands moved between areas, generating a fluid local population size and composition, arising from a system of overlapping sets of ritual and social connections with land usage rights based on membership of both matrilineal and patrilineal groupings.

The destruction of Aboriginal social organisation was heralded by European colonisation, beginning in the Perth area and extending into the south-west. The Nyungar population was decimated by epidemics, shootings and the draconian policies introduced by the colonial administration, including forced exclusion of Nyungars from certain areas (eg Carrolup, Moore River). The restrictions on movement and labour resulted in an attenuation of traditional ties with the land and with sites (Berndt 1979; Hammond 1933). As a result, there has been a loss of traditional mythological and

ritual associations with the land along with the knowledge which underpins these connections. However, there is still a substantial degree of knowledge available within Nyungar society concerning traditional mythological and ceremonial sites. In some instances, the sites are known but the mythology is lost; in other cases, the mythology is remembered but the site location has been forgotten.

Rather than destroying all senses of solidarity and sources of identity, the ravages of colonisation have served to strengthen Nyungar social bonds and have created a strong Nyungar identity. New links to the country on the basis of historical and biographical associations have been formed postcolonisation and the attendant relocation and reorganisation of Nyungar groups.

In summary, there are two principal kinds of connections between individuals and families and the land and sites in Aboriginal society. They are:

. spiritual, mythological or religious, and
. historical/social associations.

These associations are not simply a matter of sentiment; Aboriginal connection with the land, and specific sites is spiritual. This means that Aboriginal people perceive links which involve the total life-cycle (birth, death, transitions of station/initiation) which infuse the sites with a dense and culturally palpable meaning. This may extend to beliefs that the trees, earth and other natural features are the domain of spirits deceased. This locates Aboriginal attachments to the land and sites in a spiritual history, grounding their present actions, and which provide a framework for a meaningful and culturally continuous future. These associations are crucial elements of Nyungar society.

3.6.2 Site Archaeology/Ethnography

. **Archaeology**

An initial search of the records of the Department of Aboriginal Sites revealed fifteen sites previously recorded within a 5km radius of the redevelopment area, none of which were located in it. These included artefact scatters, burials, ethnographic camp sites and other places of contemporary Aboriginal significance. A large number of sites are also known in the township and its surrounds.

The majority of sites so far discovered are small, low density artefact scatters confined to the ground surface, hence without stratified deposits. These sites are unevenly distributed towards the seaward side of the estuarine system, possibly due to a combination of prehistoric Aboriginal land use strategies, research emphasis and site discovery potential. While the study area is located within the zone of highest site density, and therefore might be expected to yield artefactual material, it represents only a small proportion (9.4ha) of the total area over which sites are distributed.

No archaeological sites, as defined under Section 5 of the Aboriginal Heritage Act (1972-1980), nor any isolated finds were located as a result of the survey.

While areas of inundation, poor surface visibility and high levels of previous disturbance characterise the redevelopment area, it is highly unlikely that sites exist within the area that remain undiscovered. There are, therefore, no archaeological impediments to redevelopment of the area.

. **Ethnography**

The coastal region around the redevelopment area was constantly traversed by Nyungars and used for camping, meeting, ceremonies and food gathering. According to the principal Aboriginal informant contacted for this study, local Nyungars identified their territory as a domain extending along the coast to include the proposed redevelopment area.

Socio-cultural and ethnographical perspectives on the area and its surrounds are gained by contexting the known sites within the region with the informant's knowledge. The proposed redevelopment area is within the orbit of Nyungar runs and pads which extend down the coastal region, linking resource areas, camping sites and ceremonial sites. It is believed that there have been camps on and around the proposed redevelopment area, although precise locations could not be identified.

Aboriginal people have expressed the wish that the area be appropriately named and signposted, consistent with the aims of Aboriginal people in the Mandurah area to preserve their culture and to educate both the Aboriginal and white communities regarding Aboriginal heritage in the region.

The ethnographic study undertaken by McDonald, Hales & Associates resulted in two recommendations regarding the proposed redevelopment area, namely:

> "It is recommended that development should proceed subject to a Section 18 clearance being sought and accepted as defined in the Aboriginal Heritage Act 1972-1980."
>
> and
>
> "In addition it is recommended that consultation on naming, signposting and related matters be undertaken with the Winjan Progress Association."

Section 18 clearance for the redevelopment site has been obtained by the Proponent under the Aboriginal Heritage Act 1972-1980. The relevant documentation is contained in Appendix 3.

3.6.3 European History

The Mandurah region was originally settled around 1830 by a small number of families under the direction of Thomas Peel, and the English migrant settlement scheme he established. The settlement came to be known as Peeltown and was established on the western bank of the entrance channel to the estuaries (Mandurah Channel).

The fertile fishing grounds of the ocean and estuaries saw the township of Mandurah develop largely around the fishing industry. Development of the area continued around the fishing and holiday centre until the 1960s. While this attraction has remained continued residential, tourist and light industrial development has seen the area progress as a retirement and tourism location, with a larger and more permanent population. Today the Mandurah region is the third most popular tourist destination in Western Australia (Dames & Moore 1987; LEC 1990).

3.6.4 Community Usage

The development of the Mandurah townsite has seen increasing importance placed on the estuarine system as a community resource. EPA Bulletin 103 has identified "Beneficial Uses" associated with marine and estuarine waters in Western Australia. Bulletin 103 defined a beneficial use as "any use of the environment or any element or segment of the environment that is conducive to public benefit, welfare, safety or health". The following beneficial uses apply to the waterways associated with the redevelopment area:

1. Direct contact recreation
2. Harvesting of aquatic life (excluding molluscs) for food
5. Passage of fish and other aquatic life
7. Maintenance and preservation of aquatic ecosystems
8. Maintenance and preservation of foreshores and banks
9. Scientific and educational uses
10. Flushing water and water replenishment
16. Navigation and shipping.

The growth in Mandurah's permanent, retiring and transient tourist populations indicate an increasing demand for:

- land suited to residential development
- holiday homes
- accommodation for the elderly
- accommodation close to shopping and recreational centres.

The Mandurah foreshore land use study (Wilson, Sayer Core, 1988) also stated that the high level of boat ownership in the region indicated a potential for development of residential water-based properties.

The proposed redevelopment described in this report is well suited to fulfilling these demand expectations.

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Figure 4.1
PROPOSED DEVELOPMENT CONCEPT

4. PROJECT DESCRIPTION

4.1 CONCEPT AND LAYOUT

The layout of the redevelopment proposal is shown in Figures 4.1 and 4.2. The proposal comprises four development precincts, being:

1. An R40 housing precinct of 41 dwelling units (R40)
2. A detached housing precinct of 56 single residential lots (R20)
3. A grouped dwelling site of 13 dwelling units (R40)
4. A commercial precinct redeveloped on the site of the existing marina administration and commercial area.

4.1.1 R40 Housing Precinct

The R40 housing precinct comprises an area of 1.8819ha and is situated in the northernmost portion of Lot 11, between Old Coast Road and the recreation reserve on the foreshore of the Peel Inlet. The precinct has been designed so as to provide 41 house lots in accordance with the Residential Planning (R) Code designation of R40.

The area of land allocated, would, if developed to the R40 density as a group dwelling site, yield 75 units on strata title. The proposal as submitted however is presented at a gross residential density of 22 units per hectare. The lots (to be offered as freehold home and land packages), range in area between $220m^2$ and $432m^2$. The average lot size is $307.7m^2$.

In preparing the design of the precinct, urban design principles were incorporated such that the roadways themselves would create safe pedestrian environments and interesting vistas. The road reserves vary in width between 14m and 22m within which brick paved centrally drained carriageways provide a pedestrian scale to what is primarily a vehicular environment.

The architectural brief called for the design of housing styles all of which comprise family homes of three bedrooms, two bathrooms and suitable living areas. The designs, all zero lot line, were required to be accommodated on standard lots of between $220m^2$ (10mx22m) and $450m^2$ (15mx30m) with the latter being of single storey construction. The designs, developed in accordance with the R40 code, were then assimilated within the precinct having due regard to the preservation of privacy within each lot, the maximisation of views over the estuary and the waterway and the creation of an exciting visual precinct.

The result is a precinct of 41 architecturally designed homes to be built as a one stage development, unique in its application of the standards of the R40 code.

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Figure 4.2
PROPOSED SUBDIVISION

The homes have been consciously designed to relate to the internal circulation and movement system as a catalyst to the development of a community awareness and attitude amongst residents. The relationship of single storey and two storey homes has been addressed to create view corridors to areas of activity, particularly the northern basin of the development and the commercial precinct, interest areas such as the residential canals to the north-west and the estuary mouth to the east and longer framed views such as the town centre area.

4.1.2 Detached Housing Precinct

The detached housing precinct represents a conventional subdivision format offering single residential lots of between 450m^2 and 785m^2 in area. These have been designed in accordance with the R20 provisions of the Residential Planning Codes. It is proposed that a total of 56 lots be developed around one enlarged southern basin.

The lots are to be serviced by a single cul-de-sac of 15m in width in accordance with Policy No. DC2.6 of the Department of Planning and Urban Development. The road reserve is 15m in width and will comprise a 6m carriageway. The configuration of the lots has been considered so as to offer a variety of outlooks from the individual dwellings. The nineteen lots on the southern and eastern extremities of the subdivision all have a rear or side boundary to an existing or proposed public recreation reserve. Those lots to the west will overlook the Mandurah Channel whilst those to the south will overlook the future southern waterway entrance to the proposed Port Mandurah Canal Estate. There will be 22 lots overlooking the redeveloped southern embayment.

4.1.3 Grouped Dwelling Site

A 3,270m^2 group housing lot has been set aside on the southern side of the main canal embayment opposite the commercial precinct. The site will be capable of accommodating 13 dwelling units at a density of R40.

The units themselves will command views over the canal to the commercial precinct beyond. The lot also has a common boundary with Reserve No. 37161 (the foreshore reserve), as such several of the units will enjoy aspects over the Peel Inlet Entrance Channel and the reserve.

4.1.4 Commercial Precinct

The concept of the development of a commercial precinct is predicated upon the redevelopment of the land based activities within the existing site. The "Mandurah Marina" has been fulfilling a role in the community for more than thirty years. It has been serving the needs of both the recreational and commercial boating fraternities in the areas of motor and boat repair and trimming, fuelling facilities, both wet and dry pen storage, chandlery, marine hardware, boat launching facilities and dinghy/ houseboat/launch hire. The site has also previously housed the activities of a fishermen's co-operative, fresh fish market and growers' market.

The redevelopment will seek to enhance the traditional activities associated with the marine industries and to encourage the development with its associated broad base of activities to become a recreational destination for both the residents of, and visitors to, Mandurah.

The area of land allocated to the marine industry/commercial precinct comprises 1.55ha of land inclusive of the existing northern marina embayment. Neither the configuration of the embayment nor the wet pen storage functions of the basin will alter. The commercial or land component of the precinct will be redeveloped to comprise:

- boat hire and repair facility and associated slipway
- chandlery and marine hardware outlet,
- freestanding small commercial tenancies for
  - bakery
  - fish and chips
  - fresh fish market
  - ice cream kiosk,
- tavern restaurant facility, and
- refuelling and sullage pump out facilities.

The precinct has been designed to use the prominent position on the water to its fullest advantage and to create a node of activity and interest which will act as a unifying element and focal point in the total and cohesive redevelopment of Lot 11 (Figure 4.3).

The redevelopment will not incorporate the retention of the dry pen storage facilities currently associated with the "Mandurah Marina". Wet pen facilities will however be significantly upgraded and increased in number. The function of the northern embayment will as previously mentioned, remain virtually unchanged and will continue to house approximately 40 vessels. The enlarged southern embayment will be capable of accommodating a further 16 vessels. In addition to these wet pens, the embayment has been designed to allow for the construction of private jetties and moorings for each of the 22 single residential lots and the grouped housing site.

Parking has been allocated within the commercial precinct in accordance with Council's District Zoning Scheme No. 1A with 174 car bays being provided exclusive of a further 11 car and trailer bays.

4.2 SITE CIRCULATION PATTERNS

4.2.1 Vehicular Circulation

Vehicular circulation throughout the development may be described as comprising three major elements.

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Figure 4.3

COMMERCIAL PRECINCT

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(i) An entrance into the estate leading directly from Old Coast Road to the commercial precinct. This road serves the marine industry/ commercial development and 109 dwelling units. The trip generation per dwelling unit is estimated to be 10 trips per dwelling per day (Department of Planning and Urban Development). A total of 1,090 tips per day assigned to the residential component of the development would be experienced at the Old Coast Road intersection.

A local distributor designation has been assigned to the entrance road which will carry less than 6,000 vehicles per day. The road will comprise an 18m reserve with a 7m carriageway.

(ii) The detached housing development is served by an access way comprising a 15m reserve and 6m carriageway. Traffic flows at any one point will not exceed 800 vehicles per day. The 64 dwellings served by the road will generate a maximum of 640 vehicles per day.

(iii) The R40 housing precinct is served by a looped access way comprising a minimum 14m reserve and a minimum 5.5m wide carriageway. Traffic flows at any one point will not exceed a maximum 410 vehicles per day generated by the 41 dwellings served by the road.

4.2.2 Pedestrian Circulation

Pedestrian movement throughout the development is facilitated by linkages created by pedestrian access ways (PAWs). These PAWs ensure access from all adjoining (both existing and proposed) recreational/foreshore reserves, throughout the development (Figure 4.4).

4.2.3 Bicycle Circulation

The design has not been intended to encourage bicycle use of the Peel Inlet foreshore reserves. It is anticipated that the future bicycle path around the Peel Inlet will make use of the internal road carriageways of this development via the southern and northern PAWs rather than utilise pathways through the foreshore reserves (Figure 4.4).

4.3 WATERWAY DESIGN

4.3.1 Design Vessel

It has been assumed for this development that the design vessel will be 10m long x 4m wide x 1.5m maximum draft.

4.3.2 Navigable Waterway

Figure 4.5 shows the proposed layout for wet pens in the Mandurah Marina. The minimum waterway widths have been set so as to maintain a clear navigable waterway between mooring piles of at least twice the design boat length, that is 20m.

Figures 4.6 and 4.7 represent cross-sections of the waterway at two locations to illustrate the possible configuration of wet pens with respect to the navigable waterway.

This development satisfies the requirements of the recently amended Canal Estate Guidelines. The guidelines govern depth of clear navigation water, width of navigation section, design of mooring areas, shoreline stability, layout of the waterway for navigation safety, construction of moorings, jetties and launching ramps, property boundaries and flood mitigation. A copy of the guidelines is provided in Appendix 6.

4.3.3 Wet Pen Facilities

The redeveloped southern embayment will accommodate up to 51 vessels on jetties or in wet pens. The layout shown on Figure 4.5 indicates that every wet pen will be accessed by a shared jetty structure.

The wet pens will be of minimum width 5m and minimum length 11.5m to accommodate the design vessel. There is likely to be a significant difference between types and sizes of craft moored within this waterway, and therefore some variation in pen sizes is proposed to accommodate this range.

It is envisaged that the jetty structure will be of steel and timber construction on steel tubing piles and the mooring piles will be of timber or steel, subject to final design details.

4.4 EARTHWORKS

4.4.1 Proposed Building Blocks

It was demonstrated by the Public Works Department (PWD) in its publication "The Murray River Flood Study" that water in the Peel Inlet could rise to a level of RL1.6 AHD as a result of a one in one hundred year flood of the Murray River (in addition to the Serpentine and Harvey Rivers) associated with a reasonably high ocean tide of RL0.6. It has also been established that it is possible for a cyclonic storm surge equal to RL1.5 to occur approximately mid way between the old PWD jetty tide gauge and the old Mandurah traffic bridge. It is estimated that this level could occur in conjunction with a water level in the Peel Inlet of approximately RL0.7m. This compares with measured readings taken during Cyclone Alby in April 1978 of RL0.88m at the PWD tide gauge and 0.53m in the Peel Inlet (Chimneys tide gauge) and is therefore a very much more severe occurrence than Cyclone Alby.

These levels and the location of various relevant points and levels are graphically represented on Figure 1 in Appendix 4.

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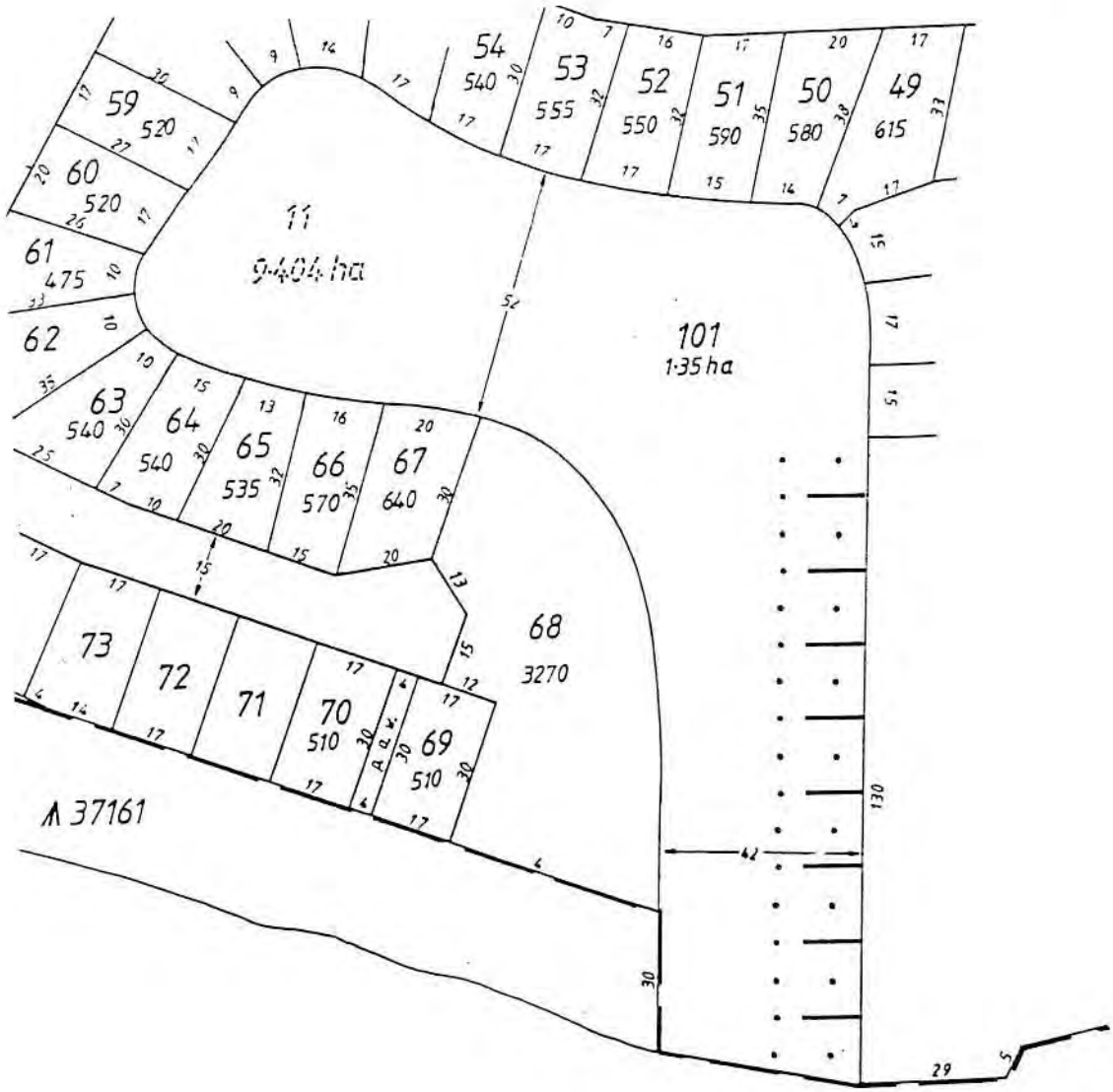
Figure 4·4
PEDESTRIAN AND BICYCLE CIRCULATION



MANDURAH MARINA

WET PEN LAYOUT

Figure 4.5

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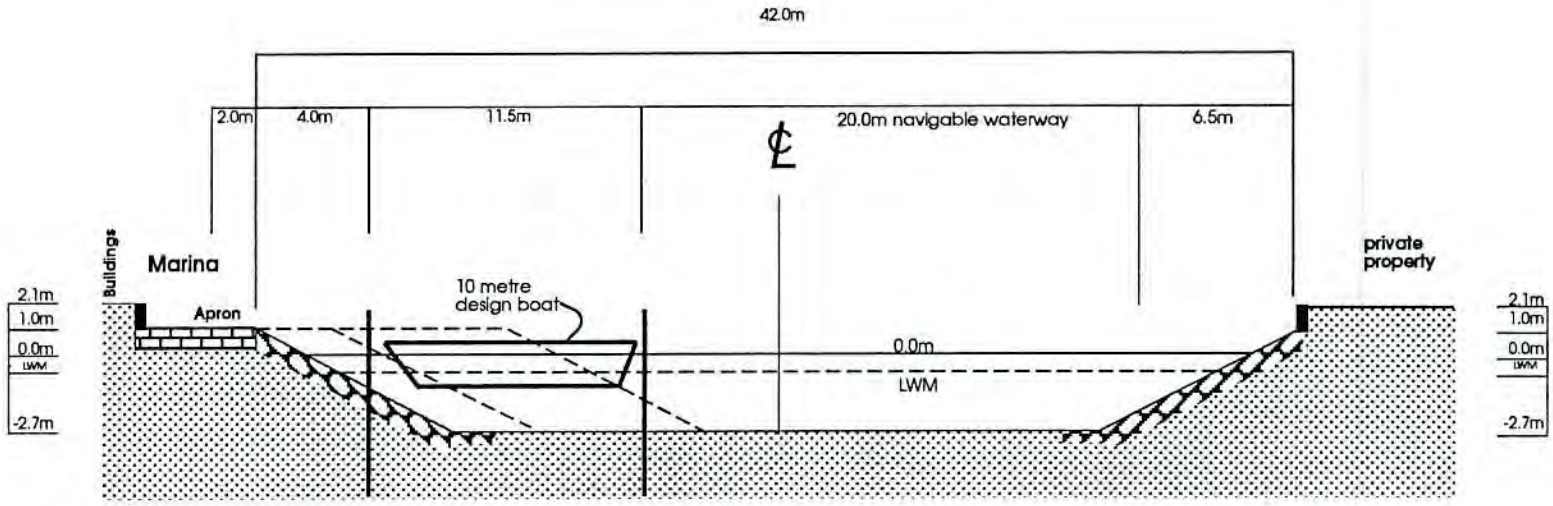

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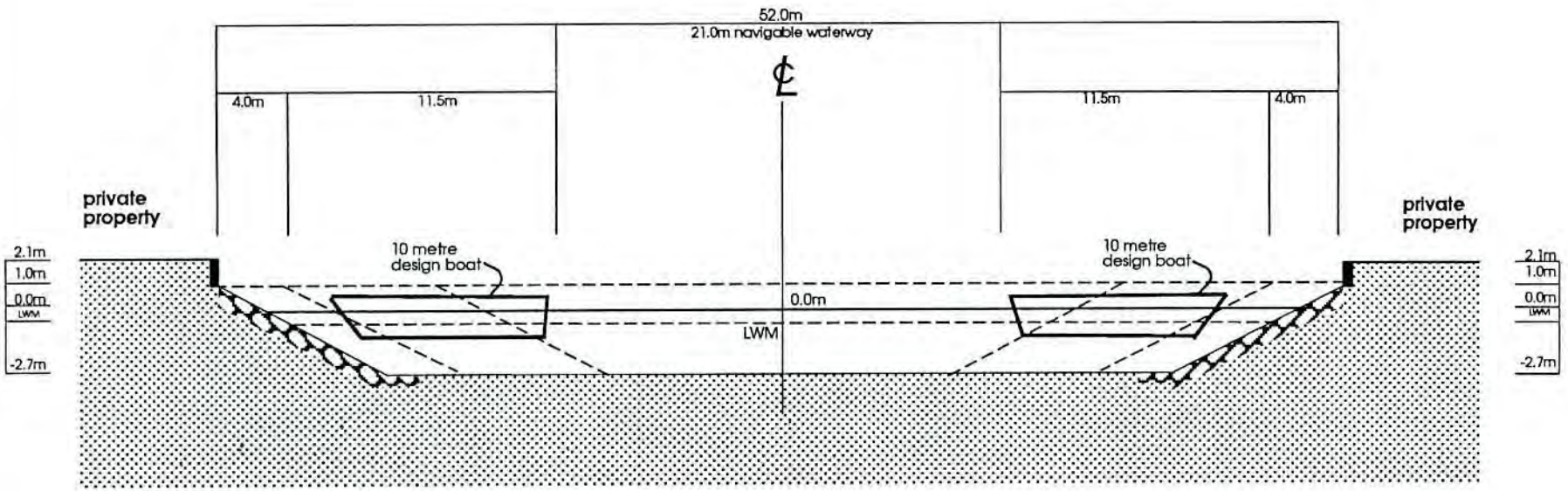
MANDURAH MARINA

MARINA CROSS SECTION A-A

Figure 4.6



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MANDURAH MARINA

MARINA CROSS SECTION B-B

Figure 4.7

The proposed block levels for the development have been established by comparison to the methods by which the approved block levels of two neighbouring developments were established (all levels are to AHD).

