Placement Strategy and Monitoring of the Tweed River Entrance Sand Bypassing Project Nourishment Works

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ABSTRACT

To offset erosion of the southern Gold Coast beaches influenced by the extension of the Tweed River entrance training walls in the early 1960s, the Queensland and New South Wales Governments instigated the Tweed River Entrance Sand Bypassing Project. To achieve the Queensland objective of restoring and maintaining beach amenity, nourishment works between Snapper Rocks and North Kirra were undertaken by dredge over a number of campaigns between 1995 and 2001. The permanent sand bypass system also commenced operations in 2001, with the primary outlet located east of Snapper Rocks.

A placement strategy was developed and refined over the course of the nourishment works to best achieve the objective. This paper outlines the placement strategy adopted and the issues involved in sand nourishment activities for a coastline renowned for its beach and surf qualities. The monitoring activities undertaken for the placement areas are also discussed, the results of which demonstrate the effectiveness of the nourishment strategy.

1 INTRODUCTION

The Tweed River Entrance Sand Bypassing Project is a joint initiative of the New South Wales and Queensland Governments with the dual objectives of: restoring and maintaining the amenity of the southern Gold Coast beaches, as well as establishing and maintaining a navigable entrance to the Tweed River.

The project is located on an open high-energy coastline with a net northerly movement of sand. The area has substantial social, environmental and economical considerations which include the strong and economically viable surfing and tourism industries that are dependent on high quality recreational beaches and surfing conditions.

2 BACKGROUND

The southern Gold Coast and Tweed Heads region, located at the border of the States of Queensland and New South Wales, is a major international and national tourism destination. The coastal processes are dominated by predominant easterly and south-easterly waves (Pattearson and Patterson, 1983) with an annual average net northerly longshore sediment transport rate of 500,000 cubic metres.

In the early 1960s the Tweed River entrance training walls were extended seawards approximately 380m to improve navigation conditions at the entrance which had deteriorated since the formation of an extensive entrance bar. Although improving navigation, the southern training wall created an effective trap for the littoral sand, resulting in a loss of sand supply to the southern Gold Coast beaches. These extensions improved navigation conditions for almost 20 years before a sand bar moved past the end of the southern training wall to block the channel once more.

Cyclonic conditions in the late 1960s caused substantial erosion of the southern Gold Coast beaches. The loss of longshore sand supply from the south hindered recovery of these beaches and resulted in progressive recession at Coolangatta and Kirra.

