3.0 SITING OF MARINAS

Proper siting is probably the single most important aspect of developing a coastal marina in an environmentally sound manner. A well chosen marina location that meets the developer's needs and at the same time minimises environmental impacts should be the most cost effective to develop and is more likely to receive the quickest approval by regulatory authorities and to minimise monitoring requirements. Importantly, marina siting will also greatly dictate the design and engineering criteria of the development (refer also to AS3962 - 1991).

This chapter provides information and guidance on coastal marina site evaluation and selection. The discussion contains an overview of the advantages and problem areas associated with certain marina sites and introduces topics of marina development to be expounded in more detail in later sections.

The ultimate environmental performance of a marina depends not only on the site location but on the design, construction, operation and maintenance of the facility. Every marina site presents unique aspects in relation to providing adequate recreational boating facilities at a reasonable cost to the developer while minimising adverse environmental effects. The engineer and developer may need to evaluate several planning and design options in determining the most suitable marina development. Designing the marina to take maximum advantage of the natural attributes of the site can contribute significantly to reducing or eliminating potential environmental problems from marina construction. This evaluation includes, among other aspects, considerations of land and water access, access to utilities, the area required for facilities, ambient weather and physical environmental conditions, sensitive environments in need of protection, the existing social environment and aesthetics.

3.1 Zoning

Check GBRMP zoning of proposed marina site

Joint permits granted by GBRMPA and QDEH are required for the development and operation of marinas within the GBRMP.

Zoning and zoning plans are one of the principle tools for management of the GBRMP. Zones within the Park range from highly protected areas with restricted access through to general use areas. Marina developments can only be permitted in certain zones and it is unlikely that a marina could be allowed in a more protected zone if it involved destruction or alteration of the marine environment.

3.2 Wind Climate

Assess local winds, waves, currents, tides and flooding for desired sites.

Wind, waves, currents, tides and floods are collectively termed coastal processes and influence the distribution of sediments and thus the shape of the coastline. Winds can influence marinas indirectly through their effect on wave climates (Section 3.3) or directly by affecting comfort, manoeuvrability of vessels in confined areas, or design strengths necessary to prevent damage to vessels and structures in extreme conditions.

Berths should be aligned directly into the prevailing winds.

The marina designer must evaluate local wind conditions both in terms of prevailing winds and predicted wind conditions under adverse weather conditions. A desirable site would allow berths to be aligned directly into the prevailing winds, thus limiting lateral movement and pressures on moored vessels and ensuring that vessels do not lay off fingers, making boarding difficult.

Assess direction and strength of winds on marina operations with consideration of extreme conditions.

The design of a marina must be such that it can be entered under adverse weather conditions and would provide enough shelter that vessels could manoeuvre within channels and fairways to enable access to berths without threat of collision. The proposed site should ideally provide shelter from the prevailing winds. Careful consideration should be given to the direction and strength of the strongest winds in relation to both manoeuvrability and design strengths.

Highly exposed areas may benefit from the use of wind breaks.

In areas exposed to extreme conditions the wind climate may be modified by planting a tree wind break or careful positioning of land-based buildings to act as a barrier.

3.3 Wave Climate

Sites must have safe and comfortable wave climates. (See Table 3.1)

The most essential purpose of a marina is the provision of a safe passage to a sheltered area for boating or shipping-related activities. Thus, the site should be free of, and readily protected from, strong surge or the potential for wave damage. It is necessary to determine the wave climate of a potential site as it is the most important engineering factor that

governs the siting of a marina. The provisionally recommended criteria for a 'good' wave climate in small craft harbours are set out in Table 3.1. These criteria would appear suitable for adoption in the GBRMP.

Wave parameters to include:
- **height, period and direction of waves**
- **steepness**
- **coincidence with extreme winds and currents.**

It is necessary to examine the steepness, height, period and direction of waves, the coincidence of waves with extreme winds (cyclones) and currents, and the probability of occurrence of wave characteristics related to likely structural or boat damage (i.e. whether the wave climate exceeds recommended criteria for marinas). This will enable the developer to design and incorporate adequate protective works (breakwaters) and mooring structures. It should be noted that the Beach Protection Authority can supply data on expected combined tide and surge levels for various recurrence intervals along most of the Queensland coast.