The original Port Mandurah Development was known as the Halls Head Waterway Development and was approved in July 1985 with minimum block levels of RL1.9. The project was reassessed for its new principal in 1989 when an additional allowance of 0.3m was made for a possible future Greenhouse Effect and a minimum block level of RL2.2 was approved as per Table 4.1.

The maximum threat to flooding on the marina site is not from a river induced flood but is controlled by the same mechanism as the Port Mandurah Development, that is a possible high storm surge and the maximum likely level is RL1.31m. Hence the proposed minimum block level for this development is as indicated on Table 4.1.

TABLE 4.1

MINIMUM BLOCK LEVELS FOR PROPOSED AND EXISTING DEVELOPMENTS

	Proposed Mandurah Marina - 1991	**Revised Port Mandurah - 1989**
Maximum storm surge	RL1.31m	RL1.5m
Wave run up	RL0.20m	RL0.2m
Freeboard	RL0.20m	RL0.2m
Greenhouse	RL0.30m	RL0.30m
Total	RL2.01m	RL2.2m

Hence, a minimum block level of RL2.1 AHD will be utilised for all the likely building envelope areas of the development.

The Department of Marine and Harbours has still to refine the modelling on the likely impacts that the Dawesville Channel will have on storm surge levels in the Peel Inlet. Once this information is available the necessary changes will be made, if applicable, to minimum block levels. However, at this stage because of the conservative nature of the figures used it is not believed that significant change in levels will be required.

4.4.2 Excavation and Dredging

The enlarged southern embayment will have a minimum bed depth of RL-2.7 at the southernmost point of the waterway. It will be excavated with a mildly sloping bed with the depth steadily increasing to RL-3.5 where it enters the Mandurah Channel. This gradual slope will facilitate complete turning over of the water within the waterway and will still enter the main channel considerably higher than the bottom level of the main channel adjacent to the marina which approximates RL-4.70.

There are two alternative options available for the excavation works. The best option can only be positively determined at the time of detailed design as it is partly a matter of costing and partly a matter of preference for the type of sloping wall protection used in the waterway walls. It is likely that excavation in the dry will be the preferred option, using limestone pitched walling. The two alternative options for excavating the new basin are described below.

- **Excavation in the Dry (Dewatering)**

Initially an earth bund wall will be constructed across the existing marina adjacent to the estuary. The clean water from the existing marina will then be pumped into the Mandurah Channel in a manner so as not to disturb the banks or produce turbid water.

Once the existing marina is dry, a stilling basin will be constructed in the easternmost portion of the marina adjacent to the estuary by the construction of a secondary low bund across the marina. The stilling basin may then be properly dewatered utilising the bulk of the existing marina as a subsidiary basin. The stilling basin is then excavated down to its final depth and width and the stone pitched sloping walls constructed to normal water level.

Dewatering of the remaining section of marina will continue as excavation proceeds in the dry. The finished stilling basin will receive the dewatering effluent and slow its velocity prior to discharge to the channel so that any solids within the water will sink to the bottom and result in clear, non-turbid water being discharged.

After the excavation has been completed to the final embayment shape, the sloping limestone pitched walls to the waterway will be completed. When all stonework is complete a dredge will move into the development from the entrance to the estuary and dredge its way slowly through the temporary bunds of the stilling basin. Dredging of the bunds will result in a short-lived and localised sediment plume being generated in the Mandurah Channel.

Spoil from the dredging operation will be discharged onto the areas to be filled after they have been earth-bunded to contain the water from the dredged spoil. One such bunded area will be utilised as a shallow stilling basin into which the water runoff from the dredged spoil will be directed prior to discharging to the channel.

Excavation is planned to cover a four to six week period.

- **Dredging**

Initially, temporary bund walls will be constructed from compacted sand fill on the areas which are to be filled, to receive spoil discharged from the dredging operations. The dredge will then move slowly into the development from the estuary, dredging a fan-shaped entrance channel to match up with the finished depth of the proposed new basin. Water from the dredged spoil will overflow from the bunded areas to a shallow stilling basin prior to being directed into the channel as a clear, non-turbid water.

It is not considered feasible to construct sloping limestone walls on properly laid filter cloth below water level and therefore this excavation option of dredging only will necessitate the use of concrete flex mats or some similar canal lining. After the dredging operation has proceeded to a reasonable extent and a section of the marina is cut to exact lines as far as the sloping sides to the waterway are concerned, laying of the concrete flex mats will commence.

Concrete flex mats will be laid to above the low water mark. The remainder of the block filling and wall construction above and below high water mark will be completed using limestone pitching.

4.4.3 Source of Fill

The source of the filling material to raise the blocks above the 1:100 year flood level will come from two sources:

- the dredged material as referred to in Section 4.4.2 above, and
- imported sand fill from an external source.

This imported sand fill will be of a free-draining variety to ensure that no problems are encountered either with draining within the house properties or with road subgrades. The source of fill will be cleared with the EPA.

4.5 CONSTRUCTION OF WATERWAY WALLING

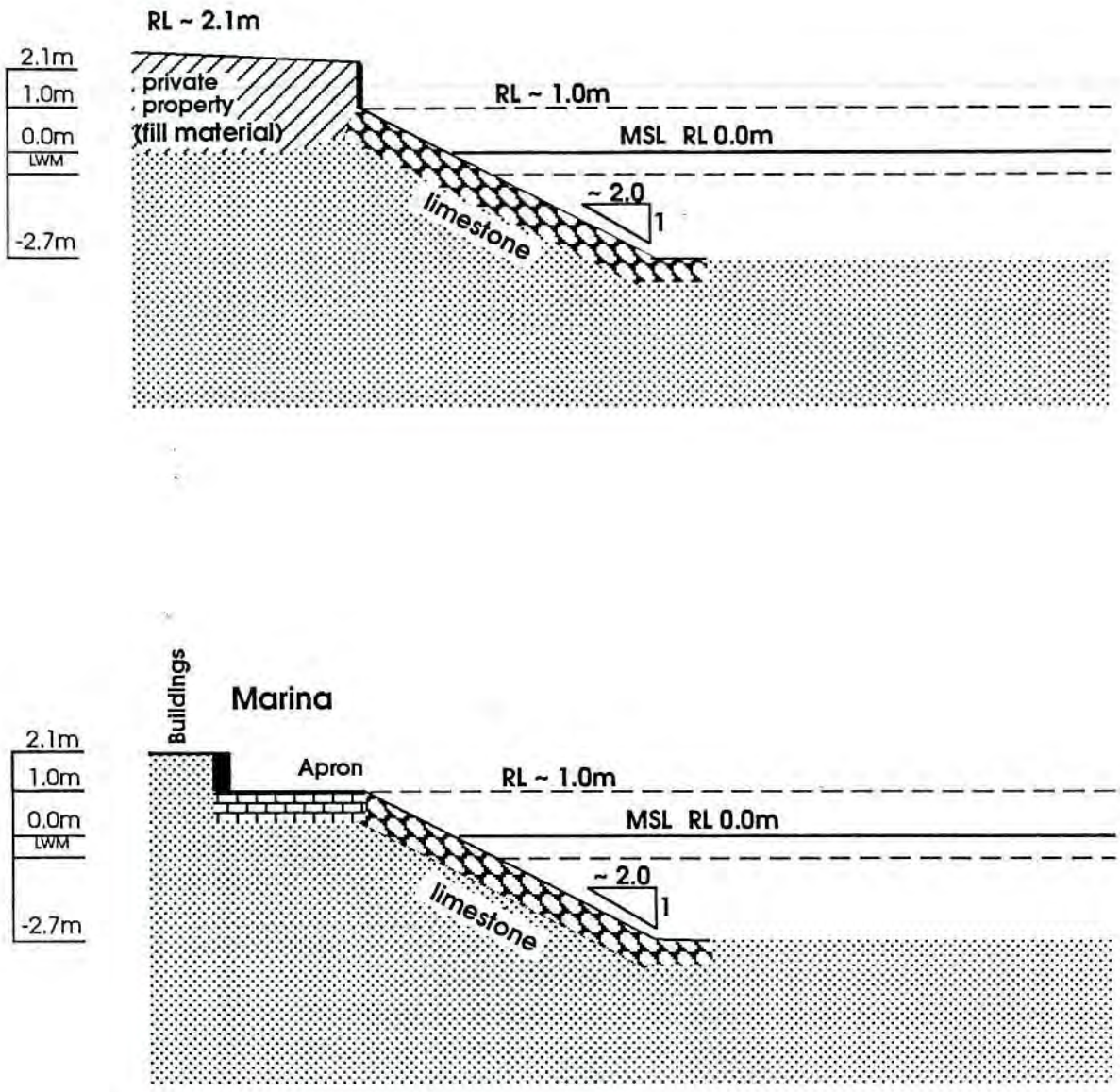
Typical wall sections are presented on Figure 4.8. The walling for the waterway will consist of a sloping revetment lined with limestone spalls of a size approximately half a metre in diameter to prevent movement by either the limited wave action within the basin or vandalism. The rough sloping texture of the rockface will aid in dissipation of wave energy generated by boats within the embayment, but at the same time the rapid increase in depth from the two horizontal to one vertical slope of the wall will ensure maximum availability of water area for boat mooring and manoeuvrability. The rock face will be underlain by an approved filter cloth to permanently protect the land from erosion.

It is confidently predicted that with some minor maintenance over the years, the wall will have a 100 year design life. The construction proposed is similar to that of the entrance into the recently completed Port Mandurah Development and that of the earlier Waterside Mandurah Development.

4.6 SERVICES

4.6.1 Roads

The development's internal road system will be a standard subdivisional construction of a flexible pavement and asphalt seal. Certain key areas will be brick paved to enhance the development's appearance.



THE PLANNING GROUP PTY LTD

MANDURAH MARINA

TYPICAL WALL SECTIONS

Figure 4.8

4.6.2 Stormwater Drainage

A piped stormwater drainage system will be installed within the road reserve. Consistent with the moratorium on stormwater discharge to the Peel Harvey system there will be no nett increase in nutrient discharge to the Mandurah Channel. Stormwater from a 1 in 10 year storm event will be retained on-site for a period of three to four days prior to its release to the waterway development. The outlet pipe leading from the retention basin to the waterway will be designed so that gross floating pollutants will be retained within the basin. The basin will be regularly cleaned by the Waterways Manager.

A separate and trapped drainage system will also be constructed for the boat repair area.

The stormwater drainage system will be designed for the normal subdivisional requirements to cater for a 1 in 5 year return period storm without surcharging to any gullies or manholes. A larger storm than a 1 in 5 year return period will be catered for by temporary ponding on the road pavement and a major 1:100 year storm will be prevented from flooding houses by escape to the waterway system and the estuary by means of the strategically located public accessways, which will be below the level of the house lots.

Difficulty has been experienced with small lot subdivisions in the Mandurah region with disposing of stormwater on the site, therefore, a stormwater connection will be provided to each house lot for connection to the roof plumbing downpipe system.

The existing stormwater drainage gullies on the adjacent Old Coast Road will be picked up and piped through the development to the waterway system. In addition, drainage lines approaching the site from the north which drain a section of Mary Street immediately west of the bridge will be provided with a stormwater connection through to the waterway system so that the table area will have a completely piped drainage system.

4.6.3 Sewerage Reticulation

The site is within the catchment area of the main Port Mandurah vacuum sewerage pumping station. Site reticulation to this vacuum main will require extension from a location near the intersection of Mary Street and Leighton Place.

A sullage pump-out facility will be constructed adjacent to boat refuelling facilities. The pump-out will be connected to the deep sewerage system with siting and design of the system finalised in consultation with the EPA.

4.6.4 Water Reticulation

A connection to the water supply will be constructed to the low pressure reticulation on the public open space between Mary Street and the Shell Service Station on Old Coast Road since the pressure main adjacent to the lot is a high pressure main and cannot be tapped directly.

4.6.5 Underground Power and Telecom

Underground power reticulation will be supplied to the development by the State Energy Commission. Telecom services will be provided to all lots in the development.

4.7 DEVELOPMENT SCHEDULE

The proposed scheduling for redevelopment of the Mandurah Marina will be as follows:

. Pre-calculation of survey	May 1993
. Design and documentation	June-July 1993
. Calling of tenders	August 1993
. Dredging and Excavation (including dewatering)	September-November 1993
. Construction of marina walling	October-December 1993
. Filling operations	December 1993-Jauary 1994
. Construction of marina secondary walling	January-April 1994
. Installation of infrastructure and servicing	February-April 1994
. Housing construction	May 1994 onwards
. Redevelopment of marina and commercial precinct	June-December 1994.

5. ENVIRONMENTAL IMPACTS

5.1 INTRODUCTION

Redevelopment of the Mandurah Marina has the potential to impact the environment both during the construction phase and as a result of ongoing operations.

Specific impacts on the surrounding physical environment may include:

- potential for reduced water quality within the basins
- alteration of natural drainage
- modification of landform
- reduction in groundwater levels resulting from dewatering.

Potential impacts on the biological environment include:

- loss of wetland habitat
- impact on the foreshore and its biota
- impact on water quality within the Mandurah Channel
- impacts on recreational fisheries.

Impacts on the human environment potentially include:

- noise and dust during construction
- foreshore access
- modification of landscape and aesthetics
- impacts on historical attributes.

Similarly, the surrounding environment may impact on the ongoing operation of the estate. Such impacts could include:

- the impact of pest organisms
- the effect of estuarine water on the basins.

5.2 IMPACTS ON THE PHYSICAL ENVIRONMENT

5.2.1 Shoreline Structure and Stability

The development will see dredged excavation only in shore areas associated with the existing basins. The existing Mandurah Channel shoreline will not be affected, other than to remove a small section of previously filled shoreline occurring between the two basins.

5.2.2 Topography and Bathymetry

The existing topography of the site will be modified by:

- excavation and enlargement of the southern basin by 7,000m^2
- the addition of fill to areas within the development zone below RL2.1 AHD
- earthmoving and levelling prior to redevelopment.

The southern basin will be excavated to a surface area of approximately 11,000m^2 (1.1ha). This will include excavation from the existing basin mouth to the Mandurah Channel to maximise flushing of the redeveloped basin. Spoil dredged from the new basin will be used for on-site fill as described in Section 4. The excavation of the mouth is likely to result in only beneficial impacts on water movement.

5.2.3 Flooding

None of the redevelopment area proposed for building is outside the limit of development (flooding) area as shown in PWD map 52725-6-1, thus no essential natural floodways will be impeded by the proposal. Areas contained within the 100 year flood-prone region will be filled above flood levels as described in Section 4.

5.2.4 Drainage

Existing stormwater drainage through the site will be maintained.

The stormwater drainage gullies on the adjacent Old Coast Road will be piped through the development to the waterway system. Drainage approaching the site from the north will be provided with a stormwater connection through to the waterway system.

All stormwater drainage originating from the site will pass through a retention basin prior to discharge to the waterway system. A piped storm-water drainage system will be installed within the road reserve. In addition, a separate and trapped drainage system will be constructed for the boat repair area. The retention basin will be designed so that a 1 in 10 year storm event will be retained on-site for three to four days.

The gradual slope and difference in bottom level will facilitate complete flushing of the basin. Any pollutants entering the waterway would therefore be removed from the basin within a short period of time and would not adversely affect the water quality.

A public education programme will be initiated by the Waterways Manager to advise landowners on ways to minimise nutrient release from their holdings. This will centre, for example, on the use of slow release fertilisers, fertiliser application rates and the preferential use of native plant species.

5.2.5 Dredging Impacts

It is expected that a localised increase in water turbidity will result from dredging of the southern basin mouth. The combination of rapid flushing from the Mandurah Channel and particle settling are likely to limit the extent of this impact to only local areas of the channel. Furthermore the impact will be temporary until dredging is completed.

Throughout the excavation/dredging operation, sand excavated from the basin will be used to provide fill for the redevelopment area. To minimise the impact of turbid water discharge the spoil water and dewatering effluent will be stored in stilling basins on-site, allowed to settle and then discharged at low turbidity to the Mandurah Channel.

Dredging activities associated with excavation of the southern basin will be conducted at all times to the satisfaction of the EPA and Peel Inlet Management Authority (PIMA).

5.2.6 Groundwater

As part of the adjacent Halls Head Waterways development (Feilman, 1981) a survey was conducted to determine the position of all domestic bores in the study area. A total of 80 bores were located and these were all situated to the west of McLarty Road, more than 1km from the proposed Mandurah Marina redevelopment. Groundwater drawdown during dewatering for the Halls Head development was calculated to be 0.3 to 0.4m at a distance of 500m from the site.

Due to the distances involved the proposed redevelopment will have negligible long term effect on the groundwater regime in its vicinity. A localised drawdown in groundwater levels in the vicinity of the excavation would be expected during the construction period as a result of dewatering activities. This drawdown will be short-lived due to the restricted four to six week excavation period proposed. The high permeability of the superficial aquifer will result in groundwater levels returning to their pre-excavation levels within a short period following cessation of excavation. During dewatering activities groundwater levels will be monitored and ameliorative measures taken if necessary.

The redevelopment proposal will include no domestic bores, thus maintaining current groundwater levels.

5.3 IMPACTS ON THE BIOLOGICAL ENVIRONMENT

5.3.1 Terrestrial Biota

Little remnant terrestrial vegetation remains on the redevelopment site with the site now being dominated by introduced weeds and pasture. Therefore redevelopment will have no significant impact on valuable terrestrial ecosystems.

5.3.2 Wetland Biota

The redevelopment proposal will cause 2.24ha of samphire wetland to be covered by fill. These areas include the tidal drainage basin at the northern end of the site and a portion of the southern samphire area. The areas to be filled represent those portions most damaged by previous

activities. In the case of the northern wetland the depression has been used as a compensating basin for stormwater discharge and displays considerable weed invasion. The wetland is partly maintained by drainage from areas to the west that are currently proposed for future urban development. The impacts of this future development on the viability of the wetland (without redevelopment of the Mandurah Marina) are not known.

The vegetation components of the southern samphire wetland are described in some detail in Section 3.5.3 and Appendix 2. It is proposed that this area be reclaimed up to the foreshore reserve boundary which will be maintained as a samphire wetland. This will result in loss of the area behind the previously filled bund where tidal influence has been restricted and a portion of the area east of the bund.

Maintenance of the foreshore samphire area will preserve that area of highest species diversity immediately adjacent to the tidal channel.

5.3.3 Estuarine/Marine Biota

The development's impact on the local estuarine biota will be confined to an increase in turbidity of waters in the vicinity of the site during excavation operations and placement of limestone on the entrance channel walls. Discharge of slightly turbid groundwater during dewatering operations will also occur during construction.

There may be a localised short term impact on organisms in nearshore waters, however, this is expected to be minimal. The solid substrates provided by walls and mooring piles will subsequently provide additional habitat which will be colonised by a range of organisms.

Increasing population pressure in the Mandurah area may result in increased fishing pressure on local fish stocks. This potential impact results from natural population growth and may eventuate with or without this redevelopment proposal. Techniques will be adopted within the development to educate boat owners on their responsibilities relating to minimum sizes and bag limits for recreational fishing.

5.3.4 Water Quality

Local water quality is not expected to deteriorate as a result of the development. Some localised turbidity will, however, occur during the construction period. This effect is expected to be temporary as the water will be dissipated quickly by the tidal effect.

Management procedures to control discharges from the development will be employed to ensure minimal entry of nutrients and other contaminants to the basins in the long term. Provision will also be made for the removal of litter, floating debris and weed accumulation as appropriate.

- **Flushing**

Recognising the need to demonstrate that the proposed redevelopment will not result in the degradation of the water quality in either the source water body (ie the Mandurah Channel) or the enlarged basin, HGM was commissioned in June 1991 to assess the future flushing characteristics.

The Flushing Study (contained in Appendix 5) estimates the influence of tides, winds and density variations on the flushing of the proposed Mandurah Marina redevelopment. Exchange rates calculated for each of the flushing mechanisms show that gravitational exchange will dominate, with flushing of the water body taking place over timescales of the order of one day (or less).

In the absence of the density gradients required to drive gravitational flushing, wind generated shear dispersion will flush the enlarged basin in around 6.3 days (depending upon the strength and duration of the surface winds). Tidal flushing of the basin will take place over a period of around 10 days depending upon the tidal range.

The proposed enlargement has been carefully designed to maximise the potential flushing of the water body through:

- The north-south alignment of the enlarged basin maximising the exposure of the water surface to the dominant wind sectors in the critical late summer months.

- The specification that the bed profile gradually slopes towards the Mandurah Estuary channel so that the enlargement is no deeper than either the existing basin or the channel so as to prevent trapping of dense water within the marina.

Previous work carried out in waterway and canal developments in both Peel Inlet and the Mandurah Channel has demonstrated that the combination of gravitational, wind and tidal forcing was sufficient to flush the relevant water bodies over periods ranging from one to five days. The results described in this report indicate that the enlarged basin will demonstrate similar flushing characteristics and thereby ensure that the quality of the water in the basin is consistent with that of the source water body (ie the Mandurah Channel).

Therefore:

- The water quality in the redeveloped basin will be consistent with that of the source water (ie the Mandurah Channel).

- The water quality in the Mandurah Channel (or in Peel Inlet) will not be adversely affected by the enlargement of the basin (provided the appropriate management strategies are implemented).

- The water quality in the proposed development will be affected from time to time by the poor water quality in Peel Inlet, however, it has been shown (LeProvost et al. 1989) that the water quality in the Mandurah Estuary channel is consistently higher towards the ocean (ie towards the location of the existing Mandurah Marina).

A report prepared by LeProvost et al. (1989), describing the results of a three year water quality monitoring programme in the Waterside Mandurah Development, showed no evidence to suggest that the waterways development had affected the water quality in the Mandurah Channel. Indeed, it was concluded that the water quality of the canals was largely determined by the source water in the channel and, thereby, in Peel Inlet.

It is therefore confidently predicted that flushing of the redeveloped basin will be sufficient to ensure effective exchange between the basin and the channel. There should be no degradation of water quality in either water body as a result of the proposed redevelopment. This assumes the adoption of standard management guidelines to control the input of potential contaminants into the basin such as boat anti-fouling coatings, oil spills, stormwater runoff, etc.

5.3.5 Sediment Quality

The development offers the potential for sediments to accumulate nutrients, heavy metals and other contaminants. The results of sediment monitoring in other waterways and canals in the vicinity suggest that sediment nutrient levels follow trends observed in the adjacent Mandurah Channel and Peel Inlet. This indicates that, with effective management of nutrient discharge to the basin, the sediments within the basin will not act as a nutrient sink.

Although management procedures implemented within the development will minimise metal contamination of basin sediments, heavy metals may accumulate over time. It is proposed to monitor the metal content within the sediments on a regular basis. The results will be reviewed in conjunction with the EPA to determine the need for any ameliorative measures to be introduced.

5.4 IMPACTS ON THE HUMAN ENVIRONMENT

5.4.1 Regional Effects

Redevelopment of the marina site will have no adverse impacts on regional social components. Existing service facilities will be expanded to accommodate the requirements of the development and normal ratepayer services will be provided by the City of Mandurah.

Upgrade of these facilities coupled with modernisation of the small commercial precincts will enhance the area's attractiveness for boating and a safe anchorage. Incorporation of all appropriate navigational aids to the approval of the Department of Marine & Harbours will help ensure boating safety.

Redevelopment of the site will also see a considerable change in character of the area. The replacement of existing buildings and boat storage areas with buildings that have been architecturally designed will generate a development of high visual amenity.

5.4.2 Local Effects

The most apparent local impact of the proposal will be a modernisation and upgrade of facilities within the redevelopment area. The expansion of the marina basin, modernisation of the small commercial area and provision of building lots in an attractive waterway setting will significantly enhance the character of the location. This upgrading is consistent with the identified requirements for further housing, commerce and tourism developments of this style in the region.

Access to the estuary foreshore will be provided as part of the redevelopment for both residents and the public. Walkways and cycle paths will be provided through the precinct. Access will enhance the opportunity for public enjoyment of the foreshore area, consistent with its reserve status.

5.4.3 Effects on Historical Values

No specific sites of archaeological or ethnographic significance have been identified on the redevelopment site and it is concluded that the proposal will not impact on any areas of significance (Appendix 3).

It was however, noted that the coastal region encompassing the redevelopment location is of considerable significance to local Aboriginal communities and that camping grounds would have been established in the area. To recognise this significance the proposal will, in conjunction with the Winjan Progress Association, adopt commemorative naming and/or signposting within the redevelopment.

5.4.4 Construction Impacts

As part of the construction phase of the redevelopment, some inconvenience may be experienced by local residents due to noise associated with traffic and earthworks on the site. This disturbance is expected to be minimal as no residences are immediately adjacent to the site and are separated by the channel and major local roads. Regular traffic associated with construction will whenever possible avoid residential areas and limit activities to suitable hours as determined in conjunction with the City of Mandurah and the EPA.

It is unlikely that dust leaving the site will present a significant problem as the majority of soil used for fill will be moist. Where required, dust in work areas will be controlled by water sprays.

5.4.5 Nuisance Organisms

Maintenance of the southern samphire foreshore immediately adjacent to the proposed residential area poses potential for nuisance impact on the development residents. As identified in Section 3.5.4 the samphire area is a breeding ground for mosquitoes. The Foreshore Management Programme (Section 6.2) will include integration of this area into the City of Mandurah's current mosquito control programme.

6. ENVIRONMENTAL MANAGEMENT

6.1 INTRODUCTION

As described in Section 5 of this report it is anticipated that the proposed redevelopment will have minimal detrimental impact on the environment. A summary of the specific management considerations designed to minimise these impacts are shown in Tables 6.1 to 6.3.

