NOOSA BEACH RESTORATION SCHEME

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1. SUMMARY

A significiant beach restoration scheme has been implemented at the coastal resort of Noosa in South-East Queensland. The scheme which cost $1,400,000 involved sand nourishment, dune stabilisation works and the relocation of the entrance to the Noosa River using sand pumping techniques.

The effect of the scheme has been to greatly improve the quality of the main surfing beach at Noosa as a recreational facility and to provide much needed protection to a canal estate development which had been constructed within the Noosa River estuary close to the river entrance.

The successful implementation of this scheme also demonstrates that practical solutions to beach erosion problems are available and that sand pumping techniques may be used to economic advantage where relocation or closure of a river entrance is required and where local conditions and analysis indicate that such techniques can be applied.

Photograph 1 shows the completed restoration scheme.

2. SITE DESCRIPTION

Noosa Beach is located immediately south of the entrance to the Noosa River and seaward of the barrier dunes which separate the Noosa River estuary from the Pacific Ocean. The beach extends south east to the rocky headlands of Noosa Heads and is well known for producing excellent, safe surfing conditions.

The main commercial centre of Noosa is located precariously on the barrier dune landward of the surfing beach. Further landward is the Noosa River estuary and Hays Island - an area which was recently developed as a canal estate. Figure 1 shows the site of the restoration scheme.

The catchment area of the Noosa River comprises an area of approximately 87,000 ha. Most of this area is low lying with only two percent above 150 m above Mean Sea Level. The area is drained by a complex series of lakes and streams which finally join together to form the Noosa River. which in turn meets with the ocean in the form of a wide unstable tidal estuary. Lake Cootharaba (3750 ha) and Lake Weyba (990 ha) are the major lakes of the drainage system and both are only slightly tidal with tidal ranges being less than 5 percent of the corresponding ocean tide ranges. Figure 2 shows the catchment area.

3. GEOLOGICAL DESCRIPTION

In terms of geological units the Noosa River estuary is defined as a Holocene Tidal Delta - an area of developed intertidal banks which represent successively abandoned channels.

PHOTOGRAPH 1 - The completed scheme (August 1979)