TABLE 3.1 Recommended criteria for a 'Good' Wave Climate in small craft harbours

Direction and Peak Period of Design Wave	Wave Event Exceeded Once in Fifty Years	Wave Event Exceeded Once A Year	Wave Event Exceeded Once Each Week
Head seas less than 2 seconds	these conditions not likely to occur during this event	less than 0.3 m wave height	less than 0.3 m wave height
Head seas between 2 and 6 seconds	less than 0.6 m wave height	less than 0.3 m wave height	less than 0.15 m wave height
Head seas greater than 6 seconds	less than 0.6 m wave height or 1.2 m horizontal motion	less than 0.3 m wave height or 0.6 m horizontal motion	less than 0.15 m wave height or 0.5 m horizontal motion
Beam seas less than 2 seconds	these conditions not likely to occur during this event	less than 0.3 m wave height	less than 0.3 m wave height
Beam seas between 2 and 6 seconds	less than 0.25 m wave height	less than 0.15 m wave height	less than 0.1 m wave height
Beam seas greater than 6 seconds	less than 0.25 m wave height or 0.6m horizontal motion	less than 0.15 m wave height or 0.3 m horizontal motion	less than 0.1 m wave height or horizontal motion

* For criteria for an 'excellent' wave climate multiply wave height by 0.75 and for a 'moderate' wave climate multiply wave height by 1.25.

Source: Mercer et al. (1982)

3.4 Water Circulation

Site marinas in areas of high water exchange rates.

Through optimal site selection and marina design, many of the problems associated with either excessive or inadequate circulation can be avoided or minimised. High water residence times will lead to deterioration of water quality within the harbour basin. In the absence of adequate flushing, accumulated wastes from harbour-related activities (e.g. minor oil spills, land runoff and sewage from boats) diminish the attractiveness of the harbour and could threaten the quality of nearby fisheries and beaches. Although the overall aim should be to minimise the entry of pollutants, marinas sited on estuaries, creeks, and waters characterised by high flushing rates or high rates of water exchange should exhibit fewer water quality problems than marinas in areas of low water exchange. High exchange rates tend to dilute and disperse any sanitary waste or stormwater runoff pollutants from a marina.

Place marina structures so as to maximise the rates of water exchange.

Revetments or harbour structures may interact with local wind, tide and wave forces to alter offshore currents, sand distribution, and shoaling processes. A variety of other factors including depth and orientation, and groundwater flow into the harbour will influence seawater residence time and circulation within the harbour. In addition, water quality can be indirectly affected when structure emplacement, particularly breakwaters, reduces water circulation. Therefore, all structures should be designed and placed so as not to restrict water circulation or mixing within the marina basin or to increase shoaling. Water circulation can be ensured by using properly designed culverts, pilings and bridge spans, and by using discontinuous mounds for open water discharge.

Incorporate currents, wind patterns, wave conditions and groundwater influx in studies of harbour flushing.

The marina designer must have good knowledge of nearshore currents, wind patterns, wave conditions (regular and storm), and groundwater influx to determine the harbour configuration for maximising both harbour flushing and safety (refer to Section 4.1 for more specific guidance on configurations).

A hydrographic survey should be carried out including a past history of the substrate.

Tidal range, natural water depth at the site and the projected completed project depth at the marina are hydrographic considerations necessary for evaluating the natural circulation of the area and the projected flushing rate of the marina basin. During the hydrographic survey, it is also important to note the locations of underwater hazards or obstructions and to review the past history of the substrate in terms of siltation rates, marine life, bottom growth and shoaling.

Examine tidal, eddy and flood-related currents and tide range.

Currents which need to be considered in marina design are tidal currents and those associated with rainfall induced flooding. Tidal currents vary in direction between ebb and flood, whereas currents associated with flooding are generally directed downstream. Eddy currents should also be considered, as should tide range.

Qualified personnel must assess:
- **the effects of flooding on marina**
- **the effects of the marina on flood behaviour**
- **flood levels for various recurrence intervals.**

Physical model studies which examine the effects of rainfall induced flooding on the marina, and conversely, the effects of the marina on flood behaviour, may be required, particularly if the marina occupies a significant portion of an important floodway. Such investigations should be supervised and carried out by qualified personnel. For marina sites located in flood prone areas it will be necessary to establish flood levels for various recurrence intervals. The model results should then be applied to assess the likely biological and physical results.

Plans must show the relationship between MLW and the other datums used.

Maritime structures should be related to the Mean Low Water (MLW) mark. MLW is **not** a standard tidal plane and must be calculated by approved methodology. Where land based structures or services are associated with the maritime structures and are related to a different datum (e.g. AHD, local water supply or sewerage datum), it is essential that plans show the relationship between MLW and the other datum. AHD should be used where ever possible.

MLW must be established in a tidal planes study and surveying.

