INTRODUCTION

BACKGROUND
The sand shoals at the Tweed River entrance have endangered navigation since the earliest days of settlement. In recent times they have jeopardised the operations of the local fishing fleet and have inhibited recreational boating and boat charter activities.

In an attempt to improve navigation, river training walls were built around 1900 and extended during the period 1962-65. In addition, the river channels have been dredged intermittently for over a century. These actions improved the situation for a time but the effects were short-lived and the shoals returned.

The NSW Government wishes to improve the entrance but, rather than continuing to pursue short-term remedies, a permanent solution is sought which achieves the following principal objectives.

--- Safe navigation for fishing vessels and recreational craft by providing at least 3.5m (ISLW) water depth over the bar.
--- Reduced flood levels in the lower estuary.
--- Improved water quality in the lower estuary.
--- Maintain and where possible enhance the present ecological richness and diversity of the lower estuary.
--- Maintain the natural net northwards littoral drift to Point Danger.
--- Effective use of Crown and community assets (e.g. river sand).

Accordingly, a major Feasibility Study was commissioned to identify and assess options for improvement of the Tweed River entrance which would achieve these objectives.

Stage 3: Implementation of a wide range of investigations to assess the options, leading to the identification and more detailed evaluation of a short-list of options.

COMMUNITY PARTICIPATION
The Feasibility Study has been conducted throughout in close consultation with Tweed community groups and organisations to ensure that their concerns and aspirations were fully and properly considered.

The Tweed Entrance Community Liaison Committee was formed at the outset of the Study and is chaired by the local member, Mr Don Beck. Its members comprise representatives from community groups, the Public Works Department, the Tweed Shire Council and the Gold Coast City Council.

PEER REVIEW
The Study has involved a number of major scientific investigations dealing with the estuarine and coastal processes of the region. Due to the complex nature of these processes and the importance of the Study, a Technical Review Panel was commissioned to provide an independent peer review of the scope, methods and findings of the investigations.

The Panel comprised Professor Colin Apelt of the University of Queensland, Professor Jon Hinwood of Monash University and Mr Peter Stone, then of the Australian Construction Services. In its detailed report, the Panel endorsed the findings of the Study, concluding that the scope and methods were appropriate and the findings soundly based.

REPORTING
A three-tiered reporting system has been adopted to disseminate the findings of the Feasibility Study at various levels of detail.

Level 1: Summary Report (this document)
Level 2: Detailed Summary Reports
Level 3: Source Reports

The Source Reports comprise the detailed methodologies and results of the numerous investigations and data collection programmes undertaken throughout the Study. These covered four principal topics.

--- Coastal Processes
--- Estuarine Processes
--- Ecological Environment
--- Socio-economic Environment

The Detailed Summary Reports provide comprehensive summaries of the source reports under each of these four topics.
THE PROBLEM

THE RIVER IS SHOALING
The entrance sand bar has become progressively more dangerous over the past two decades and this trend is expected to continue. Moreover, sand from the entrance is being carried into the river by tidal currents, forming shoals within the lower estuary. This will eventually constrict tidal flows near the entrance to almost half their present level.

THE ENTRANCE BAR JEOPARDISES THE FISHING INDUSTRY

In 1989, 37 licensed trawler operators and 25 registered trawlers were based at Tweed Heads. The average value of the annual offshore fish catch exceeded $3 million. About 250 people in the region are employed either directly or indirectly in the fishing industry.

The bar causes frequent damage to boats and limits operations to about 120 days per annum. It is not uncommon for the Tweed fleet to be barbound while the Southport fleet to the north is able to operate.

If the bar can be improved, the fleet could expect to operate up to 180 days per annum. However, if the bar continues to deteriorate, eventually the trawlers could be forced to abandon the port.

THE BAR LIMITS RECREATIONAL BOATING

About 1400 recreational craft are registered in the Tweed district. In 1988 the Air Sea Rescue received 85 emergency calls for assistance adjacent to and outside the entrance.

Improvement of the bar would enhance safety and act as a catalyst to expansion of recreational and tourist boating.

