



Government of **Western Australia**
Department of **Transport**

BROOME BOATING FACILITY



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BROOME BOATING FACILITY

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EXECUTIVE SUMMARY

In the port town of Broome there have always been difficulties in providing maritime facilities due to its very large tidal range in excess on 9 metres and to the regular occurrence of cyclonic storms.

From the late 1980's at least fifteen different small-craft harbour concepts have been examined in a search for a commercially viable development which would provide shelter and services for the wide range of smallcraft in Broome. The earlier group of proposals anticipated private funding, with the high capital cost being offset by freehold land development. The private proponents did not find a scheme acceptable to their needs. A latter group of proposals was initiated by a local steering committee, which anticipated public funding, again being offset by freehold land sales. While they recommended a preferred option, the cost was very high and the project was not taken up by the State Government.

To date, proposals have centred on comprehensive full-tide, locked harbours which would provide safe cyclone moorings for the majority of the Broome recreational and commercial fleet, supported by boat ramps, service facilities and adequate land for maritime industry development. The cost of these facilities has been prohibitive, generally in the range of \$150 million to \$230 million in today's dollars.

The current investigations have been directed at developing boating facilities which will serve the majority of the boating public but do not require the construction of a costly boat harbour.

There are currently some 1600 recreational boats and about 120 commercial boats at Broome. These numbers are expected to grow to at least 3000 recreational boats and about 180 commercial boats by 2031.

The major boating requirements at Broome are:

- Improved boat launching facilities;
- Increased capacity to remove boats from the water for repairs and maintenance;
- Passenger and cargo handling for charter and commercial operators, preferably at all levels of tide;
- Safe mooring for both commercial and recreational boats; and,
- Cyclone protection.

This report presents the development of a boating facility that caters for the majority of the Broome boating fleet.

The proposed boating facility is to be located in west Roebuck Bay. The site is adjacent to the Port of Broome's slipway site and within the Port Boundary. The development would include the following key elements:

A. Boat ramp

A new multi-lane boat ramp at optimum grade down to a low water level that will offer shelter from adverse winds under normal boating conditions. It will cater for the launching and retrieval requirements of at least 80% of the boats at Broome. Being adjacent to the existing slipway, it will also permit the use of wheeled jinkers in the event of a cyclone. Associated works will include access roads and parking areas.

B. Extended Ramp and Dredged Basin

Providing a dredged basin at the ramps will permit the toe of the ramp to be extended to a lower level. The dredged basin will permit all-tides boat launching and retrieval.

C. Protective breakwater and floating jetty

The main breakwater will give better shelter to the ramp, extending its usage window and making it safer to use. A multipurpose floating jetty can be installed in the sheltered water afforded by the breakwater. This jetty will serve primarily as a holding jetty for the ramps but can also be used for loading and offloading of passengers and equipment for charter boats and possibly offloading of catch from fishing boats.

D Cyclone Strategy

A cyclone management strategy will be developed as a part of these works. This strategy may include elements such as the provision of cyclone moorings in Dampier Creek, more swing moorings and cyclone tie downs in the parking area.

The proposed boating facility will cater for all the trailable boats, which represents at least 80% of the Broome fleet, and provide significant advantages for the medium sized commercial boats in the area. It will be a major improvement in operating safety and efficiency for small to medium size vessels in Broome.

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1 INTRODUCTION

Since 1987 the Department of Transport (DoT) and its predecessor organisations has been examining options for the provision of small-craft facilities at Broome. Prior to that time, the Public Works Department and the Port of Broome also sought sites for such facilities. The limited launching sites and the small-craft landings at the Entrance Point jetty were the best available options at that time. The complications in the provision of shelter, landings and launching ramps resulted from high tides and currents, cyclone exposure, other claims on favourable sites, and difficulties in justifying the (resulting) necessarily high expenditure for a small community.

To date, DoT has examined some fifteen conceptual harbour plans and some ten boat launching ramp options. Most of these have been discussed with the Broome community; none have been able to provide for all the boating needs at an acceptable site and at an acceptable (capital and operating) cost. Although the problem stems in part from the wide range of small craft for which facilities are needed, the fundamental problems relate to the high tide range, cyclonic conditions, offshore bathymetry, isolation and lack of available land.

The examined harbour proposals were mainly located at or near the Port of Broome, utilising land in the Port Area. Most sought to offset the high capital costs of the harbour component by developing (and selling) land for residential or industrial use.

In the absence of either public or private funding for the early schemes, the only investment for recreational boats has been for the existing East and West ramps at Entrance Point, and the limited ramp at the Town Beach.

The most recent and comprehensive study (in 2002)¹ was directed at identifying suitable boat harbour sites in and around Broome. This study short-listed four possible sites and the preferred option was for an inland harbour at Riddell Point. While it had some potential for staging and was capable of serving all but the largest of the local boats, it was costly to build (currently at least \$150 million in today's dollars) and generated some local opposition. This option was not pursued.

Transport has subsequently looked at the possibility of building sheltered all-tide boat ramps on the Broome town site coast. These were considered for their probable acceptability and cost-effectiveness, but have not been further discussed with the local community. Their assessment however has enabled the further considerations of this report.

¹ Broome Boat Harbour Site Selection Report, Department for Planning and Infrastructure, Report no DPI412, August 2002

This report recognises the previous investigations and options, and identifies works which can provide major benefits for a large percentage of the Broome boating community.

