

2. HERON ISLAND BOAT HARBOUR AND ITS GEOMORPHIC SETTING

2.1 Works Constructed Prior to 1987

The situation and problems associated with Heron Island dredge spoil dump are the latest phase of a series of impacts and interactions between the natural processes which formed and which are continually reshaping coral cays and various engineering works and other human activities at Heron Island (Figure 2) during the last 50 or more years (Gourlay and Flood 1981; Gourlay 1983b). The impacts of cyclones and climatic variations on a secular time scale of 10 to 30 years have resulted in movements of the shoreline of the western end of the island from a northwesterly position in 1936 to a southwesterly one in October 1966 prior to the initial construction of the boat harbour (Flood 1974, 1981, 1986). This movement was associated with the loss of sand from the island and reef platform as ebb tide currents drained seaward through a gap in the reef rim, blasted in 1945, at the location of the entrance to the present boat harbour. It also required the construction during the 1950s and 1960s of a seawall to protect resort buildings on the northwestern side of the island.

Dredging of the original boat harbour during late 1966 and early 1967 was interrupted by cyclone "Dinah" which partly infilled it and the project was not completed until October 1967. Material dredged from the boat harbour was used to reinstate the sand spit on the western end of the island. Subsequently, the helipad was built on this reclaimed area in 1968. While there are no records available, this whole operation must have created considerable environmental disturbance and the reclaimed sand spit would have been in many ways similar to the spoil dump created from the more recent operations. However, it is unlikely that any attempt was made then to confine the silt generated by the dredging operation and the disturbance created by cyclone "Dinah" may well have removed most of it from the beach and indeed from the reef platform itself.

Subsequently, the low rubble walls surrounding the boat harbour were damaged by cyclones in 1971 and 1972, culminating in the partial infilling of the boat harbour by cyclone "Emily" in early April 1972. Maintenance dredging was carried out in October 1972 and the material removed from the harbour placed in front of the rock seawall on the northwestern side of the island. The harbour was again partially infilled with sediment by cyclone "David" in January 1976 and more sediment was deposited in it by cyclone "Simon" in February 1980. During this period, tidal currents spilling through gaps in the walls surrounding the harbour were also depositing sand in it. Maintenance dredging was again undertaken between November 1980 and February 1981, the dredged material being placed behind the timber seawall originally constructed in 1970 to protect the helipad. In 1982-83, two hundred 2 tonne concrete blocks were placed in two rows, one to the north and the other to the south of the harbour in an attempt to block the outflow of tidal currents through the boat harbour.

There are no recorded observations of environmental disturbance caused by the release of fine silt from the maintenance dredging operations or from the dredged material placed upon the cay's shoreline during these earlier works.

2.2 Boat Harbour Enlargement Works 1987

The project for maintenance dredging and enlargement of the boat harbour commenced around 14 September 1987 and was finished by the second week in November 1987. Most of the dredging was completed by the middle of October 1987. A further minor enlargement of the harbour was undertaken between 19 and 21 February 1988. The main project included the construction of a timber jetty and some maintenance of existing bund walls surrounding the harbour (Figure 3).

The enlargement of the harbour was undertaken at low tide by an excavator which broke up coral rubble and other large material and deposited it in a vehicle for removal to the spoil dump area or various locations along the bund walls. A cutter suction dredge operated within the boat harbour and access channel to remove material deposited in them. Dredged material was pumped ashore and deposited in the spoil dump area south from the helipad in front of the research station (Photos 1 and 2).

The original intention was to stockpile sand from the beach south of the helipad and to build a settling pond there for the dredge effluent discharge. However, the beach was found to be composed mainly of rubble with a relatively thin cover of sand.

The exact details of the construction and operation of the settling pond were not recorded at the time but it appears that rubble materials from the beach and from the harbour excavation were used to form a bund wall which was initially open at its northern end (Photo 3). Observers on the island reported that the dredge effluent including most of the fine sediment flowed back directly into the boat harbour for at least a week.

The open end of the pond was then closed and pipes inserted at the bottom of the bund to discharge the effluent from the pond back into the harbour. This arrangement was not much better than the open pond.

Following an inspection by the supervising engineer, the overflow pipes were repositioned on 8/9 October at the top of the bund so that a proper settling pond was formed (Photo 4).