WATER QUALITY AND FLOOD DISCHARGE WILL BE THREATENED

Water quality in the river is quite good although urban runoff and sewage effluent occasionally cause problems in the Terranora Inlet. Both the river and the Inlet flood periodically.

As the channels of the lower estuary become more constricted with sand, the tidal flushing of estuary waters will be reduced and the discharge of floodwaters will be inhibited.
THE ISSUES

THE OCEAN CLIMATE IS COMPLEX

Cook Island and the labyrinth of submerged reefs create a confused wave climate off Fingal Peninsula. The East Australian Current impinges on Point Danger with circulation cells off Fingal and Dreamtime Beaches. Strong longshore currents are generated by wave action.

THE LITTORAL DRIFT IS THE HIGHEST IN THE STATE

The littoral drift of sediments increases along the far northern NSW coastline because of the increasing obliquity of the coast to the prevailing south-east wave climate. Littoral sediments are generally carried by waves and currents to Point Danger where some are believed lost offshore and the remainder is carried north-westwards onto the lower Gold Coast beaches.

Extension of the Tweed breakwaters in the 1960's interrupted the littoral drift and caused accretion of Letitia Spit while the original entrance shoals were carried northwards. This improved the navigability of the river entrance for a time but the littoral drift has gradually re-established the entrance shoals as well as the northwards supply of sand to Point Danger. Some potential for growth of the shoals still remains.

THE ENVIRONMENT IS SENSITIVE

The Tweed River lies on the boundary of temperate and tropical regions allowing a wider diversity of wetland species than might normally be encountered on the eastern seaboard.

Over 400 hectares of mangroves, saltmarsh, intertidal mudflats and seagrasses provide rich breeding, spawning and feeding habitats for fish, crustacea and molluscs.

The estuarine ecology is sensitive to changes in tidal behaviour. Many of the saltmarsh and seagrass meadows occur on the tidal fringe or in shallow water and could be affected by an increase or decrease in tidal range. Tidal flushing plays an important role in distributing nutrients to the marine flora and fauna as well as the removal of pollutants.

The Tweed shorebird population is less diverse than on other major north coast rivers. Nevertheless it supports 17 species of migratory shorebird, of which 15 species are subject to agreements between the Australian, Japanese and Chinese governments. Major bird roosts exist on South Head Beach, Dreamtime Beach, Kerosene Inlet and the eastern fringe of Cobaki Broadwater. Major foraging locations are Shallow Bay, Tony's Island, the two Broadwaters and Ukerebagh Passage.

Offshore, Cook Island and the Danger Reefs provide habitat for soft corals, echinoderms and a diversity of tropical fish. The area is the focus of scuba divers from the Gold Coast and is used by seven commercial diving schools. The NSW Department of Agriculture and Fisheries is currently considering a proposal to declare the area a marine reserve.
With population growth consistently exceeding 3% per annum, Tweed Shire is one of the fastest growing areas in the State. Infrastructure is being rapidly expanded and the community is seeking to make greater use of the estuary for industry and recreation.

Tweed Shire also has one of the highest proportions of retired residents of any local government area in the State. The community’s outlook on issues such as development is quite conservative and contrasts sharply with that of the neighbouring Gold Coast.

Commercial and recreational fishing is prevalent throughout the estuary, on the ocean beaches and offshore. Sailing, canoeing, waterskiing, windsurfing and diving are also popular.

Oysters are farmed in both the river and Terranora Inlet. The value of the harvest fluctuates widely, with an average of about $1.8 million per annum.

Several charter boats operate on the river offering both day and night restaurant cruises.

Cane farming, the dominant agriculture on the lower river, relies on tidal flushing to dissipate the acidic waters arising from oxidation of natural soils that occasionally leach into the river following periods of drought.

Fingal Head village lies 3 kilometres south of the river entrance. The village grew from an aboriginal/islander settlement and holiday destination around the 1880’s. Fingal Head School was established in 1895. The present population of about 800 includes a close-knit aboriginal-islander community which has direct links with the original settlement.