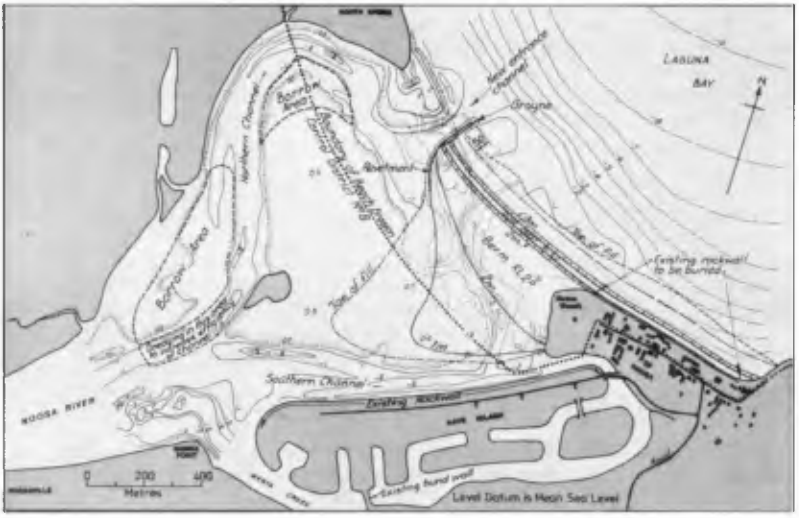


FIGURE 1 - Noosa River estuary showing the scheme of works

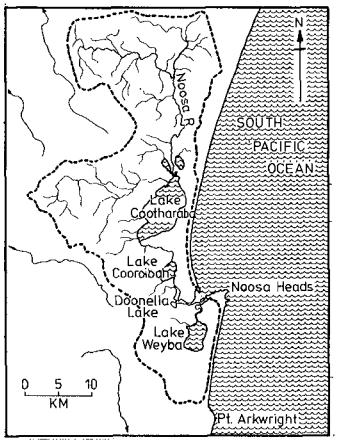
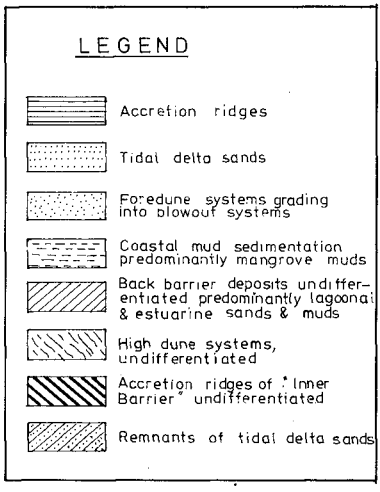


FIGURE 2 - Noosa River catchment area



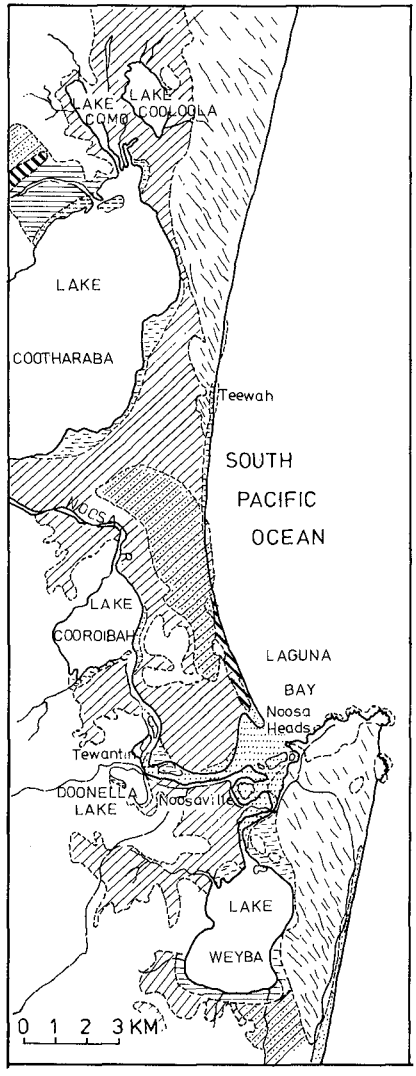


FIGURE 3 - Noosa area, geological units

The sand forming the delta has been shown to have been trapped from the beach system and to have its origins in the coastal rivers of Northern New South Wales to the south. The trapping mechanism could have been favoured by early increases in sea level.

The barrier dune which separates the estuary from the ocean is also of the Holocene epoch (probably formed in the past 10,000 years) and comprises well sorted quartz sands with minor heavy mineral deposits. Soil development on the fore dunes is minimal.

Reference 1 draws attention to alternating trends in dunal growth at Noosa and also to short term accretion trends within the estuary. Figure 3 shows the Noosa area subdivided into geological units.

4. EROSION PROBLEMS AT NOOSA

The main surfing beach at Noosa had suffered severely from erosion prior to implementation of the restoration scheme and following severe cyclonic storms in 1968 it had been necessary to construct a boulder wall full length along the beach to provide adequate protection to the development located on the barrier dune. The boulder wall was located in the swash zone and by partially dissipating wave energy in the form of turbulence and partially reflecting the waves established a process which further lowered the beach immediately seaward of the wall.

The canal estate developed on Hays Island within the Noosa River estuary had also been threatened as unforeseen movements of the main channel of the Noosa River had given rise to high velocity currents adjacent to the development. These had caused undercutting and partial collapse of some of the revetments to the development. Effectively the old channel on the northern side of the estuary which for many years had carried the main body of flow of the Noosa River was progressively abandoned in favour of a newer developing southern channel which in turn was in conflict with the canal estate development. Photographic records of the estuary indicate that the process of abandoning the older northern channel was quite natural and that the new southern channel adjacent to Hays Island was well established before any construction work at Hays Island commenced. Figure 4 shows the progressive changes which recently occurred in the estuary.

With the development of the new southern channel it was possible for waves entering the estuary through the river entrance to impinge on the works at Hays Island and the revetments had not been designed for such a contingency.

