Sand Bypassing the Tweed River Entrance:

An Overview

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Abstract

The entrance bar of the Tweed River has historically been a concern for navigators. Extensions to the river entrance walls were built in the early 1960s to improve the situation. This was relatively successful for a period, but over time sand accreted on the beach to the south of the entrance and, as sand began to pass the entrance again, a new bar developed seaward of the old bar. During this transition period, extensive erosion occurred on beaches to the north. As the Tweed River is in NSW and the affected beaches are in Queensland, the problems were jointly addressed. A solution was agreed that involved artificially bypassing sand from south of the entrance area to the Queensland beaches.

From the start of work in 1995 until the permanent sand bypassing system began operations in May 2001, 3.6 million cubic metres of sand were dredged from the entrance and used to nourish the beaches to the north. This restored the condition of the southern Gold Coast beaches to their former condition and gave some relief to boat operators.

A permanent system, which has the capacity to move the full littoral transport through pipelines placed under the river and below ground, was built in 14 months and commissioned in May 2001, after the channel was again cleared.

The sand bypassing system is an environmental sustainable method of maintaining the improved beach and navigation conditions.

1. Introduction

The breakwaters at the entrance to the Tweed River were extended in the early 1960s to improve navigation conditions. Navigation conditions improved as a result of the works, but this improvement did not last. Sand accreted to the south of the entrance and, as sand began to pass the entrance again, a new bar formed and navigation conditions worsened.

Beaches to the north eroded to an extent that sea walls were constructed to protect property and infrastructure. They had not fully recovered by the early 1990s, despite the construction of groynes and associated beach nourishment works.

Studies showed that there is a net littoral drift of about 500,000 m^3 a year to the north at this site, and that the interruption of this sand movement by the walls could account for much of this erosion.

2. Interstate Agreement

As the Tweed River entrance is near the border between NSW and Queensland, the problems became a matter for extensive negotiations between the two States. These led to an agreement to undertake a joint project with the following aims:

- establish and maintain an improved navigable entrance to the Tweed River; and

- place an initial quantity of sand on the southern Gold Coast beaches to restore their amenity, and then provide a continuous supply of sand to those beaches,

The agreed solution, which satisfied these objectives, was to artificially move sand from the entrance area to the Queensland beaches.

The work was to be carried out in two stages:

- dredge sand from the entrance and use it to restore the beach profile by placing a net 2.55 million m^3 of sand, and

- develop a permanent sand bypassing system, to collect sand from the southern side of the Tweed River entrance and transport it to the Queensland beaches in perpetuity.

The agreement was ratified by acts of parliament in each state.

3. Initial Dredging and Nourishment

The beaches of the Southern Gold Coast were substantially depleted and navigation conditions were poor when the agreement was reached between the States. Consequently, it was considered desirable to dredge the bar and restore the southern beaches of the Gold Coast as a matter of priority before the construction of the sand bypassing system.

An environmental impact assessment study established the benefit of undertaking this work, and led to the granting of planning approvals.

A contract was awarded to Dredeco Pty Ltd and work commenced in April 1995. A large trailing suction dredge moved about 1.5 million m^3 in a period of 5 weeks. Placement of 600,000 m^3 of sand on the upper beaches from Rainbow Bay in the east to North Kirra in the West was achieved by pumping from a bow pipe through a specially constructed pipeline. This provided an immediate benefit to beach users.

An additional 900,000 m^3 was placed in the nearshore area to provide a foundation to maintain the improvements. While the use of a large dredge was economical, the large volume in each load deposited resulted in an uneven bed surface that adversely affected surfing conditions for several months.

