CHAPTER 5

Conclusions

In an environment such as that of the coast and near-shore zone of Cleveland Bay many variable processes interact to shape the physical and biological evolution. The geology and climate in the coastal catchments influence rock weathering, erosion, river regime and therefore fluvial sediment supply to the coast. Marine processes are controlled by wind, wave and tidal regimes. The wind produces waves not only within the bay but in the available fetch seaward and also may produce currents especially in shallow water. The alternate flooding and ebbing of the tides moves the zone of breaking waves back and forth across the intertidal zone and also induces tidal flood and ebb currents which reach maximum velocity on spring tides in restricted channels. In addition to these natural catchment and marine processes man may have a considerable effect, through such activities as constructing dams on rivers, which trap not only water but sediment; concentrating pollution at particular localities where sewage and industrial effluent flows out to the coast; and dredging sediment from one locality and dumping it in another. Where such a wide range of natural and man induced processes are interacting, isolating the effects of any one particular process is difficult and complicated. However, against such a background is set this assessment of the influence of dredging in Cleveland Bay.

For the first 81 years of dredging, from 1883 to 1964, records of amounts and localities of dredging in the Townsville Harbour area are intermittent. The fact that amounts of dredged material are recorded in several different units which cannot be related to each other lessens their usefulness further. The greatest problem concerning this

earlier period however is shortage of information about dump sites; only for 1883 and 1893 do written records exist which indicate that dredge spoil was dumped near Cockle Bay, Magnetic Island. Verbal information only suggests that before the mid 1960's a dump site south of Middle Reef was used, but for what exact period is unknown. Because of these serious limitations in the records, it was possible to assess the effects of dredging only very generally in the light of present knowledge and understanding of processes. The more lithified dredge spoil from developmental dredging, especially in the harbour area, will not have been so liable to redistribution from the dump site as is the unconsolidated finer sediment from maintenance dredging. The latter is likely to have been moved from the dump site by tidal and wind-induced currents, but whether this was predominantly in an eastward or westward direction is uncertain from present knowledge of these currents, as the use of different methods to measure these has led to some contrasting results. It seems possible however that some of the fine sediment from the dump sites near Cockle Bay and Middle Reef was subsequently deposited on the large adjacent coral reef flat, which extends from the south-west coast of Magnetic Island.

From 1965 onwards detailed dredging records which show localities and amounts of dredging have been kept by the Townsville Port Authority. Throughout this period the main dredge spoil dump site has been the shallow draft site south-east of Magnetic Island with a deep draft dump site east of Magnetic Island being used in addition from the early 1970's onwards. A permit for continued dumping at these two sites was issued in 1988. Also, more wind, wave and tidal data has become available for all or part of this period, which greatly aids understanding of the processes influencing sediment movement in Cleveland Bay. Aerial surveys have been carried out in this area from 1941 onwards and although they were relatively infrequent and their cover was variable

during the next 30 years, in the 1970's and 1980's comprehensive coastal surveys have been undertaken every 3 to 4 years. These aerial surveys have been used to investigate coastline and intertidal changes and, on occasions of clear under-water visibility, also changes in adjacent parts of the subtidal zone. An assessment has been made of the influence of dredging on these changes.

The most direct effect of dredging has been near the mouth of Ross River. Here 2,319,660m^3 of sand were removed from the intertidal sandbanks between 1968 and 1970 to be pumped ashore for adjacent land reclamation. A further 400,000m^3 of sand was removed in 1979-80 from the Ross River bed immediately upstream of Goondi Creek, for land reclamation on the east side of the Harbour's Eastern Breakwater. The presence of the Ross River Dam upstream, which traps sediment, is likely to result in only slow natural replenishment of this sand. The sand removal plus developmental dredging between 1977 and the early 1980's in the Ross River channel, followed by maintenance dredging, has had two effects. Firstly the channel has been moved westwards from its previous natural route across the intertidal zone, which has affected the pattern of sedimentation. Secondly the sediment, which has been proved to be highly polluted from the sewage outfall on the east side of the Ross River mouth, has been used for land reclamation mainly, but some has been carried to the shallow draft dumping ground south-east of Magnetic Island from which it is likely to have spread out subsequently in response to current movements.