A number of community groups at Fingal Head actively oppose commercial development of the Fingal peninsula as well as supporting reforestation of natural areas and promoting recognition of local and regional cultures.

If the estuary channels below Barneys Point and the Dry Dock were dredged to a depth of -5m AHD, (the depth required for unrestricted navigation), some 3.7 million m³ of sand would be obtained. If the dredging was continued to -10m AHD, a total of 12 million m³ would result.

This sand is suitable for construction fill. Sand extraction companies have indicated unreserved interest in purchasing the sand to satisfy a strong regional demand.

If the sand could be sold, from $7 million to $24 million could be raised in royalties depending on the depth to which the channels are dredged. The resource would last from 10 to 25 years depending on demand and the amount permitted for extraction.

Across the border, the Gold Coast beaches have suffered from periodic erosion since earliest settlement. In the succeeding years, development has been permitted on the frontal dunes in areas likely to be affected by both short and long-term beach recession. Groynes and seawalls have been built to protect the beachfront development with consequential effects on natural beach behaviour and amenity.

There is considerable conjecture about the extent the Tweed breakwaters may have contributed to the erosion and loss of amenity of the Gold Coast beaches, and the extent to which the problem is due to natural long-term recession coupled with the effects of beachfront development and protective structures.

The Queensland Government has allocated $32 million for beach nourishment using sand dredged from offshore areas.
THE OPTIONS

The options to achieve the objectives of an improved river entrance were of two basic types.

--- Rectifying the deficiencies of the existing entrance, whether by dredging, installing a bypass and/or modifications to the training walls.

--- Taking advantage of potential hydraulic efficiencies, tidal gradients and natural wave shelter to create a better entrance at a new location.

Options for a new entrance were included on the basis of earlier studies which had suggested that a new entrance at Fingal, for example, may offer safer navigation as well as more efficient tidal flushing. Several new locations were therefore considered, and at each a range of dredging, entrance bypass and existing entrance treatments examined.

A wide range of options were thus initially considered as possible ways to improve the entrance. From these, the iterative procedure inherent in the Feasibility Study process progressively identified and discarded the non-viable options. The options selected for detailed evaluation are listed below and are located as shown in the adjoining figure.

The dredging referred to in the options comprises deepening the river channels downstream of Barneys Point and Boyds Bay bridges to a depth of - 4m ISLW.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CODE</th>
<th>OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Entrance</td>
<td>EI</td>
<td>Install Bypass</td>
</tr>
<tr>
<td></td>
<td>EID</td>
<td>Install Bypass and Dredge River</td>
</tr>
<tr>
<td></td>
<td>ED</td>
<td>Dredge River</td>
</tr>
<tr>
<td>Fingal</td>
<td>FC</td>
<td>Install Bypass; Close Existing Entrance</td>
</tr>
<tr>
<td></td>
<td>FH</td>
<td>Install Bypass; Part Close Existing Entrance</td>
</tr>
<tr>
<td></td>
<td>FHD</td>
<td>Install Bypass; Part Close Existing Entrance; Dredge River</td>
</tr>
<tr>
<td>Wommin</td>
<td>WC</td>
<td>Install Bypass; Close Existing Entrance</td>
</tr>
<tr>
<td></td>
<td>WH</td>
<td>Install Bypass; Part Close Existing Entrance</td>
</tr>
<tr>
<td></td>
<td>WHD</td>
<td>Install Bypass; Part Close Existing Entrance; Dredge River</td>
</tr>
</tbody>
</table>

It is noted that Option ED does not meet the navigation objective of 3.5m (ISLW) over the entrance bar. However it was included in the evaluation because of its environmental benefits to the lower estuary and potential economic advantages.
OPTION IMPACTS

Any change to the river entrance will have wide ranging effects on the coastal and estuarine processes as well as on the ecological and socio-economic environments.

ESTUARINE PROCESSES

The options affect tidal ranges and flood levels in the lower river to varying degrees.

