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SPITFIRE CHANNEL DREDGING

HYDRAULIC, ECOLOGICAL AND FISHERIES EFFECTS

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Synopsis:

This report provides a preliminary assessment of environmental issues associated with dredging Spitfire Channel (depths to increase from -14.5 m to -17.5 m Port Datum).

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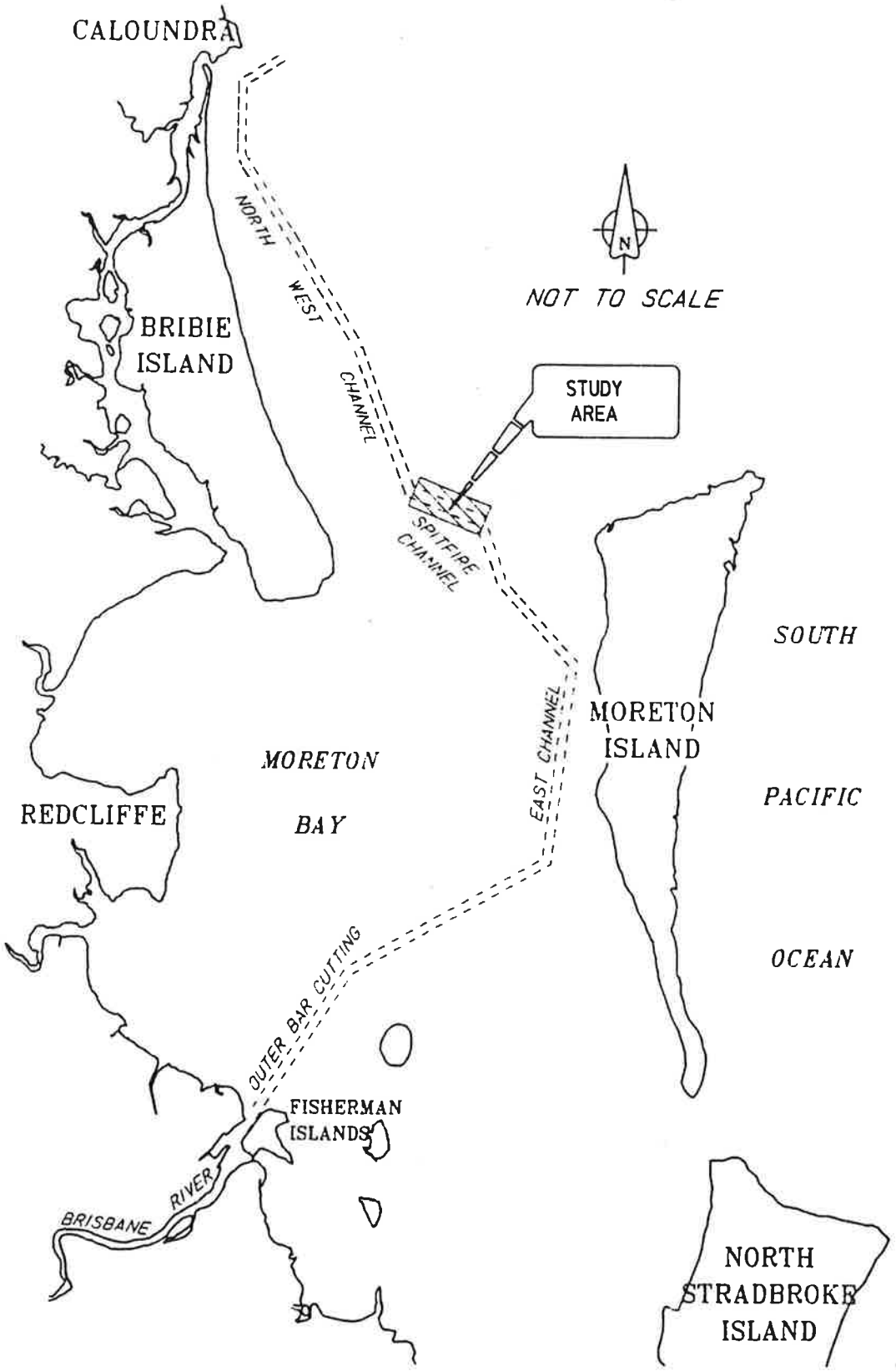
1.0 INTRODUCTION

Spitfire Channel forms part of the northern exit/entry of the Port of Brisbane shipping channel across Moreton Bay (Figure 1.1). It provides a connection between the North West Channel adjacent to Bribie Island and the Main/East Channel adjacent to Moreton Island. The channel is maintained to the depth required for shipping by regular maintenance dredging by the Port of Brisbane Corporation.

On a 'once off' basis, the Corporation plans to carry out an extended dredging campaign this financial year to remove approximately two million cubic metres of sand from the channel, for use in reclamation works at Fisherman Islands. This will deepen the channel in this area by up to about 3 metres with the new minimum depth being 17.5 m below Port Datum. As a result of this work, the Corporation anticipates not having to return to the channel for further maintenance work for some years (assuming normal weather patterns). The Corporation is presently reviewing timing options for the work, which are very much dependent on the dredger used. Options being examined would see the work take between three and nine months, depending on which dredger is used.

WBM Oceanics Australia has been commissioned by the Port of Brisbane Corporation to undertake a preliminary study to identify environmental issues associated with the proposed dredging in Spitfire Channel. This report presents the results of that study, discussing hydraulic, coastal processes, ecological and fisheries effects. Issues relating to legislation applicable to the dredging are beyond the scope of this study.



FIGURE

LOCALITY PLAN

1.1

2.0 MORETON BAY ENTRANCE DELTA CHARACTERISTICS

2.1 TIDAL DELTA MORPHOLOGY

Spitfire Channel, towards the northern entrance to Moreton Bay, is part of a large and complex tidal delta system of sand banks and channels.

Moreton Bay is a large mesotidal embayment. Its formation is the product of sea level rise and transgression into the former valley of the Brisbane River,now bordered to the east by the large aeolian sand masses of Stradbroke and Moreton Islands.

The tidal delta has its origins in the ancient and geologically recent coastal shelf and beach zone sands. These are now being reworked constantly by the flood and ebb tide currents which flow broadly north-south to and from Moreton Bay.

The tidal range in the Bay amplifies by some 40% from that in the ocean to a range of 2.8 metres on large springs at the West Inner Bar. This generates currents of 1.0 - 1.5 m/s over much of the delta area, and over 2.0 m/s in some of the more constricted sections. Depths in the channels are typically 10 - 20 metres, with sand banks and ridges less than 2 metres deep extending over large areas.