TABLE 6.1

PREDICTED IMPACTS ON THE PHYSICAL ENVIRONMENT AND MANAGEMENT STRATEGIES

Predicted Impact	Expected Significance	Management Adopted
Topography modification	Low	Managed design and flooding control
Shoreline stability	Low	Modification of waterway area and mouth only
Dredging impacts	Low	Spoil water settling on-site, EPA/PIMA managed
Debris accumulation	Low	Ongoing maintenance
Oil/fuel spills	Low	Oil spill contingency plan
Groundwater levels	Low	Establishment of monitoring bores on-site

TABLE 6.2

PREDICTED IMPACTS ON THE BIOLOGICAL ENVIRONMENT AND MANAGEMENT STRATEGIES

Predicted Impact	Expected Significance	Management Adopted
Loss of samphire areas	Medium	Maintenance and management of foreshore samphire areas
Loss of terrestrial vegetation	Low	Replanting of natives in landscaped areas
Increased pressure on fisheries	Low/Medium	Inevitable with population growth. Education to highlight responsibilities

TABLE 6.3

PREDICTED IMPACTS ON THE
HUMAN ENVIRONMENT AND MANAGEMENT STRATEGIES

Predicted Impact	Expected Significance	Management Adopted
Landscape modification	Low/Medium	In many ways a beneficial improvement
Noise and dust during construction	Low	Watering and restricted timing of activities
Aboriginal or historical impacts	Low	Naming/signposting in conjunction with Winjan Progress Association

Apart from these specific strategies, two more general management plans will be adopted as part of the redevelopment proposal, these are a Foreshore Management Plan and a Marina Management Plan.

6.2 FORESHORE MANAGEMENT PLAN

6.2.1 Aims

The Foreshore Management Plan aims to:

- maintain the stability of the foreshore surrounding the redevelopment area;
- preserve samphire components of the southern reserve; and
- enhance the northern foreshore for passive recreation.

6.2.2 Structure and Stability

Analysis of aerial photography indicates that the shallow banks between the foreshore and the Mandurah Channel in this region are slowly growing. Thus the foreshores are accreting rather than eroding.

The southern samphire wetland adjoining the Mandurah Channel will remain unaltered. This area will be protected from erosion due to boats entering and leaving the basin by the provision of hardwalling around the basin mouth. The interface between the samphire and the filled area will be bordered by a retaining wall situated within the development boundary.

The northern foreshore reserve is virtually devoid of native vegetation and will be rehabilitated for public recreation. It is not anticipated that hardwalling will be required to prevent erosion. The sloping foreshore will be isolated from the residential area by a retaining wall and will allow for public access to the foreshore reserve.

6.2.3 Vegetation

The southern foreshore reserve will remain as a tidal samphire wetland. The species present are described in detail in Appendix 2 and are expected to remain unchanged in the foreseeable future.

As a result of previous clearing, the northern foreshore is well suited to development for passive recreation purposes with replacement of pasture grasses with lawn areas. The northern foreshore reserve will be rehabilitated as a lawned area with replanting of native trees and shrubs to encourage passive recreational usage by residents and the general public.

6.2.4 Public Access

Public access will be provided into the northern foreshore reserve from within the residential area. A dual use path will provide both pedestrian and cyclist passage to this reserve. Both pedestrian and cyclist access will be routed past rather than through the southern reserve area. While access will not ultimately be prevented, the provision of paths within the development area will act to encourage passage away from the samphire reserve.

Boundary fencing and the building areas will limit vehicle access to the foreshore reserves. This will be augmented by exclusion barriers at other potential vehicle access points.

Maintenance of the retaining walls bordering the foreshore reserves will be the responsibility of individual lot owners, under supervisory control of the City of Mandurah.

6.3 WATERWAY MANAGEMENT PLAN

6.3.1 Aims

The primary aims of the Management Plan are to:

- ensure the long term viability of structures and facilities associated with the development,
- maintain acceptable water quality standards with both basins, and
- ensure that there is no detrimental impact on water quality within the Mandurah Channel.

6.3.2 Construction

Construction traffic will have access to the site via the new traffic bridge and Old Coast Road. This will minimise the need to pass through the Central Business District of Mandurah. Noise association with construction will be minimised by limiting works to hours agreed to by the City of Mandurah and the EPA. Dust will be controlled by the use of water sprays, the soil surface will also be revegetated, compacted and stabilised immediately following filling to prevent erosion.

6.3.3 Waste Management

Any shortfall in required fill following dredging will be met by import of clean fill to the satisfaction of the City of Mandurah and the EPA.

All waste materials generated during construction will be disposed of at the Mandurah landfill site. Portable on-site toilet facilities will be provided for construction workers and will be maintained in accordance with Department of Health regulations.

6.3.4 Sewerage and Drainage

Design and construction of a reticulated vacuum sewerage system will be in accordance with requirements of the Water Authority of Western Australia (WAWA), including contingency safeguards for system failure to prevent the input of sewage effluent to the waterway.

Drainage from the redevelopment site will be managed to ensure that all stormwater is discharged in accordance with the moratorium of stormwater disposal within the Peel-Harvey system. Drainage lines approaching the site will be piped through the development to the waterway.

All stormwater originating from the site will pass through a retention basin prior to entering the waterway. The design of the retention basin will ensure that gross pollutants are retained within the basin.

The stormwater drainage system will be designed for normal subdivision requirements to cater for a 1 in 5 year return period storm without surcharging to any gullies or manholes.

Each house lot will be provided with a stormwater connection to the roof plumbing downpipe system to ensure there is no difficulty in disposing of stormwater on-site. Formal approval for the system proposed will be obtained from the EPA and PIMA.

6.3.5 Oil and Fuel Spillage

A manual of emergency procedures including oil and fuel spill contingency plans will be developed by the Waterways Manager to the satisfaction of the EPA and PIMA.

6.3.6 Water Quality

Water quality within the enlarged basin and the existing northern basin is expected to be maintained at a high level due to the well flushed nature of the basins and the monitoring and management controls to be put in place.

In line with the EPA's strategy to minimise the impact of tributyl tin antifouling paints, no boat using these paints will be allowed to moor within the basin. Furthermore, use of these paints on any other structures or equipment used or stored within the development will not be permitted.

It is expected that macroalgae and other debris will enter and accumulate in the waterways. It will be the responsibility of the proponent for the first five years of operation, and the Waterways Manager thereafter, to regularly remove such debris. This responsibility shall extend to the shoreline of the development area.

6.3.7 Navigable Entrance and Walling

Maintenance of the navigable entrance and walling of the basins will be the responsibility of the proponent for the first five years of operation following redevelopment and will be conducted to the satisfaction of the Department of Marine & Harbours and PIMA. After this time the water body will be ceded to the State, at which time the Waterways Manager shall assume responsibility.

6.3.8 Management

Responsibility for maintenance and monitoring will rest with the proponent for the first five years following redevelopment of the site. After this time management of the water bodies will be the responsibility of the Waterways Manager who shall be the City of Mandurah. Prior to construction activities commencing a management agreement for the long term maintenance of the development will be formalised with the City of Mandurah.

6.3.9 Monitoring Programmes

Final design of the monitoring programme will be undertaken in consultation with PIMA and the EPA.

. Water Quality

Monitoring will be carried out monthly for the first year and then quarterly for the following four years, at which time the programme will be reviewed in conjunction with PIMA and the EPA.

Parameters to be monitored at a central location with the southern basin and at a control site in the Mandurah Channel will include:

- temperature profile
- salinity profile
- dissolved oxygen profile
- total phosphorus (surface and 0.5m above sediment)
- orthophosphate (surface and 0.5m above sediment)
- total nitrogen (surface and 0.5m above sediment)
- inorganic nitrogen (surface and 0.5m above sediment)
- high attenuation (by secchi disk).

- **Sediments**

Twice yearly sediment collections will be performed to determine phosphorus fractionation. Annual sediment collections will be made to determine a range of metal concentrations (Cd, Cu, Pb, Zn, Sn, Cr).

- **Sedimentation**

Annual hydrographic surveys will be conducted to determine the rate of sedimentation within the extended southern basin.

- **Entrance and Walls**

The structural soundness and condition of waterway walls will be monitored during the first five years by underwater inspection and photographic comparisons.

7. CONCLUSIONS

Redevelopment of the Mandurah Marina will provide important benefits to the local and regional community, including the provision of a boat haven and public boating facilities, and the provision of new residential, tourist and recreational opportunities. These benefits may be accompanied by a number of potential environmental impacts. However, successful implementation of the proposed management plans will ensure the environmental acceptability of the development during construction and in the long term. The proponent will manage all aspects of the development until the date of handover of the development to local and state government authorities.

8. PROPONENT'S COMMITMENTS

The following commitments are made by the proponent with respect to the project.

Preconstruction

1. A Foreshore Management Plan will be prepared to the satisfaction of the EPA, PIMA and DPUD. This plan will detail:

   1.1 Nutrient application and monitoring.

   1.2 Areas at the canal entrance which will be hardwalled to prevent erosion.

   1.3 The location and maintenance of retaining walls between the foreshore and areas which have be infilled.

   1.4 Rehabilitation of the foreshore reserves.

   1.5 Retention of the southern tidal samphire wetland.

   1.6 Location and design of public accessways to the northern foreshore reserve.

   1.7 Restriction of public access to the southern foreshore reserve.

   1.8 The location of exclusion barriers to limit vehicle access to foreshore reserves.

   1.9 The integration of the samphire area into the City of Mandurah's mosquito control programme.

   1.10 Maintenance of retaining walls bordering the foreshore reserves. Maintenance will be the responsibility of individual lot owners under the supervision of the City of Mandurah.

2. A Waterway Management Plan will be prepared to the satisfaction of PIMA and the EPA. This plan will detail:

   2.1 Maintenance of structures and facilities.

   2.2 Contingency safeguards for failure of the deep sewerage system.

   2.3 An emergency procedures manual incorporating oil and fuel spill contingency plans.

   2.4 Responsibilities for the regular removal of macroalgae, debris and litter from the basins.

2.5 The regular monitoring and reporting of hydrographic parameters, and water and sediment quality within the basins and the Mandurah Channel (this programme will run for five years from the time of dredging after which the programme will be reviewed in conjunction with the EPA). Ameliorative measures will be proposed in the event that unacceptable deterioration occurs.

3. Formalisation of a long term waterways management agreement with the City of Mandurah.

4. Waterway construction methods will be finalised to the satisfaction of the Department of Marine and Harbours.

5. Drainage details and design of the retention basin for the development and for the boat repair area will be finalised to the satisfaction of the EPA and PIMA.

6. Wall construction materials, including the installation of approved filter cloth, will be finalised with the EPA.

7. Design of the deep sewerage system will be finalised to the satisfaction of WAWA.

8. The origin of imported fill will be cleared with the EPA.

During Construction

9. Construction work will be limited to the hours agreed to by the City of Mandurah and the EPA.

10. Dredging activities will be conducted at all times to the satisfaction of the EPA and PIMA.

11. Dust generated during construction will be controlled by the use of water sprays.

12. The soil surface will be compacted, stabilised and revegetated following filling to prevent erosion.

13. Construction waste materials will be disposed of at the Mandurah landfill site.

14. Minimum block levels will be set out at 2.1m AHD subject to review by the Department of Marine and Harbours of tidal range and storm surge within the Peel-Harvey system.

15. A stilling basin will be constructed to receive dewatering effluent prior to its discharge to the channel. Water will be discharged in such a manner so as not to disturb the banks or produce turbid water. The quality of discharge water will be to the satisfaction of the EPA and PIMA.

16. Groundwater levels will be monitored during dewatering activities and ameliorative measures taken if necessary to the satisfaction of the EPA and PIMA.

Post Construction

17. The stormwater retention basin will be regularly cleaned and maintained by the Waterways Manager and nutrient discharge minimised to the satisfaction of the EPA and PIMA.

18. No boat using tributyl-tin based anti-fouling paints will be allowed to moor within the development. Tributyl-tin based paints will not be used on structures or stored within the development. This will be the responsibility of the Waterways Manager.

19. Accumulated debris, litter and algae in the basins will be regularly removed by the proponent and then the Waterways Manager following transfer of responsibility.

20. The navigable entrance and basin walling will be maintained by the proponent for the first five years of operation and then by the Waterways Manager following transfer of responsibility to the satisfaction of the Department of Marine and Harbours and PIMA.

21. The proponent will be responsible for enactment of the Waterways Management Plan for the first five years following development when management responsibility will transfer to the Waterways Manager.

22. Hydrographic parameters, and water and sediment quality within the basins and Mandurah Channel will be regularly monitored for five years from the time of dredging at which time the programme will be reviewed in conjunction with the EPA and PIMA. Ameliorative measures to the satisfaction of the EPA, proposed in the Waterways Management Plan, will be enacted should unacceptable deterioration occur.

23. All appropriate navigational aids will be incorporated into the development following the advice of the Department of Marine and Harbours.

9. REFERENCES

Black, R.E. and Rosehr, J.E. 1980. The Peel Inlet and Harvey Estuary System Hydrology and Meteorology, Report No. PD232/1980/AM30.

Dames & Moore Pty Ltd, 1987. Point Grey Development Project Environmental Review and Management Programme. Prepared for Forx Pty Ltd.

Department of Conservation and Environment, 1981a. The Peel-Harvey Estuarine Study 1976-80, DCE Report No. 9.

Department of Conservation and Environment, 1984b. Peel-Harvey Estuary Progress. The Life in the Estuary, Bulletin No. 146 (9).

Environmental Protection Authority, 1981. Water Quality Criteria for Marine and Estuarine Waters of Western Australia. Report of the Working Group established by the EPA. Department of Conservation and Environment, Bulletin 103.

Environmental Protection Authority, 1990. A Guide to Wetland Management in Perth. Bulletin 374.

Erickson, R., George, A.S., Marchant, N.G. and Morcombe, M.K., 1973. Flowers and Plants of Western Australia, Reid, Sydney.

Estuarine and Marine Advisory Committee, WA, 1981. The Peel-Harvey Estuarine System Study, Department of Conservation and Environment Bulletin No. 88.

Feilman Group, 1981. Halls Head Waterways, Environmental Review and Management Programme. Prepared for Parrys Esplanade Limited.

Heddle, E.M., 1979. Mapping the Vegetation of the Perth Region in Gentilli, J. (Ed.) Western Landscapes pp153-182 University of WA Press, Nedlands WA.

LeProvost Environmental Consultants, 1990. Mandurah Quay Consultative Environmental Review. Prepared for Forx Pty Ltd.

LeProvost, Semenuik & Chalmer, 1981. Waterways Project - Halls Head Mandurah: Environmental Considerations: in Feilman Planning Consultants Pty Ltd (1981), Parrys Esplanade Limited, Environmental Review and Management Programme, Vol. 2, Appendices.

LeProvost, Semenuik & Chalmer, 1989. Waterwide Mandurah Canal Estates Environmental Monitoring Programme, August 1986 to June 1987. Submitted to EPA.

Lukatelich, R.J. and McComb, A.J., 1986. Nutrient recycling and the growth of phytoplankton and macroalgae in the Peel-Harvey Estuarine System. Report to the Waterways Commission, Western Australia.

McArthur, W.M. and Bettenay, E., 1960. The Development and Distribution of the Soils of the Swan Coastal Plain, Western Australia. CSIRO Soil Publication No. 16.

Public Works Department of WA - Design Branch, 1980. Murray River Flood Study West Murray Area Interim Report. Technical Report No. D1/80.

Seddon, G., 1972. A Sense of Place, University of WA Press, Nedlands WA.

Smith, G.G., 1973. A Guide to the Coastal Flora of South-Western Australia. Western Australian Naturalists' Club, Perth. Handbook No. 10.

Speck, H.N., 1952. Plant Ecology of the Metropolitan Sector of the Swan Coastal Plain, M.Sc. Thesis, University of Western Australia.

Wilson Sayer Core Pty Ltd, 1988. Mandurah Foreshore Land Use Study. Draft Report to Mandurah Town Council and South West Development Authority.

APPENDIX 1

CONSULTATIVE ENVIRONMENTAL REVIEW GUIDELINES

GUIDELINES FOR THE CONSULTATIVE ENVIRONMENTAL REVIEW FOR MANDURAH MARINA

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what they propose to do, to discuss the potential environmental impacts of the proposal, and then to describe how these environmental impacts are going to be managed so that the environment is protected.

Throughout the process, it is the aim of the Environmental Protection Authority (EPA) to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. However, it is the responsibility of the proponent to design and implement proposals which protect the environment, and to present the design proposals for review.

These Guidelines have been prepared to assist the proponent in identifying issues which should be addressed within the Consultative Environmental Review (CER) for the proposed Mandurah Marina. They are not intended to be exhaustive and the proponent may consider that other issues should also be included in the document.

Purpose of the CER

The principal function of the CER is to place this project in the context of the regional environment and progressive developments, including the cumulative impact of this development. It should seek to explain why the project is proposed in the form it is, at this location, at the time. It should also set out clearly the likely associated environmental impacts, and include management steps proposed to be undertaken in order to either avoid, ameliorate or mitigate these impacts. This discussion should be concise, accurate, and easily understood. Specialist information should only be included where it assists in the understanding of technical aspects of the proposal, except when specialist information has been specifically requested by a Government department or local authority.

A copy of these Guidelines should appear within the CER.

1. SUMMARY

The CER should contain a brief summary which includes the following information:

- features of the proposal;
- details of existing infrastructure associated with current marina facilities;
- description of receiving environmental and analysis of potential impacts and their significance;

- proposed environmental monitoring, management and safeguards and commitments thereto; and

- conclusions.

2. INTRODUCTION

This should include a brief overview of the proposal, including what is proposed, by whom, where and why.

3. DESCRIPTION OF EXISTING ENVIRONMENT

This should include a brief description of the physical, biological and social environment of the area likely to be impacted by the proposed development, in particular processes sustaining the system.

4. DESCRIPTION OF PROPOSAL

This should include a specific description of the proposal itself, including overall layout, timing and method of construction, source of building materials, and method of disposal of wastes.

Detailed plans of the site should include:

- existing land uses, including vegetation and wetland areas and types;

- adjacent land uses;

- roads and auxiliary services, and

- proposed land uses and land tenure.

5. ENVIRONMENTAL IMPACTS AND MANAGEMENT

This section should discuss predicted environmental impacts associated with construction and ongoing operation of the proposed development, and measures proposed to be implemented to overcome or minimise these impacts.

Specific environmental concerns associated with construction of a marina at this site include:

- control of noise and dust during construction phase;

- drainage and stormwater discharge management;

- water quality within artificial waterway (marina), including contingency plans for fuel spills, effects of boat anti-fouling paint on adjacent estuarine waters, and details of ongoing monitoring mechanisms to ensure maintenance of appropriate water quality standards;

- method of sewage and other waste disposal including sullage pumpout facilities;
- traffic management (vehicle and boat);
- control of emissions (air, water, noise);
- impact of groundwater during construction, and
- management of foreshore reserves.

Other impacts that are identified during preparation of the document should also be addressed. Significance and timing of the various potential impacts identified should be examined.

An Environmental Monitoring and Management Programme (EMMP) should be described based on the predicted impacts discussed, and an appropriate commitment to undertake the monitoring included within Section 7 of these Guidelines. Content and reporting schedule for the EMMP, and authorities responsible for managing various components in the short term and the long term should also be included.

6. CONCLUSIONS

This section should include an overall synthesis of the environmental impacts associated with the proposed marina and associated facilities, and how these have been addressed to ensure the proposal is environmentally acceptable.

7. COMMITMENTS

Where an environmental problem has the potential to occur, there should be a commitment made by the proponent to avoid, ameliorate or mitigate it. Commitments proposed to be undertaken by the proponent to protect the environment should therefore be clearly defined and separately listed and numbered to assist environmental auditing post construction.

Commitments should clearly state:

- who will do the work;
- what the work is;
- when the work will be undertaken, and
- to whose satisfaction the work will be carried out.

8. REFERENCES

GLOSSARY (definitions of technical terms, abbreviations)

CER GUIDELINES

APPENDICES

APPENDIX 2

SAMPHIRE FLORA

APPENDIX 2

SAMPHIRE FLORA

Field surveys during June and August 1991 identified thirteen (13) species of native samphire and remnant fringing vegetation in the two wetland areas on the redevelopment site. These were:

Samphire
Frankenia pauciflora
Halosarcia halocnemoides
Halosarcia indica ssp bidens
Halosarcia ? pergranulata
Halosarcia syncarpa
Muellerolimon salicorniaceum
Sarcocornia blackiana
Sarcocornia quinqueflora
Suaeda australis
Suaeda australis or *Threlkeldia diffusa*
Wilsonia humilis

Fringing
Casuarina obesa
Juncus kraussi

Based on the description of salt-marsh formations in Smith (1973) the distribution of the identified species has been divided into five associations, these are:

Association 1
Halosarcia indica ssp bidens
Frankenia pauciflora
Suaeda australis/Threlkeldia diffusa

Association 2
Sarcocornia quinqueflora

Association 3
Halosarcia halocnemoides
Sarcocornia quinqueflora
Halosarcia syncarpa

Association 4
bare sand

Association 5
Halosarcia indica ssp bidens
Suaeda australis/Threlkeldia pauciflora

Distribution of these associations is shown in Figure 3.2 in the main body of the text.

The categorisation of these associations has been based on the dominance or co-dominance of various species, which in turn has been derived from the percentage cover of a species over its area of distribution. Typical breakdowns of the distribution patterns in each association are as follows:

Species	% Cover	Comments
Association 1		
Frankenia pauciflora	40%	locally higher ground, on wetland margins, up slopes
Halosarcia indica ssp bidens	40%	wetland margins, higher ground
Halosarcia ? pergranulata	minor	localised higher ground, wetland margins, up slopes
Sarcocornia quinqueflora	minor	
Suaeda australis/Threlkeldia diffusa		minor locally higher ground, grades from wet onto rises
Association 2		
Sarcocornia quinqueflora	90%	in standing water
Suaeda australis	minor	
Association 3		
Halosarcia halecnemoides	50%	
Halosarcia syncarpa	20%	
Sarcocornia quinqueflora	10%	
Wilsonia humilis	10%	
Muellerolimon salicorniaceum	<7%	
Frankenia pauciflora	minor	
Oscillatoria sp	minor	covering sand areas in standing water
Association 4		
Bare sand		

Association 5

Halosarcia indica ssp bidens	dominant	
Suaeda australis	dominant	
Frankenia pauciflora	minor	
Juncus kraussi	<20 clumps minor	
Sarcocornia blackiana	minor	wetland margins, up slopes
Sarcocornia quinqueflora	minor	

These species and their associations are common to the salt-marshes of coastal regions from Perth to Bunbury.

Both of the samphire wetlands identified as part of this study fall into the Category M (Multiple Use) grouping, based on the survey checklists provided in EPA Bulletin 374.

APPENDIX 3

ABORIGINAL HERITAGE REPORT

AND SECTION 18 CLEARANCE

MINISTER FOR ABORIGINAL AFFAIRS

6TH FLOOR 32 ST GEORGE'S TERRACE, PERTH, WESTERN AUSTRALIA 6000
TELEPHONE (09) 221 1377 FACSIMILE (09) 221 3758

Your ref. TMcA:je:E

9 SEP 1991

Mr Tim McAuliffe
Environmental Manager
for Norman Hope Nominees Pty Ltd
Halpern Glick Maunsell
PO Box 524
WEST PERTH WA 6005

Dear Mr McAuliffe

SECTION 18 NOTICE UNDER THE ABORIGINAL HERITAGE ACT 1972-1980 LOT 11 OLD COAST ROAD MANDURAH

I refer to the notice, dated 30 July 1991, given by Halpern Glick Maunsell Pty Ltd, on behalf of Norman Hope Nominees Pty Ltd, to the Trustees of the Western Australian Museum under Section 18 of the Aboriginal Heritage Act.

In accordance with my powers under Section 18(3) of the Act, I hereby give consent to Halpern Glick Maunsell Pty Ltd, on behalf of Norman Hope Nominees Pty Ltd, to use Lot 11, Old Coast Road, Mandurah, for the purpose of the development of a marina and housing estate.

Yours faithfully

Dr Judyth Watson MLA
MINISTER FOR ABORIGINAL AFFAIRS

A REPORT OF AN ARCHAEOLOGICAL AND ETHNOGRAPHIC SURVEY FOR ABORIGINAL SITES PROPOSED MANDURAH MARINA

TO

HALPERN, GLICK, MAUNSELL

BY

DR. R.G. LOCKE & A. MURPHY, BSc (HONS.)

Mc DONALD, HALES AND ASSOCIATES

5 ELLEN STREET
FREMANTLE 6160

JULY 1991

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SECTION 1: INTRODUCTION

1.1 Introduction and Consultancy Brief

McDonald, Hales and Associates was commissioned by Halpern, Glick, Maunsell to conduct a survey for Aboriginal sites over Lot 11, Old Coast Road, Mandurah. This area (PDA) contains an existing, though limited, marina facility and it is proposed that this be upgraded and accompanied by a residential subdivision.

The 9.404 hectares was examined for archaeological sites on June 18th 1991 by A Murphy assisted by L. Collard. The ethnographic survey was undertaken by Dr R. Locke on 20th June 1991.