The mode of operation of the original settling pond was such that little fine material was likely to have been deposited in it. Indeed information has been given that, during the operation of the pond, a 200mm thick layer of fine silt/clay, like a cement slurry in appearance, was deposited at the outlet of the settling pond in the present boat ramp area between the helipad and the jetty. This layer was of the order of 100mm thick in December 1987. Most of this material had disappeared by May 1988 although some fine material apparently remained on the reef flat between the northern harbour bund wall and the northern line of concrete blocks. The effectiveness of the final settling pond arrangement is unknown but presumably a greater proportion of the fine sediment from the dredge effluent was retained in the spoil dump.

After completion of the dredging, the rubble bank was pushed down and the available sand spread over it to form a beach on its present location. The permit for the project allowed the beach toe to be moved 30m seaward from its pre-existing location. The beach was to be restored to its original condition with an upper surface of soft unconsolidated beach sand. This did not occur. As noted by Kinsey in early 1988 "In reality the surface is now hard compacted shingle with some sand. It is particularly unyielding and can not in realistic circumstances be walked on by tourists in bare feet". (Kinsey 1988).

2.3 Geomorphic Setting of Heron Island

Before describing the investigations for the spoil dump monitoring programme, it will be helpful to describe the geomorphic setting of Heron Island, in particular the nature of the reef flat which surrounds it.

Heron Reef is a typical lagoonal platform reef and geomorphically can be subdivided into the 'reef slope' below the line of intersection of the reefal mass and the water surface at low tide, and the 'reef top' above and inside this line (Jell and Flood 1978). Heron Island is a sand cay developed on the leeward end of the reef top. The reef top includes the outer "Reef Rim" which is the highest part of the intertidal portion of the reef being a few centimetres above the upper level of coral growth. It is almost continuous around the reef except for a few places on the

western and northeastern margins. The harbour is a major breach in the rim and controls the ebb tide currents. The reef rim is not well developed for the first 100m eastsoutheast of the wreck (Figure 4). The reef rim varies from 20 to 80m in width on the western end of Heron Reef and can be subdivided into an outer coral/algal zone, an outer moat, and an inner rubble zone. This is a high energy zone and sand size sediment is restricted to the potholes, crevices and interstices between the rubble. Algal turf entraps considerable quantities of sediment of fine sand to silt size. Sediment in this area varies considerably from one sample site to another and is not significant in this study.

The Reef Flat is that portion of the reef top which is exposed during low tides and extends inwards from the rubble zone of the reef rim. It consists of:

- (i) an outer coral-algal zone of living coral with extensive algal encrustations and sheets of coral shingle, with sand patches restricted to coral pools and shallow channels which are commonly arranged normal to the refracted wave fronts;
- (ii) a coral-sand zone containing fewer stands of living coral, with dead coral commonly encrusted by both coralline and fleshy algae;
- (iii) a sand zone typified by broad expanses of sand, with sparse clumps of living coral interspersed with patches of dead coral; the sediments are continually being bioturbated by holothurians.

On the western end of Heron Reef the coral-algal zone is 15 to 105m wide on the southern side and up to 275m on the northern reef flat. This merges with the coral-sand zone which may be 50m to 250m in width. On the northern side the sand zone is up to 500m in width but is much narrower on the southern side. Sediment is transported across the reef flat as evidenced by the sand waves or ripples and samples taken at any one locality are representative of that area. To the east of the island the sand zone of the reef flat merges with the broad sandy shelving area below low water level. This is the shallow lagoon and represents a prograding sand wedge into the deeper lagoon of the central part of the reef top.

Heron Island is the sand cay formed of supratidal deposits on the reef flat at the western end of the reef top. It rises abruptly from the southern reef flat to a maximum height of 8m above low water datum and then slopes gently northwards. A sandy beach, 15 to 30m wide at low tide, surrounds the cay. This in turn is partly surrounded by beach rock, 9 to 21m in width on the southern shore, 3 to 6m wide in the north and west. On the southern side the beach rock is bordered by a shallow moat which is 15 to 30m wide and consists of a sandy floored depression approximately 80cm below the general level of the reef flat. The moat represents the plunge line of the main body of breaking waves and is caused by wave scour. A large sand spit is developed off the northeastern side of the island and is exposed at low tide.

There are no recent or extensive hydrographic surveys of the reef flat and only a very general impression of its elevation can be given. The general level is 0.6 to 0.8m above low water datum (see section 3.4) with the region either side of the boat harbour originally being lower than this. The level of the top of living corals at the western end of the moat opposite the end of the presently exposed beach rock is 1.0m above low water datum. The reef rim is probably at least this elevation.

Details of the geomorphic, ecological and sedimentological zonation of Heron Reef are discussed by Jell and Flood (1978). These authors also provide maps of the distribution of the zones, especially for the western end of the reef which is relevant to this study.