A new entrance at either Fingal or Wommin will increase the hydrodynamic efficiency of the estuary to a greater extent than installing a bypass at the existing entrance. However, if dredging of the lower reaches of the estuary is also introduced then the improvement with all entrance options (except for ED) becomes more or less equivalent. An increase in tidal range of up to 0.5m could be expected at Barneys Point and up to 0.25m at the Dry Dock.

The Fingal and Wommin options offer marginally better tidal flushing of the river than the Existing Entrance option involving a bypass and dredging, while the reverse applies for the Broadwaters.

All options offer a small but worthwhile reduction in flood levels around Chinderah, with those options involving river dredging having the greatest effect. Effects upstream in the river and in the Terranora Inlet would be insignificant.

Regarding the Fingal and Wommin options, the hydrodynamic performance resulting from part closure of the existing entrance (i.e. FH and WH) was found to be equivalent to full closure of the existing entrance (FC and WC). Therefore options FC and WC were not considered further.

COASTAL PROCESSES

The Existing Entrance bypass option would result in a reduction in the size of the entrance shoals thereby achieving the desired navigation improvements along with a substantial reduction in the movement of sand into the estuary. This is likely to change the ebb tidal pattern which may influence offshore sediment losses east of the entrance. Letitia Spit would be cut back, releasing some of the accumulated sediment and it is expected that shoreline fluctuations along the Spit would increase. As a result of these changes, there may be a slight increase in the net littoral transport along the Spit.

For the Fingal and Wommin options, it is expected that shoreline fluctuations would increase on the south and north sides of these new entrances. The training walls and ebb tidal jet may modify existing nearshore current patterns, changing the local sediment processes near Cook Island. For the Wommin option, ocean currents may impact more directly on the Cook Island-Fingal Head area, thereby increasing the local sediment movement to the south.

ECOLOGICAL ENVIRONMENT

The options will affect the estuarine and coastal marine ecology - both beneficially and adversely. Remedial measures can be taken to restore or compensate for adverse impacts and provision has been made for the cost of these measures in the Development Costs of the options. Action might also be taken to enhance the ecological environment.

MARINE FLORA

The increased tidal range caused by all options will increase the inter-tidal margins and hence potentially enlarge the area of tidal wetlands.

However, it will have adverse impacts on:

- the shallow seagrass meadows in Ukerebagh Passage, Chinderah Bay and Shallow Bay (by increased exposure to the sun);
- the saltmarshes on Ukerebagh Island, Boyds Island and Cobaki Broadwater (by reduced inundation periods).

Remedial measures would involve skim dredging to deepen the affected seagrass areas with the resulting dredge spoil used to re-create low-lying island saltmarsh wetlands.

The Fingal options would destroy the northern end of Bonneys Lagoon, a wetland designated under SEPP 14. Thus, compensatory wetlands would need to be created elsewhere.

MARINE FAUNA

In general, the increased tidal range produced by all options will benefit marine fauna through enhanced nutrient distribution and pollutant dispersion. Those options including dredging of the river would provide additional shelter and spawning areas for large fish.

Adverse impacts on oyster beds due to potentially greater exposure to the sun would be avoided by lowering the oyster racks.

Tonys Bar is a shoal having a particularly diverse and prolific marine life which would be threatened by additional wave action under the Wommin options. This would be avoided by the provision of a sheltering seawall.
Offshore, the nutrients, turbidity and decreased salinity of the tidal flows from the Fingal options would affect the corals of Cook Island and nearby reefs (although the magnitude of the impacts are unknown at this stage).

**BIRDLIFE**

The potential for greater access of humans and feral animals to bird roosts on Ukerebagh Island, Tonys Island and Tonys Bar at low water could be prevented by selective dredging to ensure these areas are surrounded by water at all times. The re-created island habitats mentioned above would also provide alternative roosts for shorebirds.

**SOCIO-ECONOMIC ENVIRONMENT**

**DEVELOPMENT COSTS**

The capital cost to government of the Existing Entrance options range from $2.4 million (for ED) up to around $15 million for either EI or EID whereas that for a new entrance at either Fingal or Wommin is in excess of $55 million. The corresponding annual operating costs are $1.6 million for the Existing Entrance options (excluding ED), $1.5 million for Fingal and $2.3 million for Wommin.