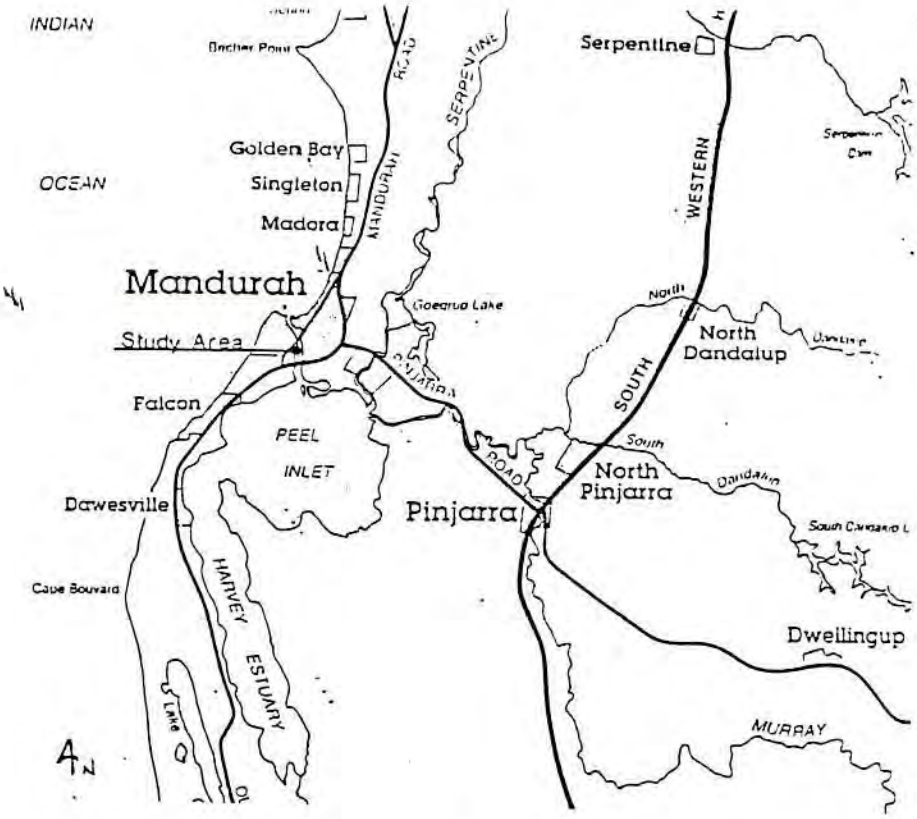
No archaeological or specific ethnographic sites were located within the PDA, however, the area was known to have been used by Aboriginal people, and, therefore, it is recommended that the development be permitted to proceed subject to Section 18 (Aboriginal Heritage Act 1972-1980) clearance being sought and accepted.

1.2 Local Environment and Land Integrity

The site proposed for the construction of the Mandurah Marina consists of some 9.4 hectares of land bordering the Peel Inlet. The eastern boundary of the PDA is formed by the Old Coast Road, from which access to the site is obtained. Existing, though limited, marina facilities take up most of the foreshore and consist of moorings and slipways. Associated buildings; offices, dry boat storage sheds, shops and fuel depot, occupy less than one third of the remaining land. The remainder of the PDA, though presently without any formal use, has been extensively modified by human activity as a consequence of the existing marina development.

1.2.1 Geology

The PDA is wholly contained within the Spearwood Dune sub-unit of the Swan Coastal Plain (McArthur and Bettenay, 1960). This consists of sand dunes which have been lithified to limestone, forming ridges (up to 150m high) and troughs roughly parallel to the present coast. Within and especially along its eastern edge are permanent lakes, occurring in chains parallel to the present coast. These may represent old lagoons cut off by beach deposits formed after a drop in sea level and are variably saline, brackish or completely fresh.



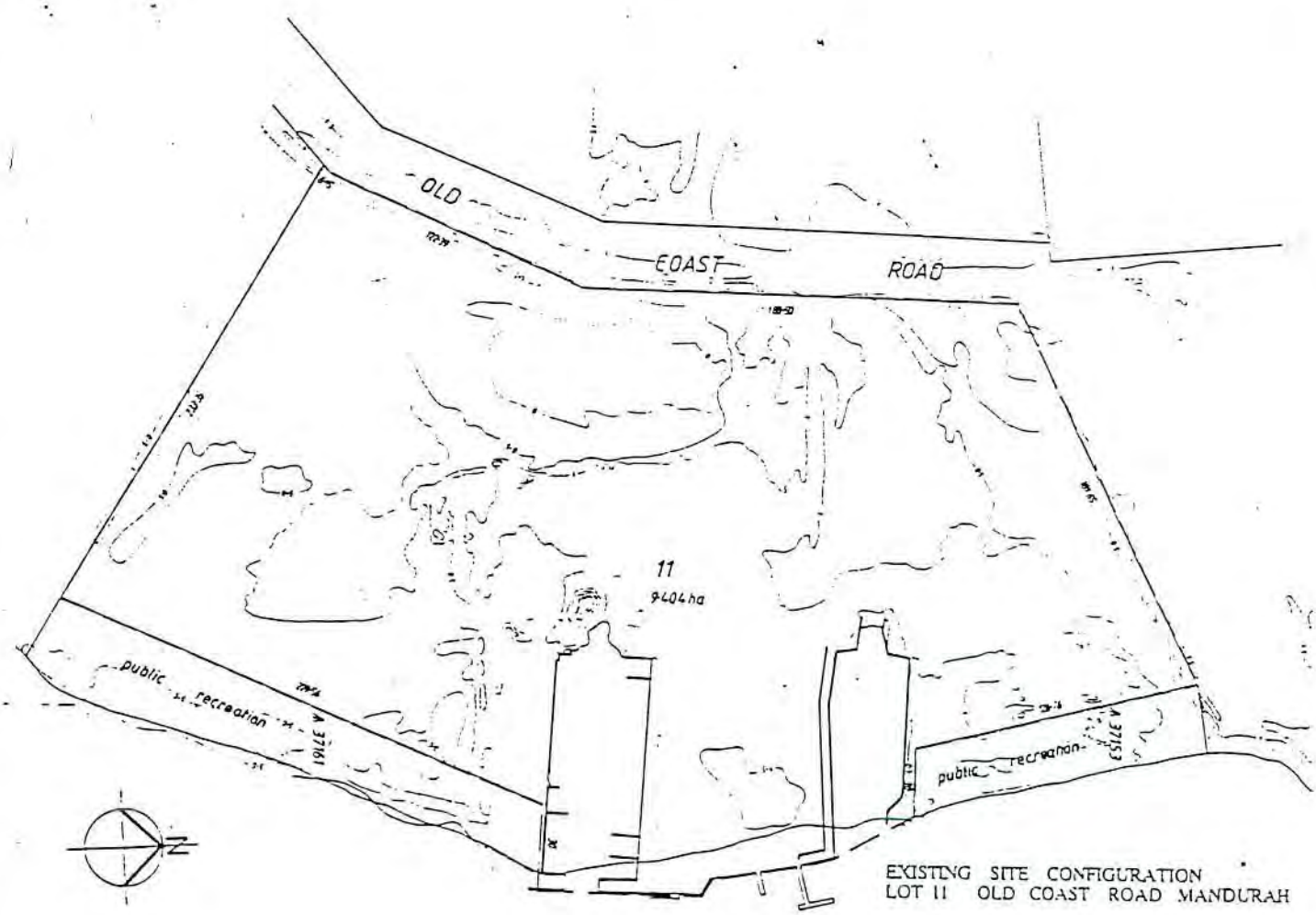


FIG 1: MANDURAH MARINA

Location and Detail

Yellow quartz sands make up the dune deposits with some areas of heavy mineralisation within them. Underlying the sands are aeoleanite rocks, wind blown deposits which have become consolidated, known as Tamala Limestone. This basal sediment extends far beyond the Spearwood system, both to east and west, outcropping on offshore islands and appearing as "floaters" within the more landward Bassendean Dune system.

Unlike the lagoons, the Peel Inlet-Harvey Estuary represents a river valley drowned by the rise in sea levels, after the last glacial maximum, which also created the offshore islands. Here, estuarine/riverine sediments overlie the Spearwood Dunes, forming a more stable surface for plant growth.

1.2.2 Climate

Although further to the south than Perth, the Mandurah area is still said to experience a Mediterranean climate, having cool wet winters and warm to hot dry summers. It lies within the 850mm isohyet and receives most of this moisture as winter rain (May to October). Summer droughts (January to April) are less pronounced, however, due to the greater quantities of precipitation and lower maximum temperatures, which range from an average high of 28C (February) to an average low of 6C (June).

1.2.3 Vegetation

Within the PDA what remains of the natural flora consists almost exclusively of sedgeland. This is a broad general term for the vegetation typical of periodically inundated lands which may not consist exclusively of sedges (e.g. *Cypera spp.*) but also representatives of other species of reed-like plants, including *Typha, Juncus* and *Baumea.* Indeed, *Juncus* marsh may replace the sedges along the open water borders of tidal estuaries. On better drained soils typical tall wetland vegetation occurs, composed mainly of *Melaleuca spp* (Paperbarks), occasional Flooded Gums *(Eucalyptus rudis)* and sedgeland continuing as an understorey. In the PDA this complex is confined to an undeveloped southern portion of the lot.

Introduced plant species are also present and include Buffalo and Veldt grasses which occur discontinuously throughout the entire PDA. Other weed species, including Arum lillies and Watsonia, are more confined to the northern boundary of the site.

SECTION 2: ARCHAEOLOGICAL SURVEY

2.1 Archaeological Background

Prior to commencing fieldwork a search through the files held by the Dept. of Aboriginal Sites was undertaken. This revealed that some 15 sites have previously been recorded within a five kilometre radius of the proposed development area none of which are located within it. These include artefact scatters, burials, ethnographic campsites and other places of contemporary Aboriginal significance.

Whilst only a limited number of systematic research projects have been undertaken around Mandurah, (e.g.O'Connor et al 1990; Quartermaine 1986; Strawbridge, 1989) a large number of sites are known for the township and surrounding areas. The majority of sites so far discovered are small, low density artefact scatters confined to the ground surface, hence without stratified deposits. In common with much of the Swan Coastal Plain quartz is the dominant lithic type in these scatters and the assemblages consist mainly of flakes and chips made from this material. The majority of sites are located on the margins of the Peel Inlet/Harvey Estuary and along the banks of the rivers which drain into them. It is interesting to note, however, that sites are not evenly distributed around either the inlet or estuary. The greatest proportion of sites are located on the seaward side of the estuary system. Factors which could account for this patterning include prehistoric Aboriginal land use strategies; research emphasis and site discovery potential.

For Aboriginal groups utilising this area, the land between estuary and ocean would most likely have provided the greatest variety of resource procurement options, allowing easy access to both environments.

Fresh water, a major determinant in site positioning, could have been readily obtained from the many rivers and streams which feed into the Inlet/Estuary system (although there is a corresponding spread of sites along the major drainage features). Additionally, the coastal dune systems provide a better drained and, hence, a more comfortable environment for camping than the alluvial flats to the east. Thus, people could occupy comfortable locations without diminishing the range of resources to which they had easy access.

However, this suggestion probably does not account entirely for the observation, since site discovery and recording is largely dependent upon where researchers choose to look. Around Mandurah particularly the focus of development, which is generally the motivation for survey work, has been the coastal strip. Conversely, the eastern margin of the Estuary is predominantly under private ownership, has experienced little development and has no major transport corridors in its vicinity. Hence, access is more restricted and it has

access is more restricted and it has experienced little impetus for research.

Associated with this is the ease with which sites are discovered in any given environment. Coastal dune systems which in general are found to have a low site density, (Dortch etal, 1984) can provide an attractive environment for survey work since large areas are left denuded of vegetation by wind and wave action. Tracks are also common, created by people seeking ever greater access to the beach, and these provide a network for sampling which often extends for considerable distances through the dune fields. On the eastern flats, the ground surface is more stable, allowing for increased growth of obscuring vegetation. Irrigation and other intensive forms of agriculture also dominate this area which result in a lushy year round covering of pasture over much of the ground surface. Consequently, the site discovery potential of this region is very low.

It is, however, most likely a combination of these factors which is responsible for the site distribution in this region since more individually, is sufficiently influential.

The study area is located within the zone of highest site density and, therefore, might be expected to yield artefactual material. However, it represents only a small proportion (9.5 ha) of the total area over which sites are distributed, so the probability of a discovery being made is somewhat reduced.

2.2 Archaeological Survey

The survey was accomplished by traversing all available ground surface on foot. This amounted to approximately half the total area proposed for development as the buildings already outlined took up approximately one quarter of the site and the remainder was under water (in some parts more than knee deep) at the time of survey. An attempt was made to investigate the inundated areas, however this was abandoned due to extremely poor visibility. A similar visibility problem was encountered in the remainder due to the growth of introduced grass species and, although the entire area was traversed, less than 30% of the ground surface was available for inspection. It is estimated, therefore, that something approaching 30 percent of the available ground surface was actually inspected.

No archaeological sites, as defined under Section 5 of the *Aboriginal Heritage Act (1972-1980)*, nor any isolated finds were located as a result of this study.

2.3 Discussion and Recommendations

The small area involved, generally poor surface visibility and high disturbance levels characteristic of the PDA are most likely the reasons for the failure of this study to locate any sites.

Despite the visibility problems encountered, it is considered that the survey was sufficient to locate any sites present in the PDA. The small amount of land involved allowed for an intensive study of all the available landspace.

It is undoubtedly true that Aboriginal people utilised this area in the time before colonisation but, with the constellation of known sites surrounding it, they may well have chosen to camp elsewhere. As evidenced by the large scale inundation noted by this study, the PDA would have been an unattractive place for habitation, at least during the three months of winter, and possibly beyond. It is highly unlikely, therefore, that sites exist within the PDA which remain undiscovered.

There are, therefore, no archaeological impediments to development in this area.

It is recommended that the proposed development be permitted to proceed.

SECTION 3: ETHNOGRAPHIC SURVEY

3.1: INTRODUCTION

The ethnographic survey was conducted by Dr Ralph Locke. It did not yield any new sites of significance as defined by Section 5 of the Aboriginal Heritage Act, 1972-1980. However, some important observations were made about contemporary meanings of the land by the principal Aboriginal informant. Beside the principal informant, other Aboriginal people were interviewed concerning the PDA. However, it is clear that the principal informant is widely considered to be the person who should speak for the region in which the PDA lies.

3.2 Survey Methods

The survey took place on the 20th June 1991 with the assistance of an Aboriginal informant. It consisted of the following procedures:

1. Archival research
2. Physical examination of the area
3. Interviews with an Aboriginal informant ... the only available knowledgeable person for the PDA and surrounds.
4. Closer mapping of the PDA and its immediate environs

Preliminary research involved a review of existing findings in an area extending in a radius of five kilometres from the proposed development site. Following this, the ethnographic field research began.

3.3 Ethnographic Background

At the time of European colonisation, the south-west of Western Australia was occupied by thirteen socio-dialectical groups (sometimes referred to as tribes). The name which this collectivity, as a discrete sociocultural bloc, applied to itself in more recent times was Nyungar. This term of identification is still used today by south-west Aboriginal people. Berndt (1979:82) concluded that, in traditional Aboriginal terms, the area around Perth was part of the territory of the Whadjug.

The social organisation of the coastal Nyungar groups, encompassed matrilineal moieties, with four exogamous clans in each moiety. The names of these clans had totemic associations, connecting them with the physical and biological environment in which they were installed. However, ritual affiliations to sites occurred through an individual's father. Berndt (1979) further states that there may have been local patrilineal descent groups which focussed on particular

totemic sites in defined stretches of country.

A basic unit of Nyungar local social organisations was the band or horde which characteristically numbered up to forty persons and which contained a number of families. Records made by early colonists referred, inaccurately, to these groups as 'tribes' and tended to further impose European concepts by identifying them not only in terms of territorial affiliations but also in terms of what was perceived as 'leadership' or 'leaders'. For instance, *Yellagonga* was identified as the leader of a group which occupied *Mooro* country. This area was bounded by the Swan River at Perth to *Gynoorda* (Ginger Brook?) in the north. The eastern boundary was marked by the Swan River at Ellen Brook and the western border by the Indian Ocean.

From the Rockingham area, specifically from a line drawn due east from Mangles Bay, extending northwards to the foreshores of the Swan and Canning Rivers was the 'territory' of the *Beerliar* Aboriginal group. This group included Aboriginal influentials *Midgegooroo* and his son, *Yagan*. The wetlands in this region were most intensively occupied, given the availability of fresh water and food resources (water fowl, turtles, kangaroos etc). Wells were dug close to swamps in order to filter water and some swamp vegetation was consumed. Spears were made from 'spear wood' and comprised an important trade item. Pads connected the wetlands and rivers and extended through this territory from the present-day Perth area south to Rockingham, Mandurah and the Murray River.

South of the *Beerliar* territory, according to Lyon (1833, cited in Green 1979:177) lay the territory of *Banyowla* of the Murray River or *Pinjarup (Bidjareb)* tribe. In subsequent years, the area was described by Hammon (1933) as the domain of *Winjan,* a celebrated Aboriginal leader, who ranked in influence equally with *Yellagonga, Midgegooroo* and *Yagan* but with somewhat less violent associations. The local group to which Winjan belonged, according to Hammon was 'the South West tribe'. Tindale (1974:256), however thinks that they were the *Pinjarup (Bidjareb)*. The present ethnographic perspective is informed by an imputed direct line of descent from *Winjan*.

Ethnohistorical data suggests that there was a great deal of movement in these coastal groups. Individuals, families and bands moved between areas, generating a fluid local population size and composition and suggesting that boundaries between territories were very permeable. Hallam (1975) points out that the picture of Aboriginal life which emerged was an artefact of European observers' concentration on geographical areas and patrilineal relationships. A more accurate description of the situation is that of a system of overlapping sets of ritual and social connections with land usage rights based on membership of both matrilineal and partrilineal groupings.

The destruction of Aboriginal social organisation was heralded by European colonisation, beginning in the Perth area and

extending into the south-west. During this process, the Nyungar population was decimated. Epidemics, shootings by Europeans, the draconian policies introduced by the colonial administration, including forced exclusion of Nyungars from certain areas (e.g., urban areas), their concentration in settlements (e.g., Carrolup, Moore River), and restrictions on movement and labour resulted in an attenuation of traditional ties with the land and with sites (Berndt 1979; Hammond 1933). As a result, there has been a loss of traditional mythological and ritual associations with the land along with the knowledge which underpins these connections. However, there is still a substantial degree of knowledge available within Nyungar society concerning traditional mythological and ceremonial sites. In some instances, the sites are known but the mythology is lost; in other cases, the mythology is remembered but the site location has been forgotten. A similar pattern is repeated in Eastern Australia.

Rather than destroying all senses of solidarity and sources of identity, the ravages of colonisation have served to strengthen Nyungar social bonds and have created a strong Nyungar identity. New links to the country on the basis of historical and biographical associations have been formed post-colonisation and the attendant relocation and reorganisation of Nyungar groups.

In summary, there are two principal kinds of connections between individuals and families and the land and sites in Aboriginal society. They are:

1. Spiritual, mythological or religious; and
2. Historical/social associations.

These associations are not simply a matter of sentiment. Aboriginal connection with the land, and specific sites is spiritual. This means that Aboriginal people perceive links which involve the total life-cycle (birth, death, transitions of station/initiation) which infuse the sites with a dense and culturally palpable meaning. This may extend to beliefs that the trees, earth and other natural features are the domain of spirits of the deceased. This locates Aboriginal attachments to the land and sites in a spiritual history, grounding their present actions, and which provide a framework for a meaningful and culturally continuous future.

There is no doubt that the strength of attachments varies between individuals and families according to their life experiences, values, and a range of other factors. However, there is, overall, a recognition that these associations are crucial elements of Nyungar society.

3.4 Ethnographic Research

There is a number of Aboriginal sites in the region surrounding the PDA. The coastal area, as noted in the section of Ethnographic Background, was constantly traversed by Nyungars and used for camping, meeting, ceremonies and food gathering. According to the principal Aboriginal informant, Mr Frank Nannup, local Nyungars identified their territory as a domain which extended along the coast, encompassing the PDA.

Mr Nannup is a direct descendant of Winjan. During the ethnographic fieldwork, which took place on the 20th June, 1991, Mr Nannup pointed out the location of Winjan's camp, approximately 60 metres West South West of the PDA. He made a special plea for this campsite to be recognised in some way ... preservation of an area of land, signposting, and information boards were suggested.

Another influential and knowledgeable Aboriginal person, Mr Andy Nebro, was sought for the research. However, despite numerous attempts to contact him, he could not be located. It is important to note, however, that Mr Nebro had been consulted about the area surrounding the PDA in other, recent research projects conducted by McDonald, Hales and Associates, as had Mr Nannup. Indeed, McDonald, Hales and Associates has had extensive Aboriginal Heritage involvement in the Mandurah area in the last two years. During these projects, a number of Aboriginal people have been consulted concerning the location of sites.

Mr Nannup's father was also an influential Nyungar; he was responsible for significant ceremonies and especially for the dances. During Mr Nannup's lifetime, in which he has spent at least fifty years in the Mandurah area, his father exposed him to both ceremonial and secular Aboriginal patterns of conduct. In addition, the run which was established by his and related families extended from South of Bunbury to Geraldton, but the focus of life remained for the most part in the Mandurah area.

Sociocultural and ethnohistorical perspectives on the PDA and its surrounds is gained by contexting the known sites within the region with the informant's knowledge. The PDA is within the orbit of Nyungar runs and pads which extend down the coastal region, linking resource areas, camping sites and ceremonial sites.

O'Connor, Quartermaine and Bodney (1990:4) note that Aboriginal people who lived in the Mandurah-Pinjarra area before the arrival of Europeans had a ford across the Mandurah Estuary between Erksine and Coodanup. The exact location of the crossing is not known today. But there is information concerning the location of campsites. Mr Nannup noted that, in contact with Mr Tom Cooper, he learned that there had been camps on and around the PDA although precise locations could not be identified.

Mr Nannup and other Aboriginal people associated with the area

have expressed strong concerns about the spiritual values of all the land through which Nyungar people moved. Of special interest are the fresh water sites (rivers, streams, ponds, lakes, swamps) which are associated with the mythical being, the Waugal. In this belief system, the Waugal is both creator and benefactor with respect to mankind as well as destroyer and malefactor (bringer of illness, death and misfortune). Any impingement on such sites, therefore, is regarded with great seriousness.

Aboriginal people have expressed the wish that the PDA be appropriately named and signposted, as with Winjan's campsite above. This is consistent with the aims of Aboriginal people in the Mandurah area to preserve their culture and to educate both the Aboriginal and white communities regarding Aboriginal Heritage in the region.

3.5 Recommendations

It is recommended that development should proceed subject to a Section 18 clearance being sought and accepted as defined in the Aboriginal Heritage Act 1972-1980.

In addition, it is recommended that consultation on naming, signposting, and related matters be undertaken with the Winjan Progress Association.

BIBLIOGRAPHY

Bates, D 1985 The Native Tribe of Western Australia I. White (ed) Canberra. National Library of Australia.

Berndt. R. 1979. "Aborigines of the South-West" in Berndt, R. and Berndt, C.H. Aborigines of the West. Nedlands. University of WA Press.

Biggs, E.R., Leech R.E.J. & Wilde, S.A 1980 "Geology, mineral resources and hydrogeology of the Darling System, Western Australia, Atlas of Natural Resources, Darling System. Perth. Department of Conservation and Environment.

Bowdler, S. 1977 "The coastal colonisation of Australia" in J. Allen, J. Colson & R. Jones (eds) Sundra and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia. London. Academic Press.

Dortch, C.E., Kendrick, G.W. & Morse, K. 1984 "Aboriginal mollusc exploitation in southwestern Australia" Archaeology in Oceania vol 19:81-104

Grey, G. 1841 Journals of two expeditions of discovery in Western Australia Vol 2. Boone. London.

Green, N. (ed). 1979. Nyungar - The People: Aboriginal usage and European usurpation in south-western Australia. Canberra. Australian Institute of Aboriginal Studies.

Hallam, S.J. 1986. "Prehistoric Aboriginal Populations on the Swan Coastal Plain, Western Australia" Australian Research Grants Scheme. Unpublished report.

Hammond, J. 1933 Winjans People. Perth. Imperial Printing.

McArthur, E.M. & Bettenay, E.
1960 "The development and distribution of the soils of the Swan Coast Plain, W.A." in Soil, Publication 16. Melbourne. CSIRO.

Machin, B. 1989 Report of an Ethnographic Survey of the Mangles Bay Marina Development. Fremantle: McDonald, Hales and Associates.

O'Connor, R., Bodney, C., and Little, L. 1985.
Preliminary report on the survey of Aboriginal areas of significance in the Perth metropolitan and Murray River regions. Perth: Aboriginal Sites Department.

O'Connor, R., Quartermaine, G., and Bodney, C., 1990
Report on the Survey for Aboriginal Sites Mandurah Quay Development. Unpublished report to Le Provost, Sememiuk and Chalmer.

Quartermaine, G., 1986 Report on the Archaeological survey of the Point Grey Development study area. Unpublished Report to Dames, Moore.

Seddon, G. 1972 Sense of Place. Nedlands, University of Western Australia Press.

Strawbridge, L., 1989 An archaeological survey for Aboriginal sites in the area of the Dawesville Channel Project. Unpublished
Report to dept Marine and Harbours.

Wilde, S.A. & Low, G.H.
1978 "Explanatory Notes on the Perth 1;250,000 geological sheet, Western Australia" Perth. Geological Survey of W.A.