2 BACKGROUND

2.1 General

Broome was developed as a land-base for the Pearling Industry and today it is home to a varied fleet of fishing boats, charter boats and other commercial vessels as well as recreational vessels. The existing commercial fleet is the largest in WA outside of the metropolitan area and Geraldton.

2.2 Current Boat Numbers

2.2.1 Recreational Boats

There are currently 1,588 recreational boats licensed in Broome, or 93.4 boats/1000 people. Of these about 54 are over 7.5 m. For planning purposes it is convenient to assume that boats over 7.5m would require a pen or mooring, while the boats below this are trailable.

2.2.2 Commercial

Broome is home to a varied fleet of fishing boats, pearl farming boats, charter boats and other commercial vessels. Currently, there are 117 commercial vessels surveyed in the wider Broome area (Broome, Dampier, Cockatoo and Koolan Islands, and Kuri Bay). Table 1 below shows the number of commercial vessels registered in Broome that were scheduled for surveying as at 1st January 2010.

Vessel Size (Metres)	0 – 7.5	7.5 - 10	10 - 12	12 – 15	15 - 18	18 - 22	> 22
Number	37	36	20	3	3	4	14

Table 1. Commercial vessels registered in the Broome area.

Most of the commercial boats are of a size that would normally be stored in pens, but not all of them operate from Broome on a day-to-day basis. For example, a number of them are engaged in the cultured pearl or mining industry, and operate along the Kimberley coast, distant from Broome.

2.2.3 Tourism

Broome is a popular tourist destination. A survey taken over the years 2006, 2007 and 2008 for the Shire of Broome² show the number of visitors (who stayed for at least one night) were approximately 230,000 for each year. These were 48% intrastate, 36% interstate and 16% international.

² Shire of Broome Overnight Visitor Fact Sheet 2006,07,08, Tourism WA

Of the domestic tourists, 65% were in Broome for holiday/leisure purposes.

Data collected by the WA Department of Fisheries³ in association with safety inspections includes the registration number, which can be linked to the postcode of the boat owner. This shows that for Broome 52% of the vessels on the water on a good boating day are local, 48% tourists.

³ Fisheries Research Report No.127, Dept of Fisheries 2001

3 BOATING DEMAND

3.1.1 Broome Population Growth

Using historical Broome population data from 1990 to 2009 a regression line formula projects a population rise from 17,000 as at end of 2009 to 29,800 by 2031. This represents an almost doubling of the current figure. It should be noted that working from past data in small but special regional centres such as Broome is likely to give less valid predictions than judgements which can include significant 'external impacts' (such as resource developments, or the global financial crisis) that can add or subtract large numbers of permanent people. However, these predictions are consistent with the positions of the Shire of Broome and the Western Australian Planning Commission (WAPC).

The Shire of Broome is working in conjunction with key stakeholders to facilitate a major new land development for the northern part of the town (Broome North). The proposed development will be located north of Gubinge road and will cater for growth in population and the tourism industry as well as potential increased demand from the resources industry⁴. The development will produce close to 4,800 residential lots housing up to 13,000 people and will be achieved over the next 10 – 30 years.

The WAPC produces regional reports which provide a snapshot of land supply in regional centres that are experiencing land and housing supply pressures as a result of growth in the resource and/or other industry sectors.

The November 2008 regional report for Broome⁵ included the following observations:

- Broome has experienced population growth significantly higher than that of the State for a number of years. This can be attributed to a number of factors, including the rapid growth of the tourism industry, growth of government services, and growth in retail, aquaculture, agriculture and resource support industries.
- The State government has released the Northern Development Taskforce's Site Evaluation Report on the potential locations for the processing of Browse Basin gas in the Kimberley. Of the four sites identified for further studies (Gourdon Bay, James Price Point, North Head and Anjo Peninsula), three of these are within close proximity to Broome. These options will create land supply impacts for Broome, particularly the current preferred site at James Price Point.
- The Broome Port is investigating its capacity to handle increased activity if development of the Browse Basin proceeds.
- Land supply options are extremely limited and will not cater for longer term demand. Due to airport and floodplain constraints, consideration needs to be

⁴ Shire of Broome, Broome North Draft District Development Plan and Draft Local Development Plan

⁵ WAPC, Broome Regional Hot Spots Land Supply Update, November 2008

given to the development of a satellite suburb remote from the Broome townsite.

- A Dampier Peninsula Strategic Plan is to be prepared to identify the long-term land use, infrastructure provision and access to the area, providing a sustainable framework for guiding decisions about beneficial economic, social and environmental outcomes.

Considering the information available, facility planning has been based on an increase in the Broome population to 30,000 by 2031.

This increase in population will add to the number of recreational vessels and increase the demand for boating facilities in the Broome area.

3.1.2 Recreational Boating Predictions

The present proportion of boat owners in Broome is about 93 per thousand of the population. This is high compared to the WA average of about 43 boats /1000 and may represent “saturation” for this type of community. However, for many small coastal communities boating is an important recreational pursuit and boating numbers can be much higher than the state average. For example, the Shire of Roebourne has 152 boats/1000 and Exmouth has 197 boats/1000. It is considered likely that the Broome rate of ownership will remain significantly greater than the state average.