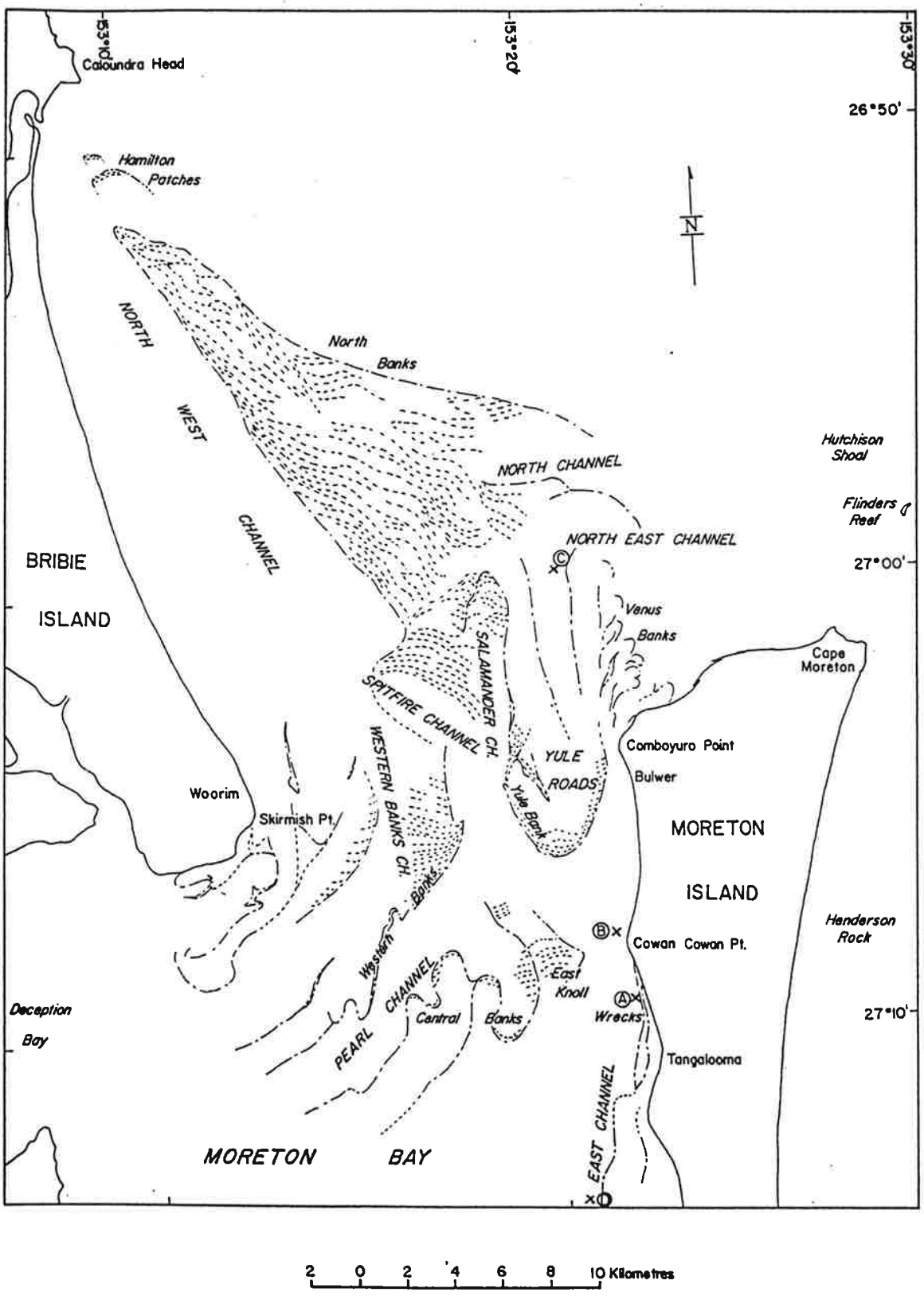
The momentum of tidal flow dissipates rapidly to the north and south of the Bay entrance. Hence, to the north, ocean-generated surface waves dominate in the transport of the sandy substrate while, to the south, muddy sediments derived from fluvial sources are deposited.

The broad configuration of the delta and associated sediment units are illustrated in Figures 2.1 and 2.2. Stephens (1978) notes that it has two broad dominant components separated essentially by the Spitfire Channel. These are:

- the seaward (northern) delta
- the inner (southern) delta

The volume of sand in the delta is so great that it is not likely to have accumulated entirely during the Holocene period. The bulk of the sand was probably trapped within the Moreton Bay entrance delta area during earlier Pleistocene high still-stands of sea level.

The tidal delta as a whole has transgressed into Moreton Bay which, in that area, was originally some 30 metres deep. The sediments there are composed entirely of oceanic quartoze sands with some shelly sand accumulations in the deepest channels. They have been



NORTHERN MORETON BAY CHANNELS AND BANKS

FIGURE 2.1

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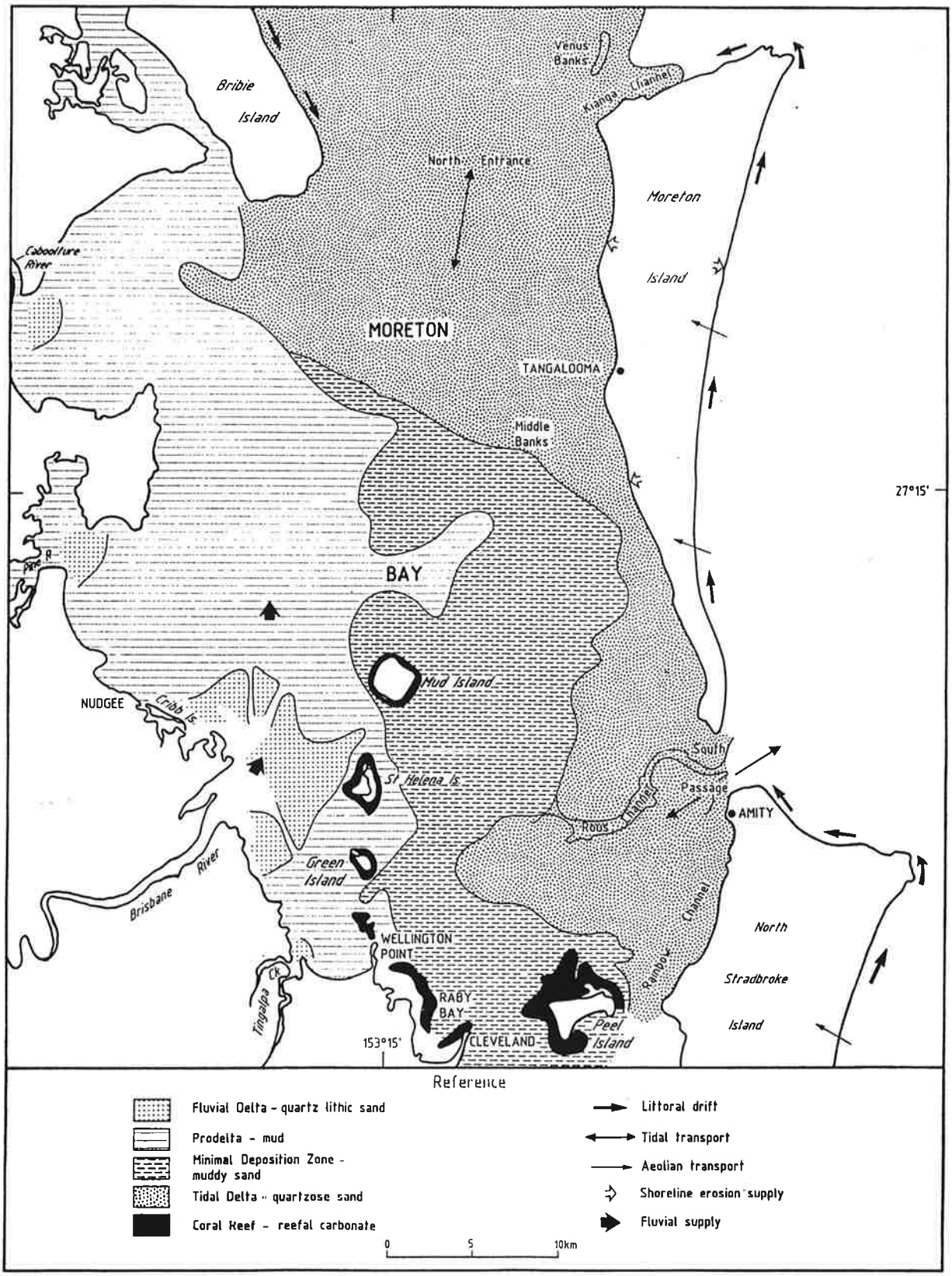