**COMMUNITY/CULTURAL STRUCTURES**

Upgrading the existing entrance would not affect the present community structure at Tweed Heads.

The Fingal options would sever educational, transport and social links within Fingal Head village and with Chinderah. Proximity of the entrance to the aboriginal-islander cemetery could result in human relics being exposed during excavation of the entrance. A new transport link with Tweed Heads would need to be provided (by closing the existing entrance or by constructing a bridge). The primary school and camping area would need to be relocated.

The Wommin options avoid dividing the village but separate it from Chinderah (where aboriginal-islander social ties exist). A new transport link to Tweed Heads would also be required.

The implications of the Fingal and Wommin options on the Fingal Head aboriginal-islander culture is a matter that would need to be carefully considered, possibly in conjunction with the Federal Government in the light of the provisions of the Heritage Act.

**COMMUNITY ATTITUDES**

During the course of the Feasibility Study, it became evident that the Tweed community associations, particularly the Fingal Head community groups, oppose the Fingal and Wommin options. This view was also held by the Tweed Shire Council.

Comments received in response to a progress report issued in November 1989 summarising the Feasibility Study Interim Findings confirmed these attitudes and indicated unanimous support for the Existing Entrance bypass option. Only two out of 33 responses opposed dredging of the river.

**NAVIGATION IMPROVEMENTS**

All options involving a bypass would substantially improve entrance navigability. The entrances would be navigable at all stages of the tide provided the offshore wave conditions are not excessive. Some wave instability may occur on ebb tides, and currents would be up to 30% stronger than at present.

The degree of improvement would be essentially the same for all options, with the Existing Entrance options being slightly favoured because of ease of approach and availability of shelter in southerly seas.

The Existing Entrance option without a bypass (i.e. ED, river dredging only) will offer only marginally improved navigation. Its navigation benefit is limited to retarding further deterioration of the bar.
RECREATIONAL AND COMMERCIAL FISHING

With the improvements in marine ecology as outlined above, all options should improve the river fish population given that potential adverse impacts to wetland and seagrass habitats can be compensated and even improved through remedial measures.

RIVER RECREATIONAL BOATING

Each of the entrance options increases tidal velocities near constrictions such as Barneys Point and near the mouth. Dredging, however, would increase the useable width of river and lessen the increase in tidal velocities brought about by the improved entrance efficiency. Overall, it is considered that the increased channel width more than compensates for the increased velocities. Indeed, if the river downstream of Fingal is dredged, a reasonable sailing course could be established. Consequently, all options that include dredging will improve recreational boating on the river.

The Fingal and Wommin options would create a sheltered embayment adjacent to Greenbank Island which would be ideal for water sports of all kinds.

QUEENSLAND PARTICIPATION

It may be argued that the Tweed entrance is approaching full natural bypassing and no action should be taken to jeopardise this situation. Full natural bypassing implies, in effect, a shoaled entrance which is unsafe for navigation together with constricted river channels. This proposition is considered neither reasonable nor acceptable to the Tweed Heads community. The options developed in this study are believed to offer a better alternative.

Lying downdrift of Tweed Heads, the Gold Coast beaches could be improved if the rate of littoral sands passing Point Danger and moving onto the Gold Coast beaches can be increased. Options that enhance the drift of sand to Point Danger may attract financial and/or technical participation from Queensland if mutual benefit can be established.

The Fingal and Wommin options increase supply to Point Danger by reducing the loss of littoral sands at the entrance (i.e. onto the bar and into the estuary). The Existing Entrance bypass option would reduce the potential entrance losses and as well could reduce the potential offshore losses at Point Danger if sand was pumped direct to Queensland beaches. This option can thereby increase the sand supply to the Gold Coast in the long term. It can also dramatically increase short term supply if required by pumping at a higher rate than the natural littoral transport.
COMPARISON OF OPTIONS

The beneficial and adverse impacts can now be used as a basis for comparison of the options and a decision made on which option or options best satisfy the project objectives.

