B4

VOLUME B: AIRPORT AND SURROUNDS

Coastal Processes and Natural Features

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GLOSSARY

The following sets out brief General Descriptions explaining the meaning of the technical terms used in this Environmental Impact Statement (EIS) Report.

Australian Height Datum (AHD): The level datum adopted as a standard throughout Australia, corresponding approximately to mean sea level.

Bathymetry: The depth related shape of the seabed.

Beach Ridge: Shore-parallel ridge of sand extending along the shore above the high tide level.

Coriolis Force: The horizontal force exerted by the rotation of the earth.

Chart Datum: The level datum applied to definition of depths on local navigation charts, typically equivalent to Lowest Astrological Tide.

Delta: System of banks, bars and channels formed at the mouth of a river, usually of sediments brought down the river and deposited there.

Diurnal: With a daily period.

Fluvial: Derived from river systems.

Holocene: The geological time period relating to the last (approximately) 18,000 years following the end of the last glacial period.

Hydrodynamics: The processes of movement of water, including level changes, currents and waves.

Inter-Tidal Flats: The gently sloping seabed between high and low tide, exposed at low tide.

Longshore Transport: Transport of sand along the coastline, related primarily to the action of waves breaking obliquely to the shoreline alignment.

Lowest Astronomical Tide (LAT): The lowest tide level that may occur, commonly used as the datum below which water depths are defined, particularly for navigation purposes.

Model Grid Mesh: The network of model nodes and elements that define the points and areas at which the calculations are made during the model simulations.

Morphology/Morphological Processes: Description of the form and behaviour of the sedimentary bed of the sea or bay.

Northern Entrance Tidal Delta: The vast expanse of sand banks and tidal channels at the northern entrance to Moreton Bay between Bribie Island and Moreton Island, including North Banks in the north and Middle Banks in the south.

Sea Waves: Waves generated locally by the prevailing wind.

Significant Wave Height: A parameter used to define the height of natural waves of irregular height and period, being the average of the highest one-third of the waves.

Spectral Wave Period: The period at which the majority of the wave energy occurs for natural irregular waves, being the period of the peak of the wave energy spectrum.

Storm Surge: The change in ocean water level caused by weather-related effects including atmospheric pressure changes and wind stress on the water surface.

Storm Tide: The water level caused by the combined effects of astronomical tide and weather related storm surge.

Swell Waves: Waves that have left the area in which they were generated.

Synoptic: Related to atmospheric pressure.

Tidal Prism: The volume of water that flows past a section in a tidal stream over the duration of the incoming (or outgoing) tide.

Wave Height: The level difference of the wave between the trough and the crest.

Wave Period: The duration taken for the travel of one wave length.

SUMMARY OF KEY FINDINGS

Existing Conditions

- The shoreline area adjacent to the Airport has been formed over the last 6,000 years since the sea level rose to the present level following the last glacial period.
- The airport region was previously part of the Brisbane River channel system and has been infilled with mud and sand derived from the river.
- In some places where the former river channel existed, muds up to about 30 m deep have been deposited.
- The shoreline has formed from sand derived from the river delta, transported shoreward by the wave action in the area to form a series of beach/dune ridges as part of the (geological) long term trend of accretion of the coastline there.
- The river delta and bar system remains massive and a continuing source of sediment for supply to the coastline.
- Water levels at the site relate to the tide together with storm surges. Tide levels reach up to about 2.71 m above LAT whereas the highest recorded water level is at about 3.2 m, corresponding to approximately the 50 year average return period design storm tide level.
- Waves at the site are predominantly local 'sea' waves. Ocean swell entering the Bay is so highly attenuated by refraction and bed friction that they are not of any discernible significance there.
- Wave action also causes an alongshore transport of sand, predominantly towards the north-west, in a relatively wide zone extending from the shoreline across the broad inter-tidal flats.
- The present day stability of the shoreline depends on the balance between onshore supply and longshore transport of the beach system sand.
- The shoreline west from Serpentine Creek inlet has developed a well-defined north-east facing alignment in response to the action of the prevailing waves.
- The shoreline closer to Juno Point is less well developed and has varying alignment because the wave action there is limited, being significantly sheltered from the predominant south-east waves by the coastline shape and the extensive river delta bar formation.
- The shoreline to the south-east of the Old Jetty structure has been quite stable for many years, with fluctuations associated with storm events and the local effects of the nearshore sand wave bed forms. It presently has a poorly constructed rock revetment that is only marginally subjected to wave attack or erosion.
- The shoreline north-west of the Old Jetty is eroding at about 0.5 m/year, due to the groyne effect of the rock material placed at the old jetty site. It is stabilised with rock revetment for a short distance from the Old Jetty.
- The Kedron Brook Floodway has been created by excavating a channel at the location of the original Jacksons Creek mouth.
- The former Serpentine Creek was infilled for the previous airport development, with its mouth now a minor tidal inlet and its upstream reaches now connected to Jacksons Creek and Kedron Brook.
- The mouth of Kedron Brook is subject to the combined effects of scouring by the tidal currents and infilling by the longshore movement of sand and appears to trend towards a mouth configuration with less cross-section area than the original design, thereby requiring dredging to maintain the original design width and depth.
- Jacksons Creek itself has increased tidal flow as a result of the previous airport development works and its channel is under erosional stress.