. Distribution and transport patterns of sediments (after Jones & Stephens, 1981).

DISTRIBUTION AND TRANSPORT PATTERNS OF SEDIMENT

FIGURE 2.2

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worked into a massive complex of sand banks, ridges and variously flood and ebb tide dominant channels.

Studies by Stephens (1978), Harris and Jones (1988) and Harris (1988), have identified the extent of natural changes in the delta bathymetry caused by the tidal flow. Change is continuing, manifesting as shifting channels and ridges, migration of often very large bed sand waves, and infilling of channels in some areas.

The North East channel area was studied by IIR Wallingford (Wallingford 1986 and 1987) to assess the potential for dredging and maintaining an alternative navigation channel in that area. The dynamic nature of that area is documented in the series of separate investigation reports which make up their study.

These document the importance in that area of ocean waves acting in conjunction with the intensive tidal flows in sediment transport, channel migration and potential channel infilling. The influence of ocean waves diminishes with distance westward and southward across the delta towards Spitfire Channel, as a result of refraction, diffraction, wave breaking and bed friction attenuation.

The north banks section of the delta has the form of a submerged sand spit extending towards the northern tip of Bribie Island. It is separated from the island by the North West channel. This was a zone of northward littoral drift of sand during periods of lower sea level, but now appears to be drowned to the extent that is supplies little or no sediment to the shore.

2.2 BEACH SYSTEM PROCESSES

The beaches of Moreton Island and Bribie Island border the northern Moreton Bay delta area. They are subject to littoral drift and storm erosion under the influence of the prevailing waves and currents.

The northern beaches of Moreton Island represent the northern limit of the littoral system of the eastern open coast beaches extending northward from New South Wales. The longshore transport of some 500,000 cubic metres of sand along this system per year is thought to deposit in part within the inner south passage delta and on balance in the North East channel area of the Moreton Bay delta and/or the north shore of Moreton Island.

The Bribie Island beach is thought to be experiencing a southward net longshore drift of sand (see Figure 2.2). In the absence of a present-day supply of sand from the north banks, this drift would have its source in the beach/dune of the island itself, resulting in long term

progressive erosion. Only the southern end of the island and adjacent nearshore shoals show signs of progressive accretion.

Neither of these beach systems is presently experiencing or dependent on a supply of sand from the delta area for stability. The only potential effects of works within the delta on the beaches would be indirect impacts resulting from any significant change in wave processes or major alterations in nearshore channel migration patterns.

2.3 SPITFIRE CHANNEL

Spitfire Channel itself represents a relatively small segment of the overall delta system. It is presently about 14 - 21 metres deep and some 300 - 500 metres wide, separating the seaward and inner delta areas.

Stephens (1978) identified the presence of large sand waves on the bed of the channel. He notes that they appear to be migrating towards the east (flood tide direction) despite his conclusion that the channel is ebb flow dominant, a discrepancy he could not explain. He reports as follows:

The charts show that the area is a "cross-over" ridge between two oppositely dominated channels and could therefore be quite complex in its transport patterns.

The western sand ripples (amplitude 4 m) moved eastwards at an average rate of 14 m/year between 1968 and 1970, and 17 m/year between 1970 and 1971. However, the sand ripples and shoals on the central ridge also moved eastwards, against the predicted direction of transport.

It is not known whether the channel dredging of 1965 was sufficient to upset the normal dynamics, or whether the regression of sand ripples was only a short term fluctuation (Smith 1969) according to tidal phases before the times of survey. Field observations, although limited, have precluded the possibility that such distances could be covered by a single ripple in only one tidal phase. This is in agreement with the results of Bokuniewicz et al. (1977). Another possibility is that sand is transported westward, but the actual major bed forms had moved eastward. In either case, the preliminary measurements at this site contradict the overall hypothesis for ebb and flood channel transport (Ludwick 1974; Robinson 1960, 1966) at least for the period between 1966 and 1971.

It is apparent from the previous studies and from the Port of Brisbane Authority experience that the adjacent shoals are migrating into the channel in several areas, being:

- from the north at the western end.
- from the north near the eastern end.
- from the south at the eastern end.

There is thus a need for maintenance dredging to maintain navigable depths.

3.0 POTENTIAL HYDRODYNAMIC AND COASTAL SYSTEM IMPACTS

3.1 GENERAL CONSIDERATIONS

Dredging of the Spitfire Channel may have potential impacts in a number of ways. These are as follows:

(i) Alteration to the tidal hydraulics of Moreton Bay, manifesting as altered tide levels and altered flow patterns. Any such changes, if significant, may in turn impact on other areas quite remote from the channel area itself.

(ii) Alteration to local flow patterns and associated sedimentation patterns.

(iii) Alteration to coastal processes on Bribie and Moreton Islands, should there be any significant changes in the prevailing wave and current patterns affecting the shoreline's there.

These have been investigated by hydrodynamic modelling and preliminary desk assessments to give guidance to the nature and significance of any likely adverse impacts of the proposed dredging.