As noted previously (under Estuarine Processes), options FC and WC were found to provide the same hydrodynamic performance as Options FH and WH and were thus discarded from further impact assessment. They are therefore excluded from the comparison.

It is evident from the previous section that the option impacts fall into two categories.

— Tangible Factors which can be quantified and compared objectively.
— Intangible Factors for which subjective judgement is needed.

These are examined below.

**TANGIBLE FACTORS**

The tangible factors are the monetary costs and benefits of the options. These have been identified and quantified and subjected to economic appraisal in conformity with Treasury guidelines.

**COSTS**

The costs comprise capital and operating expenditures as follows.

Direct Capital Costs: Planning, Design and Construction
- bypass plant and pipework
- entrance channels
- training walls
- breakwaters, etc.

Indirect Capital Costs: Environmental Remedial Measures
- bank protection
- river shoal removal
- seagrass/wetland regeneration
- bird roost creation, etc.

Operating Costs: Bypass and Entrance Civil Works
- repairs and maintenance
- fuel and labour
- monitoring of impacts, etc.

Allowances have been made in the option costs for risks. Examples of risks include the substantial natural fluctuations that can occur in the annual littoral drift and the potential for storm damage to breakwaters during construction. Since such risks are events of known probabilities, their effects can be taken into consideration in the costings.

**BENEFITS**

The benefits comprise the following.

Commercial Fishing: - increased landings/licence fees
- reduced damage to vessels.

Recreational Boating: - increased registration licence fees
- increased mooring fees
- reduced waiting time
- increased charter operations
- scuba diving
- recreational fishing
- reduced rescue calls.

Sand Extraction: - access to fill sand, concrete sand and heavy minerals.

Beach Replenishment: - avoided cost of Queensland beach nourishment.

Flood Mitigation: - reduced agricultural loss and urban damage.

River Development: - slipway, marina, moorings development.

Residual Values: - residual value of capital works at the end of the assessment period.

It is noted that the benefits of Sand Extraction have a finite life and will cease when the resource is fully extracted.

The benefits include both local and regional factors; i.e. geographic borders are not recognised. Consequently the benefits to Queensland of sand bypassing (in terms of the avoided cost of beach nourishment) have been incorporated in the appraisal.

The following table itemises the total costs and benefits of each option. These are feasibility estimates (accuracy ± 30%) and have been discounted at 7% over a 20 year planning period to enable comparison of the options on a common Net Present Value (NPV) basis. As shown in the table, the options were then compared and ranked using two economic indicators - Net Total Benefits and Benefit Cost Ratio.

Option ED has been separated from the other options and omitted from the rankings since it does not meet the navigation objective of 3.5m (ISLW) depth over the entrance bar. However, it has been included to demonstrate its potential economic advantages despite reduced benefits resulting from its deficiency with respect to entrance navigation.

Similarly, the Do Nothing option has been included in the table as a reference point. However, it must be remembered that this option would result in a steady deterioration of the navigation bar depth, closing of navigation channels within the river and declining tidal flushing. It is nevertheless much more economically acceptable than the new entrance options.

On the basis of Tangible Factors, it is evident that only the two Existing Entrance options offer a positive Net Benefit.
## COMPARISON OF TANGIBLE FACTORS

<table>
<thead>
<tr>
<th></th>
<th>Do Nothing</th>
<th>OPTION</th>
<th>OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EID</td>
<td>FH</td>
</tr>
<tr>
<td><strong>COSTS ($M NPV @ 7%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital: Planning, Design &amp; Construction</td>
<td>0.0</td>
<td>13.7</td>
<td>13.7</td>
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<td>Environmental Remedial Measures</td>
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<td>14.9</td>
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<tr>
<td>Operating: Annual</td>
<td>0.0</td>
<td>1.6</td>
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<tr>
<td>NPV (over 20 Years)</td>
<td>0.0</td>
<td>14.2</td>
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<tr>
<td><strong>TOTAL COSTS</strong></td>
<td>0.0</td>
<td>29.1</td>
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<tr>
<td><strong>BENEFITS ($M NPV @ 7% over 20 Years)</strong></td>
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<tr>
<td><strong>TOTAL BENEFITS</strong></td>
<td>(1.7)*</td>
<td>21.8</td>
<td>37.8</td>
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<tr>
<td><strong>NET TOTAL BENEFITS</strong></td>
<td>(1.7)</td>
<td>(7.3)</td>
<td>8.7</td>
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<tr>
<td><strong>BENEFIT COST RATIO</strong></td>
<td>–</td>
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<tr>
<td><strong>OPTION RANKING</strong></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Numbers in brackets denote negative values
INTANGIBLE FACTORS