APPENDIX

Obligations Relating to Sites Under the Aboriginal Heritage Act 1972 - 1980

"Report of Findings

15. Any person who has knowledge of the existence of anything in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual or ceremonial significance, cave or rock paintings or engravings, stone structures or arranged stones, carved trees, or of any place or thing to which this act applies or to which this act might reasonably be suspected to apply shall report its existence to the Trustees, or to a police officer, unless he has reasonable cause to believe the existence of the thing or place in question to be already known to the Trustees.

Excavation of Aboriginal Sites

16. (1) Subject to Section 18, the right to excavate or to remove any thing from an Aboriginal site is reserved to the Trustees.

(2) The Trustees may authorise the entry upon and excavation of an Aboriginal site and the examination or removal of any thing on or under the site in such a manner and subject to the such conditions as they may direct.

Offences Relating to Aboriginal Sites

17. A person who -

(a) excavates, destroys, damages, conceals or in any way alters any Aboriginal site; or

(b) in any way alters, damages, removes, destroys, conceals, or who deals with in a manner not sanctioned by relevant custom, or assumes the possession, custody or control of, any object on or under an Aboriginal site, commits an offence unless he is acting with the authorisation of the Trustees under section 16 or the consent of the Minister under section 18.

Consent to Certain Uses

18. (1) For the purposes of this section, the expression "the owner of any land" includes a lessee from the Crown, and the holder of any mining tenement or mining privilege, or of any right or privilege under the Petroleum Act 1967, in relation to land.

(2) Where the owner of any land gives to the Trustees notice in writing that he requires to use the land for a purpose which, unless the Minister gives his consent under this section, would be likely to result in a breach of Section 17 in respect of any Aboriginal site that might be on the land, the Trustees shall, as soon as they are reasonably able, form an opinion as to whether there is any Aboriginal site on the land, evaluate the importance and significance of any such site, and submit the notice to the Minister together with their recommendation in writing as to whether or not the Minister should consent to the use of the land for that purpose, and where applicable, the extent to which and the conditions upon which his consent should be given.

(3) Where the Trustees submit a notice to the Minister under subsection (2) of this section he shall consider their recommendation and having regard to the general interest of the community shall either-

(a) Consent to the use of the land the subject of the notice, or a specified part of the land, for the purpose required, subject to such conditions, if any, as he may specify; or

(b) wholly decline to consent to the use of the land the subject of the notice for the purpose required,

and shall forthwith inform the owner in writing of his decision.

(4) Where the owner of any land has given to the Trustees notice pursuant to subsection (2) of this section and the Trustees have not submitted it with their recommendation to the Minister in accordance with that subsection the Minister may require the Trustees to do so within a specified time, or may require the Trustees to take such other action as the Minister considers necessary in order to expedite the matter, and the Trustees shall comply with any such requirement.

(5) Where the owner of any land is aggrieved by a decision of the Minister made under subsection (3) of this section he may, within the time and in the manner prescribed by rules of court, appeal from the decision of the Minister to the Supreme Court which may hear and determine the appeal.

(6) In determining an appeal under subsection (5) of this section the Judge hearing the appeal may confirm or vary the decision of the Minister against which the appeal is made or quash the decision and substitute his own decision which shall have effect as if it were the decision of the Minister, and may make such an order as to the costs of the appeal as he sees fit.

(7) Where the owner of the land gives notice to the Trustees under subsection (2) of this section, the Trustees may, if they are satisfied that it is practicable to do so, direct the removal of any object to which this Act applies from the land to a place of safe custody.

(8) Where consent has been given under this section to a person to use any land for a particular purpose nothing done by on behalf of that person pursuant to, and in accordance with any conditions attached to, the consent constitutes an offence against this Act."

APPENDIX 4

ENGINEERING DETAILS

AIREY RYAN & HILL
Consulting Engineers

26th November, 1992

The Manager
Halpern Glick Maunsell Pty Ltd
1 Ord St
WEST PERTH W.A. 6005

Attention: Mr. Ian McCardle

Dear Sir,

MANDURAH MARINA - PROPOSED REDEVELOPMENT

Further to recent discussions we enclose herewith comments on the various sections of the engineering input to the C.R. which we have been requested to provide.

1.0 EARTHWORKS

1.1 Proposed Building Block Heights

It was demonstrated by the Water Authority of W.A. (Public Works Department) in their publication "The Murray River Flood Study" that water in the Peel Inlet could rise to a level of R.L. 1.6 AHD as a result of a one in one hundred year flood of the Murray River (in addition to the Serpentine and Harvey Rivers) associated with a reasonably high ocean tide of R.L. 0.6. It has also been established that it is possible for a cyclonic storm surge equal to R.L. 1.5 to occur approximately mid way between the old PWD jetty tide gauge and the old Mandurah traffic bridge. It is estimated that this level could occur in conjunction with a water level in the Peel Inlet of approximately R.L. 0.7m. This compares with measured readings taken during Cyclone Alby in April, 1978 of R.L. 0.88m at the PWD tide gauge and 0.53m in the Peel Inlet (Chimneys tide gauge) and is therefore a very much more severe occurrence than Cyclone Alby.

These levels and the location of various relevant points and levels are graphically represented on Figure .1

The proposed block levels for the development have been established as follows with comparisons to the method by which the approved block levels of two neighbouring developments were established. All levels are to AHD

Table 1

Waterside Mandurah Stage I - 1985 Approval

Max Storm Surge	R.L. 1.2m
Wave run up	0.2m
Freeboard	0.2m
Additional safety factor (Greenhouse etc.)	0.2m
	R.L. 1.8m

16 ALTONA STREET, WEST PERTH
P.O. BOX 553, WEST PERTH
WESTERN AUSTRALIA, 6005
TELEPHONE (09) 481 2199
TELEX AA 92881 (PUBTLX) PE1187
FAX 481 2049

P. G. Airey & Associates Pty. Ltd.
as trustee for
P. G. Airey & Associates Unit Trust
trading as
AIREY RYAN & HILL

DIRECTORS
PETER AIREY BE GRAD DipADMIN FIEAust MConsEAust
JOHN RYAN AIT MIEAust MConsEAust
JOHN HILL BE FIEAust MConsEAust

TECH. DIRECTORS
R. PATERSON BAppSc MIEAust(Civil)
G. ROBINSON BE Hons MIEAust(Structures)
J. TAYLOR AIT MIEAust(Structures)

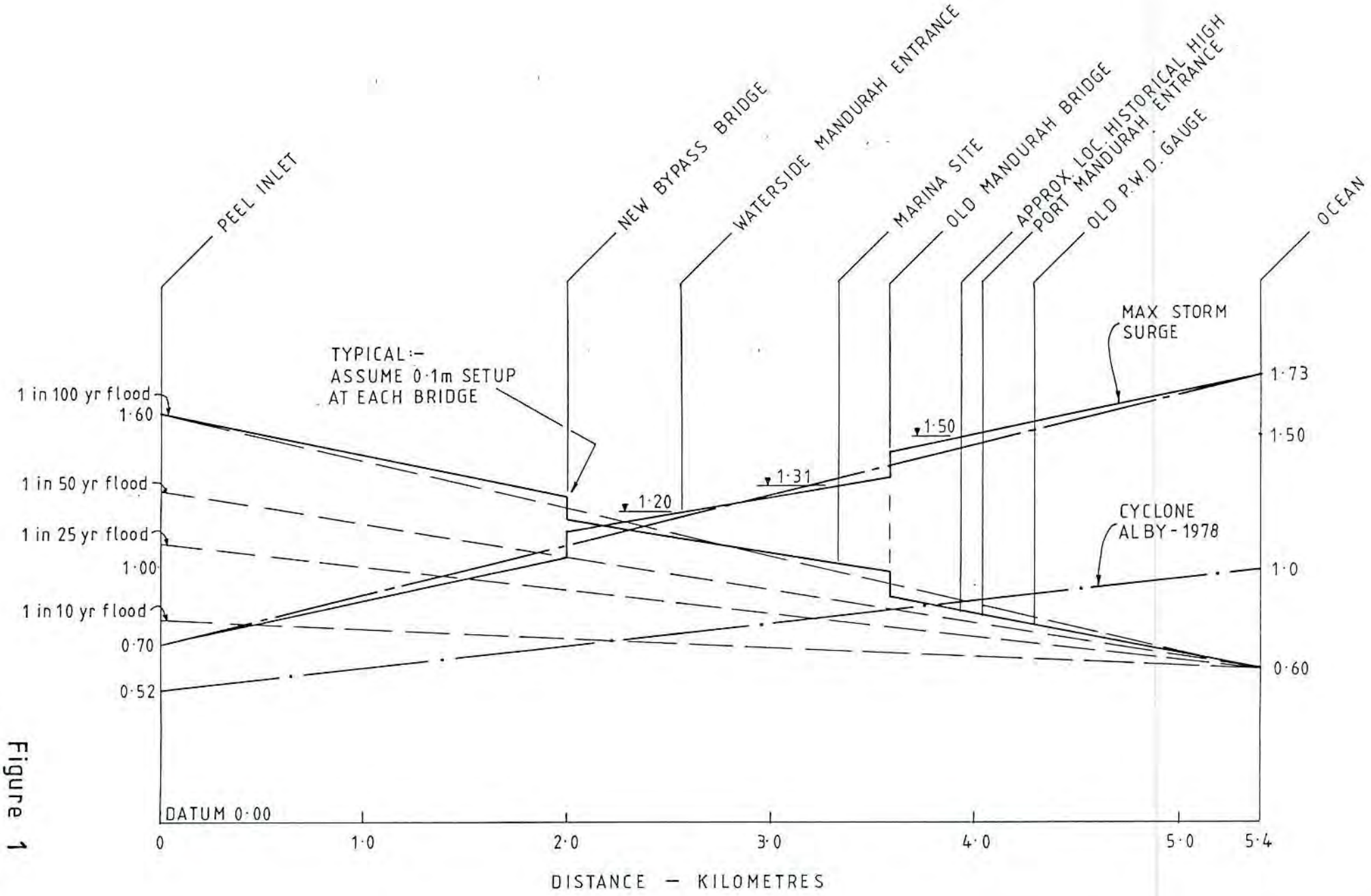


Figure 1

FLOOD LEVELS

The original Port Mandurah Development was known as the Halls Head Waterway Development and was approved in July, 1985 with minimum block levels of R.L. 1.9 as indicated below in Table 2. The project was reassessed for it's new principal in 1989 when an additional allowance of 0.3m was made for a possible future Greenhouse Effect and a minimum block level of R.L. 2.2 was approved as per the following table.

Table 2

Original Port Mandurah - 1985		**Revised Port Mandurah - 1989**
Max Storm Surge	R.L. 1.5m	R.L. 1.5m
Wave run up	0.2m	0.2m
Freeboard	0.2m	0.2m
Possible Greenhouse Effect	-	0.3m
	R.L. 1.9m	R.L. 2.2m

Therefore, with reference to figure 1. it can be seen that the maximum threat to flooding on the Marina site is not from a river induced flood but is controlled by the same mechanism as the Port Mandurah Development, that is a possible high storm surge and the maximum likely level is R.L. 1.31m. Hence the proposed minimum block level for this development is as indicated on Table 3 below.

Table 3

Proposed Mandurah Marina Redevelopment - 1991

Max Storm Surge	R.L. 1.31m
Wave run up	0.20m
Freeboard	0.20m
Greenhouse	0.30m
	R.L. 2.01m

Say 2.1m

Hence, it is proposed that a minimum block level of R.L. 2.1 AHD be utilised for all the likely building envelope areas of the development.

1.2 **Dredged Depths**

It is proposed that the marina be dredged to a minimum depth of R.L. -2.7 at the head of the marina to R.L. -3.5 where it enters the main channel. This gradual slope will facilitate complete turning over of the water within the waterway and will still enter the main channel considerably hgiher then the bottom level of the main channel adjacent to the marina which approximates R.L. -4.70.

1.3 **Source of Fill**

The source of the filling material to raise the blocks above the 1:100 year flood level will come from two sources.

a) The dredged material as referred to in paragraph 1.2 above, and

b) Imported sand fill from an external source.

This imported sand fill will be of a free draining variety to ensure that no problems are encountered either with draining within the house properties or with road subgrades.

2.0 WATERWAY WALLING

It is proposed that the walling for the waterway consist of a sloping revetment lined with limestone spalls of a size approximately half a metre in diameter to prevent movement by either the limited wave action within the development or vandalism. The method has been discussed with officers from the City of Mandurah. The rough sloping texture of the rock face will aid in dissipation of wave energy generated by boats within the waterway, but at the same time the rapid increase in depth from the two horizontal to one vertical slope of the wall will ensure maximum availability of water area for boat mooring and manoeuvrability. The rock face will be underlain by an approved filter cloth to permanently protect the land from erosion.

It is therefore confidently predicted that with some minor maintenance over the years, the wall will have a 100 year design life. The construction proposed is similar to that of the entrance into the recently completed Port Mandurah Development and that of the earlier Waterside Mandurah Development.

3.0 DESIGN VESSEL

It has been assumed for this development that the design vessel will be 10m long x 4m wide x 1.5m maximum draft.

The minimum waterway widths have been set as indicated on the accompanying drawing so as to maintain a clear navigable waterway between mooring piles of at least twice the design boat length, that is, 20m.

The above criteria satisfies the requirements of the Canal Estate Guidelines.

4.0 SERVICES

4.1 Roads

The internal road system will be a standard subdivisional construction of a flexible pavement and asphalt seal to the approval of the City of Mandurah. It is proposed that certain key areas be brick paved to enhance the developments appearance.

4.2 Stormwater Drainage

A piped stormwater drainage system will be installed within the road reserve. All road gullies will be trapped and the final manhole in each section prior to discharging stormwater to the waterway will be trapped to minimise the possibility of any pollutant from the road system entering the waterway.

The stormwater drainage system will be designed for the normal subdivisional requirements to cater for a 1 in 5 year return period storm without any surcharging to any gullies or manholes. A larger storm than a 1 in 5 year return period will be catered for by temporary ponding on the road pavement and a major 1:100 year storm will be prevented from flooding houses by escape to the waterway system and the estuary by means of the strategically located PAW's, which will be kept below the level of the house lots.

A stormwater connection will be provided to each house lot for connection to the roof plumbing downpipe system. Difficulty has been experienced with small lot subdivisions in the Mandurah region with disposing of stormwater on the site and the system proposed herein has been discussed with PIMA and with the City of Mandurah and is generally to their satisfaction. Naturally formal approval has not yet been obtained.

Discussions with the City of Mandurah have indicated that they require the existing stormwater drainage gullies on the adjacent Old Coast Road to be picked up and piped through the development to the waterway system and it is therefore planned to carry out this request. In addition, drainage lines approaching the site from the northern side which drain a section of Mary St immediately west of the bridge, will be provided with a stormwater connection through to the waterway system so that the table area will have a completely piped drainage system.

4.3 **Sewerage Reticulation**

The lot is within the catchment area of the main Port Mandurah Vacuum Sewerage Pumping Station. A vacuum main will require extension from a location near the intersection of Mary St and Leighton Place and there are no difficulties in providing this service.

4.4 **Water Reticulation**

In a similar manner, discussions with the Water Authority in Bunbury have indicated that there is no problem in supplying water reticulation to the development. A connection will have to be constructed to the low pressure reticulation on the POS between Mary Street and the Shell Service Station on Old Coast Road since the pressure main adjacent to the lot is a high pressure main and cannot be tapped directly.

4.5 **Underground Power**

Preliminary discussions have taken place with the State Energy Commission in regard to the provision of underground power. It has been advised that there is no problem in connecting the development to the S.E.C.'s reticulation.

4.6 **Telecom**

Discussions have also taken place with Telecom in regard to the provision of Telecom services to all lots and it is advised that there is no problem in providing this service.

Yours faithfully,

J. D. S. HILL
Airey Ryan & Hill

JDH2611.L1.jp

APPENDIX 5

FLUSHING STUDY

AN ASSESSMENT OF THE FLUSHING CHARACTERISTICS OF THE PROPOSED MANDURAH MARINA REDEVELOPMENT

prepared by

D.P. Lewis

July 1991

for

HALPERN GLICK MAUNSELL PTY LTD

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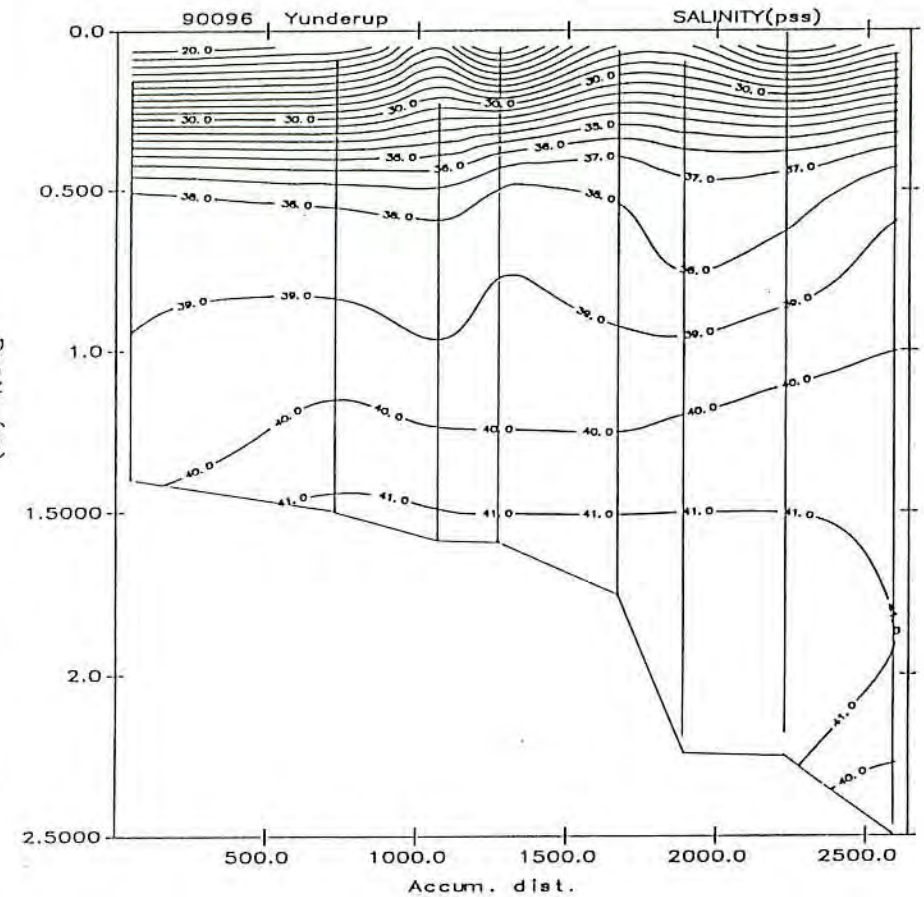

Figure 5A Salinity contours : 13 45 6/4/90

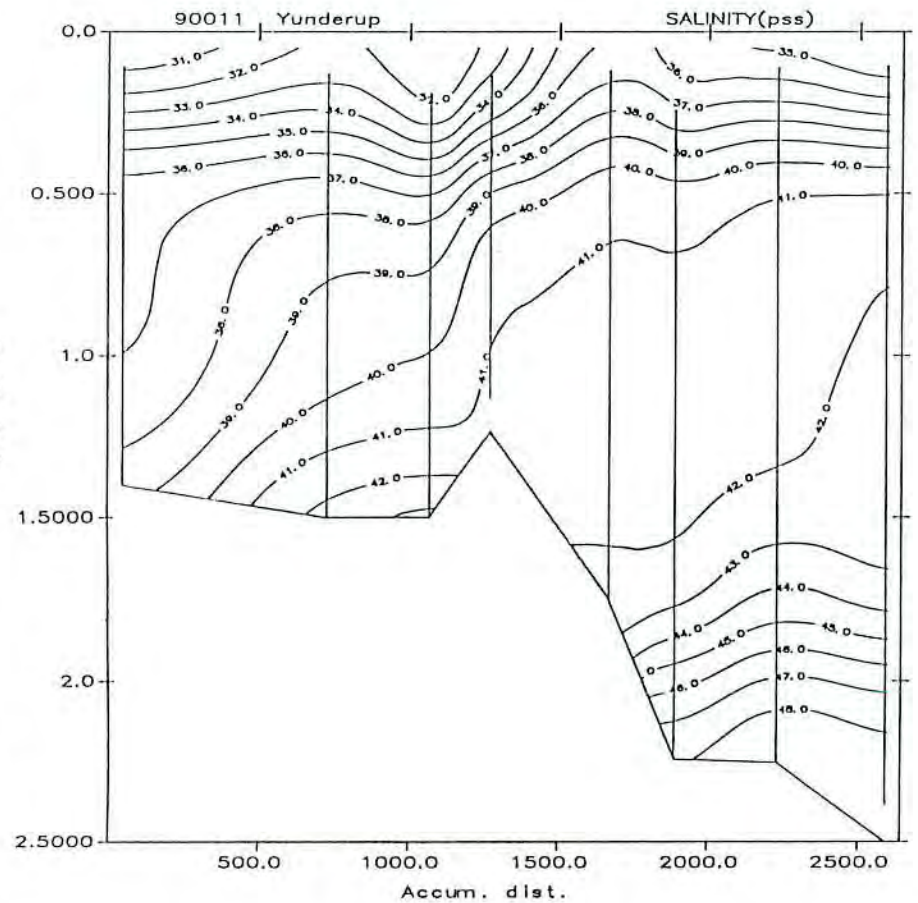

Figure 5B Salinity contours : 15 45 11/1/90

Figure 5

SALINITY CONTOURS:
PEEL INLET TO YUNDERUP CANALS

MANDURAH MARINA

(Brown et al, 1990)

Halpern Glick Maunsell

It is important to note the inclusion of two special features in the design of the enlarged basin, both aimed at maximising the rate of exchange of basin water with the Mandurah Estuary channel. First, the enlargement has been set on a north-south alignment to maximise its exposure to the predominant southerly winds experienced in summer, thereby maximising wind generated circulation within the basin. Second, the bed level of the enlarged basin has been set above the level of the bed of the existing marina basin and the Mandurah Estuary channel to ensure that no dense, poor quality water can be trapped within the development.

3. ESTIMATED RATE OF FLUSHING

Flushing of the redeveloped basin will be influenced by all of the following mechanisms:

- tidal exchange
- wind generated shear dispersion
- gravitational exchange

Previous work carried out in waterway and canal developments in both Peel Inlet and the Mandurah Estuary channel has shown that gravitational exchange is usually the dominant mechanism which, combined with tidal and wind generated circulation, has resulted in characteristic flushing times for the relevant water bodies of the order of several days or less.

This section estimates the rate of flushing of the enlarged southern basin of the development. Each of the above mechanisms is addressed in turn.

3.1 TIDAL EXCHANGE

Flushing of the enlarged basin by tides is calculated using the traditional tidal prism method. This assumes that the exchange flow is a function only of the tidal range and period. The method also assumes that the water in the basin is always completely mixed (ie that the water incoming on the flood tide is fully mixed with the water in the basin during each tidal cycle) and that none of the water leaving the basin on the ebb tide returns on the subsequent flood flow.

The time scale for tidal flushing is then given by:

$$T_t = \frac{V_{lw} T_p}{V_{tp}} \qquad (3.1)$$

where V_{lw} is the volume of water stored in the basin at low water, T_p is the tidal period and V_{tp} is the tidal prism volume (ie tidal range times the basin surface area).

As discussed in Section 2.4, the basin can be conservatively assumed to be flat bottomed with vertical boundary walls thereby simplifying Eq. 3.1 to:

$$T_t = \frac{h_{lw} T_p}{h_{tr}} \qquad (3.2)$$

where h_{lw} is the water depth at low water and h_{tr} is the range in tidal elevation.

3.1.1 Astronomical Tides

The tidal period of diurnal astronomical tides is close to one day. The ratio h_{lw}/h_{tr}, however, depends upon the assumed tidal condition. Table 1 gives a MLLW level of 0.6m with a corresponding mean tidal range of 0.3m to MHHW. The flushing time between high and low water tidal conditions is then of the order of 10 days (the average water depth in the enlarged basin being 2.94m to MLLW). The flushing time drops to 7.3 days for a tidal range of 0.4m, as quoted by Port & Harbour Consultants (1990).

This result indicates that on average, between 10% and 15% of the water volume stored in the enlarged basin will be exchanged with the adjacent channel water between the low and high water conditions of any given tidal cycle.

3.1.2 Barometric Tides

In most coastal water bodies the water velocities generated by barometric water level variations are so small as to have little influence on the flushing. The velocity V_b is given by:

$$V_b = \frac{L_b}{T_{tb}} = \frac{L_b}{T_p}\,\frac{h_{tr}}{h_{lw}} \qquad (3.3)$$

where L_b is the basin length scale and T_{tb} is the barometric flushing time scale.

In Peel Inlet, however, the extreme barometric water level fluctuations described in Section 2.1 do have some influence on the rate of exchange. Fluctuations ranging up to 0.5m occurring over periods of several days have been observed in the inlet. Such a condition would give a flushing time of around 15 to 20 days for the redeveloped basin.

3.2 WIND GENERATED SHEAR DISPERSION

Wind shear acting on the water surface of the basin will generate vertical and transverse circulation currents within the enclosed basin. The stress exerted on the surface of the water generates a vertical velocity profile in the water column with a positive velocity in the direction of the wind at the surface and a negative return flow at depth. The result is a net exchange of water between the basin and the adjacent water body (the Estuary channel) together with effective longitudinal mixing of the water column as a result of the shear dispersion generated by the velocity gradient over the water depth. In basins of non-uniform geometry, lateral circulations may also be generated, resulting in enhanced longitudinal mixing (Csanady, 1966). These transverse circulations, however, have been ignored in this study.