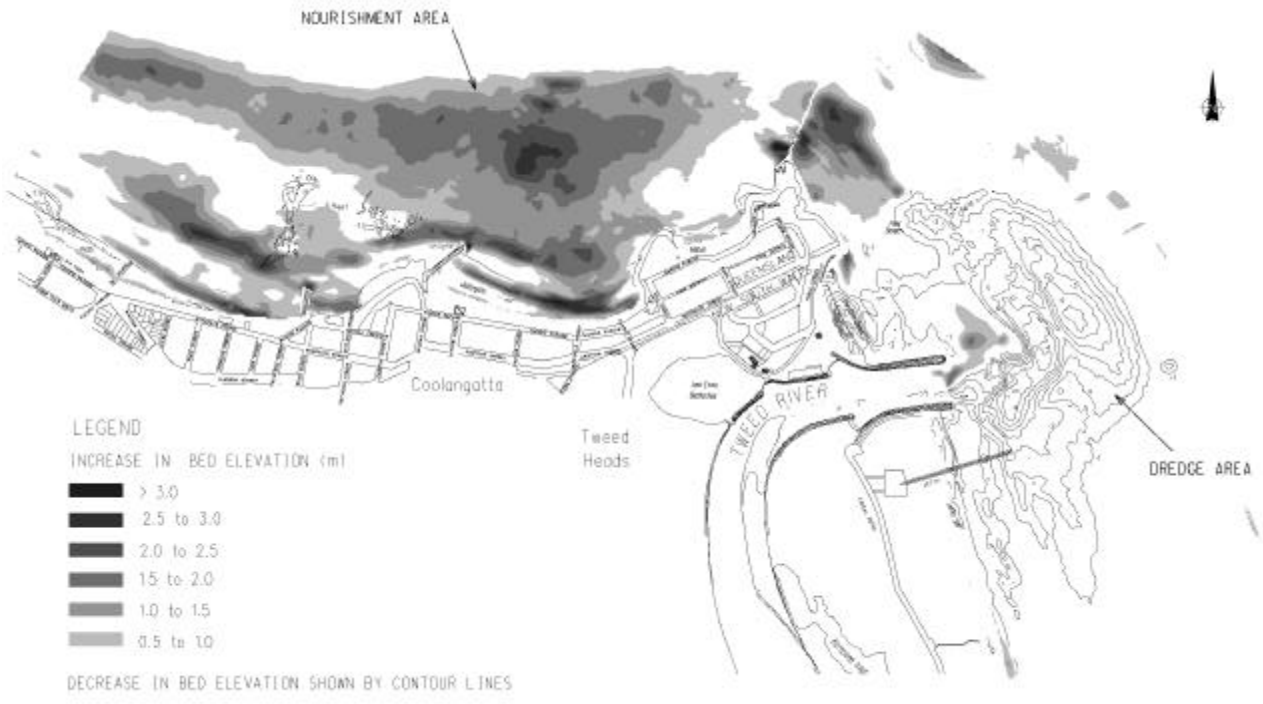

Figure 1 – Bed level changes (April 1995 – January 2001)

Dredging of the river entrance to improve navigation was carried out by shallower drafted vessels. During this work, the placement area was extended to include an area to the east of Snapper Rocks (See Figure 1). This area was under consideration for the primary outlet for the fixed sand bypassing system and is a location from which sand moves naturally to feed the upper beaches of the southern Gold Coast. This placement area also provided shorter travel distances for the dredges and was supported by the surfing community. The placement in this area proved successful and led to further use of this area in later dredging campaigns.

In August 1997, McQuade Marine was contracted for a second dredging and nourishment campaign. No sand was placed on the upper beach as the upper beach conditions were still in a good condition. However, about 40,000 m^3 of sand were placed in very shallow water. The Snapper Rocks (East) location was targeted for a larger proportion of the placement volume. The navigation channel was cleared and 800,000 m^3 of sand were placed over a 9 month period.

Further dredging was carried out in conjunction with the construction of the sand bypassing system (refer Section 4). Less sand could be placed at Snapper Rocks East during this campaign, as the permanent system was being constructed to discharge sand to this area. The nearshore nourishment area was designed to have contours similar to those that existed prior to the extension of the Tweed River breakwaters. A total of 600,000 m^3 was placed to this design between April 2000 and June 2001.

Over a six year period, a total of 3.6 million m^3 of sand was taken from the entrance and placed on the beaches at a cost of $17M. The net result was an increase of over 2.5M m^3 of sand in the beach profile, as shown in Figure 1. Details of this dredging and beach nourishment work are in Boswood et al, 2001, and information on dredge supervision is in Cummings et al, 2001.

4. Fixed Sand Bypassing System

The second stage of the project is to maintain good navigation conditions at the entrance to the Tweed River and to provide a continuous supply of sand to the beaches of the southern Gold Coast at a rate consistent with the natural processes in order to maintain their recreational amenity.

4.1. Procurement

As the project was innovative, and the technology uncertain, it was thought that it would be desirable for the sand bypassing system to be run by the private sector to limit the need for day to day involvement of the two Governments. The involvement of the private sector was a difficult task for the size of the project because of the large variability in the coastal processes, and hence the risks associated with the undertaking.

It was decided that the risk could best be shared by involving a private sector partner in a long-term agreement in which payment would be related to the performance of the system.

A call was made for expressions of interest in 1997 to obtain information about technologies that might be used by proponents in order to ensure that all probable options were considered in the environmental studies.

A Call for Proposals, made in October 1997, attracted 10 submissions. Two firms were then chosen to forward detailed proposals. These were received in November 1998.