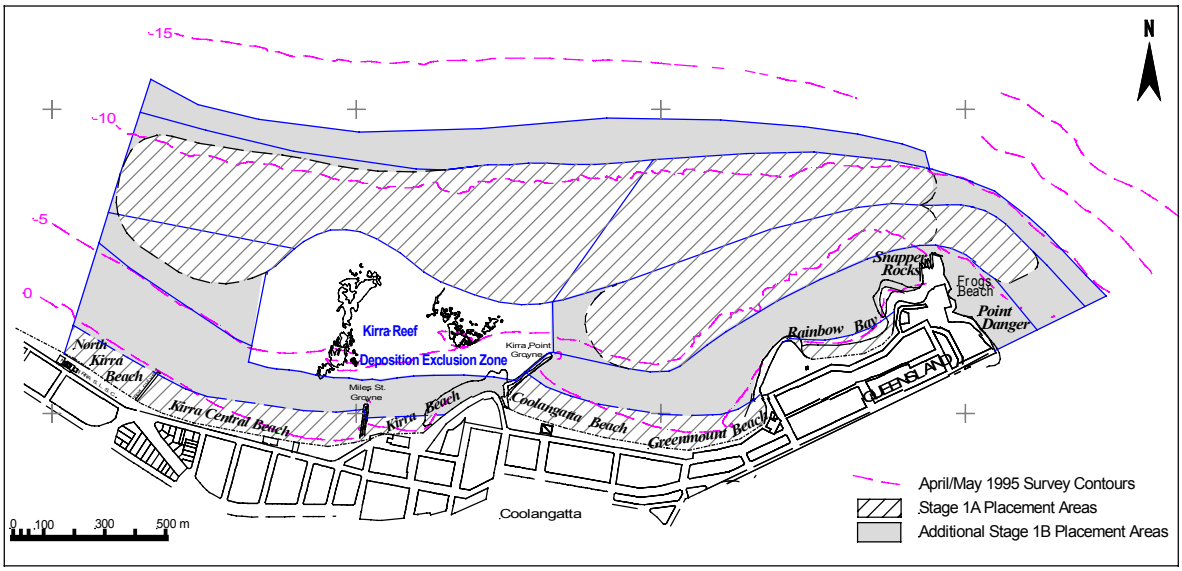

Figure 1. Stage 1 Placement Areas

Eventually a number of beach protection works were required to protect foreshore development. These included rock revetments, groynes and beach nourishment campaigns (Murray *et al*, 1995).

3 THE PROJECT

Discussions between the New South Wales and Queensland Governments, resulted in the formalisation of the project in 1994.

To achieve the project objectives, a two stage approach was adopted. Stage 1 involved removing the sand bar from the Tweed River entrance to provide material for the initial restoration of the southern Gold Coast beaches. The second stage was the development of a permanent system to maintain the restored beach amenity and navigable entrance. Stage 2 operates in perpetuity.

4 STAGE 1: INITIAL DREDGING AND NOURISHMENT WORKS

Initial dredging and nourishment was undertaken over two campaigns. Stage 1A was undertaken between April 1995 and August 1996 by Dredeco Pty Ltd, shifting approximately 2.25 million cubic metres of sand. From September 1997 to May 1998, a second campaign awarded to McQuade Marine No. 2 Pty Ltd (Stage 1B) shifted a further 800,000m^3. For both campaigns, the sand was dredged from the Tweed River entrance area and placed between Point Danger and Kirra.

4.1 Placement Strategy

The primary focus of the initial dredging and nourishment phase was to re-establish depleted upper beach and nearshore sand levels. The project area for the initial nourishment works covered the region between Snapper Rocks to the east and North Kirra Beach to the west. Placement area design levels were based on the plant available to undertake the work, and the sand levels required to produce a condition similar to that which existed prior to the extension of the training walls. The initial placement area design is shown in figure 1.

To provide immediate benefit for beach users and offset beach erosion, the placement strategy included upper beach nourishment works. The design beach profile chosen took into consideration the knowledge gained from previous nourishment activities such as the Southern Gold Coast Beach Nourishment Works (Murray *et al*, 1993). Given the operational difficulties and efficiency problems in creating a “natural profile” along the entire active beach profile, especially the surf zone, beach widths were selected to allow for the initial redistribution of the design profile by natural processes.

The benefit of upper beach nourishment during Stage 1 was dependent on how soon the permanent sand bypass system was able to supply sand to these areas. It was known that four years following the completion of the Southern Gold Coast Beach Nourishment Works, 83% of the nourished material was still within the nourishment region (Andrews *et al*, 1995).

To maintain improved beach amenity and enhance surf quality, the sand levels within the entire active littoral zone needed to be replenished. Therefore, the majority of the sand was placed in the nearshore areas between Rainbow Bay and North Kirra out to approximately 10m depth (AHD). The inshore limit was dependent on operational restrictions of the dredging plant.

Following recommendations of the Stage 1 Environmental Impact Study / Impact Assessment Statement (EIS/IAS) (Acer Wargon Chapman, 1994), a deposition exclusion zone of at least 50m was adopted around Kirra Reef to prevent direct smothering of the reefs by dredge placement and thereby minimise impacts.

Further refinements to this strategy evolved as better knowledge of the processes were acquired through monitoring. These refinements will be explained in the proceeding sections.