The vertical shear will be maximised when the wind is blowing along the axis of the basin, ie in a north-south direction. Section 2.2 indicated that during the critical late summer/early autumn months, the winds do indeed blow predominantly from the south and south-east sectors, thus increasing the effective wind flushing of the enlarged basin.

The wind shear stress acting on the water surface is given by:

$$T_{ss} = p_a C_d U_w^2 = p_w U^{*2} \quad (3.4)$$

where p_a and p_w are the air and water densities respectively, C_d is the drag coefficient (usually taken as 1.3×10^{-3}), U_w is the free wind speed and U* is the surface shear velocity.

The longitudinal flushing time scale is defined as:

$$T_w = L_b^2 / K_x \quad (3.5)$$

where K_x is the longitudinal dispersion coefficient given by:

$$K_x = C_2 h_m U^* \quad (3.6)$$

where C_2 is a constant of order 10 (Imberger and Monismith, 1986) and h_m is the mean water depth.

Assuming the mean wind speed over the water surface is $3.5 ms^{-1}$ and that this wind acts over the full surface area of the enlarged basin, then substituting for $p_a = 1.2 kgm^{-3}$, $p_w = 1{,}025 kgm^{-3}$, $C_d = 1.3 \times 10^{-3}$, $h_m = 3.1m$ and $L_b = 270m$ gives:

$U^* = 4.3 \times 10^{-3} ms^{-1}$
$K_x = 0.133 m^2 s^{-1}$
$T_w = 6.3$ days

That is, the time scale for flushing of the enlarged basin under the action of surface wind shear alone is around 6.3 days.

It should be noted that:

(a) The wind fetch has been assumed to be relatively unobstructed. Should there be significant sheltering of the water surface, then the flushing time will increase, for example, reducing the mean surface wind speed to $2 ms^{-1}$ will increase the flushing time to around 11 days.

(b) Density stratification of the water column, which may suppress the wind induced shear, has been ignored.

(c) The surface winds may cause floating debris and contaminants to be trapped in the southern end of the basin thus requiring some form of routine surface management.

3.3 GRAVITATIONAL EXCHANGE

Density driven exchange is likely to be the dominant flushing mechanism in the redeveloped marina. Chedzey et al. (1991) describes two equations for estimating the flow velocity generated by a density gradient in a water body:

$$V_v = \frac{0.011 g D_p h_m^3}{L_b \rho_w K_v} \quad (3.7a)$$

$$V_I = \frac{0.5 (g D_p h_m)^{0.5}}{(\rho_w)^{0.5}} \quad (3.7b)$$

where D_p is the horizontal density difference and g is gravitational acceleration constant.

Equation 3.7a describes the gravitational flow velocity V_v when viscous forcing balances the buoyancy flux. Equation 3.7b describes the more common result where the inertia (ie momentum) balances the buoyancy forcing (see Turner, 1973) giving the density driven flow velocity V_I. K_v in Equation 3.7a is the vertical eddy diffusivity which is defined by:

$$K_v = 0.067 h_m U^* = 8.93 \times 10^{-4} m^2 s^{-1} \quad (3.8)$$

Assuming D_p to be $2 kgm^{-3}$ (see Section 2.3) gives:

$$V_v = 0.026 ms^{-1}$$
$$V_I = 0.12 ms^{-1}$$

The relevant flushing time can then be estimated by:

$$T_G = \frac{2L_b}{V} \quad (3.9)$$

which gives a flushing time scale of between 1.25 hours and 5.75 hours depending upon the relative strengths of the viscous and inertial forcings. In either case, the rate of flushing of the basin is significantly less than one day. Indeed, a gravitational flushing time scale of one day requires a density gradient of less than $0.5 kgm^{-3}$ over the length of the enlarged basin. Given the nature of Peel Inlet and the proximity of the basin to both oceanic and riverine inputs, such a gradient is likely to exist at most times of the year.

4. CONCLUSIONS

This report estimates the influence of tides, winds and density variations on the flushing of the proposed Mandurah marina redevelopment. Exchange rates calculated for each of the flushing mechanisms show that gravitational exchange will dominate, with flushing of the water body taking place over time scales of the order of one day (or less).

In the absence of the density gradients required to drive gravitational flushing, wind generated shear dispersion will flush the enlarged basin in around 6.3 days (depending upon the strength and duration of the surface winds). Tidal flushing of the basin will take place over a period of around 10 days depending upon the tidal range.

The proposed enlargement has been carefully designed to maximise the potential flushing of the water body through:

(a) The north-south alignment of the enlarged basin maximising the exposure of the water surface to the dominant wind sectors in the critical late summer months.

(b) The specification that the bed profile gradually slopes towards the Mandurah Estuary channel so that the enlargement is no deeper than either the existing basin or the channel so as to prevent trapping of dense water within the basin.

Previous work carried out in both Peel Inlet and the Mandurah Estuary channel has demonstrated that the combination of gravitational, wind and tidal forcing was sufficient to flush the relevant water bodies over periods ranging from one to five days. The results described in this report indicate that the enlarged basin will demonstrate similar flushing characteristics and thereby ensure that the quality of the water in the basin is consistent with that of the source water body (ie the Estuary channel).

In summary:

1. The water quality in the Mandurah marina redevelopment will be consistent with that of the source water (ie the Mandurah Estuary channel).

2. The water quality in the channel (or in Peel Inlet) will not be adversely affected by the enlargement of the Mandurah marina (provided the appropriate management strategies are implemented as discussed in Section 1.1).

3. The water quality in the proposed development will be affected from time to time by the poor water quality in Peel Inlet, however, it has been shown (LeProvost et al, 1989) that the water quality in the Mandurah Estuary channel is consistently higher towards the ocean (ie towards the location of the existing Mandurah marina).

It is therefore confidently predicted that water exchange in the Mandurah Marina redevelopment will be adequate to ensure no degradation of water quality in either water body as a direct result of the proposed redevelopment.

5. REFERENCES

Brown, S., Chedzey, L. and Lewis, D.P. (1990). Yunderup Canals Flushing Study. UWA Report No. WP453SB.

Chedzey, L., Brown, S. Ivey, G. and Imberger, J. (1991). Gravitational Flow in a Canal Estate. Submitted to Inst. of Eng. Aust. Civil Eng. Trans. (In press)

Csanady, G.T. (1966). Accelerated Diffusion in a Skewed Shear Flow of Lake Currents. J. Geophys. Res. 71: 411-420.

D'Adamo, N. (1983). Hydrodynamic Considerations for the Proposed Murray River Canal Development, South Yunderup. UWA Report No. ED83044.

Hunter, J.R. (1987). The Flushing of Basins in Western Australia. Appendix to the Westport Project ERMP.

Imberger & Associates (1982). An assessment of Flushing Times in the Proposed Murray River Waterfront, South Yunderup. Appendix to Murray River Waterfront NOI.

Imberger, J. and Monismith, S. (1986). A Model for Deepening Due to Upwelling. J. Fluid Mech. 171:432-439.

LeProvost Semeniuk & Chalmer (1989). Waterwide Mandurah Canal Estates, Environmental Monitoring Programme, August 1986 to June 1987. Submitted to EPA.

Pers.comm. Riedel & Byrne (1990). Canal Flushing Study, Port Mandurah.

Port & Harbour Consultants (1990). Flushing Characteristics, Mandurah Quay. Report No. R294.

Public Works Department (1981). Map 52603 Peel Inlet and Harvey Estuary.

Turner, J.S. (1973). Buoyancy Effects in Fluids. Cambridge University, Press, London.

van Senden, D.C. (1986). The Proposed Extension to Yunderup Canal Estate. UWA Report No. WP86032.

APPENDIX 6

CANAL ESTATE GUIDELINES

POLICY NO. DC 1.8

PROCEDURES FOR APPROVAL OF ARTIFICIAL WATERWAYS AND CANAL ESTATES

BACKGROUND NOTES

1. Since 1981 with subsequent amendment, procedures for approval of artificial waterways and canal estates have been governed by provisions contained within the Recommendations for the Development of Canal Estates. This document was prepared by the Steering Committee on Canal Developments under the Chairmanship of the Waterways Commissioner and, via the then Minister for Conservation and Environment, submitted to and approved by Cabinet as Cabinet Policy.

2. In the light of events of recent years that Cabinet Policy is now in need of review. In consultation with other government departments, it has been determined that, as the procedures relate most directly to planning issues and planning processes and provide the continuum between initial proposals and development stages of a canal estate, Commission Policy is the most appropriate vehicle for setting out those procedures.

3. This Policy Statement sets out the general principles and procedures which should be observed and followed by those proposing to undertake projects involving artificial waterways and canal estates. These projects affect the interests of many authorities and agencies and so it is important that the recommended procedures are followed as closely as possible to achieve the best and quickest results from the system through which proposals must pass before approvals are obtained.

4. Since 1981, canal estate projects have been assessed using procedures set out in the Cabinet endorsed policy in a document entitled Recommendations for the Development of Canal Estates. While much of the substance of that document has continued relevance and has been repeated in this Policy, refinements and modifications have been found necessary due to changes within Government and in the light of operating experience. This Policy supersedes that earlier document.

5. Related Policy Statements are:

   Policy No DC 2.2 - Residential Subdivision and

   Policy No DC 6.1 - Country Coastal Planning Policy.

POLICY NO. DC 1.8

PROCEDURES FOR APPROVAL OF ARTIFICIAL WATERWAYS AND CANAL ESTATES

CONTENTS:

1. INTRODUCTION

The proposed Mandurah marina redevelopment is located on Lot 11 of Murray Location 58 on the Old Coast Road, approximately 300m south of the Mandurah Traffic Bridge (see Figure 1).

The site is presently used as a marina and provides limited facilities for boat launching and mooring, fuelling, dry boat storage, boat hire and marine hardware. The existing marina utilises two excavated basins with direct access to the Mandurah Estuary channel (Figure 2).

The proposed redevelopment is showm in Figure 3. The existing northern basin will remain essentially unaltered whilst it is proposed that the existing southern basin be enlarged by approximately 7,000m^2.

Recognising the need to demonstrate that the proposed redevelopment will not result in the degradation of the water quality in either the source water body (ie the Mandurah Estuary channel) or the enlarged basin, this report was commissioned in June 1991 by Halpern Glick Maunsell Pty Ltd (HGM) to assess the flushing characteristics of the marina.

The assessment of the full range of parameters likely to influence the water quality of the marina has been undertaken by HGM. This report focuses solely on the physical flushing of the marina to predict the rate of exchange between the enlarged southern basin waters and the Mandurah Estuary channel. It is assumed that flushing of the northern basin will remain unchanged from that experienced at present.

1.1 WATER QUALITY IMPLICATIONS OF THE DEVELOPMENT

Water quality in the Mandurah Estuary channel is variable throughout the year and is strongly related to seasonal changes in the water quality of the Peel Inlet/Harvey Estuary. A report prepared by LeProvost et al, (1989), describing the results of a three year water quality monitoring programme in the Waterside Mandurah Development, showed no evidence to suggest that the waterways development had affected the water quality in the Mandurah Estuary channel. Indeed, it was concluded that the water quality of the canals was largely determined by the source water in the channel and, thereby, in Peel Inlet.

Provided flushing of the Mandurah marina redevelopment takes place over time scales sufficient to ensure effective exchange between the basin and the channel, then there should be no degradation of water quality in either water body as a result of the proposed redevelopment. This assumes the adoption of standard management guidelines to control the input of potential contaminants into the basin such as boat anti-fouling coatings, oil spills, stormwater runoff, etc.

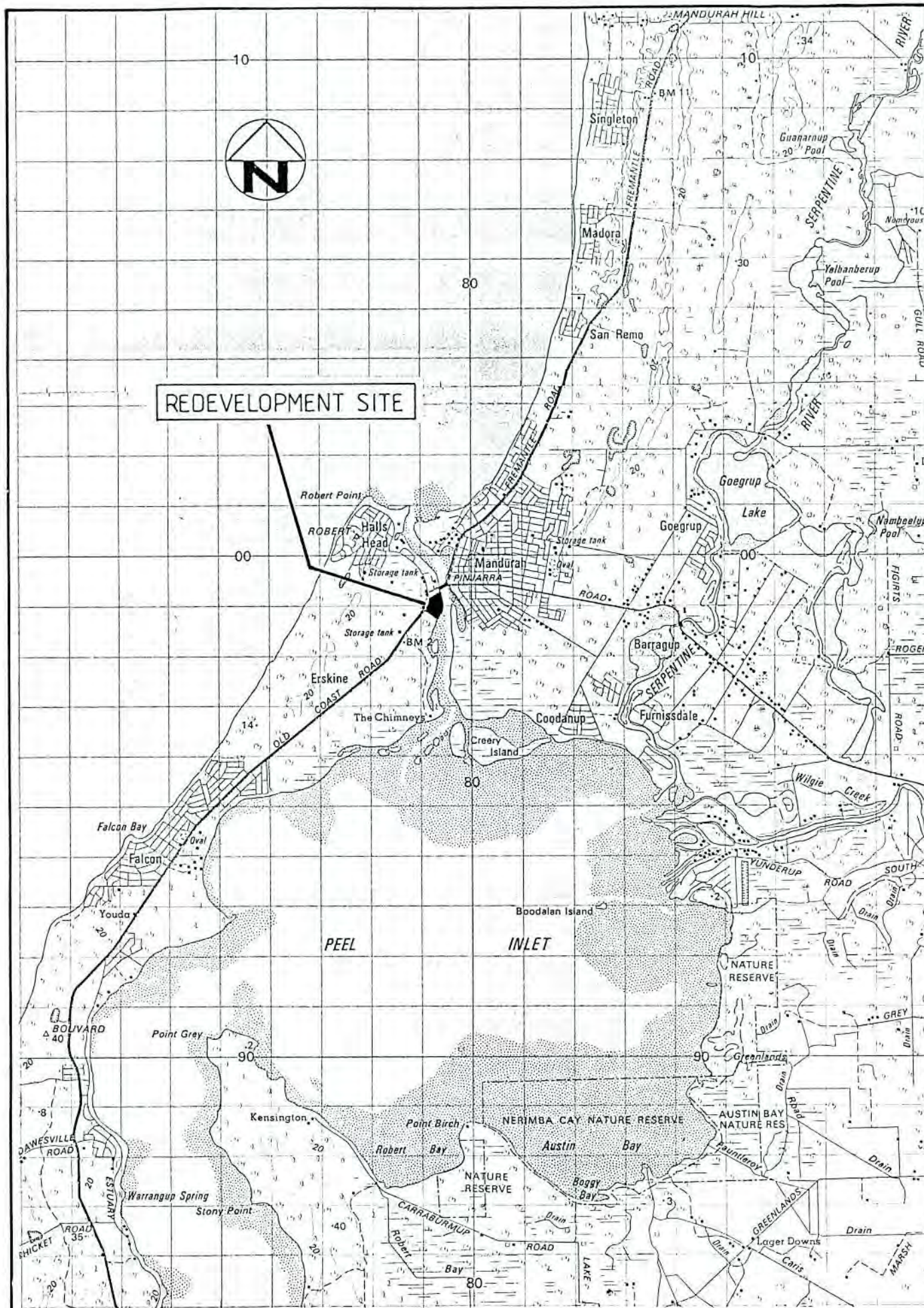

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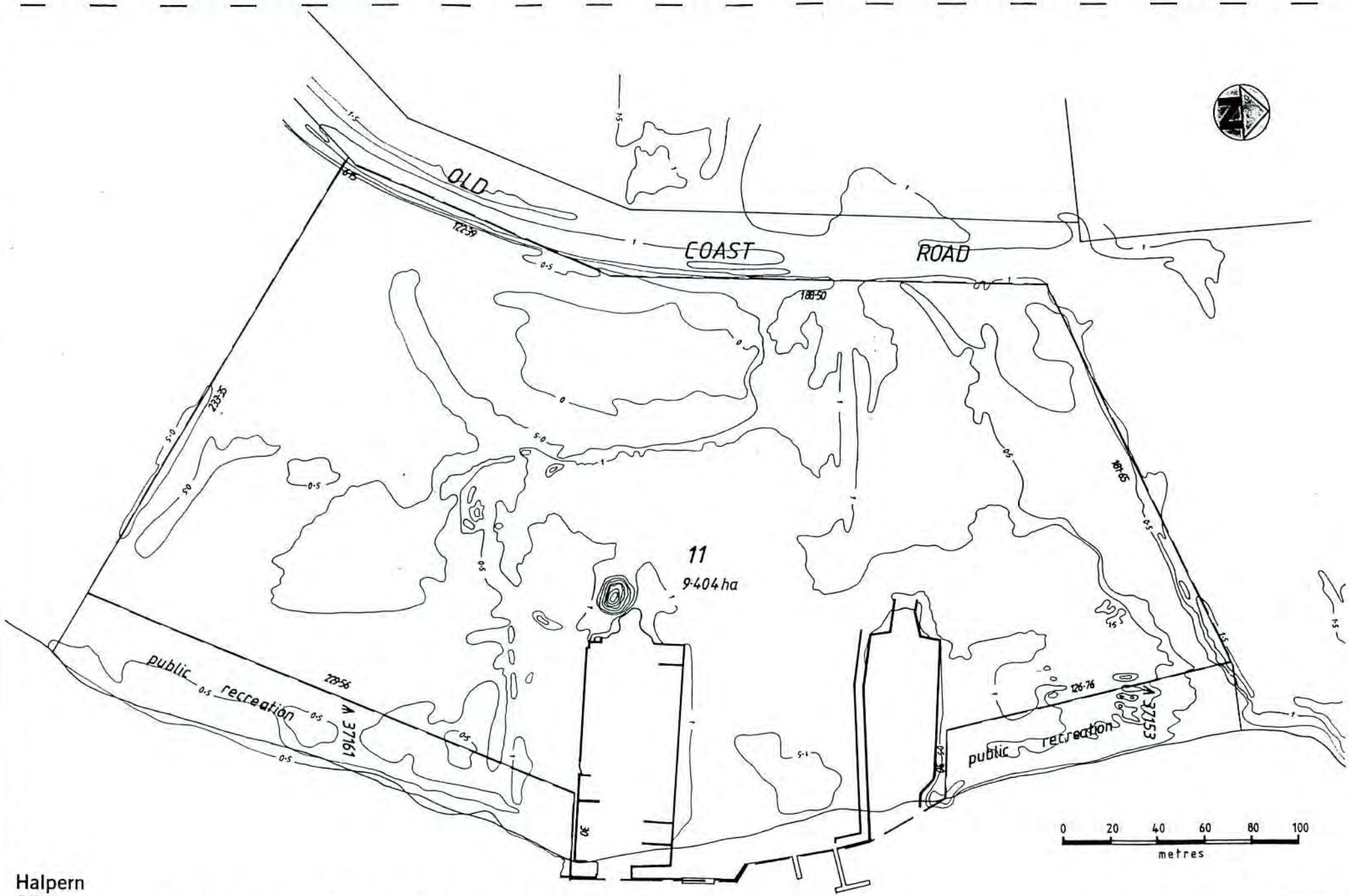
Figure 1
LOCATION MAP

MANDURAH MARINA



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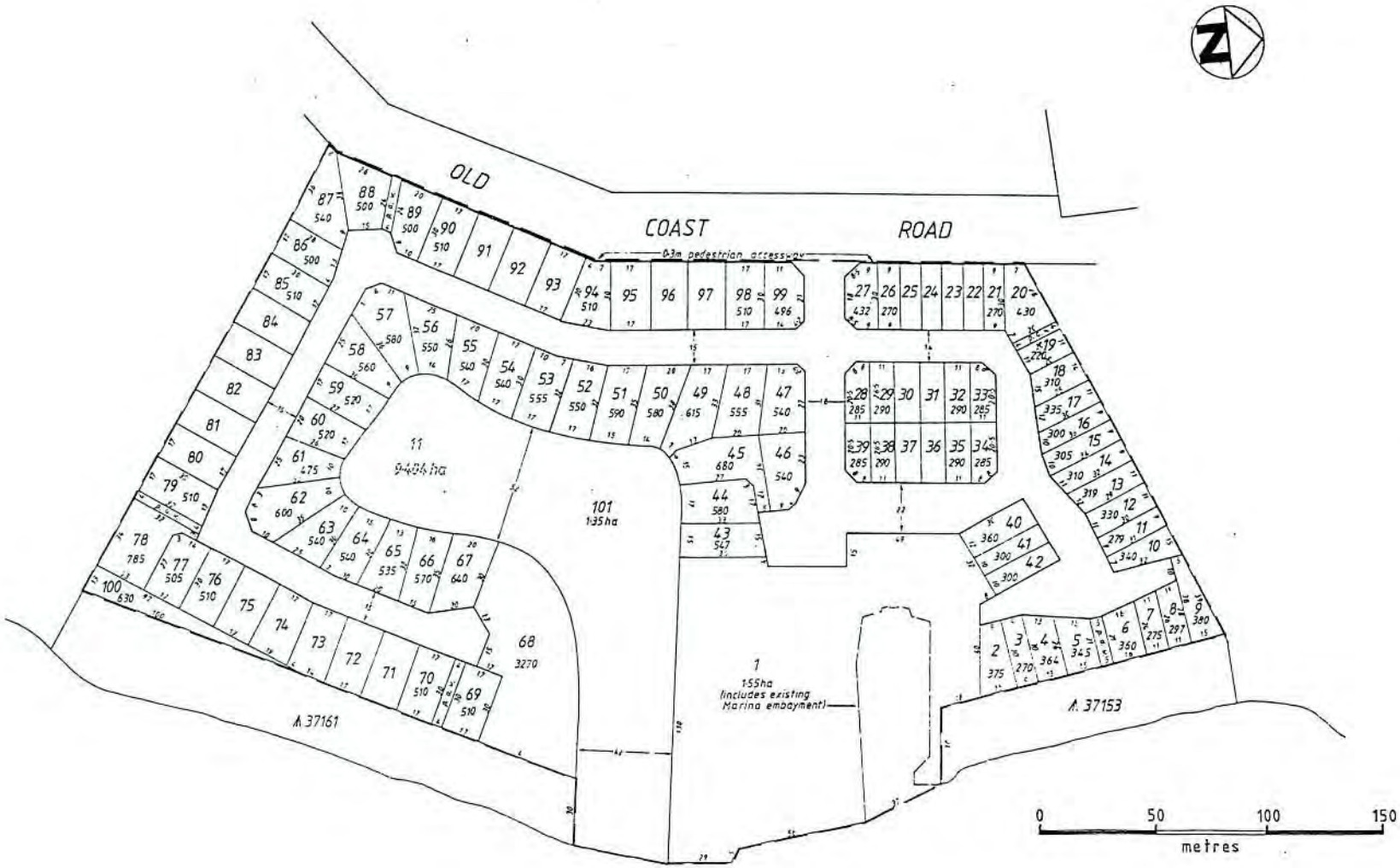
MANDURAH MARINA

Figure 2

EXISTING SITE CONFIGURATION



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MANDURAH MARINA

Figure 3
PROPOSED SUBDIVISION

2. ENVIRONMENTAL AND ENGINEERING PARAMETERS

The flushing of the basin will be influenced by tides, winds and density variations in the water body, as well as the shape and structure of the basin. This chapter defines the basic parameters required to estimate the rate of flushing of the enlarged southern basin of the redevelopment.

2.1 TIDAL FLUCTUATIONS

The tidal cycle at Mandurah, and in the Peel Inlet, is predominantly diurnal (ie period of approximately one day) with barometric components of period ranging upwards from five days.

The tidal oscillation of the water surface offshore from the Mandurah Estuary channel entrance is similar to that recorded at the Port of Fremantle, with a tidal range of around 0.5m from Mean Higher High Water (MHHW) to Mean Lower Low Water (MLLW). Mean Sea Level (MSL) is approximately 0.76m above chart datum and corresponds closely to 0.0 AHD.

Frictional losses in the Mandurah Estuary channel reduces the tidal range in the channel and Peel Inlet. The mean tidal levels in these water bodies, at high and low water, are given below in Table 1:

TABLE 1

MEAN TIDE LEVELS AT HIGH AND LOW WATER (PWD CHART NO. 52603, 1981)

	Mean Higher High Water	Mean Lower Low Water
Ocean	1.0m	0.5m
Mandurah Estuary channel	0.9m	0.6m
Peel Inlet/Harvey Estuary	0.5m	0.4m

Table 1 gives the mean tidal range from low to high water in the Mandurah Estuary channel as 0.3m with the corresponding range in Peel Inlet being 0.1m. Data presented by Port & Harbour Consultants (1990), however, indicate that these figures may be slightly conservative with the range in the channel, for example, being as high as 0.4m. The tidal range in the channel from Mean Lower High Water to Mean Higher Low Water is considerably smaller, being of the order of only 0.1m.

Meteorological conditions, including both barometric pressure variations and surface wind set up of the water surface, can significantly change the predicted tidal elevations, particularly in Peel Inlet. Data collected by Brown et al. (1990) show meteorologically forced variations in water level in the Yunderup Canal Estate of up to 0.5m occurring over periods of several days. The barometric component of such variations has been estimated to range between 0.2m and 0.3m (Imberger & Associates, 1982; Hunter, 1987).