Of the 1588 recreational boats in Broome, only 54 are over 7.5m, or of a size where they would probably be best served with a pen or mooring. This is only 3.4% of the Broome recreational fleet. On average in WA 8.1% of boats are over 7.5 m. This difference is likely due to the unavailability of sheltered moorings for the larger boats. In consequence, predictions of future boating sizes depend to some extent on the availability of sheltered moorings. If these moorings are available then it can be expected that some 8% or more of the recreational fleet will use them, but if they are not available then there will continue to be a limitation on large boat numbers. Table 2 considers both situations.

Given the uncertainties of population growth and boat ownership ratios, future boat ownership numbers are difficult to predict in advance. However, for the purpose of this report, it has been assumed that:

- Planning will be for a twenty year horizon (2031); and,
- Broome population will increase to 30,000 by 2031.

Two growth scenarios have been considered, one where the boat ownership ratio peaks slightly higher than at present at 100 boats /1000 and one where it approaches other isolated coastal towns at 150 boats /1000.

Table 2 below summarises the possible recreational boat numbers in Broome by 2031.

	Current		Low Boat Growth to 100/1000		High Boat Growth to 150/1000	
	Current (2010) Broome	Current (2010) state averaged	Predicted 2031 no harbour	Predicted 2031 with harbour	Predicted 2031 no harbour	Predicted 2031 with harbour
Population	17000	17000	30000	30000	30000	30000
boat/1000	93	43	100	100	150	150
Boat numbers	1588	731	3000	3000	4500	4500
boats over 7.5 m	54	59	102	243	153	364
% of boats over 7.5 m	3.40%	8.10%	3.40%	8.10%	3.40%	8.10%

Table 2 - Current and predicted recreational boat ownership in Broome

The number of large boats predicted under any scenario is relatively small and, realistically, does not affect the boat launching requirements, especially given the general nature of these predictions. However, it does suggest that additional cyclone moorings will need to be considered.

3.1.3 Commercial Boating Predictions

There were 89 commercial boats surveyed in Broome in 2001, and there were 117 scheduled for survey as at 1 January 2010. A simple extrapolation of these numbers suggests that there will be 182 commercial boats by 2031.

It should be noted that many these vessels are not located at Broome, but may be offshore or further up the coast. Also many charter vessels, although registered in Broome, may only visit to collect and disembark passengers.

Discussion with operators and others in Broome in 2001 indicated that there were about 20 to 30 boats that would operate from a protected facility full time and others which would use it part of the time. This suggests that some 25 to 40 would use a protected facility now, and some 40 to 60 by 2031.

The “very large” local commercial boats do not need the daily support of marina facilities, and can obtain most of their occasional cargo-handling needs from the existing port facilities at Broome. However, there has been an expressed need for all-tide passenger handling for day-charters, preferably from a floating landing. Such a landing could possibly also supply fuel and water to all craft, including recreational boats.

3.1.4 Boat Launching Predictions

As discussed above, 52% of the vessels on the water on a good boating day are local, 48% tourists.

The pertinent statistic for this evaluation is the number of vessels in use on a good boating day. Experience in larger conurbations (Perth Metro area, Peel Region) shows that only 5% of registered trailer boats are used on “good” days on long weekends. The relevance of this ratio to Broome, where large tides, tourism, cyclones and severe summers all have an impact on what might be a good boating day, must be treated with caution. However, in the absence of other guides it is proposed to proceed on this basis.

Using the 5% of local boats, with an equal numbers of tourists, gives a 2009 trailer-boat usage of approximately 150 per day, and a planning future figure of at least 300 per day requiring launching and retrieval.

4 MARITIME INFRASTRUCTURE REQUIREMENTS

4.1 Existing Facilities

The major marine facility at Broome is the Broome Jetty, in the Port of Broome. However, this structure deals with shipping rather than small boats, and is not a part of this study.

4.1.1 Boat Launching

The boats seeking launching facilities at Broome include locally registered recreational boats, smaller commercial boats and visiting tourists' boats. They currently launch across beaches, or use two exposed part-tide ramps at Entrance Point. There is also a small ramp at the Town Beach with limited high tide access.

Launching facilities at Broome are substandard in comparison with other ramps throughout the state. They are all exposed and are only usable for a part of the tide. None have boat holding facilities or wave protection. The poor quality of the launching facilities is a direct result of the high tide range and the 'flat' inshore bathymetry.

Either dredged channels or extensive earthworks are required to build ramps to below low water. These are difficult and expensive to construct. Even then, the ramps would need to be quite long to cover the whole tide range. An arrangement of either very wide ramps, a series of ramps for partial tide ranges or turning points on the ramps would need to be considered.

For shelter, breakwaters must be high, and must be heavily built to withstand cyclonic wave action.

4.1.2 Boat Mooring

There are no boat pens in Broome. Some swing moorings are available in the port area. The only protection available during cyclones or other stormy weather is by running vessels up the local tidal creeks such as Dampier Creek or taking them from the water. Larger vessels normally put to sea.

4.1.3 Boat Repairs

Medium size boats can be taken from the water at the slipway, using wheeled jinkers. However, the slipway can only be accessed at higher tides, and there are limited hardstanding and workshop facilities available.

4.1.4 Passenger and cargo loading/off loading

Currently, the larger boats can take some cargo and passengers from the port jetty. However, for most private boats and commercial vessels, loading and offload of both cargo and passengers is likely to be across the beach with dinghies.