4.1.1 Stage 1A Nourishment

Stage 1A was undertaken by three trailing suction hopper dredges (TSHD) of varying capacity. Initial placement was by the large "Pearl River", which deposited approximately 1.5 million m^3 over about 5 weeks with the sand being placed in the nearshore areas in 6 to 10m depth (AHD), and pumped on to the beaches (refer figure 1). Given the depth limitations in the placement areas, loads were limited to about 8,000 m^3.

Upper beach nourishment was commenced mid May and undertaken over a period of 3 weeks through one ship-to-shore pipeline to Kirra Point. A total of 600,000 m^3 was placed on the upper beaches.

Upon completion of nourishment by the “Pearl River”, the “Ngamotu”, a much smaller and shallower draft TSHD, shifted about 200,000 m^3 over a 5 month period and was able to place sand within 5m depth (AHD). Once the Tweed bar was deepened, the "Krankeloon" was able to work in the area and complete the contract requirements. Figure 2 shows the relative sizes of each dredge used during the Stage 1 works. For further details on the dredges, refer to Colleter *et al* (2001).

In response to community consultation, the inner nearshore placement area was extended east around Snapper Rocks in September 1995 as suggested by the surfing community. It was anticipated that sand placed in this area would move around Snapper Rocks by wave and current action, producing more natural nearshore bars and hence better surfing conditions at Snapper Rocks.

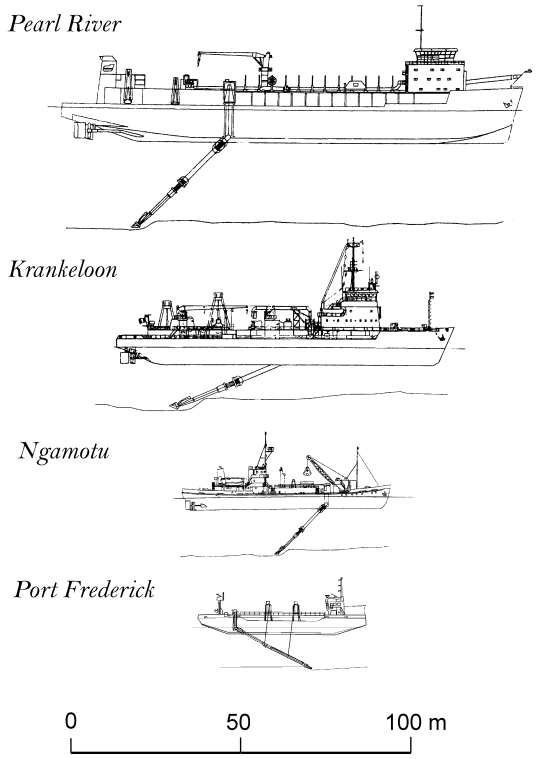

Figure 2. Relative sizes of Stage 1 Dredgers

4.1.2 Stage 1B Nourishment

Stage 1B works was mostly undertaken by the “Port Frederick”, a 50m long, 400 m^3 capacity TSHD with a draft (unloaded) of 1.7m. Given its shallow draft, high power ratio and manoeuvrability, the “Port Frederick” had an advantage over the Stage 1A dredgers in that it was able to bottom dump sand in much shallower water.

As the beaches were still sufficiently wide, Stage 1B nourishment focused on replenishing nearshore zones (figure 1) which had been depleted from the reduced littoral transport from the south. Sand was placed mostly in the inner nearshore areas so that the coastal processes would naturally feed this sand into the surf and upper beach zone.

Of the 800,000 m^3 of sand placed, about 400,000 m^3 was deposited east of Snapper Rocks as a large scale experiment to examine the area’s feasibility as a primary deposition location for Stage 2.