Where the proposal is adjacent to or in the GBRMP, the location of MLW, which forms the boundary of GBRMP, must be known quite precisely. A simple procedure for initially estimating MLW is to:

- consult the local harbour or marine authority over the actual local height of MLW (or, alternatively, determine the average for low tides over the last eight years);
- identify a tide, using a tide chart, that has a lower limit at that height;
- be on site at the appropriate time and install markers at water level at the correct time; and
- note that this estimation will probably have to be confirmed by survey prior to final approval.

Avoid pile jetting.

Structures that may be required at the marina include bulkheads, revetments, pilings, piers and breakwaters. A temporary increase in turbidity during emplacement is a direct water quality impact from these structures. This may be alleviated, if necessary, by use of pile-driving rather than jetting or by bunding the area if jetting must be used.

3.5 Implications of Sea Level Changes

GBRMPA policy is that structures withstand a category 4 cyclone. Minimum acceptable 'Greenhouse' allowance is 0.4m.

It is GBRMPA policy that, for structures in the GBRMP, breakwaters and protective works shall be designed to withstand a category 4 cyclone, including the effect of wave action, and incorporate allowance for sea level rise as predicted to result from the 'Greenhouse Effect'. The minimum acceptable 'Greenhouse' allowance for structures in or adjacent to the GBRMP is 0.4 m. This allowance should be applied to all protective structures and marina or adjacent structures having structural lives of greater than 20 years. It may be acceptable to place non-essential or short-lived facilities (pathways, internal roads, carparks) at lower levels, so long as a developer legally indicates recognition that these structures may need to be raised or replaced at a later date. The general adoption of these criteria elsewhere is highly recommended.

Examine flooding probabilities.

Where flooding occurs, consideration should be given to the possible combination of the design flood flow and other wind and tidal forces that may tend to exacerbate flooding levels. The water level during flooding can be raised considerably above high tide level. The Queensland Government is considering adoption of a policy that new residential development does not occur on land with a greater than 10% risk of inundation in any 50-year period.

3.6 Geotechnical and Sediment Processes

Assess natural sedimentary processes and likely impact of the marina on these.

An understanding of the existing natural sedimentary processes at the proposed marina site, and the likely impact of the marina on these processes is important in the planning and design of the marina. In most marina developments involving boat harbour construction along a section of coast or within an estuary, the greatest potential for sedimentation problems is at the boat harbour entrance. This sedimentation is due to longshore wave-induced sediment transport or tidal-induced bedload sediment transport for the coast or an estuary, respectively. Within the boat harbour, the main mechanisms for sedimentation are settling out of fine suspended sediments brought down by floods (in the case of boat harbours constructed on estuaries) and deposition of material at stormwater outlets.

Minimise sedimentation through harbour design (Section 5.2). Consider initial overdredging and the ongoing need for bypass dredging.

Every effort should be made to maintain longshore sediment movement - including allowance for possible future bypass dredging, It may not be possible to avoid sedimentation at the marina site, but, by careful planning, it is possible to minimise the degree of sedimentation (see Section 5.2) and ensure that any sedimentation which does occur can be relatively simply (and economically) removed. It is important that the likely siltation rate is adequately assessed so that a suitable allowance can be made. Maintenance dredging operations are very expensive and could be hampered by the presence of marina structures and boats. Consideration should be given in these cases to the option of initially over-dredging.

A comprehensive geotechnical investigation is recommended and should include:

- **soil, sediment and rock classification**
- ***in situ* soil density**
- **stratigraphy**
- **soil strength parameters and deformation**
- **chemical composition of any sediments to be excavated.**

A comprehensive geotechnical investigation is recommended at all sites. The investigation should be designed to gather all information which might be relevant to the particular site. Requirements for different sites will vary and it is necessary to plan each geotechnical investigation individually. Typical information required from a geotechnical investigation includes soil, marine sediment and rock classification; grain size distributions and shape; *in situ* soil density; stratigraphy; soil strength parameters; soil deformation parameters and, if there is any doubt over the possible presence of contaminants, chemical composition of any sediments to be dredged. Such an investigation is necessary for several reasons. It will identify the range of material types at the site, which may strongly influence the layout, cost and project feasibility. It is also necessary for the detailed design of the facility, particularly for excavation (if required), and the marina structures, e.g. jetties, mooring piles, breakwaters, seawalls, reclamations and land based facilities. Geotechnical properties may influence construction timing, techniques and costs, all of which may also affect the results of an assessment of environmental impacts.

3.7 Flora and Fauna

Include in the environmental assessment an appraisal of cumulative losses at a local, regional and state level.