The development of the southern channel also had a direct impact on Noosa Beach. Coupled with the strengthening flow in the southern channel the river entrance moved south cutting into a camping reserve at Noosa Woods at the northern extremity of the commercial centre and at the same time reducing the length of the main surfing beach.

The overall effect was that by the time a decision was made to proceed with restoration works in 1977 Noosa Beach was virtually nonexistent.

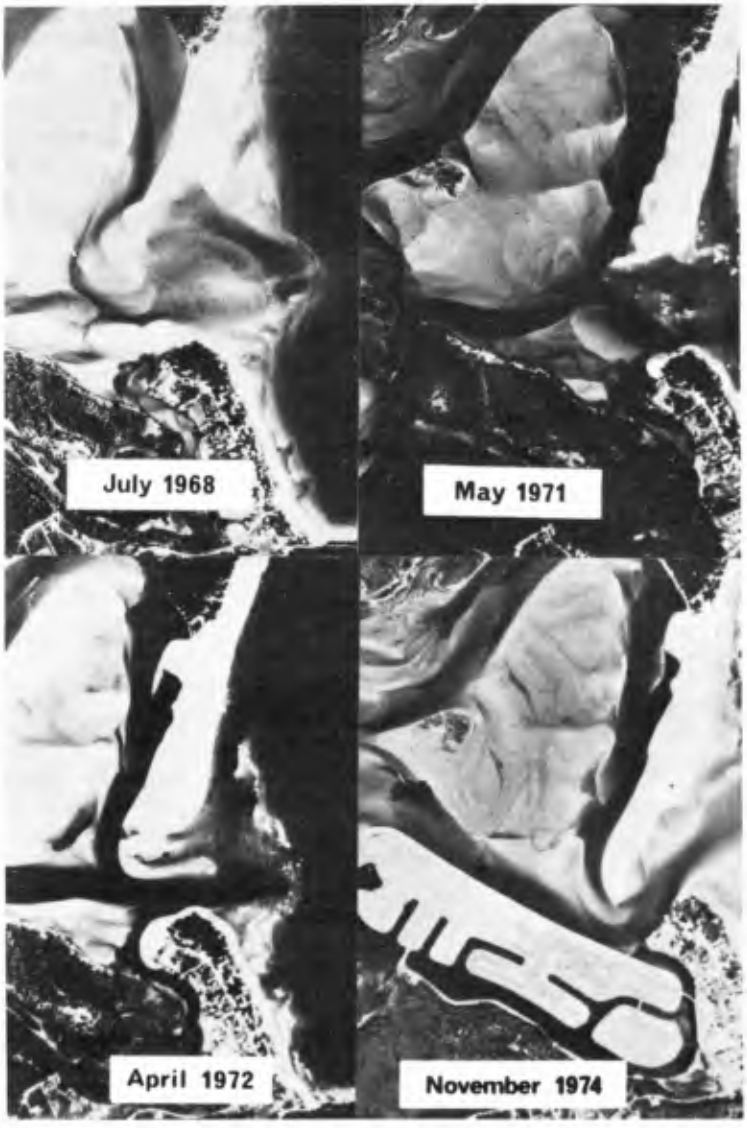


FIGURE 4 - Photographs showing progressive changes to the main channel within the Noosa River estuary

5. THE RESTORATION SCHEME

In seeking solutions to the erosion problems at Noosa model studies at the University of Queensland were initiated and several investigations commissioned (References 2 and 3). The findings of these investigations indicated that the Noosa River would have to be diverted away from Hays Island if the threat to the canal estate was to be removed.

The final scheme which was prepared in September 1977 after consideration of various alternatives was designed to provide a complete solution to all the problems previously outlined. It included the following works:-

(a) Redevelopment of flow in the old northern channel of the river by opening a new entrance approximately 500 metres north of the existing river entrance.

(b) The blocking of flow in the southern channel by means of sand pumping to form a closure bund across the original river entrance.

(c) Development of a new beach system including a large dunal area north of the Noosa Woods camping area thereby reinforcing the closure of the southern channel and protecting the development at Hays Island from wave attack.

(d) Sand nourishment of the original beach at Noosa at the rate of 250 cubic metres of sand per metre length of beach which would permit the establishment of a beach seaward of the existing rock wall.