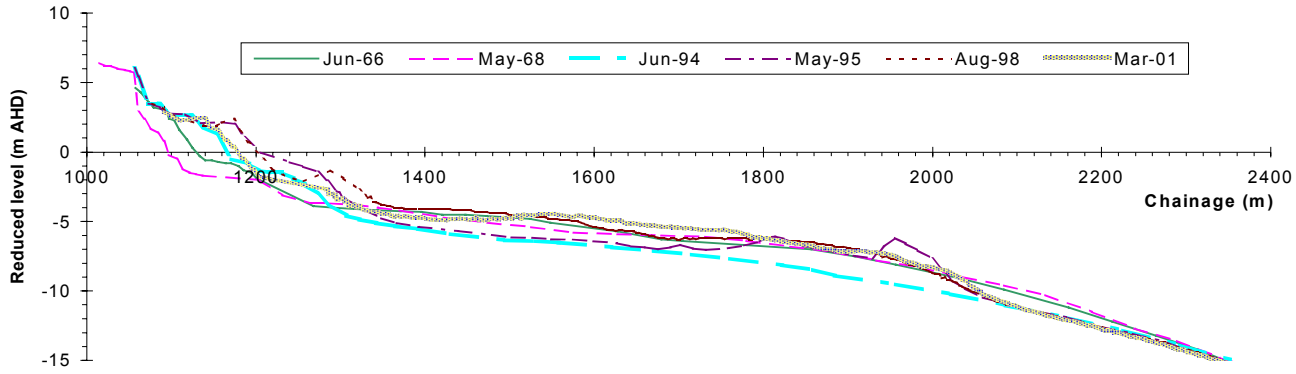

Figure 3: Coolangatta Beach Profile.

4.2 Monitoring

Environmental monitoring of the southern Gold Coast beaches included hydrographic and upper beach surveys along profiles, aerial and oblique photography, video monitoring for surf quality and nearshore processes, and wave monitoring. In particular the surveys and photography provided a good mechanism to monitor the outcomes and performance of the placement activities.

Although providing quick relief to depleted beaches, the "Pearl River" created mounds of sand in the nearshore areas which adversely affected surf quality as advised by the surfing community. The mounds were easily distinguishable in aerial photography captures. Sand placed in the offshore nourishment area was found to redistribute slowly, moving alongshore rather than on to the beaches.

It was found that by using smaller capacity dredges and spreading the sand by slowly opening the bottom hopper doors, a more regular bathymetry was achievable. This approach also allowed the "Port Frederick" to drift into much shallower water while depositing the sand. In fact, the "Port Frederick" was able to deposit about 42,000 m^3 in the upper beach nourishment area by adopting this approach.

By the completion of Stage 1B nearshore nourishment works, a continuous surf zone bar had developed from Snapper Rocks to North Kirra, providing good surf quality under suitable wave conditions.

Upper beach nourishment provided improved beach amenity and by November 1998 about 69 % of this sand was still within the upper beach nourishment zone. Figure 3 demonstrates the performance of the upper beach and nearshore nourishment for a typical profile at Coolangatta beach. It should be noted that the increased upper beach width in the 1994 profile is influenced by Kirra Point Groyne which was constructed in the 1970s to offset erosion problems. As of March 2000 (ie prior to Stage 2 nourishment), approximately 72% of the total nourishment material was still within the placement areas, and nearshore bed levels were typically raised by an average of approximately 0.9m.

Monitoring of Kirra Reef showed minimal impacts. The Stage 1 exclusion zone had minimised potential smothering with only an average 0.5m rise in bed levels up to March 2000.

5 PERMANENT SAND BYPASSING SYSTEM

The permanent sand bypassing system, provides an efficient and cost effective means of starving the entrance channel of sand and thereby reducing the need to dredge the channel on a frequent basis.

Detail on the permanent system can be found in Dyson *et al* (2001).

5.1 Placement Strategy

Figure 4 shows the adopted placement areas for Stage 2 that resulted from refinements to the Stage 1 placement areas and design levels. The Stage 2 Exclusion Zone provides a 100 m buffer around Kirra Reef.