A selection panel reviewed and evaluated the detailed proposals against a number of pre-determined criteria and recommended that negotiations be held with a consortium led by McConnell Dowell Constructors (Aust) Pty Limited to design, build and operate a system until September 2024.

These negotiations were successful, and performance based contracts were signed in December 1999. More information on this process is in Dyson *et al* (1999).

4.2. Planning Approval

Environmental Impact Assessment Studies (Hyder *et al, 1997)* were carried out prior to a decision on design, as it had been decided to obtain development approval before selecting a company to design, construct and operate the system.

Apart from predicting a deeper entrance and improved stability and amenity of the southern Gold Coast beaches (with resultant positive economic and community benefits), the environmental studies predicted the following:-

- A change in the shape, alignment and surf quality of Duranbah Beach (immediately to the North of the entrance),
- Increased wave activity on the entrance walls,
- Insignificant changes to tides, floods and storm surge propagation in the Tweed River,
- Improved water quality within the river.

Planning approval was finally obtained in July 1998.

4.3. Design

The permanent system collects sand with 11 jet pumps supported from a pier located about 250 m south of the southern breakwater. Up to five jet pumps are operated at a time, powered by high pressure water collected from the river. The sand and water mixture is then pumped under the Tweed River to the required outlet at Snapper Rocks East, Snapper Rocks West, Kirra Point, or Duranbah Beach (See Figure 2). Two pumps in series are used to move sand the larger distance to Kirra Point. The quantity of sand pumped is measured using a magnetic flow meter in conjunction with a nuclear densometer.

The system also provides for moving sand from the bar from time to time using trailer suction dredges. The frequency of such dredging will depend on the overall efficiency of the permanent system and the occurrence of storm events, which may overwhelm the jetty sand collection unit and allow some sand to "escape".

4.4. Construction

The jetty was built using land based plant and a cantilevered pile driving rig that moved seaward at the completion of each headstock. The final deck and handrails were completed as the work progressed.

The flume and other pipework were built after the jetty was completed. The jet pumps and control gear were installed last of all.

The pump and control building was built concurrently with the jetty. The site required de-watering, as the pumps are located in a basement. A 400mm polyurethane lined steel pipeline was placed under the Tweed River using horizontal directional drilling technology.

A 150mm borehole was drilled through fine sands and fractured greywacke, and this was reamed out to a final diameter of 750mm. The slurry pipeline and an electrical conduit were then drawn through the tunnel.

The other pipelines were placed in trenches in a conventional manner. Care was taken to bund and treat some material with potential acid sulfate soil properties. Particular care was taken in the construction of the outlet at Snapper Rocks West to ensure that it did not impact on the natural scenic beauty of the area.