(e) The construction of a rock groyne and revetment on the southern side of the new river entrance to retain sand on the newly developed beach and also to prevent further southward migration of the new entrance.

(f) The stabilisation and vegetation of all newly formed dunal areas (approximately 20 ha) to prevent damage by wind erosion.

(g) The implementation of an effective monitoring program to record changes to Noosa Beach and within the Noosa River system.

Sand required for implementation of the works would be taken from borrow areas within the estuary. Figure 1 shows the location of the works including the designated borrow areas.

6. LIMITATIONS OF THE RESTORATION SCHEME

At the time the scheme was prepared its limitations were recognised. The more important of these were as follows:-

(a) Undercutting of the rock groyne and revetment on the southern side of entrance might occur and maintenance could be required.

(b) Erosion of freehold properties to the north of the new entrance could occur as northward movement or development of the new entrance would not be constrained by the scheme.

(c) The new beach alignment would depend on the natural action of the sea and the supply of sand to the newly formed and restored beach.

(d) A continuing maintenance commitment would be required to retain the newly vegetated dunal areas in satisfactory condition.

(e) Maintenance of the beach in the form of additional sand nourishment following periods of severe storm wave attack might be required.

(f) The scheme was not designed to control the behaviour and movements of channels within the Noosa River estuary.

7. CRITICAL PHASE OF THE SCHEME

The most critical phase of the restoration scheme was the closure of the original entrance to the Noosa River. While initially it had been expected that earthmoving plant might be required to effect final closure detailed examination showed that closure could be effected by sand pumping alone. Furthermore alternative techniques involving the use of earthmoving plant were found to be more costly.

Design calculations indicated the following:-

* A continuous sand pumping rate of approximately 500 cubic metres per hour was required to construct a sand bund across the southern channel following the opening of a new entrance to the old northern channel.

* The nett loss of sand from the works area during the closure operation would be minimal even though sand transport in the region of the closure bund would be high.

On this basis it was decided to adopt the sand pumping technique for the closure operation and the more costly techniques involving earthmoving plant were discarded.

In preparation of contract documents for implementation of the restoration scheme a sand pumping rate of 800 cubic metres per hour was specified for the entrance closure operation. This rate which was 300 cubic metres per hour in excess of the theoretically required sand pumping rate was considered necessary because of possible dredging plant failure.

8. CONSTRUCTION

Implementation of the restoration scheme comprised two distinct phases - the civil engineering works involving sand pumping and groyne construction and the dune stabilisation works.

Tenders for the civil engineering works were invited and five tenders ranging from $1,263,435 to $2,299,702 were received. The lowest tender was accepted and sand pumping works commenced on site on June 12, 1978 under the supervision of Departmental engineers. The specified sand pumping capacity was provided by these dredgers fitted with 250 mm diameter suction and delivery lines connected to pumps powered by diesel engines of 200 Kw rating.

Dredging commenced at the site of the new entrance with spoil being directed to the closure bund which was being developed from the northern side of the existing entrance. By June 20 the new entrance to the northern channel had been opened and by June 27 closure of the original entrance had been effected.

During the closure operation sand was pumped to the head of the closure bund to discharge points located well above water level. This resulted in much of the sand being deposited on the head of the closure bund above water level and rapid forward progress of the toe of the bund was made when slumping of this deposited material occurred.

While no technical problems were encountered with the entrance closure operation, the decision to specify a sand pumping rate of 800 cubic metres per hour was justified as actual records of dredging plant indicate that the average pumping rate achieved during the period June 12 to June 27 was only of the order of 600 cubic metres per hour because of dredging plant failures and the need to shift and maintain the associated equipment and dredge lines.

Following completion of the entrance closure operation, vehicular access to the site of the rock groyne became available and groyne construction was able to proceed. At the same time the final phases of sand pumping works were able to commence and all such works including the development of the beach and dunal areas north of the Noosa Woods camping area as well as sand nourishment of the original beach were completed by September 13, 1978.