The EIS/IAS for Stage 2 identified that at least 75% of the total annual sand quantity be placed at Snapper Rocks East (the primary outlet). The system also provides for discharge at Snapper Rocks West, Duranbah and Kirra Point.

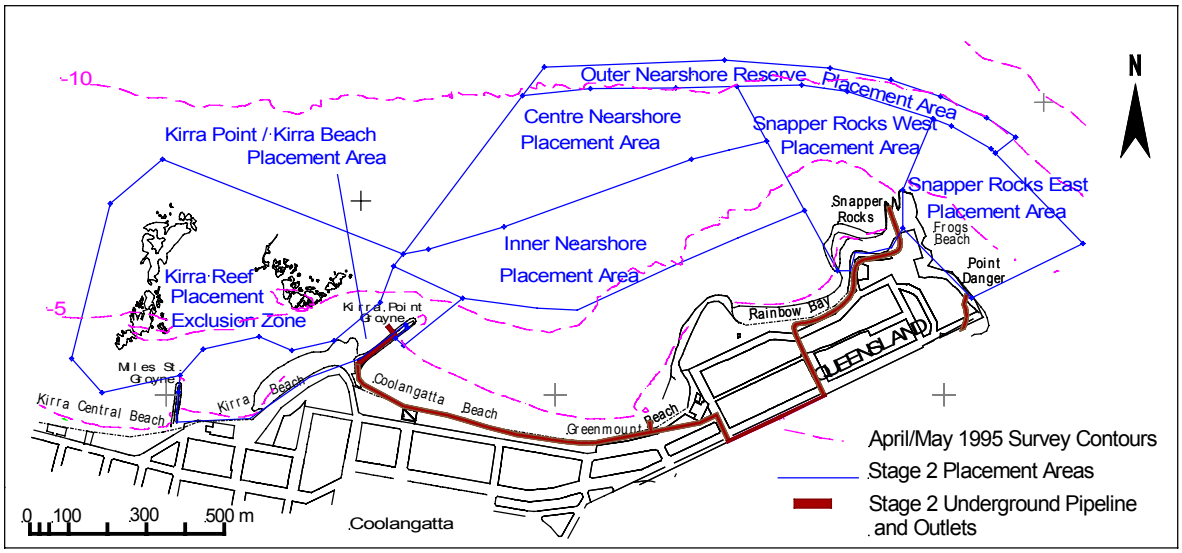

Figure 4: Stage 2 Placement Areas

The contract allows for supplementary dredging and nourishment if the clear navigation channel is compromised by sand infeed not collected by the permanent system.

5.1.1 Pre-Commissioning Nourishment

With delays between the completion of Stage 1B (May 1998) and the commencement of construction of the permanent system (February 2000), the Tweed entrance channel had again become restricted by sand infeed and further dredging works were required. Given their previous success and availability, McQuade Marine were commissioned in April 2000 by the Stage 2 constructors McConnell Dowell Constructors (Aust) Pty Ltd to clear the navigation channel, again using the "Port Frederick". Re-establishment of the channel occurred in September 2000, following the delivery of 324,000 m^3 of sand to the Nearshore and Snapper Rocks East placement areas.

The "Port Frederick" continued dredging to maintain the channel until commissioning of the permanent system. By May 2001, a total of 532,000 m^3 had been placed in the nearshore areas and it was anticipated that another 180,000 m^3 would be required to clear the entrance area.

5.1.2 Sand Discharge by Permanent System

From the commencement of the 30 day operating trial in March (Dyson *et al*, 2001) to the end of May 2001, a total of 250,250 m^3 had been pumped. Of this quantity, 66,000 m^3 was discharged to Duranbah, with the remainder going to Snapper Rocks East.

5.2 Monitoring

The monitoring program for the placement areas adopted for Stage 1 works has been continued for Stage 2. Additional profile surveys on the beaches between Letitia Spit and Kirra and in the Snapper Rocks East and West Placement Areas are undertaken by the operator of the bypass system every three months.