2.2 WIND CONDITIONS

Wind data have been collected in the general region by the Fremantle Port Authority (FPA) at Fremantle and by Steedman & Associates at Cape Peron and Fremantle. On a more local scale, the Bureau of Meteorology routinely measures wind data at the Mandurah Post Office, while a range of wind data have been collected in the last decade in association with various development projects proposed around Mandurah.

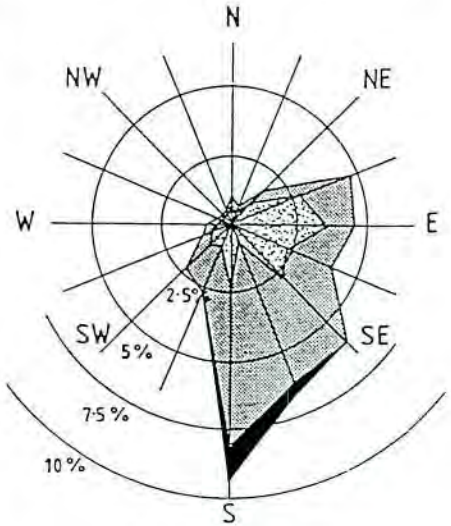
D'Adamo (1983) collected wind data at South Yunderup on the Murray River between 1981 and 1982. The wind speed at Yunderup ranged up to $10ms^{-1}$, averaging between $3ms^{-1}$ and $4ms^{-1}$, with the dominant directions being from the south-west/south and east.

Port & Harbour Consultants (1990) analysed seven years of hourly wind data collected by Steedman & Associates between 1971 and 1977 at Fremantle. Their analysis indicated that during summer, the predominant wind direction (61% of the hourly data recorded) was from the south and south-west sectors with 46% of the wind speeds recorded below $5ms^{-1}$ (this being the mean wind speed assumed by Port & Harbour Consultants for their analysis of the wind flushing of the Mandurah Quay development). Calm periods occurred for only 1% of the record duration.

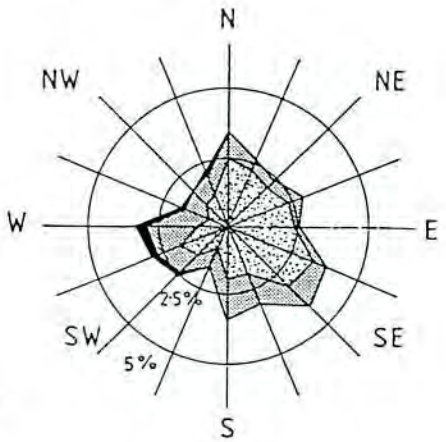
Wind data have recently been collected immediately to the north of the proposed Mandurah marina redevelopment site by the proponents of the Port Mandurah project. Wind speed and direction were recorded every 30 minutes over a full year between August 1986 and September 1987 (see Figure 4).

These data showed a marked difference to those recorded by the Bureau of Meteorology at the Mandurah Post Office. During summer, the measured directions were more southerly and south-easterly, whilst in winter the direction tended more to the north and south-east than the directions recorded at the Post Office. The authors of that work (LeProvost et al, 1989) concluded these differences to be due, in part, to the local effect of the Halls Head ridge to the west of the site.

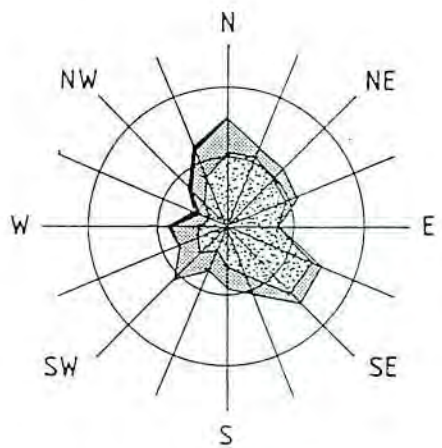
The data showed a summer mean wind speed in excess of $4ms^{-1}$ compared to $3ms^{-1}$ measured at the Post Office. The mean wind speed in autumn was measured between $3ms^{-1}$ and $4ms^{-1}$ at Port Mandurah. During the months of summer, the greatest duration of calms (ie wind speeds less than $1.5ms^{-1}$) was around one day.



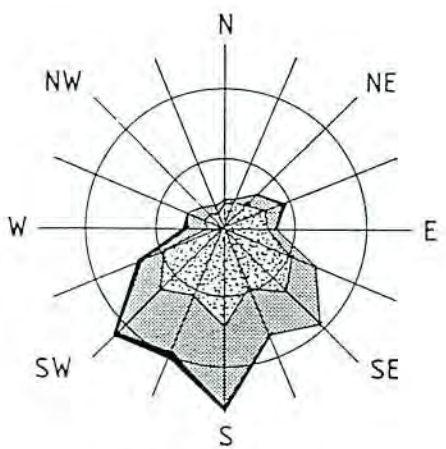
SUMMER WINDS



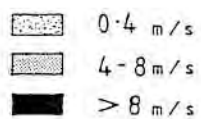
AUTUMN WINDS

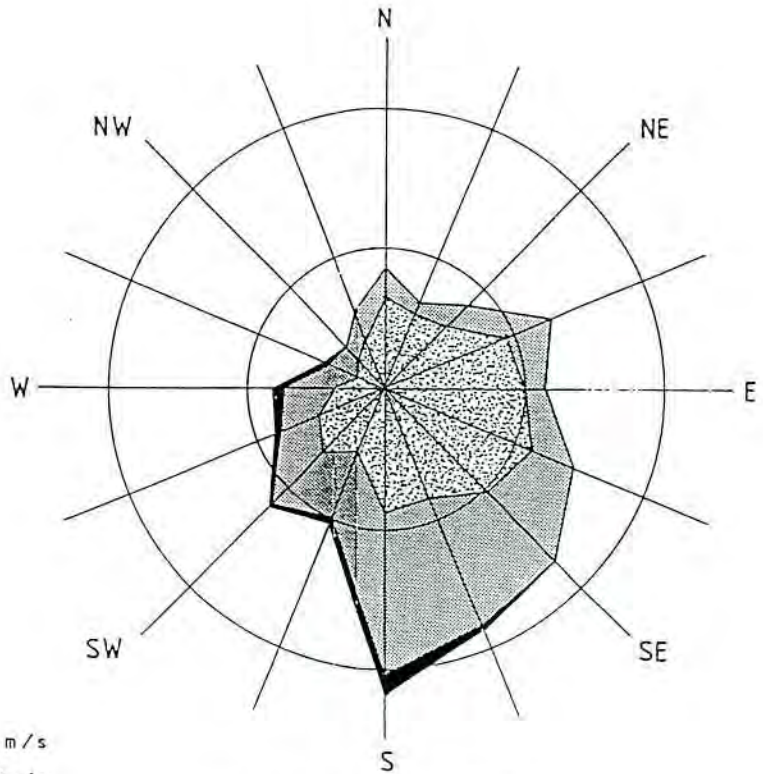


WINTER WINDS



SPRING WINDS





WINDS FOR WHOLE YEAR

AUGUST 1986 TO SEPTEMBER 1987

MEASURED AT PORT MANDURAH SITE

(Le Provost et al, 1989)

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MANDURAH MARINA

Figure 4

PORT MANDURAH MARINA WIND ROSES 1986/1987

The most likely period for experiencing poor water quality conditions in the Mandurah Estuary channel and Peel Inlet is during late summer and early autumn when the water bodies are very strongly stratified, and there is unlikely to be any significant fresh water inflow from the rivers feeding into the Inlet or the Harvey Estuary and wind generated mixing is weak. For the purposes of estimating the wind driven flushing of the proposed basin during times of potential poor water quality in the source water body (ie the channel), wind conditions representative of late summer/early autumn have been adopted. The data described in the above references indicate a mean wind speed at this time of year of around $3.5ms^{-1}$ with a predominant bearing from the south to south-east. Extended calm periods of several days could be expected.

2.3 WATER DENSITY VARIATIONS

Seasonal density stratification in Peel Inlet, Harvey Estuary and the Mandurah Estuary channel is well documented (eg Imberger, 1982; van Senden, 1986). Horizontal density gradients resulting from the variation in this stratification over the area of the Inlet and Estuary have been shown to lead to rapid gravitational flushing of both the Yunderup Canal Estate (Brown et al, 1990) and the Port Mandurah development (pers.comm. Riedel & Byrne, 1990).

The very nature of Peel Inlet, with its large expanse of drying tidal beds, and the input of fresh water from the Murray and Harvey Rivers and sea water from the ocean, ensures some degree of horizontal density variation in the water body at most times of the year. For example, Figure 5 plots salinity contours derived from data collected by Brown et al, (1990) along a transect from the Inlet into Yunderup Canals. Figure 5A presents data collected in April 1990 after strong fresh water inflow from the Murray River (ie a winter-type condition), while Figure 5B plots data collected in January 1990 where strong seasonal evaporation has resulted in dense, hypersaline water being trapped in the deeper parts of the canal system (ie a summer-type condition).

In Figure 5A, the salinity varies by 20ppt over the depth of the water column. Differential wind mixing of the water body then generates a strong horizontal density gradient between the Inlet and the canals (estimated to be of the order of $2kgm^{-3}$). In Figure 5B, the observed horizontal density variation of around 5ppt was equivalent to a similar horizontal density gradient.

Brown et al, (1990) describes the result of dye dispersion experiments used to define the rate of flushing of the canal system at the time the above data were collected. These experiments showed a flushing time of 5.4 days in January 1990 and 2.3 days in April 1990. Chedzey et al. (1990) showed that gravitational exchange was the dominant flushing mechanism through a combination of viscous and inertial forcing.

A similar field assessment of the flushing of the Port Mandurah canal development was carried out in July 1990 by Riedel & Byrne Pty Ltd. During these experiments, significant salinity and temperature variations over the depth of the water body were observed.

Dye dispersion tests completed during the study gave a flushing time of less than one day (pers.comm. Riedel & Byrne, 1990). It was concluded that gravitational exchange was again the dominant flushing mechanism.

2.4 WATERWAY CONFIGURATION

The existing marina development utilises two excavated basins as shown in Figure 2. The northern basin is approximately 2,200m^2 in area while the southern basin is approximately 4,000m^2 in area.

Both basins are rectangular in plan form and average approximately 2.5m deep below chart datum (the zero datum being 0.76m below Mean Sea Level and AHD). The depth of the Mandurah Estuary channel opposite the two basins ranges up to 4.7m below chart datum. The depth of the channel along its full length between the ocean and Sticks Channel in Peel Inlet generally varies from around 2m to 4m below chart datum.

The proposed enlargement of the southern basin is approximately 7,000m^2 in area with a minimum bed depth of 1.94m below chart datum (ie 2.7m below Mean Sea Level) at the southernmost point. The new basin will be excavated with a mildly sloping bed with the depth steadily increasing towards the entrance to the Mandurah Estuary channel.

For the purposes of estimating the flushing characteristics of the enlarged water body, it has been assumed that the basin is bounded by vertical walls with a constant average depth of 3.1m below Mean Sea Level. Although the basin will be bounded by a combination of vertical walls and soft slopes, the above assumption is conservative as it over-estimates the volume of stored water in the basin. Table 2 summarises the parameters required to estimate the flushing time.

TABLE 2

ENGINEERING PARAMETERS

Parameter	Existing Southern Basin	Enlarged Southern Basin
Area	4,000m^2	11,000m^2
Average depth below MLLW	3.14m	2.94m
Volume below MLLW	12,560m^3	32,340m^3
Average depth below MSL	3.3m	3.1m
Volume below MSL	13,200m^3	34,100m^3
Tidal range: MLLW-MHHW	0.3m	0.3m
Tidal prism: MLLW-MHHW	1,200m^3	3,300m^3

1.0 INTRODUCTION

1.1 This Policy is addressed specifically to those subdivisional and/or development projects proposing to incorporate artificial waterways or canals. Projects coming within the scope of this Policy will be referred to as canal estates. These include not only the creation of canals, but also harbours and marinas whether as a result of the construction of breakwaters into a natural waterbody or by dredging inland harbours. The development of land within 100m of a canal or proposed canal together with artificial ornamental lakes with development over or abutting waterways will be regarded as canal estates for the purpose of this Policy unless the Hon Minister for Planning determines otherwise.

1.2 To permit canal estates to proceed without reasoned and detailed technical appraisal holds potentially serious implications for the environment, public health and safety and financial costs to the community at large. Therefore it is most appropriate that such projects are carefully examined by all of those agencies or authorities involved in terms of their construction, later development of the land and subsequent management.

2.0 DEFINITIONS

2.1 **Canal or Canal Waterway:**

Any artificial channel, lake, harbour or embayment for use or intended for use for navigational, ornamental and recreational purposes, or any of those purposes. The term includes any access channel or connecting channel, any addition to or alteration of any canal within the meaning of this definition and any system of canals within the meaning of this definition provided in any development of land. The term also includes any other waterway designed for other purposes such as drainage, but which is capable of use as a canal as herein defined.

2.2 **Canal Banks:**

All natural or constructed boundaries to the waters, extending from the canal bed to the upper level of the flood and wave affected canal shore. This upper level shall be defined with respect to a 1 : 100 year flood event.

2.3 **Canal Bed:**

Land below the canal water which is maintained to a specific navigable depth.

2.4 **Canal Estate:**

A development or subdivision proximate to a canal. For planning purposes any development within 100m of a canal or proposed canal shall be deemed to be part of a canal estate unless the Minister for Planning determines otherwise.

2.5 **Canal Management:**

Except as otherwise arranged by agreement between the proponent or manager of a canal estate project and the State and/or a local government, the authority responsible for managing a canal, a canal waterway or a connecting channel shall be:

- the Department of Marine and Harbours for matters related to the dredging and maintenance of waterway depth, maintenance of breakwaters, monitoring and management of water quality, replacement and repair of navigational aids and other related issues;
- the local government authority for all other matters such as the collection and removal of weed or waste, the repair and replacement of pumps and equipment required for water exchange and flushing; or
- the land owner for the repair of canal banks and other structures used to support that owner's abutting land. (For this purpose the expression land owner shall include the body in which the land is vested for its care and management).

2.6 **Canal Structures:**

Jetties, launching ramps, bridges, moorings, water control structure or any other structures on, in or over the canal waterway.

2.7 **Canal Zone:**

A zone (as created within an operative Town Planning Scheme) within which a canal estate is permitted. Individual areas of land included within a canal zone may be subject to specific provisions of that town planning scheme which may restrict development to certain types or classes.

2.8 **Connecting Channel:**

Any channel in navigable water associated with the construction of a canal and connected or intended to be connected to such canal, and retaining wall or other works associated with such channels. The term includes any addition or alteration to any such channel, retaining wall or other works.

The development or use of any land, including:

- any demolition, erection, construction, alteration of or addition to any building or structure on the land;
- the carrying out on the land of any excavation or other works; and
- in the case of a place to which a Conservation order applies, any act or thing that-
  - is likely to change the character of the place or the external appearance of any building; or
  - would constitute an irreversible alteration of the fabric of any building.

2.9 **Flood Plain - Flood Prone Land:**

Those areas inundated by the flood which can be expected, based upon recorded historical precipitation, river flows and other valid data, as having a statistical 1% chance of being equalled or exceeded during any one year (1:100 year flood).

2.10 **Foreshore Reserve:**

The area between a natural waterway and the adjacent boundary of the canal estate.

2.11 **Navigation Aids:**

Lights, leads, buoys, beacons installed to guide the safe navigation of vessels.

2.12 **Navigable Waters:**

Rivers, lakes, inlets and other inland waters on which any vessel or any type of marine craft can be navigated and includes all water below high water mark within three nautical miles of the coastline of the State.

2.13 **Waterway Management Authority:**

The authority responsible for managing a natural waterway, where the waterway is water defined under both the *Waterways Conservation Act 1976* and the *Swan River Trust Act 1988*, is the agency specified in that legislation.

3.0 POLICY OBJECTIVES

- To establish a consistent and coordinated approach to the processing and evaluation of proposals to develop canal estates throughout the State.
- To set down clearly the prerequisites to be satisfied before such a proposal can be regarded as being acceptable from a planning point of view and is therefore permitted to proceed.
- To provide clear guidance as to the procedures to be followed by the proponent of such a project to achieve the best results from the planning, environmental and technical appraisal systems.
- To ensure by careful evaluation by all relevant professional and technical disciplines that the prospects for adverse impacts on the environment, public health and public safety as well as the potential for public maintenance costs are eliminated or ameliorated.
- To establish a sound and coordinated approach to ongoing management and maintenance of canal estates.
- To ensure that canal estates are constructed to established standards and environmental requirements.
- To ensure that future obligations and responsibilities are fully understood by all authorities and persons involved in the development of and later occupation or purchase of land in a canal project.

4.0 POLICY MEASURES

4.1 Principal Elements In The Approval Process

Proponents should recognise the following prerequisites to approval of their canal estate projects and that they will be required:

- to show by title or enforceable contract to purchase that he/she has full control over the land involved or affected directly by the projects;
- to circulate preliminary plans of the project to the Department of Marine and Harbours, the Local Government Authority, the Environmental Protection Authority, the Waterways Commission (or its Management Authorities as appropriate) and to the State Planning Commission (Commission) to determine:
  - whether fundamental objections arise which cannot be resolved and would require the project to be abandoned, or
  - if no objections arise, the general requirement which would need to be met by detailed designs and studies and town planning scheme amendments,
- to satisfy the requirements of the *Environmental Protection Act 1986;*
- to accept that the land must be included within a Canal Zone in an operative Local Government Authority town planning scheme covering the area of land concerned which in most cases will involve a town planning scheme amendment (ie, a rezoning);
- to apply for and obtain from the Commission the necessary approvals to subdivide the land;
- to apply for and obtain approval to commence development or planning approval from the Local Government Authority and where appropriate the Commission; and
- to establish procedures by which licences and approvals from Department of Marine and Harbours and the Waterways Commission are to be sought and obtained if the proposal is to proceed,

Although the foregoing issues are listed separately, in the usual order of events, it may be possible for some stages to run concurrently with others, as described in the balance of this Policy.

The following paragraphs have been prepared for the purpose of clarifying the above list of prerequisites.

4.2 Determinations of General Feasibility of Proposals

4.2.1 Nature and Purpose of General Feasibility Determinations

Given the wide range of issues involved in canal estate projects and the very detailed, and hence expensive, research and design costs, it is strongly recommended and clearly desirable that a proponent conduct a round of preliminary consultations as set out in this Section to establish whether or not the proposal is acceptable in broad principle an to establish the nature and extent of the research and design detail which will be required in order to bring the project through its approval processes to completion. Where appropriate, meetings of some or all of the agencies can be arranged to determine requirements for designs, plans and reports.

The expectation of this process is that the proponent will consult with all affected authorities and obtain a general determination from those authorities that the proposal is, or is not, technically and environmentally feasible.

It will also be necessary to determine whether or not the Local Government Authority is prepared to initiate an amendment to its town planning scheme to have the land appropriately zoned for the purpose proposed. In this latter connection, it is a fundamental premise of this Policy that correct zoning (i.e. a Canal Zone classification) is an essential prerequisite to a canal estate project proceeding.

In recommending the process of undertaking a preliminary round of consultations, the Commission is conscious of the fact that legislation does not provide for such a process and, therefore, if determinations are made or advice is given, they can only be regarded as a guide to the proponent with respect to proceeding with the proposal.

4.2.2 Requirements for Plans and Other Information for Preliminary Consultations

The following information will be needed for this round of consultations:

- A site plan showing the land, its contours and its local setting;
- An aerial photograph showing the same area;
- A basic concept plan showing the approximate shape of proposed waterways, connecting channels, subdivision, land use and development; and
- Basic hydraulic, environmental and ecological studies showing the perceived impact of the development on natural and physical features of the site and its environs.

4.2.3 Department of Marine & Harbours

The foregoing information should be sufficient for this Department to advise the proponent as to whether or not fundamental objections to the proposal exist. Any such objection will relate to the suitability of the site for the purpose proposed against a technical and economic appraisal of such issues as:-

- littoral drift and sand by-passing requirements and their consequences for subsequent management;
- exposure to damage by tide, flood and storm surge levels;
- adverse effects upon coastal regimes;
- potential insufficiency of natural or even artificial flushing to maintain canal water quality;
- economic viability of the proposal taking into account the measures required to off-set any difficulties as set out above against the perceived yield from the proposal and its capacity to meet annual maintenance costs; and
- maintenance costs, sources of funding for monitoring and maintenance of canal waterways by the developer for a predetermined maintenance period, and the prospect of reaching agreement with local government regarding ongoing funding arrangements once any developer obligations cease.

Objection to any proposal by Department of Marine & Harbours will normally be regarded by the Commission as sufficient reason to recommend to the Hon Minister for Planning that a scheme amendment (a rezoning) be refused.

If a proposal is acceptable in broad principle, the Department of Marine & Harbours will still advise on the foregoing list of issues as well as those set out below for the purpose of assisting in more detailed design work:

- canal design and stability (including walls, banks and revetments);
- entrance design and stability;
- navigation requirements;
- tide and storm surge levels;
- mooring design specifications;
- impact on coastal processes;
- other relevant matters particular to each case.

4.2.4 Local Government Authority

The Local Government Authority should be requested to advise whether or not, in general planning and local engineering terms, the proposal is acceptable and the circumstances under which it would be prepared to proceed with an Amendment to its town planning scheme (ie a rezoning of the land) when formally requested to do so. If the Local Government Authority is not prepared to initiate the rezoning of the land, the issue cannot be progressed. There is no right of appeal against any such decision. Local Government Authority support for the project is therefore vital to the entire process.

Responsibilities for maintenance will need to be discussed with the Local Authority at an early stage to determine expectations of the proponent (normally 5 years) and the Local Authority thereafter. Maintenance for the proponent will involve the entire project other than those which will be assumed by purchasers of lots within the Canal estate. Maintenance by the Local Authority thereafter will relate to the public areas such as the waterways, connecting channels, breakwaters, and canal walls and embankments where these abut land set aside for use by the public at large.

4.2.5 Environmental Protection Authority

A proposal comprising the information set out in paragraph 4.2.2 and submitted to the Environmental Protection Authority will be regarded as a referral under Section 38 of the Environmental Protection Act. The Environmental Protection Authority will advise of any additional information which may be required to enable it to be assessed pursuant to Part IV of the Environmental Protection Act. This may include:

- water quality and its management involving natural or artificial flushing or water exchange;
- coastal estuarine or river environments and the prospect for impacts upon those environments;
- wetlands and other habitats for flora and fauna;
- prospective impact upon ground water reserves and such other matters as salt water intrusion and draw-down; and
- waste disposal with particular regard to disposal of waste water (including sewage) and contaminated surface water run-off.

If, at the time of determining whether or not the project should be assessed, the Environmental Protection Authority is aware of a fundamental objection to the proposal, it will advise the proponent of that objection. In such circumstances, the proponent should not proceed unless action can be taken to overcome that objection.

In the absence of any overriding objection to the project, the Environmental Protection Authority will advise the proponent as to whether or not the proposal will require assessment pursuant to Part IV of the Environmental Protection Act and, if it does, the level of the assessment (eg. Consultative Environmental Review (CER), Public Environmental Review, (PER) or Environmental Review and Management Program (ERMP)).

4.2.6 State Planning Commission

During the process of preliminary consultations at the concept stage of the project, it is recommended that a copy of the concept plans and supporting documentation be provided to the Commission through officers of the Department of Planning & Urban Development. It is also recommended that the matter be discussed with officers of the Department to ensure that all parties to the approval process are kept fully informed of the proposal and its progress. These discussions will draw attention to any objections to the project from the Commission's point of view or any issues which will need to be addressed in the formulation of a detailed proposal. When and where appropriate, the Department will provide a coordinating role by arranging joint meetings and discussions.

4.2.7 Other Agencies

In addition to the foregoing consultations it will, in particular circumstances, be appropriate to confer with other authorities, e.g. Waterways Commission and its management authorities (Peel Inlet Management Authority the Leschenault Inlet Management Authority or the Albany Waterways Management Authority), Swan River Trust, the Department of Conservation and Land Management and the Department of Land Administration.

5.0 RECOMMENDED STEPS TO GAINING FORMAL APPROVAL TO PROCEED WITH A CANAL ESTATE

5.1 General

5.1.1 Action necessary to secure the necessary statutory approvals to proceed with a canal estate project centre on two principal features:

- agreement by the Minister for the Environment that the project may proceed, with or without conditions as he may direct following assessment under Part IV of the Environmental Protection Act, and thereafter;

- the land concerned being included within a Canal Zone in the Local Government Authority's town planning scheme by way of a formal scheme amendment, a normal prerequisite to which will be the requirement for the proponent to enter into a Deed of Agreement with the Local Government Authority and the Department of Marine and Harbours.

5.1.2 Approvals to subdivide land and to commence and carry out development will flow from completion of the provisions of paragraph 5.1.1.

5.1.3 Under most circumstances, the environmental assessment will involve a period of public advertisement for the purpose of allowing public submissions to be made. The procedures through which a town planning scheme amendment must pass similarly includes a public advertisement and submissions period. It is logical, therefore, that the two procedures run concurrently to avoid public confusion.

5.1.4 Because environmental considerations are pivotal to the entire process, the Commission will expect the Local Government Authority not to finalise its evaluation of submissions to the town planning scheme amendment until the Environmental Protection Authority's environmental assessment report is made available. Reference to that report will enable the Local Government Authority to determine whether it would proceed with the amendment and, if so, the modifications to the amendment (if any) which should be made.