The dumping of very large quantities of dredged sediment in the early and mid 1970's probably played a significant part in more widespread changes to the seagrass beds throughout the Cleveland Bay area. The moderate seagrass cover visible on the 1959 and 1961 aerial surveys was reduced

to almost none by the time of the 1974 survey, but showed the beginnings of a recovery in 1978 and subsequently a steady expansion on the 1981 and 1985 aerial surveys. The long interval in the 1960's and early 1970's when no aerial survey suitable for assessing seagrass cover was flown is unfortunate and makes it difficult to pinpoint more precisely the time of seagrass cover destruction. However it seems highly likely that it occurred in the early 1970's when major natural events and dredging activities combined to deliver a huge amount of fine sediment for distribution in Cleveland Bay. Cyclone 'Althea' in December 1971, followed by the rain depression produced by Cyclone 'Bronwyn' in January 1972, and Cyclone 'Una' in December 1973, followed by a long period of heavy rainfall in January and February 1974 caused major Burdekin River floods. These entered the Coral Sea as freshwater plumes, carrying large quantities of terrigenous sediment, which were turned northwards and north-westwards by the prevailing south-east winds and waves to subsequently reach the Cleveland Bay area. There was also a more direct freshwater and sediment influx to the bay from the smaller rivers flowing into it; about 458,700m^3 of sediment had to be removed by maintenance dredging from the Platypus Channel following Cyclone 'Althea' and the subsequent river floods. Developmental dredging to cut the seaward dog-leg channel to the Platypus Channel and increase the swing basin depth in the Harbour during the early and mid 1970's produced enormous quantities of dredge spoil. The total annual dredging figures soared to a peak of over 2 million tonnes in 1973/74, which is equivalent to nearly two-thirds of the Burdekin River's average washload plus bedload of 3.45 million tonnes (Belperio, 1979). As much of this dredged sediment appears to have been Holocene mud it is likely to have been redistributed in the bay from the dump sites, in response to tidal and wind-induced currents.

It therefore seems highly probable that most of the seagrass was buried by the deposition of this huge quantity of sediment delivered to Cleveland Bay both by natural processes and from dredging. It may have contributed also to the extensive death of mangroves, which took place along the south-west coast of Magnetic Island, during the 6 years following Cyclone 'Althea'. However from the aerial survey evidence it was not possible to detect any changes to the coral reefs, except in the seagrass growing in the sediment on the extensive south-west Magnetic Island coral reef flat.

Future Assessment of the Effects of Dredging in Cleveland Bay

To assess the effects of dredging in the future, with greater precision than has been possible in this retrospective assessment, it is suggested that the following monitoring and research programme is required:

1 Detailed recording of localities of dredging, amounts and type of material dredged, and locality of dumping.

2 Observations of the movement of the dredge spoil plume under different wind, wave and tidal conditions.

3 More detailed instrumental measurements of tides and tidal currents throughout Cleveland Bay and West Channel to provide an understanding of the circulation pattern, and to resolve the apparent contradictions in the earlier measurements obtained by different methods.

4 Establishment of a wind recording station to replace that at Cape Cleveland, which closed in 1987. Continued measurement of regional wind flow at a similar station is important to link to wave records, and for determining wind-induced water currents.

5 The wave recorders should be adapted or changed to enable wave direction to be recorded, in addition to wave height and wave period, as at present. Records from both Townsville Port Authority wave recorders, sited off Cape Cleveland and in Cleveland Bay, should be analysed by the Beach Protection Authority, not only the former as at present.

6 Monitoring of the various types of change discussed in this report, should be undertaken at carefully selected sites. Linked aerial and ground surveys would be especially valuable. Analysis of these changes in the light of varying wind, wave and tidal conditions, and the dredging programme should enable its impact to be assessed effectively.