During the progress of the works sand pumping rates being achieved by individual dredgers were measured. The rates varied between 280 and 370 cubic metres of sand per hour with only one test showing a result of less than 300 cubic metres per hour. Based on these measurements it is estimated that in excess of 1,000,000 cubic metres of sand were incorporated in the works. Of this approximately 150,000 cubic metres of sand were required for the entrance closure operation.

Progress of the civil engineering works is shown on Figure 5, a sequence of aerial photographs of the works.

After the completion of sand pumping works dune stabilisation works were able to proceed. These works proceeded on a day labour basis under the control and supervision of Departmental staff well experienced in dune stabilisation techniques.

Approximately 20 ha of the newly created dunal areas were initially stabilised against wind erosion by the establishment of a vegetative cover of grass. The speed with which this operation was carried out was greatly assisted by the balanced application of fertilizer.

In addition to establishing grasses, in excess of 20,000 creepers, shrubs and tree seedlings were planted and are now well established. Fencing and access paths were also constructed to control both vehicle and pedestrian movements in the stabilised areas.

FIGURE 5 - Photographs showing progress of the works

9. MONITORING

The restoration scheme included an extensive monitoring program as an integral part of the scheme. The major activities included in the program were as follows:-

- Water level monitoring at four locations - three stations upstream of the development site on the Noosa River and a single station at Boreen Point on Lake Cootharaba.
- Aerial photography at regular intervals.
- Regular measurements of the tidal compartment.
- Sand sampling.
- Daily recording of wave and beach conditions at Noosa by a trained volunteer observer.

This monitoring program many aspects of which have remained in operation is providing valuable information on erosion and accretion trends of the restored beach and also on behavioural patterns of water level movements within the Noosa River and Lake Cootharaba.

10. BEHAVIOUR OF NOOSA BEACH SINCE IMPLEMENTATION OF THE RESTORATION SCHEME

The nett longshore transport at Noosa Beach is to the north. This conclusion is based on longshore transport calculations using observed and derived wave climates for Noosa Beach. It is also supported by the fact that available photographs of an old groyne which was constructed on Noosa Beach show sand build up on the southern side only. The nett longshore transport rates which have been derived are of the order of 140,000 cubic metres of sand per year to the north.

Since implementation of the restoration scheme the southern portion of Noosa Beach has receded visibly and successive surveys carried out along fixed lines spaced at 80 m intervals along the beach indicate that in excess of 100,000 cubic metres of sand has been lost in the 12 month period following implementation of the scheme. The bulk of these losses have been concentrated in the area above the -5 metre contour (relative to Mean Sea Level) and there has been no observable loss to offshore areas. The beach lines extend several kilometres offshore. The likely explanation of this behaviour is that the supply of sand to the southern portion of Noosa Beach has not been sufficient to make good sand losses from the area due to longshore transport to the north.

In the mid region of Noosa Beach adjacent to and to the immediate north of the Noosa Woods camping area surveys indicate that there has been little or no change in the quantity of sand on the beach in the 12 month period following implementation of the restoration scheme. While there have been some beach profile changes above the -7 metre contour (relative to Mean Sea Level) seaward of this contour the shape of the seabed profile appears to have remained relatively constant and any variations in level between surveys are considered to be caused primarily by the accuracy limitations of the survey techniques adopted. Based on the above it is considered that in the mid region of Noosa Beach there has been a balance between supply and loss of sand.