Early indications suggest that the sand discharged by the permanent system is remaining within the beach and surf zone. A extensive bar system has redeveloped from Snapper Rocks to Kirra and sand can be seen to be moving onto Kirra Central Beach on the leeward side of Miles Street groyne.

Based on historical photography and local community advice, the upper beaches and nearshore bathymetry is taking on characteristics similar to the pre 1960s with the re-establishment of shoals offshore of Rainbow Bay, Greenmount, and Kirra. Surf quality over this period has been reported to be excellent, especially off Snapper Rocks.

The sand spreading approach by the "Port Frederick" has shown no noticeable negative impact on surf quality. As of December 2000, approximately 69% of the sand placed during Stage 1 and 2 has remained within the nourishment area. Figure 5 demonstrates the performance of the nourishment works as of February 2001.

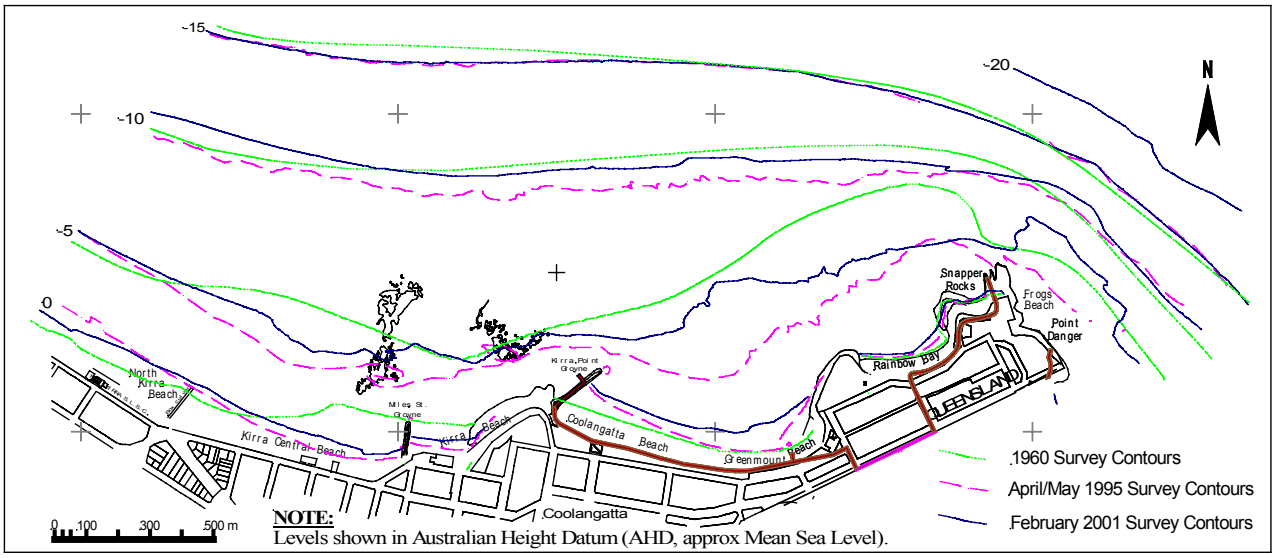

Figure 5: Changes in Nearshore Bathymetry

Kirra Reef has shown no substantial increases in sea bed levels with only a 2,000 m^3 increase mainly on the shoreward edge of the Stage 2 Placement Exclusion Zone over the period May 2000 to February 2001.

6 CONCLUSIONS

The adopted placement strategy has successfully raised sea bed levels and increased beach width such that conditions are approaching that which existed prior to the extensions of the Tweed River entrance training walls. Monitoring has shown so far that the majority of the deposited sand has remained within the nourishment area. Placement of sand within the nearshore zone and east of Snapper Rocks has resulted in more natural beaches as the coastal processes rework and distribute this sand.

Operation of the permanent system will assist in maintaining these restoration works by feeding sand directly into the beach and surf zones. Monitoring will continue during operations to assist in managing future sand placement.

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