Loss of wetland and submerged vegetation may result from a variety of construction activities (also from changes to water levels and/or water flow), although dredge and fill operations have historically been the most destructive. The marina developer must carry out a comprehensive environmental assessment. Included in this should be an evaluation of the significance of any rare, endangered or protected species at local, regional, national and international levels, and the significance of cumulative impacts (of which the proposed development is just one) at these levels.

Be aware of the ramifications of dredge-and-fill operations on flora and fauna and carry out these activities so as to minimise turbidity and sedimentation.

Modification of the shoreline and nearshore submerged lands by dredging and filling activities results in the destruction by removal or smothering of benthic habitats and life forms such as coral reefs and their associated fauna. The degree of destruction obviously depends on the quantity and quality of the benthic community at the site and the extent of the construction activity. Additional direct effects of dredge-and-fill operations include generation of turbidity plumes and crushing of shallow reef communities by heavy equipment. The disposal of dredged material should occur on land. Offshore disposal of this material can cause significant turbidity and sedimentation and is not regarded as an acceptable option in most cases.

Minimise contaminants input directly or in surface runoff.

Inhabitants of the aquatic environment can also be affected by changes in water quality, which at times include nutrient enrichment and low dissolved oxygen resulting from sewage and upland runoff, hydrocarbons from boat exhausts and fuel spills, heavy metals from antifouling paints and other pollutants.

Locate marinas to minimise loss of wetlands and seagrasses.

Marinas are designed to provide safe, protected moorings for boats and are therefore usually located in calm waters on protected shorelines. These calm, sheltered areas generally support wetlands and submerged seagrass beds. Thus, the potential for habitat loss or alteration of these productive habitats is a major consideration in marina siting and design.

Site marinas to minimise impacts on primary productivity, nursery areas, coastal processes and coastal aesthetics.

The importance of plant communities such as mangroves, salt marsh grasses and seagrass beds lies in the vital functions that they perform in the aquatic ecosystem. First and foremost is their role in converting sunlight and nutrients into food useable by animals, thus forming the base of the aquatic food chain. In addition to serving as a food source, wetlands and submerged vegetation provide shelter and nursery areas for the young of many economically important species such as prawns, crabs, barramundi and whiting. Maintenance of water levels and inundation is vital to the health of mangrove forests and should be observed. Another important function of vegetation is to trap silt and

absorb pollutants and excess nutrients resulting from surface runoff. Vegetation also protects upland areas by stabilising coastal sediments and preventing erosion. Finally, natural vegetation increases the aesthetic appeal of the coastal zone.

Avoid sensitive areas such as oyster beds, particularly those used for human consumption.

Oyster beds are habitats requiring specific consideration during marina siting and development. In addition to their direct economic value to man, oyster beds provide spawning and nursery areas, substrates for attachment for many organisms, and food for invertebrates, fish, birds and humans. Oyster beds physically influence the marsh-estuarine ecosystem by modifying current velocities, changing sedimentation patterns and actively augmenting sedimentation through biodeposition. Oyster beds could be affected by physical disruption of habitat during marina construction or by changes in water quality resulting from marina operation or boating activities. A poorly sited or designed marina has the potential to degrade water quality so that oysters are unfit for human consumption - contamination by antifoulants or sewage being the most common causes.

The potential ramifications of the loss of a coral community are extensive. Coral reefs can serve a variety of functions, some that are not readily apparent:

- they provide protection to the shoreline from the effects of large wave action;
- they can provide fish for economic stability, recreational fishing and meal value;
- they are an important resource for education and culture; and
- they provide aesthetic values by playing a significant role in tourism and the 'sun, sand, and sea' appeal of the Queensland coast.

Coral reefs are particularly susceptible to turbidity related impacts.

Coral reefs are sensitive to episodic events in which turbidity is temporarily raised to many times the ambient amount, and thus are particularly susceptible to turbidity caused by dredge-and-fill processes. Episodic events may be tolerated if they are infrequent and do not greatly exceed the upper levels of natural turbidity at the site. However, above a threshold, such an event may kill coral reefs. Chronic stress from turbidity may manifest itself in more subtle ways, i.e. by changing the community structure of the reef. Advanced knowledge of currents in the area of construction, and of sedimentation characteristics, allows prediction of direction and persistence of turbidity plumes, thereby facilitating assessment of potential impacts of dredging on surrounding marine communities. Local currents also play a role in recruitment and survival patterns related to the distribution and zonation of corals and other marine life. Thus, dredging and the resultant physical alteration of topographic features that may alter current regimes can also have profound effects on reef community structure in the surrounding area.

3.8 Social Amenity and Infrastructure

Marinas are to include appropriate and aesthetic social amenities and infrastructure.