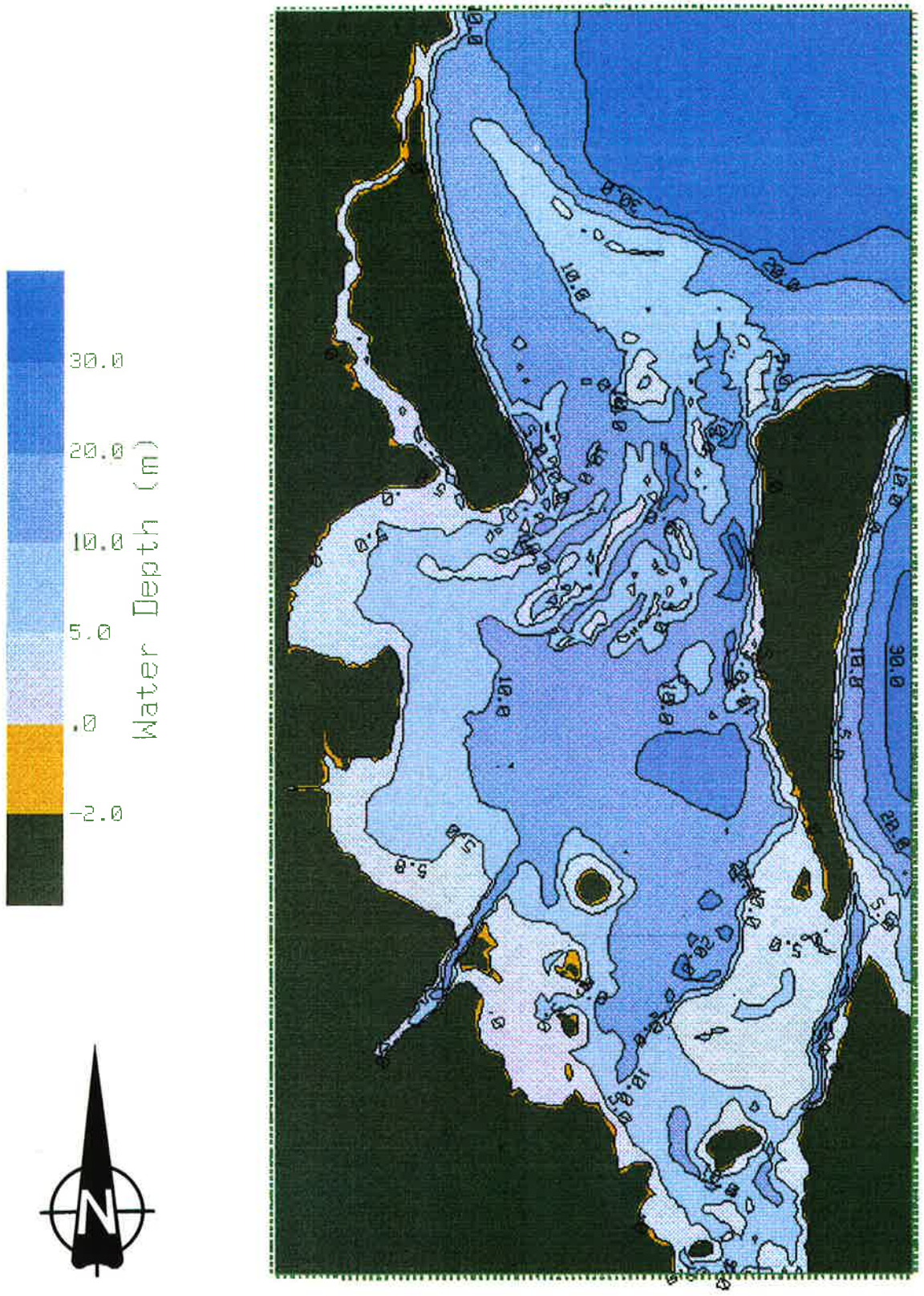
3.2 HYDRODYNAMIC MODELLING

The WBM Oceanics Australia tide model of Moreton Bay has been used to determine the extent of any impacts likely to be caused by the dredging on the tidal regime (levels and flows) of Moreton Bay, both locally and regionally.

The model is 2-Dimensional (in plan) with a 500 metre grid resolution (Figure 3.1). It has been described previously by Patterson and Witt (1992), including the bathymetry detail and validation to measured water levels at various locations in the Bay. The initial tidal attenuation across the delta and subsequent substantial amplification towards the southern bay areas are properly reproduced in the model.

Bathymetric representation in the model is taken from the available charts. In the context of the dimensions of Spitfire Channel, the 500 metre grid resolution is not refined, but is adequate for the present purposes.

Model testing has been undertaken for the existing situation and for the 'as-dredged' case. A sinusoidal mean spring range ocean tide has been used.



FIGURE

Moreton Bay 2D Model

3. 1

Impacts of the dredging have been determined in terms of tide levels and current patterns both locally and remote from the site. Figures 3.2 and 3.3 illustrate the pre and postdredging current patterns during ebb and flood tide conditions respectively while Figure 3.4 illustrates the percentage change in velocity at these times. The results can be summarised as follows:

(i) There are no discernible changes in the tidal ranges near Bribie Island, near Cowan Cowan or at West Inner Bar.

(ii) There are changes in local tide current patterns near Spitfire Channel itself, being:

- significant decreases in velocities within the dredged portion of the channel itself (up to 20%).
- slight decreases (less than 3%) in velocities in the adjacent Salamander and Western Banks Channels.
- increases (up to about 7%) in the current speeds in the channel at either end and over the adjacent sand banks.

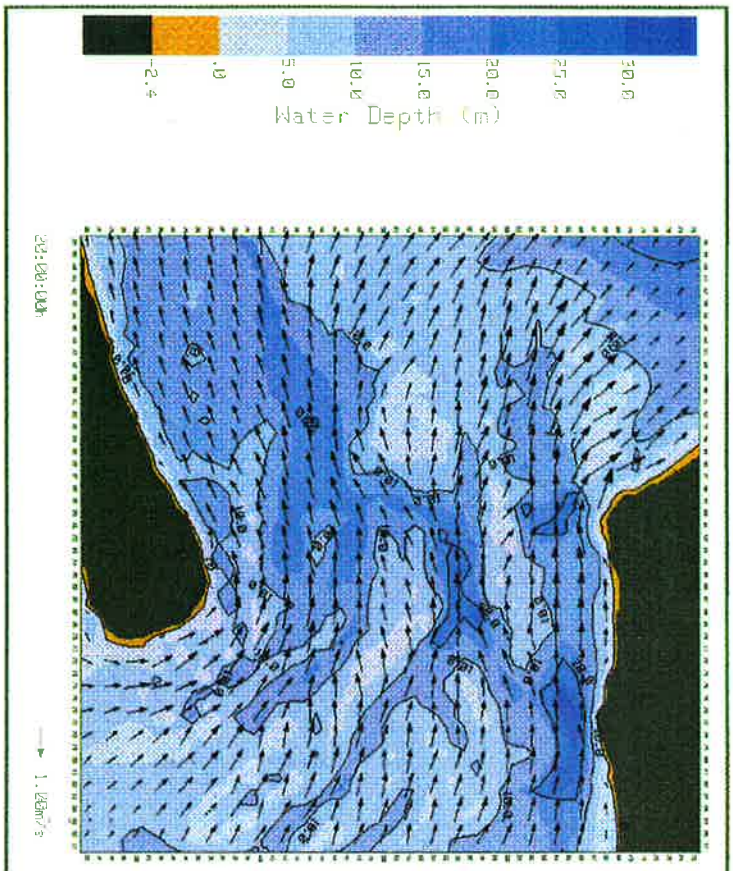
(iii) There are no discernible changes to current patterns or speeds in any remote areas of Moreton Bay, including areas adjacent to Bribie and Moreton Islands.