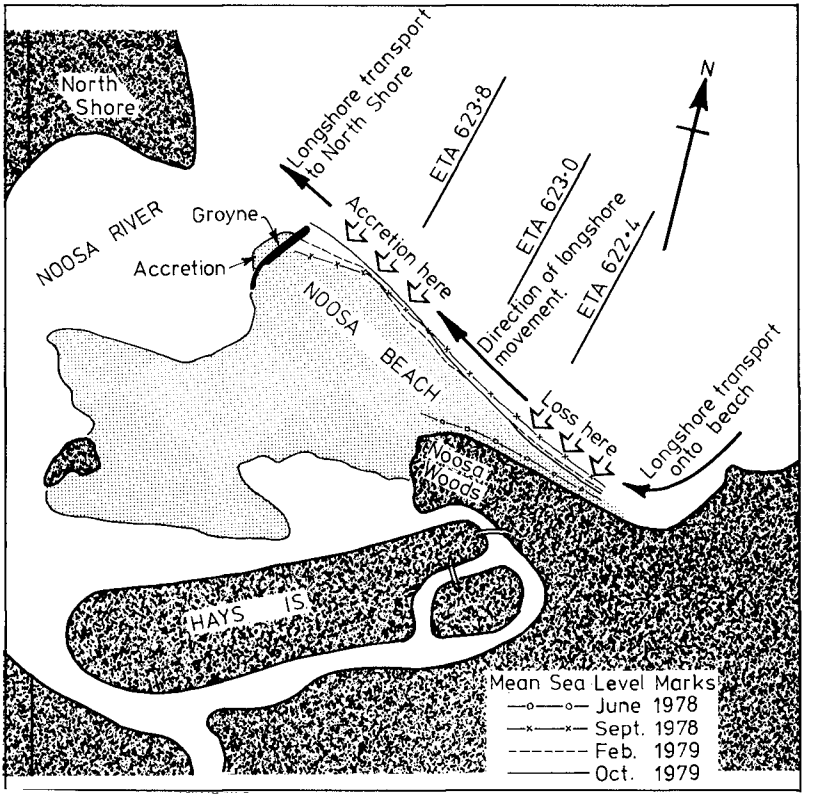


FIGURE 6 - Movements of the 0.0 contour (Mean Sea Level) as determined by beach surveys at Noosa

In the northern portion of the beach in the region of the rock groyne in the same period there has been obvious visible accretion and a substantial beach berm has developed. Beach surveys confirm this accretion and indicate that there has been accretion of sand of the same order of magnitude as the sand losses which occurred in the southern region of the beach. Virtually all profile changes were limited to the area landward of the -7 metre contour (relative to Mean Sea Level).

The nett result has been an overall change in beach alignment. Figure 6 gives an indication of this change in alignment and shows the 0.0 metre contours as determined from successive surveys carried out in June and September of 1978 and also in February and October 1979. The June 1978 survey was carried out prior to implementation of the restoration scheme. Figure 7 shows typical beach profiles obtained by survey.

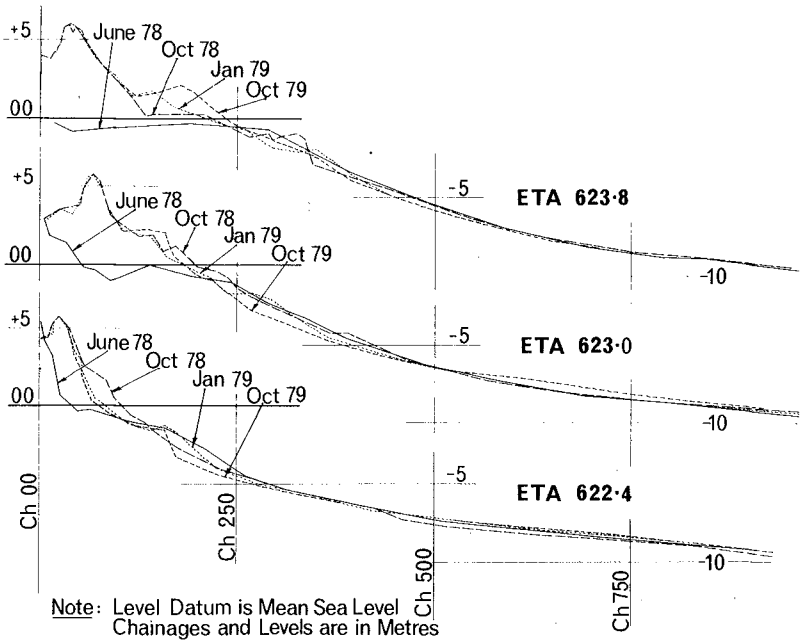


FIGURE 7 - Typical beach profiles at Noosa as determined by beach surveys. Location of beach lines is shown on Figure 6.

The accretion of sand in the northern region of Noosa Beach is attributed mainly to groyne action. However, sand bypassing has not been prevented by groyne construction as a large sandy spit has developed on the northern side of the groyne as a result of sand bypassing and the new entrance to the Noosa River has been displaced to the north.