Marinas will typically include such facilities as berthing or docking areas, shoreside facilities for unloading, loading, storage, and refuelling operations, a small-boat launching ramp and various related infrastructure to accommodate activities such as access to water, power, waste disposal facilities (especially for vessels), shower and laundry facilities, and land access (e.g. roads). Some additional guidance on these facilities may be found in AS3962-1991.

Provide for periodic repair and maintenance without loss of safety or amenity.

Most harbours also require periodic maintenance to repair protective structures, service aids to navigation, and to restore navigation depths (via maintenance dredging) within the channel and basin. Provision for adequate maintenance must be made in such a way that safety and amenity of users are not jeopardised by repair and maintenance activities.

Assess possible changes in aesthetic value of the area.

Marina location also influences the effect a marina will have on shoreline aesthetic values because introduced sights, sounds and smells will be different from the natural environment (Chmura and Ross 1978). Poorly maintained marinas will further degrade aesthetic values. Aesthetic values are often subjective and difficult to measure. However, techniques are available and qualified sociologists and landscape architects can assist in these areas. Marinas located in a pristine area may lessen aesthetic appeal, whereas marinas located in a developed area may enhance the aesthetic appeal and quality of the water front.

3.9 Archaeology

Archaeological surveys will require a permit.

A comprehensive surface archaeological survey should be undertaken by a qualified archaeologist to identify pre-historic and historic relics and other culturally significant features. These surveys must be done by registered archaeological consultants under an archaeological research permit required under the provisions of the *Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987.*

Contact the State Historic Preservation Officer for information on historical or archaeological resources.

Historical or archaeological resources present at the marina site or discovered during construction that may be impacted by marina development can be identified by contacting the State Historic Preservation Officer, Heritage Unit, QDEH. Mitigative measures can include:

- preservation or restoration of the artefacts;
- photographic documentation; and
- survey or excavation by professional historians or archaeologists.

3.10 Safety

Site use aspects must be tightly controlled.

Construction activities often involve heavy machinery, traffic, blasting and pile driving which may be hazardous to the public and workplace. Blasting activities are regulated by the Queensland Mines Department and will be conducted to guidelines specified by that Authority. Construction supervisors are required to exercise all suitable cautions including public notification and exclusion, warning sirens and protective barriers.

Blasting in Marine Park requires application to GBRMPA also.

Blasting activities are generally constrained within the GBRMP and are regulated by GBRMPA. Blasting within the GBRMP therefore requires close and early consultation with GBRMPA as well as with the Queensland Mines Department. It is GBRMPA policy that blasting in the Marine Park is considered a technique of last resort, and will only be approved if other methods can be demonstrated to be unsuitable.

3.11 Navigation

Navigation aids must be provided to appropriate standards.

Aids to navigation such as channel beacons, buoys and leads are required for entrances to marinas and channels of access. All navigation aids will be designed, installed and maintained in accordance with Queensland and Commonwealth Departments of Transport.

3.12 Economic Considerations

Financial viability studies must separate capital costs from estimates of costs of ongoing operations.

The ultimate financial success of a marina may often be dependent on or linked to associated tourist facilities, residential and or commercial property sales rather than the marina being self sufficient financially. The demand or need for the use of public land and waters to provide 'added value' commercial or residential developments should be clearly assessed and justified. Whilst it is sometimes acceptable to offset capital costs by sale of associated land, it is also necessary to demonstrate ongoing viability without subsequent income from sale of capital assets.

Comprehensive economic planning and impact studies should be conducted as part of any EIS.

Demand for facilities should be assessed by studying boat registration statistics and tourist projections, boat owner surveys, public subscription and regional planning studies. The belief that 'marinas breed boats' is questionable and design should be substantiated by demand studies. The developer should also clearly identify to assessment agencies the financial support available to the project. Appropriate conduct of initial environmental, engineering and social studies in the planning stages should also provide potential developers and investors with more accurate estimates of the development and associated costs such as approvals, construction and monitoring considerations, prior to committing more substantial funds to the project.

Developers will be required to post an environmental bond or bank guarantee.

In most cases developers constructing a marina in the GBRMP are required to post a substantial bond or bank guarantee to GBRMPA to cover any environmental damage or rehabilitation costs of the project. These funds may be applied to complete construction of specific components of the project; to allow removal and environmental repair; or to clean up or repair the site following accidental damage.

3.13 Existing Use

Comprehensive social impact assessment is required.

Proponents should be able to demonstrate the effect of the proposal on existing use of the site and nearby areas. This will necessitate a survey of current use and may include separate public consultation with interest groups etc. Properly designed surveys for social impact assessment will be required.