The changes to current patterns can be attributed to the dredged channel being slightly more efficient and attracting more flow. In the dredged portion, while the flows will be higher, the greater depth and hence cross-sectional area results in lower velocities. Where the higher flows pass into undredged areas at either end of the channel and over sections of the adjacent banks, the velocities increase. The implications of these velocity changes with respect to navigation should not be significant but should be discussed with the Department of Transport. The effects on sediment transport and related processes are discussed below.

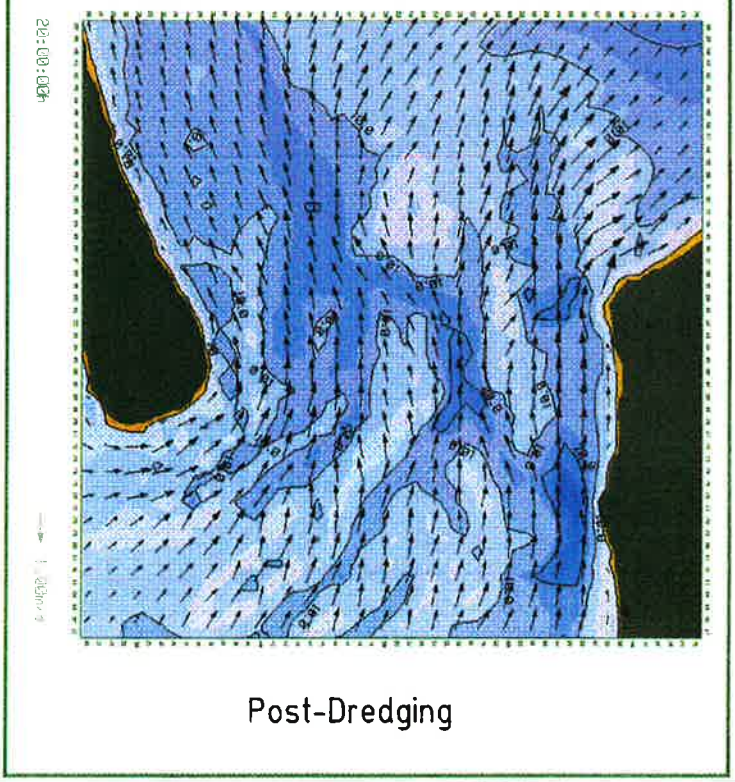
3.3 COASTAL SYSTEM IMPACTS

As discussed in Section 2, there is no direct supply of sand from the tidal delta to the adjacent coastal and beach systems of Bribie and Moreton Islands. Potential impacts there would result only if there were significant changes to the waves approaching the shore or to nearshore wave/tide induced currents.

The hydrodynamic modelling has shown that there will be no discernible effects on tidal currents near the islands. The altered current patterns in the vicinity of the dredged channel may result in some localised redistribution of sediments with scour in some areas and deposition in others. However, as the existing banks and channels are subject to a high degree of mobility, such redistributions are not likely to result in any adverse consequences.



Pre-Dredging



Post-Dredging

Pre and Post Dredging
Ebb Tide Current Patterns

FIGURE
3. 2

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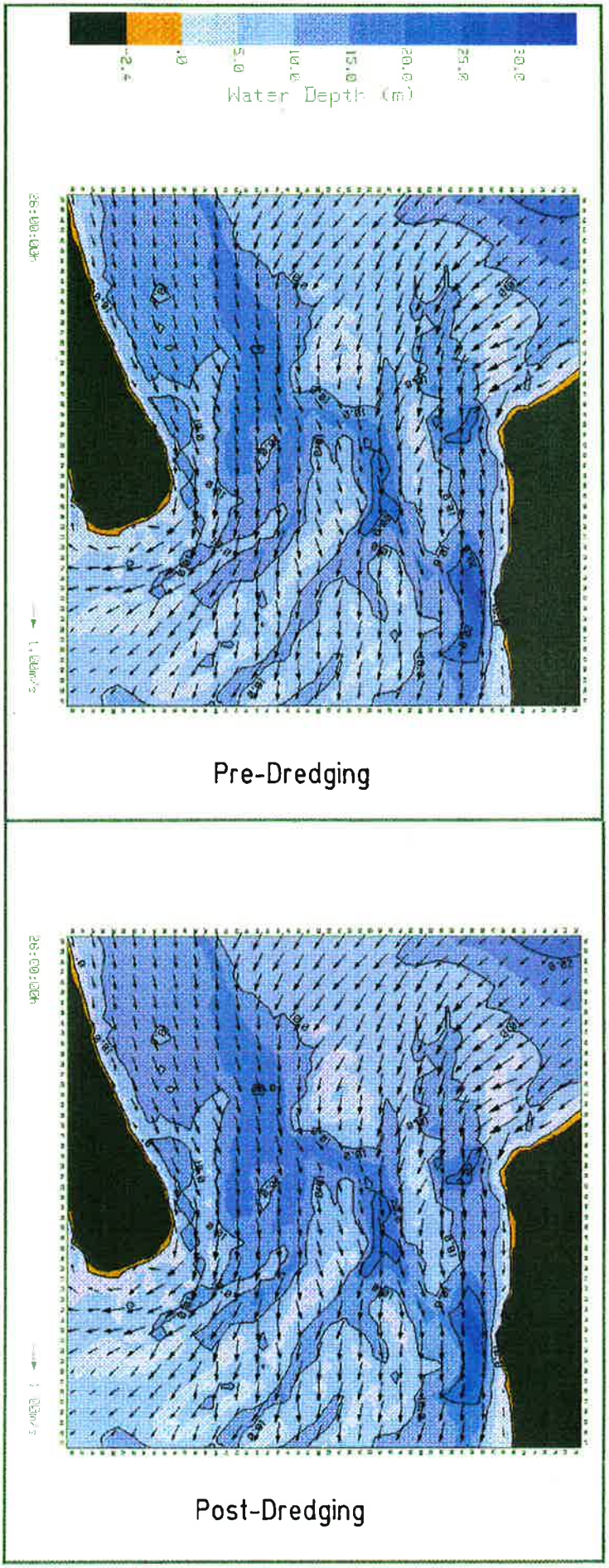