The grain size of sand obtained from the estuary for beach nourishment purposes was generally coarser than the native beach material and it is not considered that sand losses at the southern extremity of the beach have been significantly increased by the loss of fine material. Figure 8 shows the results of sand sampling within the estuary and also on Noosa Beach.

It is postulated that the beach recession which has occurred along the southern portion of Noosa Beach has been caused by an intermittent sand supply from around Noosa Headlands. This arguement is supported by photographic evidence which shows that the condition of Noosa Beach and the small pocket beaches between the headlands fluctuates with time. It is considered that the fluctuating condition exhibited by these beaches is the result of a fluctuating sand supply to these beaches and that the condition of the southern portion of Noosa Beach where restoration work has been carried out will continue to fluctuate under the influence of natural processes. The small pocket beaches between the headlands have not been in good condition since the restoration scheme was implemented. Thus it could be expected that the southern portion of Noosa Beach would currently be experiencing a period of recession.

FIGURE 8 - Photographs showing the fluctuating condition of beaches around Noosa Heads. Immediately south of Noosa Beach. The January 1978 photograph is typical of the condition which has existed since implementation of the restoration scheme.

11. BEHAVIOUR OF WATER LEVELS WITHIN THE NOOSA RIVER AND LAKE COOTHARABA

Monitoring of water levels within the Noosa River and further upstream in Lake Cootharaba has not shown that current water level behaviour differs greatly from that which was previously recorded prior to the restoration scheme being implemented.

Spring tide ranges at Munna Point (refer Figure 1) are as follows:-

* Prior to Restoration Scheme being implemented -
  1974 - 0.77 m
  1975 - 0.70 m
  May 1968 - 0.48 m

* Following implementation of restoration scheme -
  November 1978 - 0.73 m
  July 1979 - 0.62 m
  December 1979 - 0.62 m.

The above figures indicate that fluctuating spring tide ranges were a feature of water level behaviour within the Noosa River prior to the restoration scheme being implemented. Spring tide ranges based on data recorded since implementation of the scheme lie within the limits of previously recorded ranges.

12. MONITORING OF THE ENTRANCE CLOSURE OPERATION

During the entrance closure operation a sand bund with a crest level of approximately RL +4 metres (relative to Mean Sea Level) and a base width of approximately 150 metres at RL -2 metres was constructed across the entrance to the southern channel over a period of approximately 16 days. During this period regular surveys of the closure gap were carried out. The results of selected surveys are shown on Figure 10. Each of the surveys shows the presence of a deep channel located hard against the head of the closure bund. This channel was effectively pushed ahead of the closure bund as the closure operation proceeded.

The cross-sectional area of natural material eroded from the entrance is represented by the difference in cross-sectional area between the original channel profile and a line traced by the lower limit of the previously described channel as it was pushed ahead of the closure bund. This area which has been estimated to be 330 square metres is shown on Figure 9 as a cross-hachured area marked below the plot of the first survey of the entrance which was carried out on June 16, 1968.

Based on this survey information and aerial photography it was estimated that of the order of 30,000 cubic metres of sand was eroded from the natural bed of the entrance channel during the closure operation.