4.2 New Infrastructure Requirements

There has been considerable work done on identifying the main boating needs for Broome. The primary requirements are for:

- Improved boat launching facilities;
- Increased capacity to remove boats from the water for repairs and maintenance;
- Passenger and cargo handling for charter and commercial operators, preferably at all levels of tide;
- Safe mooring for both commercial and recreational boats; and,
- Cyclone protection.

Other desirable requirements include:

- Improved catch offloading facilities for fishing boats;
- Capacity for private boat owners to safely embark and disembark from their boats; and,
- Capacity to develop local marine industry including boat servicing.

Ideally, boating facilities should be accessible at all stages of the tide but, where this is not possible, access time should be maximised. Essentially, access time is dictated by the depth of water at the particular facility.

4.3 Infrastructure Development Constraints

Broome is a difficult place to build small-craft facilities because:

- The normal tide range is in excess of nine metres;
- The region is subject to frequent cyclones;
- There is a shortage of suitable rock in the region for breakwater construction;
- Much of the shore is surrounded by tidal flats;
- Longshore tidal currents may tend to move silt into channels;
- Sandstone substrate makes excavation, and particularly dredging; difficult and expensive;
- There is a lack of suitable and available land; and,
- Construction costs in Broome are high compared to the rest of Australia, and are in the order of 50% above Perth rates.

The 9 m tidal range at Broome affects a number of factors, including boating facility operation, vessel mooring, harbour aesthetics, design wave height and breakwater size.

The shallows offshore from Broome, particularly the Pearl Shoals, limit the design wave height inshore at low tides. However, they have much less effect at high tides. The eastern shoreline of the Broome peninsular is more protected than the south west shoreline down to Entrance Point.

Essentially, this means that a breakwater east of the port will require about 4 tonne rock armour and a similar structure west of the port will need 20 tonne rock armour.

20 tonne armour stone is not available locally in any quantity. Accordingly, a development west of the port will demand that either imported armour or alternative breakwater types and materials will have to be considered. This may include precast concrete units in lieu of rock, or sheet piling or caisson-type structures. Given the limited amount of even 4 tonne armour, this restriction may also apply to works east of the port.

Whatever breakwater type is used, the costs will be considerable.

The shore of Roebuck Bay adjacent to Broome is tidal mud flats. This material is mobile under the influence of the tidal and longshore currents and any channel through these flats may be prone to siltation, and require ongoing maintenance. The sandstone substrate under the area will make excavation of a basin or channel difficult and expensive.

5 CURRENT PLANNING

Previous attempts to provide a boat harbour at Broome which would meet all user requirements have been unsuccessful. The basic problem has always been the cost of such a facility. The significant technical problems associated with the delivery of any marine facility in this location can be overcome, but only at a price. For some proposals opportunities for significant cost returns have been identified, but the difficulty in accessing suitable land has prevented progress.

DoT is now proposing a range of smaller boating facilities. This approach will provide valuable facilities to a large proportion of the boating public at a cost for which funding can be more readily obtained and justified. It does not preclude the future development of harbour facilities, but this is not part of the immediate works.

5.1 Separate Small-craft Group Requirements

Small-craft at Broome can be classified into four groups, each with different needs, at different seasons. They are:

- Trailable recreational boats (nominally 7.5 metres or under)
- Locally registered larger recreational boats (nominally 7.5 to 15 metres)
- Locally surveyed commercial boats (under 15 metres)
- Locally surveyed larger commercial boats (15 to 35 metres)

Larger tourist or commercial boats do visit Broome for short periods, but normally require a Port berth for their needs.

5.1.1 Trailable Recreational Boats

The largest single group is trailable boats seeking launching facilities at Broome. They include locally registered recreational boats, smaller commercial boats and visiting tourists.

The primary requirement for trailer boats is for protected launching ramps with adequate parking. All tide ramp access is desirable, but they can cope with some tidal limitations.

Trailer boats are currently launched across beaches, or from exposed part-tide ramps at Entrance Point and Town Beach. Exposure and tidal restraints limit the effectiveness of these ramps. In addition and as discussed previously, population increase estimates suggest that the daily launching demand will double, requiring a minimum of two further ramp lanes. The provision of sheltered all-tide paved ramps could well add a latent demand to this requirement, so added all-tide ramp lanes should be included if costs are not significantly increased.

The relatively high tidal range at Broome separates it from most other places in WA, in that it requires complex ramps to be constructed if all-tide capability is to be provided. The natural sandy beach slopes which average a grade of perhaps 1:50 must be modified by a substantial structure to provide a 1:10 ramp gradient. For shelter, breakwaters must be

high, and must be heavily built to withstand cyclonic wave action. The option of building a ramp on a steeper rocky shoreline is not readily available, and where it is available there is no natural shelter to minimise the breakwater structural problems.

5.1.2 Larger Recreational Boats

For planning purposes, it has been assumed that boats over 7.5 m will require pens or moorings, and boats under this will be kept on trailers. However, some larger boats are also kept on trailers, and some smaller boats require (or desire) pens. Also, there may be a latent demand at Broome, where the lack of mooring facilities has most likely deterred ownership of larger boats.