Pre and Post Dredging
Flood Tide Current Patterns

FIGURE
3. 3

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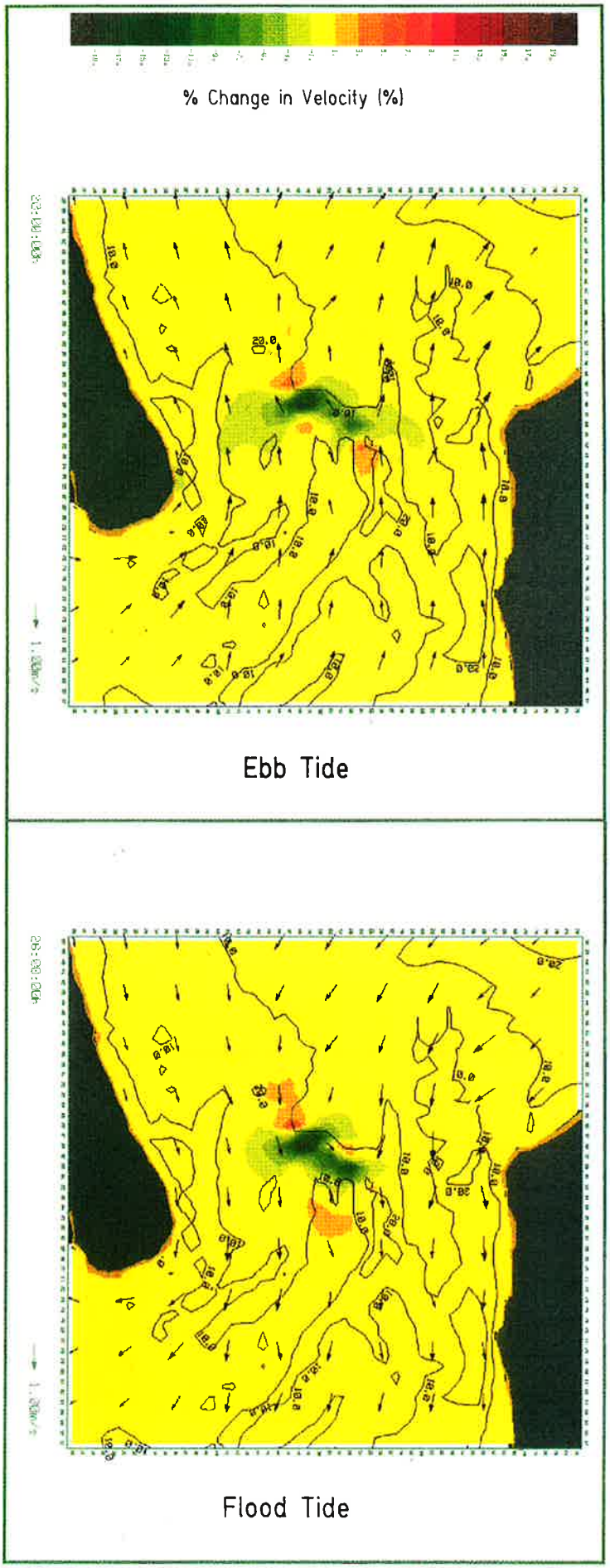

Ebb Tide and Flood Tide Impacts on Current Velocities

FIGURE 3. 4

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Waves incident on the shorelines might be affected if refraction patterns are altered by the dredging. This is considered not feasible for the following reasons:

(i) The dredging will involve only the bed of the channel itself, and not the shallower banks and ridges which dominate the control of refraction patterns.

(ii) At the depths involved, only the ocean waves of longer period (greater than 7 seconds) are likely to be subject to significant modification of refraction patterns by the dredging.

(iii) While there may be some alterations to the banks immediately adjacent to the channel as discussed above, these changes would be in a relatively localised zone where waves have been substantially reduced in height by friction, refraction and breaking over the shallow outer banks.

(iv) Those waves which dominate the littoral processes of the southern beaches of Bribie Island are primarily from the northeast sector and do not pass over or near Spitfire Channel.

4.0 MARINE ECOLOGY

4.1 EXISTING ECOLOGICAL STATUS

Spitfire Channel is part of the major navigable channel for larger ships across Moreton Bay. It bisects a series of sand banks (Western and Spitfire Banks) extending from the southern tip of Bribie Island to the northern tip of Moreton Island.

WBM Oceanics Australia are not aware of any published ecological studies conducted in the Spitfire Channel region. The region does not appear to provide any unique habitats and should be similar to other areas near the northern entrance to Moreton Bay.

The channel has a gazetted depth of 13 m below Port Datum. Actual depths average around 14.5 m below Port Datum and vary up to about 21 m below Port Datum. The minimum channel depth is maintained via maintenance dredging which is undertaken on average every second year (but is dependent upon weather conditions).

Strong tidal currents, typically 1 - 3 knots (depending upon the tidal phase) occur within the channel and adjacent sand banks. Channel and bank sediments consist of mobile sands with a low silt content. Sediments associated with the banks would be frequently disturbed by wave action.

The channel probably has a limited capacity to support large and diverse populations of benthic fauna (bottom dwelling fauna such as burrowing worms) as a result of the high current velocities, the mobile nature of the substrate and periodic disturbance from maintenance dredging and shipping traffic (propellor wash). Studies undertaken in similar habitats (Dredge and Young, 1974, WBM Oceanics Australia, 1993) have shown that epibenthic fauna is probably restricted to starfish, sea urchins and feather stars, although no data are available for the Spitfire Channel region.

No seagrass beds occur within 10 km of the channel, the closest being at Comboyuro Point, Moreton Island (Hyland *et al.* 1989). Tidal scouring in the Spitfire Channel region is strong and moving sand would bury or damage seagrass.

No rocky/coralline reef habitat occurs in the region.

The channel and nearby banks would provide suitable habitat for aquatic fauna, such as sand crabs, prawns and demersal fish but are unlikely to be nursery grounds for species of direct value to Moreton Bay fisheries (see Section 5.0).

The only Moreton Bay fish community studies conducted in similar habitats to those of the Spitfire Channel region were completed on the Middle Banks as part of environmental impact assessments for the Brisbane Airport extension (Dredge and Young, 1974). Fish surveys conducted in waters of less than 8 m indicated:

- seventeen species of fish were recorded. Many of the small fish were juveniles of species capable of digging into sand (eg. flounder, sole and flathead).
- all species were widespread in Moreton Bay.
- stout whiting, dragonets, and leatherjackets were particularly abundant.
- large bottom dwelling fish were uncommon being restricted to areas of rock shelf (rock shelves do not occur near Spitfire Channel).
- prawns were scarce on shallow portions of the banks and the area was not considered a prawn nursery.
- shoals of bait fish (eg. juvenile Clupeoids) were common midwater.
- juveniles of commercial/recreational significance such as summer whiting, snapper and bream were rare although they are abundant elsewhere in Moreton Bay (see Section 6.0).