5.2 Formal Procedures

5.2.1 Local Government Authority

If, following receipt of general comments from affected authorities as a result of the preliminary round of consultations, the proponent elects to proceed, then a formal approach to the Local Government Authority should be made for a rezoning of the affected land by way of a Scheme Amendment.

The documentation required by an Local Government Authority, unless formally exempted, will usually include the following:

- Plans at appropriate scales indicating all relevant details including:-
  - site boundary, site contours, and physical features;
  - canals, connecting channels and the water body to which connection is to be made;
  - layout of subdivision and/or development for land within the canal estate;
  - land to be ceded to the Crown as waterways, foreshore reserves, etc.
- Aerial photography or mosaic at an appropriate scale showing the land and its environs.
- Reports detailing:
  - existing zoning of the land and its environs;
  - present land use and land form with characteristics, soil, types, vegetation etc;
  - results and nature of any physical, biological, hydraulic and sociological studies undertaken.
- Formal Town Planning Scheme Amendment Documentation prepared in consultation with the Local Government Authority.[1]
- Such information or environmental review report as may have been requested by the Environmental Protection Authority pursuant to Part IV of the Environmental Protection Act.
- A submission showing all of the matters believed by the proponent to be the basis upon which a Deed of Management Agreement can be entered into between him or her, the Local Government Authority and, as appropriate, the Department of Marine & Harbours.

If the Local Government Authority resolves to amend its town planning scheme, it is required to refer the proposed rezoning to the Commission for consent to advertise.

5.2.2 Environmental Protection Authority

Concurrently with the approach to the Local Government Authority (paragraph 5.2.1), the proponent should submit to the Environmental Protection Authority the information identified by that Authority as being necessary to satisfy the provisions of the Environmental Protection Act.

The Environmental Protection Authority and the Commission (in granting consent to advertise the scheme amendment) will seek to synchronise the advertisement and submissions periods to ensure that all available information is available to the public at much the same time for the reason previously described.

Once the submission period for the environmental assessment has expired, the Environmental Protection Authority will prepare its report and will forward copies to the proponent, the Local Government Authority, and the Commission as required under the Environmental Protection Act.

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1 Schedule 1 contains a set of Model Scheme Text provisions which, with suitable modifications to suit each circumstance, may be adopted by Local Government Authorities for incorporation into their town planning schemes as part of the rezoning amendment.

5.2.3 State Planning Commission and Minister for Planning

On receipt of town planning scheme amendment documents from the Local Government Authority, the Commission will confer with the Environmental Protection Authority to ensure that the matter has been referred to the Authority for evaluation.

If the Commission decides to grant consent for the amendment to be advertised, public inspection and submission periods will, where possible, be synchronised as previously described.

Where objections are raised and the Commission opposes the rezoning, it will refer the rezoning to the Minister with a recommendation for refusal. If the Minister agrees with the Commission consent to advertise the amendment is not granted and the matter cannot proceed further. If the Minister believes that the Scheme Amendment should be advertised for public inspection, he/she will direct the Commission to grant consent to advertise.

5.2.4 Local Authority

As noted earlier, the Commission will expect the Local Government Authority to await receipt of the Environmental Protection Authority's report before resolving to proceed with the Amendment to its Scheme. Once received, however, the Local Government Authority must consider each submission and decide whether or not the Amendment should be modified or the submissions rejected.

At this stage the Local Government Authority should, if it is of a mind to proceed with the amendment, approach the proponent and Department of Marine & Harbours with a view to determining the issues to be covered by, and the procedures to be followed for the preparation of the Deed of Management Agreement discussed in paragraph 5.2.6.

Having considered the submissions including the report of the Environmental Protection Authority, the Local Government Authority shall then resolve either:

- not to proceed with the Amendment, in which case the proposal cannot be taken any further; or
- to proceed with the Amendment and adopt it for the purpose of seeking the Minister's final approval; or
- to proceed with the Amendment but require modifications to the Amendment.

In the latter two cases the Amendment will be forwarded by the Local Government Authority to the Minister via the Commission for final approval. Where a period in excess of 42 days has been taken to determine the submissions, the Local Government Authority must seek the Minister's agreement to an extension of time.

The proponent may wish to consider, at this point in the procedures, whether to proceed to lodge:

- an application for approval to subdivide the land (if appropriate) with the Commission; and/or
- an application for approval to commence development (i.e. a planning application) with the Local Government Authority.

Action in this regard will obviously depend upon the proponent's view of the prospect that the Scheme Amendment will gain final approval from the Minister for Planning. Decisions on these applications would not be forthcoming until the Scheme Amendment receives final approval and is gazetted.

5.2.5 State Planning Commission and Minister for Planning

The Amendment will be reviewed by the Commission and a recommendation made to the Minister with respect to the granting of final approval. If the proposal is unacceptable, final approval will not be given. Conversely if the proposal is acceptable, allowing that some modifications may be required, then the Minister, before making a formal decision, will advise the Local Government Authority of his/her disposition to grant final approval and the conditions under which he/she is prepared to do so. One of these conditions will be the requirement that the Local Government Authority, Department of Marine & Harbours, and the proponent enter into Deeds of Agreement as discussed below.

5.2.6 Deeds of Agreement

The purpose of the first Deed of Agreement between the Local Government Authority, Department of Marine & Harbours, and the proponent is to ensure that:

- the development proceeds;
- it is effective; and
- a reasonable period of maintenance is undertaken by the proponent before the waterways become a public responsibility.

Thereafter it is imperative that the second agreement between the Local Government Authority and the Department of Marine & Harbours provides suitable financing for on-going maintenance as may be mutually agreed. Sources of revenue may include such items as fees paid for public facilities such as boat launching ramps, marine pen licence fees, commercial leases, lump sum payments made by the developer for this

purpose, as well a rating revenue via general, special area or differential rating methods. It is expected that such projects should not place any additional financial burden upon the State but that all such expenditure should be met by those deriving enjoyment from and use of the facilities concerned.

The Deeds of Agreement will cover the following major points:

- commitment to seek and obtain planning approval for the project and thereafter to carry out development within a predetermined period;
- bank guarantee against default of the above committments and to cover any defects which might become evident during the period of the developer's obligation;
- construction, monitoring and maintenance of specific canal and channel works;
- monitoring and management of water quality;
- identification of funding sources for the construction and maintenance work referred to above;
- the proponent shall not cease to be a party to the agreement until at least five years after the date of practical completion of the project, such date to be set by the Department of Marine & Harbours;
- a Deed of Agreement shall apply to each stage of development of a canals project;
- arrangements between the Local Government Authority & Department of Marine & Harbours regarding the raising of revenue for maintenance following the expiration of the proponent's responsibility.

Unlike Deeds of Agreement prepared before the coming into operation of the Environmental Protection Act, future Agreements may not need to address all the environmental issues as these will form the subject of conditions under which the project is permitted to proceed pursuant to that or other legislation.

5.2.7 Final Approval to Scheme Amendment

When the Deeds of Agreement are completed and executed, the Local Authority then formally adopts the Scheme Amendment documentation and forwards it to the Minister via the Commission for final approval. The Minister's final approval, if granted, is gazetted and the Scheme Amendment is operative from that date.

5.2.8 Subdivision and Development/Planning Approvals

As noted in paragraph 5.2.4, it is quite possible for applications for these approvals to be lodged prior to the grant of final approval to a Scheme Amendment although it is a requirement of this Policy that approvals to any such applications should not be granted until after that event.

If advantage was not taken of the opportunity to submit these applications before the Scheme Amendment was finalised in anticipation of the grant of final approval with the concurrent release of subdivisional and development/planning approvals, then clearly the proponent is free to lodge those applications once the Scheme is amended.

6.0 GUIDELINES FOR THE DESIGN OF CANAL ESTATES

6.1 General

There are guidelines for conventional subdivisions to allow a developer to design a subdivision which will satisfy the reasonable needs of the community.

Canal estates have some features which do not exist in conventional subdivisions.

The guidelines in this section are specifically for canal estates and they will aid the developer in designing this type of development.

6.2 Design Requirements

6.2.1 Canal Dimensions

To define navigable widths and depths for canals, lateral loads on mooring structures and dimensions of mooring areas, a 'design boat' should be selected. The following table lists recommended sizes for a design boat. These sizes are based on draughts appropriate to yachts, and beams appropriate to cruisers.

Boat Length (m)	Beam (m)	Draught (m)
up to 6	2.6	1.4 (0.6)*
6 to 8	3.2	1.5 (0.8)*
8 to 10	3.8	1.6 (1.01)*
10 to 12	4.2	1.8
12 to 15	4.5	2.0
15 to 18	4.0	2.5
18 to 20	4.5	3.0

* It is possible that some inland canal estates may cater for small power boats only. If this is the case, these reduced drafts may be acceptable.

Depth of clear navigation section
(at Mean Low Water):

- not less than 1.0 m;
- not greater than the associated water body;
- not less than the maximum draught of design vessel
  plus - half the predicted wave height;
  plus - 0.3 m for soft bed or 0.5 m for a rock bed;
  plus - allowance for siltation;

Width of navigation section:

- is twice the length of design vessel between the limits of the moorings;
- not less than 15 m;
- increased widths will be required if more than 20 residential units are upstream of any channel cross section;
- the widths of the navigation sections is to be measured from the boundaries of the moorings sections or in the case of sloping canal beds or walls, from the design depth contour, whichever is appropriate.

Width across water between property boundaries:

- Not less than 30 m.

Mooring areas:

- Mooring areas should be defined, and include all mooring structures, jetties, piles, etc plus sufficient clearance to moor the design boat,
- In the case of single residential lots, the width of the lot and the location of the mooring should be such that the moored vessel is entirely in the water area bounded by the extension of the property boundaries.
- End mooring should be discouraged in main navigation channels.
- Depth of mooring areas is to be the same as the navigatable depth.

Canal waterway length or area:

To relate hydraulically to non-scouring currents at entrance and in canals (note that this will be dependent on soil type and bank construction). These currents are to be conservatively assessed against any annual event, and may be limited only at the 1:100 year probability level.

6.2.2 Shore Stability

- All land or structures within the canal estate should be designed to resist damaging erosion by wind and wave action for a 30 year design life span and should take account of predicted climate change.
- All land or structures bordering the connecting channel should be designed to be free of erosion by water and wave action which may occur in 100 year life span. The design should be virtually maintenance free.

6.2.3 Layout for Navigation Safety

It can be assumed that a boat speed of 8 knots or less will be required within the canal system. While power boats may be in the majority, use of canoes, rowing dinghies and small sail boats must be expected.

- Navigation safety requirements should comply with the requirements of the Navigation and Marine Authority.
- It is preferred that the canal waterway system contain clearly defined main waterways, with branches. Cross intersections should be avoided.
- Junctions of canal waterways should maximise clear sight distances.
- Navigation beacon piles should identify the presence of any hazard to navigation for the design vessel and should be marked with both day marks and reflective coloured night marks in accordance with the requirement of the Navigationand Marine Authority.
- Bridge clearances appropriate to the needs of the design vessel for both height and width should be provided in accordance with the requirements of the Navigation and Marine Authority.
- Lighting within the canal zone should not be a hazard to safe navigation through excessive glare or inappropriate colour.

6.2.4 Moorings, Jetties and Launching Ramps

- All these facilities should be contained within the water space determined [See paragraph 6.2.1 Canal Dimensions] to be available for mooring. No intrusion into the navigation channel should be permitted.
- Jetties, ramps and moorings should not be constructed except with the approval of the waterway management authority and the Local Government Authority where applicable.
- When it is expected that there will be a large number of similar structures, such as boat ramps or jetties, a policy relating to such structures should be set in consultation with the LGA, and DMH. This policy should include standard designs for structures.

- As waste disposal from boats will result in the pollution of the canal waterways, sewage pump out facilities should be required for each canal estate.

6.2.5 Property Boundaries

Within a canal zone it is assumed that properties on the canals will have a private water frontage and that individual property owners on the canals will be responsible for the stability and integrity of that private water frontage.

- The property boundary shall be such that all structures which stabilise a land lot are within the boundary of that lot.
- The normal site requirements which apply in a residential zone shall apply to the land in a canal zone with the exception that:
  - A minimum building setback of 9 m from the canal frontage should apply, or building envelopes specified by the developer and justified by him.
  - Finished ground levels and building floor levels should be above the 1:100 year flood level as determined for the canal estate making reasonable allowance for the predicted effects of climate change.

6.2.6 Flood Mitigation

The hindrance of flood flow by fences or barriers should be evaluated and, in areas where they seriously inhibit flow, they should not be allowed.

Some land within a canal estate may be intentionally constructed as a floodway in order to manage rare flood events. This land and the anticipated flood levels should be clearly marked on public plans such as the Local Government Authority Town Planning Scheme.

7.0 TOWN PLANNING SCHEMES & SUBDIVISION REQUIREMENTS

7.1 Scheme Requirements

As noted in paragraph 5.1.1, it is expected that canal estate projects should not proceed until the Local Government Authority takes steps to amend its Scheme to include the affected land within a Canal Zone. The following represent a list of some of the principal matters which may be covered by a Scheme:

- land use
- residential codes
- building densities
- the siting of buildings with particular reference to flood levels and to canal banks
- out-buildings including boat sheds ramps and hoists
- the reservation of land
- entry and inspection for Local Government purposes

The Local Government Authority may also wish to control:

- works ancillary to or consequent upon the Scheme
- the general character of buildings
- landscaping
- the conservation of natural features and the preservation of features of scientific or historic interest
- other matters covered by the *Town Planning Development Act 1928* which the Local Government Authority deems appropriate.

Where no subdivision is required, matters normally covered by subdivisional conditions may be covered by a Town Planning Scheme or in conditions imposed on development approvals or in Certificates of Approval granted pursuant to the *Strata Titles Act 1985*.

Appendix 1 contains typical clauses appropriate for inclusion in a Scheme Text covering some of the issues raised above.

7.2 Subdivision Requirements

7.2.1 General

Conditions of subdivision will be used to ensure that matters necessary to the project are of adequate standard. They will normally include:

- compliance with the approved final development plan
- road and path construction
- drainage and drainage sumps
- water reticulation
- effluent disposal
- the construction of canals
- the filling of land
- the construction of canal banks, retaining walls and canal structures
- public open space and other reserves (see paragraph 7.2.2)
- such other matters as the Commission may determine

All of these should accord with the requirements of the appropriate authority as recommended in the approval processes set out in this policy.

7.2.2 Public Open Space & Other Reserve Requirements

There is a need for several different types of reserves associated with canal estates. The reasons for, and the functions of, these reserves are quite separate. The canals themselves are considered to be 'water roads' rather than recreation reserves.

Apart from the normal 10% public open space requirement for residential subdivisions, a foreshore reserve is necessary between the natural waterway and the canal estate. Within the normal Public Open Space requirement, adequate public access to waterways should be provided. Active recreation areas which are usually required in conventional sub-divisions remain necessary.

Public Open Space can be divided into two forms:

- Small multi-purpose reserves (canal access and maintenance, recreation) adjoining canal waterways.
- Larger recreation reserves which may be located adjacent to, or away from, canal waterways.

Foreshore Reserve adjoining the Natural Waterway

The purpose of this type of reserve is to maintain the integrity of the natural waterway and, for this reason, it is of regional significance rather than just local significance although it will still be required to be vested in the Crown pursuant to Section 20A of the Town Planning and Development Act for recreation. The Commission believes that a Foreshore reserve of 30 m is in most circumstances, a minimum and where the waterway has, or has the potential for extensive public use, a 50 m reserve can be justified.

The foreshore reserve will allow maintenance and erosion control to be carried out, allow for flood mitigation and where applicable maintain the option for enlargement of the natural waterway. These are necessary functions of waterway management.

The foreshore reserve will ensure public access to the natural waterway. Access should not be confined to canal estate residents and should be provided from the nearest public road with adequate car parking facilities.

Recreation at this foreshore reserve should be passive and water oriented. This reserve should exist for the benefit of the natural waterway and its users, rather than for land based activities which can be located elsewhere.

The foreshore reserve should (see Figure 1):

- allow space for widening the effective channel of the natural waterway;
- include the usual Commission requirement for foreshore reserves on other situations together with an extra 'no development' space to allow for flood mitigation; and
- allow a further area as a zone of limited development to make further allowance for flood mitigation and the effects of climate change.

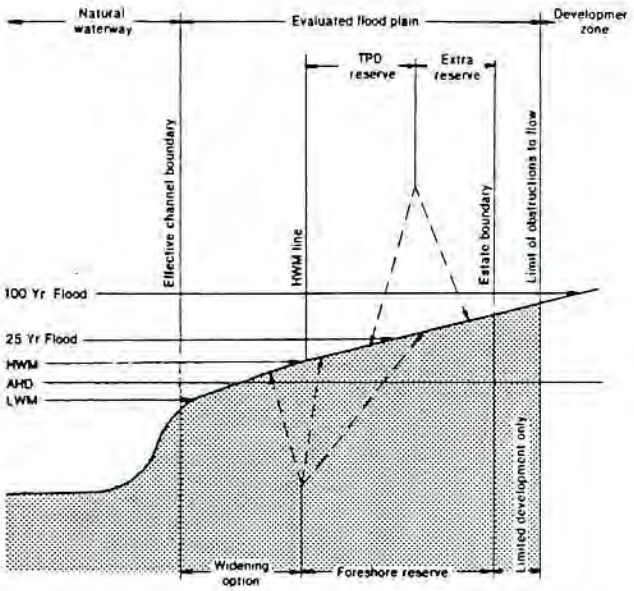

Figure 1. Foreshore Reserve Adjacent to Natural Waterway

Small Multi-purpose Reserves adjoining the Canal Waterway

These reserves are to provide access to the canal waterways to a sufficient extent to permit emergency access for individuals.

The canal waterways must be accessible for water cleaning, including the removal of accumulated weed, flotsam and jetsam, and for other maintenance.

Access ways 4 m wide should be provided at least once every 300 m along each canal bank and at points of obvious debris collection and where these are less than 1000 m^2, they may be rights-of-way which should not be included in the Public Open Space calculation.

Multi-Purpose reserves should be a minimum of 1000 m^2 Reserves of this size and greater can be included in the Public Open Space calculation.

These reserves can also be used for recreation which is not water oriented. However, the reserve development must permit vehicle access to the canal waterways.

It is not intended that these reserves should contain features which attract large numbers of people, e.g. a public launching ramp.

Public Open Space in Canal Estates

Recreation areas on land are essential for community activities and are as important in canal estates as in a conventional subdivision. Provision of the usual 10% Public Open Space is, therefore, necessary.

Public Open Space calculations normally exclude major roads, schools and major drainage areas, and, in a canal estate, the area of the canal waterways and the foreshore reserve should also be excluded from the area of land used to determine the 10% Public Open Space contribution.

Consideration should be given to the location of some Public Open Space away from the canal waterways, because casual or formal sporting activities and playgrounds for small children are not normally compatible with a waterside site.

8.0 WATER QUALITY REQUIREMENTS

The guidelines set out below are relevant to the design and assessment of canal estate proposals. The guidelines apply to adjacent natural waters and/or source water and their relationship to canal waterways. If the source water does not meet these requirements, a canal estate proposal for that location is inappropriate.
Water quality within a canal estate is likely to be lower than that of its source water. The quality may also vary with each development.

The attainment and maintenance of acceptable water quality will require active management.

These requirements do not override the criteria established by the Environmental Protection Authority. (Refer EPA Bulletin 103, April 1983).

8.1 General Guidelines

8.1.1 Water quality within canals must be such that the following 'beneficial uses' should not be adversely affected:

- occasional human immersion and wading
- boating
- adjacent development
- passive recreation (which can be affected by odour, insects, rubbish).

8.1.2 A canal estate should not be permitted where the source water has a beneficial use or water quality that is a lower standard than the beneficial uses in paragraph 8.1.1

8.1.3 The presence of one or several canal estates should not be permitted to measurably reduce the quality of the natural water body.

8.1.4 A canal estate should not have an unacceptable impact on the passage of fish in the natural water body.

8.1.5 No industrial or residential waste or effluent of any nature should be discharged directly or indirectly into canal waterways.

8.1.6 Parameters regarded as being significant for assessing water quality are:

- suspended solids
- chemical constituents
- pH
- dissolved oxygen
- bacteriological counts
- nutrients
- other factors, such as salinity or biota may be significant in some instances.

8.1.7 It is apparent that boat toilets which can discharge into the waters are not compatible with canal estate uses. Action to prohibit this form of discharge will be necessary. Pump out or toilet facilities at service sites should be provided.

8.1.8 The maintenance of canal water quality should not be entirely dependent upon mechanical equipment or chemical additives.

8.2 General Aesthetic Guidelines

The following general aesthetic guidelines are desirable for waters within and adjacent to a canal development.

Waters should be:

- Free from substances which will settle to form putrescent or otherwise objectionable sludge deposits.
- Free from floating debris, oil, grease, scum, foam and other floating materials in amounts sufficient to be unsightly or otherwise objectionable.
- Free from materials which will produce colour, odour, turbidity, or other conditions to such a degree as to be unsightly or otherwise objectionable.

APPENDIX 1:

CANAL ZONES IN TOWN PLANNING SCHEMES

1. General

Given the different construction of Scheme Texts and the variety of proposals falling within the definition of a canal estate, it is clearly not possible to provide an exhaustive set of recommendations appropriate to all schemes and all proposals. It will therefore be necessary to examine the relevance of each provision and customise any Scheme Amendment to suit each Scheme and circumstance.

2. Scheme Amendment Documents

Where an Amendment involves a Scheme in which there is no current reference to a Canal Zone, there will be a need to prepare the following formal documentation as provided in the Town Planning Regulations:

2.1 A Scheme Amendment Resolution. (Reg 25c)

2.2 A Scheme Amendment Report in which the proposed development is described and justification given for amending the Scheme. (Regs 12 & 25a)

2.3 A Scheme Amendment Text setting out full particulars of the precise wording of the amendments and additions to be made to that text by deleting words, phrases or sections or by inserting new. (Regs 11 & 25a)

2.4 A Scheme Amendment Map showing the land to be removed from its present zoning classification and included within a Canal Zone.

3. Scheme Text Provisions

3.1 Definitions

In most Schemes having no current provisions for Canal Zones, the list of definitions and interpretations will probably fall short of that which will be necessary to provide adequate control. Desirably, any Scheme Amendment should incorporate the definitions set out in Section 2 of this Policy.

3.2 List of Zones & Zoning Table

Appropriate amendments to these provisions of a Scheme Text will need to be made to include the Zone Classification - 'Canal Zone'.

Where the Zoning is amended to include Canal Zone, appropriate symbols will need to show the particular land uses which are or are not permitted within the Zone together with those uses which may be permitted at Council's discretion.

3.3 General Provisions

The following typical clauses may be used as appropriate in addition to other more specific provisions as may be required in each case:

Clause No .... Development in Canal Zones

3.3.1 Council's intention in controlling development within the Canal Zone is to:

- encourage a high standard of development within the zone;
- promote and safeguard health, safety, convenience, environmental quality and the general welfare and amenity of the locality;
- promote a high standard of maintenance of canal and other waterways (through cooperation with the Management Authority and the Department of Marine and Harbours).

3.3.2 A canal estate may only be developed within
a Canal Zone as shown on the Scheme Map and the uses and development which may be permitted within that zone are set out in the Zoning Table (or in Part...).

3.3.3 Land comprised of artificial waterways in a canal estate developed within a Canal Zone is land for the purpose of this Scheme and, notwithstanding any other provision of this Scheme Text, any development in, on, under, over or abutting any such waterways requires the Council's prior approval in accordance with the procedures set out in this Scheme.

3.3.4 Any development proposed between the boundary of a canal waterway and the setback distance for an buildings on the land as prescribed by this and other provisions of this Scheme, requires the prior approval of the Council in accordance with the procedures set out in this Scheme.

3.3.5 Where development as described in Clauses 3.3.3 and 3.3.4 above is proposed on a land, Council shall refer the development application to the Building Management Authority and the Department of Marine and Harbours for their consideration and shall give these Authorities 42 days within which to respond. Council shall take into account any comments in making its determination.

3.3.6 All canal retaining walls along a canal front age shall be kept in a structurally sound condition and shall not be altered, extended or removed without prior written approval of Council, Building Management Authority and the Department of Marine and Harbours. The owner or vested manager of land adjoining the canal waterway shall be responsible for the stability of the interface between the water of the canal and that land and shall maintain this interface to the satisfaction of those authorities.

3.3.7 All Dwellings shall be set back a minimum of 9 m from a canal frontage and 6 m from a road frontage.

3.3.8 No retaining wall or fencing shall be erected along the canal frontage or within 1m of the top of a canal wall or canal frontage whichever is the greater setback as determined by Council.

3.3.9 No retaining wall situated more that 1 m but less than 7.5 m from a canal fronta shall exceed 1m above the stabilised surface level.

3.3.10 No retaining wall situated more that 7.5 m but less than 9 m from a canal frontage shall exceed 1.5 m above the stabilised surface level,

3.3.11 No fence situated within 7.5 m of a canal frontage shall exceed 1 m above the original stabilised surface.

3.3.12 No fence situated more than 7.5 m from a canal frontage shall exceed 2 m above the original stabilised surface.

Adopted: 10 December 1991

PROCEDURES FOR APPROVAL OF ARTIFICIAL WATERWAYS AND CANAL ESTATES

(For details refer to Policy DC 1.8)