The primary requirement for these large recreational boats is a safe mooring. In Broome, this means a safe cyclone mooring. Secondary requirements are for loading and offloading, facilities, fuelling facilities and maintenance areas. Like trailer boats, all tide access is desirable, but they can cope with some tidal limitations.

Currently 3.4% of Broome's locally registered boats exceed 7.5 m compared to the state average of about 8.1%. So, although there are currently only 54 recreational boats over 7.5 m registered in Broome, there is a probable latent demand for more pens than this.

5.1.3 Small Commercial Boats

About 96 of the 117 commercial boats surveyed at Broome measure less than 15 metres length. Many of these could be housed in a marina, though many are employed away from Broome and will not require a permanent mooring. Others are trailable. For planning purposes, half of these should be included in the first stage of a future harbour development. This is in line with the preliminary estimates of commercial boats requiring pen moorings given in Section 3.1.3 above.

The requirements for small commercial boats are similar to those for the larger recreational boats - safe mooring, refuelling, etc. However, this class of vessel has a greater need for loading and off loading facilities and maintenance facilities such as slipways.

Charter vessels require a facility to safely load and offload passengers and gear.

5.1.4 Large Commercial Boats

These come in two groups, with 20 or so in the 15 to 35 metre range, and very few vessels above that length. This conceptual group separation is by vessel draught, for which 2.1 metres matches a power boat of 35 metre length. This draught is a proposed separator for Broome facilities, since it matches the draught for which a half-tide automatic gate can economically manage a marina water depth at Dampier Creek. However, the turning and mooring space needed by the boats above 15 metres reduces the space available for the shorter boats which can effectively share the cost of such "non-commercial" sheltered water, so the affordability of their inclusion would need to be further evaluated.

These vessels would generally benefit from the availability of safe cyclone moorings, even if they are not in a harbour.

The very few larger boats, together with the “small cruise ship” vessels of up to some 70 metres length, are catered for at the inner berths of the Port’s jetty, where they can obtain the short-stay service they need for re-supply and passenger/crew changeover.

5.2 Sheltered All-tide Boat Ramps

In 2009, the DoT examined whether it was possible to build a simple sheltered all-tide boat ramp at any site in Broome. In the absence of large armour stone which can withstand cyclone-induced wave action, a concept was developed using steel sheet piling to contain a 1:10 gradient ramp extending from above high water to below low water, and to give wave protection from one side. This was judged to be the most economic structure. Shelter from other wave directions was to be provided by another stand-alone breakwater, which also sheltered a space which could be dredged in the future to provide a modest all-tide basin for temporary use by smallcraft. In most locations examined, some minor dredging of rock was needed at the toe of the ramp to allow use at the lowest tides, since the Broome ocean shores normally have a flat rock platform at about one metre above low tide. Filling was needed for access roads to the ramp top, and for some car/trailer parking space.

The locations considered for this concept included the two existing boat ramp sites at Entrance Point, together with sites adjoining deep water at Riddell and Gantheaume Points. A development inside Roebuck Bay was also included in this review, though it was clear that the channel dredging required introduced a costly dredging requirement which was not needed at the rock-based locations. These sites are known to all have constraints of land use and access from existing tenure, environmental and land availability. They were also assessed from their potential shelter from the dominant easterly and westerly wind waves and from the dominant currents associated with flood and ebb tides.

The following comments apply to each of the sites considered in this assessment:

- Entrance Point (Existing west ramp):- difficult to shelter from the west; limited car parking; access through Port secure area; vulnerable to cyclonic storms from many directions; difficult currents across ramp.
- Entrance Point (Existing east ramp):- limited car parking; access through Port secure area; cross currents.
- Entrance Point (South of Port jetty):- substantial reclamation to reach deep water; limited car parking; adjoins possible Port rig service base and must access through Port secure area; difficult to shelter from the east.
- West Roebuck Bay (North of Port jetty):- dredging required at toe to reach low water; has potential to eventually shelter jinker ramp area; needs reclamation for parking area. (This is the preferred site)
- Riddell Point: - site has been rejected for major harbour; site believed to be needed for Port purposes; incorporates dune area.

- Gantheaume Point (West):- site adjoins important “footprint” location; limited car parking.
- Gantheaume Point (East):- long reclamation needed to reach low water line; difficult to shelter from westerly waves.
- Roebuck Bay (applies to any location between Entrance Point and townsite):- major dredging required across current to reach low water; channel will need regular (annual) maintenance; access (or parking area) is within the dune area; long and expensive breakwaters needed to shelter ramp and channel from waves and cross currents.

This review effectively shows that the best options for ramp development are located within the Port area, and that further investigations should be aimed at one of the Port sites which

- a) Is compatible with other plans for use of the port area
- b) Offers the best opportunity for future expansion for the benefit of the maritime community.

5.3 Separate Facilities

As previously stated, the concept of considering separate facilities for each of the user groups allows an overall staging of the development of small craft facilities and the better opportunity to justify funding for each part. However, it does not mean that the overall joint benefit of the development for each site should not be identified, and joint use must be considered for each development. For example, any dredging of a channel should be optimised for joint use by compatible groups, provided that neither the overall cost nor the overall functionality is compromised.

5.3.1 Boat Launching Ramps

New boat launching ramps with protection from dominant wave action, access over a greater tide range, an increased launching capacity and more parking will cater for the largest user group, the trailed boats.