Assessments of deeper areas (12 - 21 m) revealed a similar fish fauna to the adjacent shallower areas (ie. numerically dominated by leatherjackets and flatfish such as soles) although king prawns (*Penaeus plebjus*) were abundant at commercially exploitable levels.

It should be noted that the techniques used in the Middle Banks survey (trawls and diver surveys) would not be efficient for recording pelagic fish such as tuna or mackerel which are known to occur in the area.

4.2 ECOLOGICAL EFFECTS OF DREDGING

The proposed dredging activities would occur only in the Spitfire Channel. The dredging operations would deepen the existing channel to a minimum depth of 17.5 m below Port Datum although many portions of the channel are already deeper than this. Dredging would therefore not result in major changes in habitat types available.

The sandbanks adjacent to the channel would not be dredged. The dredging will not result in discernible changes to tidal ranges in the region but would lead to significantly lower velocities within the dredged channel (up to 20%) and slight increases (7%) in current velocities at the ends of the channel and on adjacent banks (Section 3.2). Such changes are not likely to have substantial effect on ecological processes in the region considering the mobile nature of sediments and changing morphology of the region.

Benthic communities populations directly in the path of the dredging operation will be removed. This would occur periodically in association with channel maintenance dredging although would be more extensive as a result of the present proposal. As noted above, it is unlikely that the Spitfire Channel supports abundant or diverse benthic communities (although no confirmatory data are available). Large areas of similar habitat, which would presumably support comparable benthic populations, occur in adjacent regions.

Studies completed upon the effect of dredging on benthic communities in comparable environs, indicate that benthic communities tend to return to pre-dredging abundance and composition within a matter of months (Stephenson *et al.* 1978). The long term effect of the proposed dredging operation upon benthic communities within the Spitfire Channel is therefore expected to be negligible.

Dredging is unlikely to affect mobile fauna associated with the sediments (eg. fish, prawns, other macroinvertebrates) to a significant degree since they would avoid the immediate area of disturbance.

The clean nature of the sediments within the channel would ensure that any turbidity plumes are limited in intensity, extent and duration. Potential impacts should be limited to the channel with minimal, if any, potential turbidity effects on the adjacent sand banks. Fauna in the region should be tolerant of such conditions considering the natural current/wave climate which would disturb/resuspend sediments.

Overall, the dredging operation would not involve disturbance of any unique or highly productive aquatic habitats. Large areas of similar habitat occur in adjacent regions of the northern entrance to Moreton Bay. Disturbed portions of the channel would be rapidly recolonised.

5.0 FISHERIES

Little information is available on commercial or recreational fisheries in the Spitfire Banks region. The information presented below results from general information on northern Moreton Bay and from fisheries knowledge held by WBM Oceanics Australia staff (staff have previously been employed by Department of Primary Industries Fisheries Branch and have undertaken several major consultancies for the Queensland Commercial Fishermen's Organisation). Detailed site specific information could be gained by liaising with fishermen who operate in the region.

Fish and crustacean populations of value to fisheries are likely to be limited to transient or pelagic species which would occur in similar habitats (i.e. mobile sandy substrates with high current velocities) elsewhere in northern Moreton Bay, and probably the South Passage region.

The region near Spitfire Channel does not contain any well known fishing grounds and does not appear to provide habitat of high fisheries value. The lack of shelter (eg. mangroves, seagrass, coral or rock reefs) and probable low level of food resources (due to the mobile nature of sediments) results in it having low value as a nursery or feeding ground compared to more protected inshore areas of northern Moreton Bay. The region is unlikely to be an area used by spawning fish (eg. bream, Pollock, 1982). It may support significant prawn populations on occasions although no confirmatory data is available.

5.1 COMMERCIAL FISHERIES

Northern Moreton Bay supports a number of regionally important commercial fisheries. These include the:

- crab fishery - targeting sand (*Portunus pelagicus*) and spanner (*Ranina ranina*) crabs with baited pots.

- prawn fishery - targeting several species (*Penaeus* and *Metapenaeus*) of commercial prawns utilising trawling operations. Sand crabs are also taken as incidental catch in northern Moreton Bay.

- pelagic fishery - targeting the pelagic species (such as the mackerels) with lines and ring nets.

These fisheries (crab, prawn and pelagic) do not operate within the Spitfire Channel and adjacent banks to a large extent primarily because of the:

- strong tidal currents, resulting in difficulties in maintaining position and operation of fishing gear
- movement of large vessels within the channel presenting the risk of collision and gear loss
- unsuitable habitat for maintenance of abundant populations of the preferred target species
- availability of more suitable fishing grounds elsewhere in Moreton Bay

Some sand crab and spanner crab fishermen periodically operate on the margins of the channel and on the adjacent banks. No detailed catch information specific to the area is available however it is probable that the Spitfire Channel area is not regarded as a prime fishing ground. The Department of Primary Industries in 1987 conducted a sand crab study which involved tagging 7 700 crabs. Tagged crabs were not recaptured from the Spitfire Channel (Figure 5.1) suggesting limited usage of the region by crab fishermen.

The Moreton Bay sand crab fishery has peak catches from September to May with crabs being caught in gutters and along edges of sand banks in water depths greater than three meters. The main regions for the sand crab fishery are south east of Bribie Island and the south/south western portions of Moreton Bay.