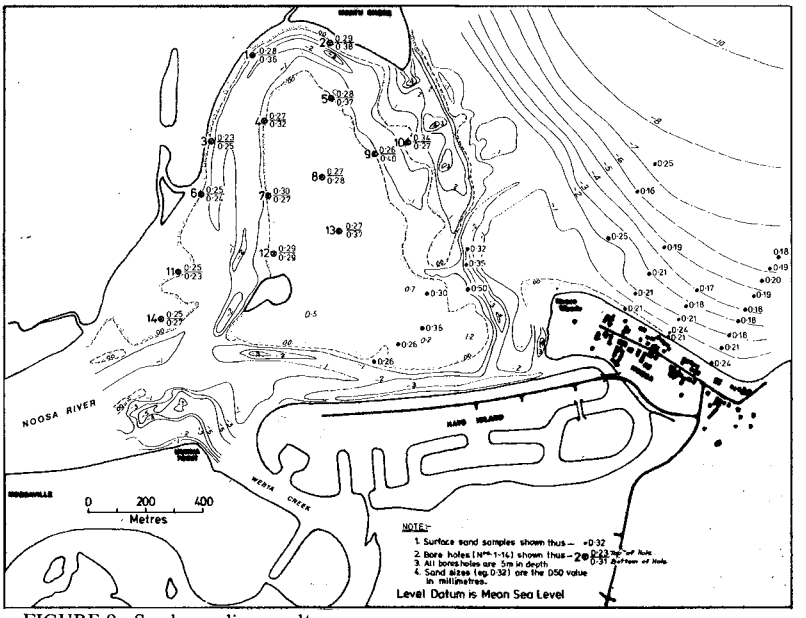


FIGURE 9 - Sand sampling results

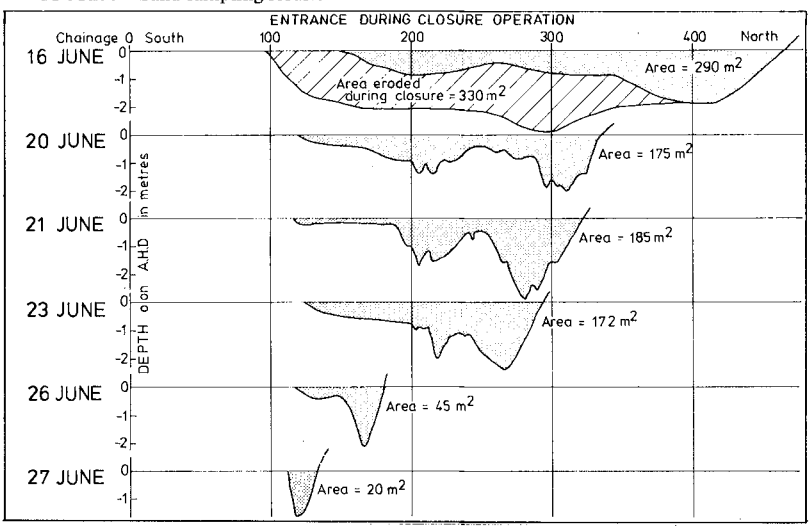


FIGURE 10 - Surveys of Noosa River entrance during closure operation

13. BEHAVIOUR OF NEW ENTRANCE

In the 18 month period following opening of the new entrance to the old northern channel of the Noosa River estuary on June 20, 1978 the entrance has continued to develop with the pattern of flow changing continuously. A new bar across the entrance has formed and surveys carried out in February 1980 show that this is continuing to extend seaward.

The cross-sectional area of the new entrance measured below Mean Sea Level as determined by survey in October 1979 was approximately 300 square metres. This is similar to the area which existed in 1896 when the entrance was first surveyed. It is also similar to that which existed when the restoration scheme was first investigated in September 1977.

As the cross-sectional area of an untrained entrance may be related to the tidal prism (Reference 4), the behaviour of the entrance would indicate that implementation of the restoration scheme has not had a significant impact on the tidal compartment of the Noosa River.

14. CONCLUSIONS

From a beach protection viewpoint the Noosa restoration scheme has been successful. The aerial photograph of the restoration scheme site which was taken after the artificially formed beach profiles had time to adjust to prevailing wave and current conditions shows that large areas of new beach are now available for a wide variety of recreational purposes whereas previously no such beach areas existed. Although there have been several periods of rough seas and high tides there is no evidence of a significant nett loss of sand from the beach system. In addition the new beach north of the Noosa Woods camping area has successfully withstood the attack of two cyclones without any damage to the artificially created frontal dune.

From the viewpoint of the development within the Noosa River estuary the threat of damage to revetments and property through undercutting and wave action has been removed.

From a technical viewpoint the success of the entrance relocation operation using sand pumping techniques has demonstrated for the first time in Queensland that both suitable plant and the necessary expertise are available locally to enable full use of this specialised low cost technique of entrance closure.

In view of the above, it is considered that the scheme has provided an effective solution to the erosion problems at Noosa and demonstrates clearly the benefits which can be derived from a well conceived beach restoration scheme.

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