A site has been identified at west Roebuck Bay where a wide semi-sheltered ramp on a (comparatively) flat but optimum launching grade of 1:10 can be built down to a natural contour of +1.5 metres (to 2009 Chart Datum). With a small amount of dredging, this could be extended to RL -1.5 metres, which will ensure all-tide launching for all normal trailable boats. This site requires some on-shore reclamation for parking and access, which could possibly be won from dredge spoil or require imported fill.

Fig 1 shows the optimum location for this ramp, which gains some shelter from wave action at the waterline from the extension of its outer sheet-pile retaining wall. This ramp could be developed in two stages, the first without dredging at the toe, which then creates the need to bring fill from an external site. If dredging is undertaken, as

shown, much of the needed reclamation spoil could come from site, and a better all-tide launching facility will be provided.

5.3.2 All-tide Basin with Floating Jetty

A floating jetty adjacent to the boat ramps will serve as a holding jetty for launching and retrieving trailer boats and provide safer access and landing for gear and passengers, including disabled passengers. It could be used by charter operators to load and offload passengers and gear. However being a floating jetty it would be of limited capacity for other commercial vessels.

Experience has shown that any effective small-craft floating jetty requires shelter from the dominant wave action. Since this not available naturally at any all-tide Broome location, an artificial breakwater is needed.

As shown on Fig 1, the floating jetty can be positioned immediately adjoining the above boat launching ramp. It will remain partially exposed to wave action until the major breakwater, shown on the plans, has been built. The floating jetty could then be moved out to allow berthing on both sides.

Ideally, the overall shelter afforded by the breakwater should be shared by the boat ramp at the west Roebuck Bay complex and with the slipway facilities. The major outer breakwater will be expensive because of the need to design for the cyclonic forces and high tidal range but, if located at the west Roebuck Bay complex, it offers shelter to the widest number of boating interests.

For the future, this all-tide basin could be fitted with short-term moorings for occasional use by a small number of boats housed in a part-tide marina (elsewhere), should they need to layby at times of low tide. The planning of such time-and-tide usage is common in many other places throughout the world where high tidal ranges exist.

As noted above, the dredged spoil could provide fill for the reclamation needed at the ramp and the parking areas if it is proven to be suitable for this purpose.

5.3.3 Slipway

The proposed dredged basin and shelter at west Roebuck Bay is adjacent to the existing slipway.

The proposed boat ramp could also serve as a slipway for wheeled jinkers at no additional cost. However this would require proper management as a large jinker on the ramps may present as a hazard to other users, as does moving a large jinker through the trailer parking areas. Also, a jinker on the ramp during busy recreational boating days will limit access for trailer boats.

Reclaimed land will be limited, and it would be necessary to delineate areas for trailer parking and boat repairs/ maintenance.

At times of approaching cyclones, small recreational boats are unlikely to be using the ramps. It would therefore be desirable to take advantage of the ramps and hardstanding to remove non-trailed boats from the water on jinkers and store them on dry land. In this circumstance, concrete tie downs should be included in the trailer park as well as the maintenance area, and used for emergency storage. The ramps could be then used in conjunction with the slipway for improved cyclone storage.

5.3.4 Small-craft Marina

In the future, a tidally limited small-craft marina could provide pen moorings for the larger recreational boats and the smaller commercial boats. Fuelling facilities and a service jetty to facilitate loading and unloading could be included in the harbour.

To date, two options have been considered for a small-craft marina which would be accessible over part of the tide range, Dampier Creek and west Roebuck Bay (adjacent to the boat launching complex).

A marina in Dampier Creek would be similar to that previously considered and its navigable access would be available from mid-tide and above. It could serve the needs of the majority of the Broome Fleet that are not trailered.

It may be possible to develop a marina in west Roebuck Bay, adjacent to the proposed boating facility, with either partial tidal access (similar to Dampier Creek) or with full or nearly full tidal access.

DoT is not considering the development of either of these facilities at this stage, but planning will continue to ensure that future opportunities are maximised.

5.3.5 Large Commercial Boat Facility

There are currently less than 25 boats in the 15 to 35 metre length group, of which about 15 are involved in pearling. Their primary needs are for access (crew and passenger loading/unloading) and maintenance. Shelter is rarely sought, except during cyclone alerts, so including these boats in a marina requires creation of space, depth and access needs which would be rarely used.

At this time, DoT is considering catering for the non-cyclonic needs of this part of the fleet by taking advantage of shelter afforded by the major proposed breakwater at the Boating Facility combined with a floating jetty as discussed above. The slipway would be available for the continued use of individual jinkers for maintenance and for boat storage for some of these vessels when out of use. Fuel, or major cargo handling, could continue to be handled by the Port.

5.3.6 Cyclone Management Strategy

It is acknowledged that the facility options presented here do not initially fully address a primary concern for this area – the safety of large boats during cyclones. Small craft can be removed from the water on trailers. Medium size boats can be stored on the hardstand or eventually kept in pens. The balance of the fleet has to rely on swing moorings, seek shelter in the creeks or go to sea.

A comprehensive cyclone strategy still needs to be developed for Broome. This strategy should consider:

- providing formal cyclone refuge moorings in the upper reaches of Dampier Creek;
- providing tie down points in the jinker area and in the proposed trailer parking area; and,
- providing additional cyclone swing moorings.