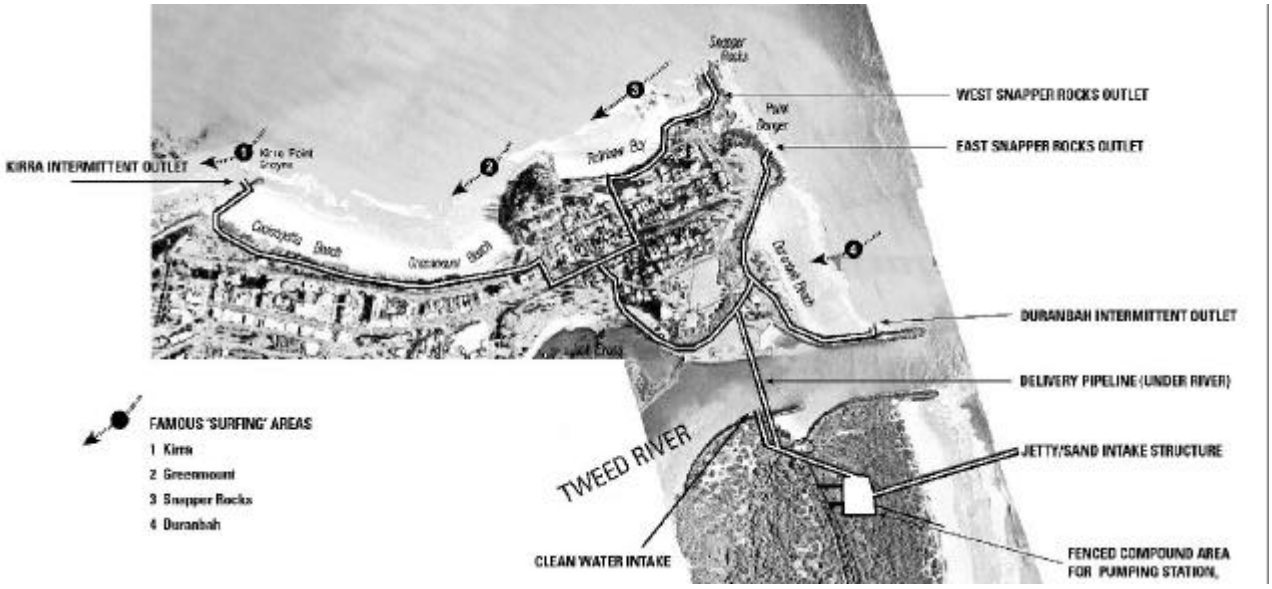

Figure 2 – Layout of Sand Bypassing System

The sand bypassing system pumped its first sand on 27 February 2001. All contract conditions were satisfied in a little over 14 months, which was within the required time period.

The system cost $23.3M. This was paid for with promissory notes, which are redeemable over a 12 year period so long as the system is complying with performance specifications.

Jetty under construction

4.5. Commissioning

Sand was placed at the primary outlet at Snapper Rocks East during the commissioning tests. The contractor was required to pump 120,000 cubic metres in 30 days and 11,500 cubic metres in a 24 hour period. The 30 day quantity was delivered within the time period and the 24 hour test was complied with a few days later. In the first instance, beach sand around the jet pumps appeared to be compacted and did not form cones of the size predicted. This reduced the efficiency of the sand trap, particularly at low tide.

Commissioning was completed on 4 May 2001, after the navigation channel was cleared and operation plans were finalised.

4.6. Operations

If sand passes the collection system and settles in the entrance channel, the operator may be required to dredge the material, but still receive payment at the same unit rate. Hence, the operator is expected to pump as much sand as possible within environmental constraints (mainly the limit on beach retreat at the jetty). Once the beach at the jetty has receded, the operator will pump or dredge an amount of sand equal to the net longshore transport supply. Hence, the system is expected to provide sand at a rate consistent with the natural processes.

The bypass is normally operated at night using a computerised control system, which arranges cycling between jet pumps (and backwashes) using slurry density data measured at each pump.

Most of the sand will be pumped to the primary outlet at Snapper Rocks East, from where it will move under natural processes around Snapper Rocks to the target beaches. However, it is proposed to place sand at Kirra Point and Duranbah Beach during February and March (the peak season for longshore transport) in order to smooth the supply of sand. Following the successful completion of the commissioning tests, 67,000 m^3 of sand was pumped to the temporary outlet at Duranbah Beach, which had been badly eroded by storms.

4.7. Environmental Monitoring

Extensive monitoring is being carried out in a number of areas, as follows:

- Surveys are taken of nearshore areas, beaches and the Tweed River.
- Surf quality at Duranbah and other beaches.
- Offshore wave height and direction is measured, wave activity on training walls is monitored, and breakwaters are monitored to detect any movement in armour stones.
- The tidal range in the Tweed River is measured and analysed to detect any changes.
- Mangroves and wetlands are monitored.
- Little Terns and other avifauna are monitored.

The purpose of this monitoring is to detect any adverse environmental impacts, should they occur, and allow remedial action to be undertaken.

4.8. Public Consultation

The project is extremely important for the communities of the area with interest in boating, surfing, beach recreation and tourism. While the usual consultation process was undertaken during the environmental impact assessment process, of greater importance was the consultation and media involvements once the project became a reality with the construction phase. The pro-active and reactive efforts during this phase were considerable but it can also be said that the outcomes of that process benefited the project in terms of modifications suggested by the public and their greater knowledge, and 'ownership' of the final outcome. Further information on this aspect of the work are in Foster et al, 2001.

4.9. Public Access to Jetty

During the course of construction, some fishermen asked Tweed Shire Council if they could access the jetty when completed. Council approached the NSW State Government, which agreed to assist in financing this development if a number of outstanding issues can be satisfactorily resolved. At the time of writing, public comment had been invited.

5. Conclusions

The project has been complex, because of the multiple objectives, the risk issues and the number of active stakeholders.

Beach nourishment has restored the beaches of the southern Gold Coast to their former glory, and the associated entrance dredging improved navigation conditions.

The uncertainty associated with coastal processes made it difficult to reach a long term agreement with the private sector that was compatible with the multiple objectives of the project, the formal agreements already reached between the two states and the conditions imposed with planning approvals. However, the performance based contract signed by the two state governments and the private sector may be expected to achieve these aims and ensure the efficient management of the sand bypassing system.

The permanent system was constructed and commissioned on time, and is operating well.

The entrance has again been cleared, and navigation conditions are expected to be more reliable now that the sand bypassing system is operating.

The constant supply of sand is expected to keep the southern Gold Coast beaches in good condition.

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