Major public projects affect the situation in which the community lives, works and recreates. The community places values on factors outside the economic elements discussed above which, though intangible and subjective, can be decisive in influencing the selection of a particular course of action.

The four principal Intangible Factors are:

| Community/Cultural Structures |
| Community Attitudes |
| Queensland Participation |
| Uncertainties |

The intangible issues involved in the first three factors have been discussed under option impacts. The fourth, Uncertainties, relates to events of unknown probabilities which, unlike risks (of known probabilities) cannot be sensibly costed. The two main areas of uncertainty are:

| The complex offshore topography around Cook Island and Danger Reefs and the highly variable nature of ocean currents in the vicinity of these areas. These reduce confidence in the prediction of coastal processes and introduce the possibility of unforeseen outcomes particularly with the Fingal option. |
| The response of the ecological systems to dramatic and immediate changes to the hydraulic parameters of the river occasioned by the Fingal and Wommin options. |

These uncertainties can be reduced by the expenditure of further resources (e.g. by additional studies, by overdesign of bypass plants, etc) but they cannot be removed entirely.

The options are compared on the basis of the four principal Intangible Factors in a simple value assessment (on a scale of one to five) in the table below. As with the Tangible Factors, the Do Nothing and ED options have been separated from the other options to reflect their deficiencies in meeting the stated objectives.

The comparison indicates that the Existing Entrance options are more attractive than those involving a new entrance.

### COMPARISON OF INTANGIBLE FACTORS

<table>
<thead>
<tr>
<th>OPTION</th>
<th>EID</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do Nothing</td>
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<td>*****</td>
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<tr>
<td>Community/Cultural Structures</td>
<td>*****</td>
<td>*****</td>
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<tr>
<td>Community Attitudes</td>
<td>*</td>
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<tr>
<td>Queensland Participation</td>
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<tr>
<td>Uncertainty - Coastal Processes</td>
<td>****</td>
<td>****</td>
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<tr>
<td>- Environmental Effects</td>
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</tr>
<tr>
<td><strong>AVERAGE</strong></td>
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<td>3.8</td>
</tr>
<tr>
<td><strong>OPTION RANKING</strong></td>
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<td>1</td>
</tr>
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</table>
CONCLUSIONS

Improving the Tweed entrance and estuary is an exercise in applying complex technologies to satisfy diverse social and environmental needs. In the search for a solution to the problem of the shoaled river entrance, a range of options has been devised, assessed and compared on the basis of environmental, social and economic factors.

From the perspective of both objective (tangible) and subjective (intangible) factors, the assessment demonstrates that the two Existing Entrance options are preferred over those involving a new entrance at either Fingal or Wommin.

The preferred options therefore are:

- EID — install a bypass of the existing entrance and dredge the river;
- ED — dredge the river.

Option EID, while economically less attractive than ED is the preferred option since it satisfies all the stated objectives, in particular those relating to the required entrance navigation depth of 3.5 m (ISLW) and the enhancement of the littoral supply to Point Danger. It is thus the most acceptable option to all concerned.

However, the benefits of option EID directly attributable to NSW (i.e., excluding the benefits to Queensland of beach replenishment) are insufficient to justify the capital and operating costs. A cost-sharing arrangement with Queensland is therefore required if this option is to proceed.