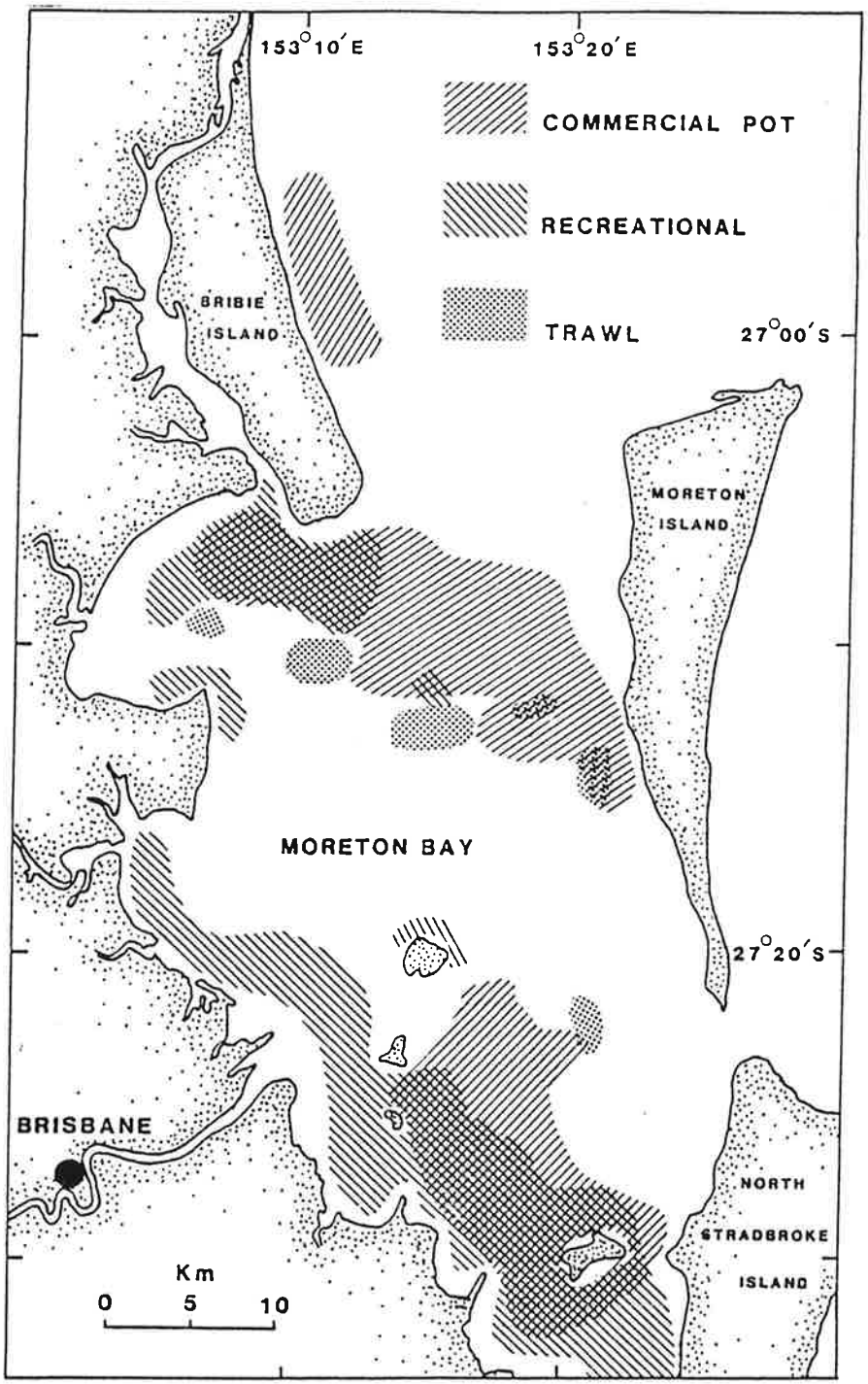
Spanner crab catches peak in the July to November. Spanner crabs generally occur in deeper waters than sand crabs. Anecdotal evidence suggests that spanner crabs are targeted by commercial fishers at the Spitfire Banks in June and July. This fishery is reported to be sporadic and seasonal (pers. comm. Mr. W. Sumpton QDPI) however no information is available on its importance.

Prawn trawl operators reportedly operate in the Spitfire Channel on an infrequent basis. No details are available on the timing or importance of such operations.

Overall, little information is available on commercial fishing near Spitfire Channel and direct liaison with commercial fishermen would be required to quantify the above. However, it is probable that the Spitfire Channel and the adjacent banks are utilised on an infrequent basis mainly by commercial crab fishers.

5.2 RECREATIONAL FISHERY

Anglers fish within the Spitfire Channel and adjacent sand banks. Most target pelagic species in the channel (and nearby deep areas) which seasonally occur within the Moreton Bay region such as mackerel (spanish, school, gray and spotted), tuna (mackerel and long-tailed) bonito, cobia and trevally (Quinn 1992). The peak activity period of this fishery is in the summer



TAGGED SAND CRAB RETURN AREAS
(after Potter and Sumpton, 1987)

FIGURE 5.1

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months (December - February), coinciding with the migration of the spotted mackerel (*Scomberomorus munroi*). Most anglers fish from drifting or slow moving vessels (trolling) as the schools of fish are highly mobile. Fishing from moored vessels is limited.

Fishing activity for shallow water species typically associated with sand banks (eg. whiting, bream) is limited due to the strong current action etc. and availability of other more accessible fishing areas.

Recreational anglers also target sand and spanner crabs with baited pots. However, this activity is limited by the high current velocities and unsuitable habitat conditions which limit the success of the commercial crab fishery (refer to Section 5.1.).

5.3 EFFECTS OF DREDGING ON FISHERIES

Commercial fishing operations appear unlikely to be significantly affected by the proposed dredging operations since:

- the channel apparently has limited usage by commercial fishermen
- habitats of high fisheries value would not be disturbed
- the dredge would be operating in the channel on an infrequent basis (ie. returning to Fisherman Islands three to four times a day)

Potential impacts resulting from the proposed dredging activities would primarily relate to the crab (sand and spanner) fisheries. Effects could involve reduced fishing times/catches on the channel margins as a result of the dredging. A few prawn trawl operations could also be affected, mainly due to the physical presence of the dredge. These effects are anticipated to be minor however they could be minimised if direct liaison was undertaken with crab and trawl fishermen to identify mitigating options.

The use of the Spitfire Channel area by recreational fishers is predominantly limited to the targeting of pelagic species (eg. mackerel) in summer months. Schools of such fish should not be affected as the fish are highly mobile. Noise from dredging may cause fish to move away from the region during dredging operations. These would return once activities are completed. Dredge activity should be periodic (3 - 4 occasions per 24 hour period) and therefore would be anticipated to have minimal impacts on the fishery.

6.0 CONCLUSIONS

- Dredging would not cause any discernible changes to tide levels

- There would be some localised changes to current patterns with decreases in velocities in the dredged channel and marginal increases in the channel at either end as well as on adjacent banks. The implications of such changes with respect to navigation should not be significant but should be discussed with the Department of Transport.

- There would be no discernible changes to current patterns or speeds remote from the site.

- Altered current patterns in the vicinity of the dredging may result in some localised sediment redistributions. However, the existing banks and channels are highly mobile and such redistributions are not likely to result in any adverse consequences.

- There is no direct supply of sediment from the tidal delta to the adjacent coastal and beach systems and therefore dredging would not alter supply conditions.

- Dredging would not have any significant direct or indirect effects (through localised sediment redistribution) on waves approaching the shore and hence the littoral processes.

- The dredging operation would not involve disturbance of any unique or highly productive aquatic habitats. Disturbed portions of the channel would be rapidly recolonised.

- The channel is not expected to support a large resident population of fish and/or crustaceans of high fisheries value.

- Commercial utilisation of the Spitfire Channel region is limited to low levels of sand/ spanner crabbing and prawn trawling. Deepening of the channel should not result in significant effects to commercial fishing. Liaison with commercial fishermen should be undertaken to quantify and reduce potential impacts to fishing operations.

- Recreational fishing in the area occurs infrequently with most anglers targeting pelagic species such as mackerel. Anglers are mobile following schools of fish which may move away from the area in response to dredge noise.

- Dredging should produce a very limited turbidity plume, restricted to the channel and its margins. Fauna in the region would be tolerant of such effects considering the current/wave climate where sediments are frequently disturbed and resuspended.

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