Additional protection will come from any harbours or basins built in the future, and can be incorporated in the cyclone management plan.

It may be possible to build formal cyclone moorings in Dampier Creek, and a useful first step would be to establish whether formal moorings, such as piled trots, would be more effective than the current system, where skippers are responsible for setting out their own anchors.

5.4 Staged Developments

The discrete nature of the current proposals lends itself to staged development of the particular elements.

It is recognised that any development must be preceded by a community consultation phase to establish the final nature of the works and to ensure community acceptance. Related environmental and ethnographic studies and detailed planning are a part of this process. Detailed technical investigations are also required, including geotechnical and wave climate studies, and specific investigations into such things as breakwater construction options, so that the actual costs and environmental impacts can be defined. These investigations will be followed by detailed design and costings.

The sequence of development will to some extent depend on the outcomes of the consultations, investigations and approval processes. In addition, ongoing management arrangements would need to be satisfactorily addressed.

However, it is expected that the general sequence will start with the development of the Boating Facility which can be implemented soon after funding comes available.

5.4.1 Boating Facility

The proposed boating facility will consist of a number of key elements that are outlined below.

5.4.1.1 A. Initial Ramp

In this stage a boat ramp could be built down to the RL+1.5 m CD (Chart Datum) contour. This will allow boat launching and retrieval for the greatest part of the tide cycle.

It is envisaged that the first part of the wide 1:10 gradient ramp could be built as a steel sheet piling mound, with earth fill contained between two parallel sheet piling walls. The outer wall would be built higher than the ramp to provide shelter to wave activity from the east. The connection to the shore above high water will also be earth fill, protected either by a rock wall or by sheet piling. The ramp surface will most likely be concrete slabs, while the approach roads and parking area will be appropriately paved. Access roads, parking areas and cyclone tie downs would be included in this stage.

5.4.1.2 B. Extended Ramp and Dredged Basin

If proven feasible, dredging a basin in front of the ramp will allow the ramp to be deepened to the RL-1.5 m CD contour. This will allow launching and retrieval for all stages of the tide. If adequate funding is available this work will be combined with the construction of the initial ramp described above to reduce overall costs.

The dredged basin should be of sufficient size to accommodate the floating jetty proposed in the next stage, as dredging to the nominated basin level is a specialised task requiring specialised plant, particularly as some of the material being handled is in-situ rock. The cost of this type of work will include a large component for establishment/disestablishment – getting the equipment to Broome and setting it up to work, then taking it back to its home. Best value for money results from maximising the extent of these works.

5.4.1.3 C. Main breakwater and Floating Jetty

Even though the proposed basin and extended ramp will allow boat launching and retrieval at all stages of the tide, the ramp usage will still be restricted by the ambient wind and wave conditions. Accordingly, a main breakwater to the north-east of the ramp is needed to give better shelter to the ramp and dredged basin, and must be completed before the floating jetty can be safely used in all normal winds.

Given the difficulty in sourcing suitable rock in and around Broome, alternative breakwater structure types will need to be investigated. As well as rock variants, these alternatives may include such options as sheet piles, caissons and artificial armour stone units in combination with some sections of local rock.

Site investigations including levels, probing and coring, and wave height determination, are a necessary preliminary to this work. This investigative phase should be added to the similar work discussed previously.

The floating jetty can be constructed within the protected waters afforded by the breakwaters.

5.4.2 Cyclone Moorings

Subject to appropriate investigations and approvals, cyclone moorings can be constructed in Dampier Creek at some stage in the future. However, if piled trot moorings are to be used, cost saving are available if the work is done when floating plant is on site for the other works.

5.4.3 Boat Harbour/Marina

In the longer term, a sheltered harbour facility will be necessary at Broome. However, it will serve a much smaller client group, than the above works. It also has greater urban planning and environmental issues, which take it on a different implementation track to the Boating Facility.

Work to date has identified two possible harbour locations, Dampier Creek and west Roebuck Bay. The Dampier Creek site is suited to a harbour that provides tidally limited access for up to medium size vessels. The west Roebuck Bay site could also be developed as a part-tide harbour but also has the potential to be developed into an all tide harbour, albeit at much greater cost.

It is also possible that a combination of the Dampier Creek option and the west Roebuck Bay option may be needed to serve Broome well into the future.

A harbour development is not being considered in the current proposed works, however, planning for this facility will need to continue.

5.5 Environmental Assessment

5.5.1 Boating Facility at West Roebuck Bay

A detailed investigation has yet to be undertaken into the environmental impacts of a boating facility development at west Roebuck Bay. However, as a part of the 2002 investigations, discussions were held with the Environmental Protection Authority and the (then) Department of Environmental Protection. The general view of both organisations at that time was that the Port sites, including the west Roebuck Bay site, were likely to raise the least environmental impacts. Although this is not definitive, and does not obviate the need for an environmental impact study, it is encouraging.