Notwithstanding this, dredging of the river is common to both of the preferred options. It offers numerous benefits to NSW including:

- most of the water quality and flood reduction benefits of the bypass/dredging option can be achieved;
- recreational and tourist use of the lower estuary can be enhanced;
- the cost of fill for construction and urban development can be reduced;
- local industry can be stimulated;
- further deterioration of the bar can be retarded.

In addition, river dredging may be financed by sand royalties at no overall cost to the NSW Government.

As these benefits highlight, dredging of the river has wide ranging implications for the environmental and social structure of the lower Tweed estuary. Therefore, it cannot be considered in isolation from these factors and should be examined within the framework of a properly formulated River Management Plan.

Such a plan establishes policies and guidelines for the management of the river waters, bed and banks to satisfy community and commercial development needs and environmental restoration and conservation requirements.
REVIVING THE TWEED

ACTIONS

In accordance with the findings of the Feasibility Study, on 3 July 1990 the Deputy Premier of NSW, The Hon Wal Murray, advised the Tweed Entrance Community Liaison Committee of the following actions regarding the future course of the project.

NEW ENTRANCE CONSIDERATIONS

A new entrance at either Fingal or Wommin is not justified on economic or social grounds and will not be considered further.

ENTRANCE BYPASSING

Action has been initiated to progress the installation of a mechanical sand bypass at the existing river entrance as a joint venture of NSW and Queensland.

Following correspondence between the NSW and Queensland Premiers, a meeting of officers from the NSW Public Works Department, Queensland Government Departments and the Gold Coast City Council was held in May 1990 to discuss joint technical and financial participation in a sand bypassing system.

Agreement was reached to jointly assess four issues as a basis for ministerial negotiations.

--- Known Littoral Processes
--- Costings of Works
--- Benefits to Each State
--- Administration of the System

Consultants have been briefed to prepare a report on these issues with costs to be shared equally between the two States. This exercise is expected to take about three months to complete.

RIVER IMPROVEMENTS

Irrespective of a bypass system, a River Management Plan for the lower estuary from Barneys Point Bridge to the entrance is to be prepared to provide a proper framework for dredging of the river. $0.5 million is to be provided by the NSW Government for the preparation of the Plan and subsequent environmental studies.

A program for the preparation of the Plan is now being drafted to identify the components for the briefing of consultants. The Plan is expected to be completed within 12 months and it is anticipated that the environmental assessment process will also commence during this period.

COMMUNITY PARTICIPATION

Community participation in the project is to continue through an extension of the Terms of Reference of the Tweed Entrance Community Liaison Committee to include the River Management Plan.

This will also be achieved through the Tweed River Advisory Committee and the Tweed River Management Study Committee. The three organisations will provide avenues through which the community can be kept fully informed on the progress of bypassing negotiations with Queensland.

The goals and actions embodied in the foregoing are summarised in the following Action Plan.
# ACTION PLAN

## PREFERRED OPTIONS

**GOAL:** To proceed with implementation of the Existing Entrance options.

**ACTION:** Discontinue assessment of the new entrance options at Fingal and Wommin. Concentrate on design of improvements to the existing entrance.

## RIVER IMPROVEMENTS

**GOAL:** To improve the lower estuary through deepening of the river channel and associated works while maintaining and where possible enhancing the ecological environment.

**ACTION:** Prepare a River Management Plan and subsequent Environmental Impact Statement to address dredging and other environmental enhancement works.

## ENTRANCE BYPASSING

**GOAL:** To enlist Queensland participation to effect bypassing at the existing entrance.

**ACTION:** Commission and fund an assessment of the bypassing issues jointly with Queensland to provide a basis for ministerial negotiations.

## COMMUNITY PARTICIPATION

**GOAL:** To involve the community in the preparation of the River Management Plan and to keep them fully informed on the progress of the bypassing negotiations with Queensland.

**ACTION:** Extend the terms of reference of the Tweed Entrance Community Liaison Committee to include the River Management Plan. Provide regular advice on bypassing negotiations with Queensland to the Tweed Entrance Community Liaison Committee, the Tweed River Advisory Committee and the Tweed River Management Study Committee.