The following environmental issues are likely to require consideration:

- The design of the terrestrial footprint of the Boating Facility will require consideration of the potential presence of a threatened ecological community (Monsoon vine thicket (TEC no. 67)) and the declared rare flora (*Keraudrenia exastia*) identified in the vicinity of the Port.
- Modification and interruption of sediment transport processes along the coast will require investigation. Erosion mitigation measures may need to be considered to minimise the impact on the adjacent coast.
- Sediment quality studies will be required to investigate the management measures necessary to dredge potentially contaminated sediments (due to the proximity of the Port).
- Turbidity generated during construction, and the potential release of hydrocarbons during harbour operation, will require management due to the adjacent aquaculture leases.
- Investigations into seabed stability will be required.
- Migratory and threatened marine mammals and other protected marine fauna (such as turtles) are identified as likely and known to occur in the area. The construction works (blasting, pile driving and dredging) will generate underwater noise which can result in disturbance to the protected marine fauna. It is anticipated that the project would require referral to the Department of Environment, Water, Heritage and the Arts (DEWHA) under the *Environment Protection and Biodiversity Conservation Act 1999* because disturbance of migratory and threatened marine mammals is considered a matter of national environmental significance. A protected marine fauna monitoring and management programme would be required.
- Dredging, excavation of the Broome sandstone and placement of rock breakwaters will generate turbidity that has the potential to impact the Benthic Primary Producer Habitats (BPPH) of coral and seagrass adjacent to the site.

The following environmental issues are also likely to be relevant:

- Mangroves are present along the mid- to high-tide area within the vicinity of the site with sparse coverage. Consideration of impacts on mangals will be required with relation to interruption of coastal processes and consideration of the harbour footprint.
- The site is located at some distance from the Wetland of International Importance under the Ramsar Convention. However, the potential impact on avifauna will require consideration due to the potential roosting or foraging of threatened bird species in the area.
- It is not anticipated that acid sulphate soils will be a concern.
- The location within the Marine Park Candidate Area.

The following issues are noted as being of relevance:

- Any development proposed should be designed in conjunction with discussions with the traditional owners as the area is located within a native title determination..
- There are no known sites of European Heritage in the vicinity of the proposed boating facility.
- The anticipated rate of infill of any dredged areas will be required.
- The potential land and water use conflicts with the adjacent Port will require investigation.

6 DISCUSSION

Broome remains a challenging place to provide affordable boating facilities. An all tide, all weather safe boat harbour will be very expensive. The only practical sites appear to be in the vicinity of the Port. Unfortunately, the lack of available land in the Port has removed the option of a cost effective inland harbour. Any boat harbour would now have to be primarily offshore and would require large and costly breakwaters. An offshore harbour is expected to cost in excess of \$200 million.

Given that it is unlikely that a harbour can be funded in the foreseeable future, the development of the Boating Facility proposed in this report undoubtedly provides the greatest benefit to the greatest number and at the least cost. The Boating Facility could be staged, and a basic ramp without wave protection can be built first, and protection added later. However, this does present some risk where boats launched in calm weather are difficult to retrieve later in the day when the waves are larger, even though the site nominated does provide some protection from all but the north-eastern quadrant. It would be preferable to construct the ramps and the wave protection at the same time, but this will depend on funds.

When breakwater protection is built for the ramp and basin, a floating jetty can be installed. This will be a major benefit to the charter boats and some commercial boats.

The occasional use of the ramps as a slipway will assist the maintenance of up to medium size vessels.

Cyclone tie-downs in the boat ramp parking area and (if possible) cyclone moorings in Dampier Creek will provide some additional security for vessels during cyclones. However, this is limited. Only a relatively few boats can be moved on to the hardstand at any one time, and moorings in a creek are still relatively exposed.

For the future, a tidally limited harbour will provide more protection, but a large harbour with full, or nearly full, tide access and with adequate moorings is necessary for maximum protection in the longer term.

Consideration should be given to the location of a boat harbour. Planning will need to continue to evaluate the Dampier Creek and west Roebuck Bay sites individually and a combination of them both.

7 SUMMARY and RECOMMENDATION

It is unlikely that a major all-tides boat harbour capable of servicing the whole Broome fleet and providing adequate cyclone protection can, or will, be built in Broome in the foreseeable future. This is primarily due to the high capital and operating costs, and the unavailability of suitable sites.

On account of the urgent need to provide formal facilities at Broome it is proposed that affordable developments are pursued that benefit the greatest percentage of the small-craft fleet.

It is recommended therefore that subject to appropriate investigations, consultation, approvals and funding, a Boating Facility is pursued at west Roebuck Bay to include:

- New boat ramps with adequate parking to cater for the trailer boats, which are some 80% of the combined recreational and commercial fleet.
- A ramp design that would also permit use by wheeled jinkers with proper management. This, combined with upgrades to the existing land infrastructure, will improve the maintenance facilities for medium size boats.
- Concrete tie downs incorporated in the new ramp parking area that will provide the opportunity to secure medium size boats on land in the event of a cyclone.
- Breakwater protection to the ramps that will allow the installation of a floating jetty. This will assist the charter boat operators particularly with loading and off loading passengers and gear. It will also be of some assistance to other smaller commercial and recreational boats.
- The development of a cyclone mooring strategy for Broome. Permanent cyclone moorings in Dampier Creek should be considered as a part of an overall strategy to provide additional protection for larger boats.

Planning activities should also continue to address the needs of the balance of the Broome small-craft fleet. These planning activities would include consideration of:

- A tidally limited harbour/marina located at either Dampier Creek or west Roebuck Bay, or a combination of both, to cater for the mooring needs of most small to medium size vessels.
- A full tide harbour.

8 FIGURES