Impacts

- There are expected to be no impacts on the coastal processes and shoreline stability along the foreshore adjacent to the Airport.
- The lighting structure is proposed to be piled such that it will be transparent to waves and currents.
- The seawall upgrade will merely replace the existing poorly constructed structure to enhance its structural and visual properties.
- There will be some changes in the tidal characteristics of Jacksons Creek following infilling of some of its upstream tidal storage, involving reduction in tidal flow through the remaining downstream parts. This will lead to a tendency for slow siltation of the creek channel towards a new regime equilibrium. This will occur in the main channel below mean sea level and will not affect the higher tidal areas where normal inundation up to the existing high tide mark will continue unaffected.
- Changes to the tidal regime and siltation of the Kedron Brook Floodway channel itself are expected to be negligible.
- There may be some scour of the deeper parts of the edge of the ship swing basin at the pump-out facility by the bow thrusters of the dredge. This is not expected to affect the shoreline.

4.1 Introduction

The existing environment of the coastal and shoreline region in the vicinity of the Airport is described in this Chapter. This outlines the morphological processes of the shoreline and adjacent nearshore zone, together with the mouth area of Kedron Brook.

4.2 Proposed Development

The proposed development (provided in detail in Chapter A4 and summarised in tabular format in Chapter B1) will not directly affect the shoreline adjacent to the airport. There may be some indirect effects of the proposed approach lighting system that will be constructed on piled supports extending 660 m across the nearshore zone. As well, the coastal sediment transport processes affect the behaviour of the Kedron Brook mouth which, in turn, may determine the nature and behaviour of the hydrodynamic and water quality processes within the Kedron Brook system.

Additionally, it is proposed to upgrade the existing poor standard rock revetment protection along the shoreline in front of the runway facilities and to review options to either accommodate or control shoreline erosion along the shoreline section extending west to the Kedron Brook mouth (see section 4.8.2.4).

4.3 Methodology

Investigation of these processes has involved both research of existing information and further investigations including:

- Review of relevant documentation including:
    - Commonwealth Department of Administrative Services (1988). New Brisbane Airport, Changes Around the Floodway Mouth November 1980-July 1987. Report No CE 88/1 prepared by Civil Engineering Branch, January 1988.
    - University of Queensland (1985). Sedimentation in the Brisbane Airport Floodway. Report CH28-85, Department Civil Engineering, January 1985.
    - Department of Housing and Construction (1985). Report of Maritime Monitoring and Interpretation Technical Review Panel, Interim report, December 1985;
- Assessment of the shoreline processes using analysis of aerial photography and beach profile surveys to identify historical and contemporary trends of shoreline change and dominant factors affecting sediment transport processes and shoreline stability; and
- Modelling of wave, hydrodynamic and morphological processes to determine the nature and behaviour of currents and seabed sand transport in the region.

The WBM hydrodynamic models used in previous investigations, including the Moreton Bay Sand Extraction Study (MBSES) (WBM Oceanics Australia 2003, 2004), have been substantially refined in local detail around airport region for the present study, to incorporate Kedron Brook, Serpentine Inlet and the adjacent mangrove areas. The model thus used has increased local detail and computational refinement in this local region.

Investigations of significance relating to the previous sand extraction project in the 1980s associated with redevelopment of Brisbane Airport, in which some 16 million cubic metres (Mm^3) of sand were dredged from Middle Banks, have been reviewed and include:

- Investigations undertaken for impact assessment prior to the works, including interpretation of the geological and contemporary coastal processes and evolutionary trends, together with assessment of the likely behaviour of Kedron Brook; and
- Monitoring of changes to the shoreline and sedimentation within the Kedron Brook system.

To assist in determining the local and regional significance of any impacts that may be caused by the proposed sand extraction from Middle Banks, a set of significance criteria has been developed in accordance with the project methodology (refer Chapter A1) and which is presented in section 4.8.

4.4 Limitations and Assumptions

The assessments made in this study have been based on the previous investigations of coastal processes and have significantly extended them primarily on the basis of analysis of the historical changes over the past 50 or more years. This has drawn upon review and assessment of the aerial photography record, together with interpretation of the hydrodynamic and wave modelling undertaken.

The aerial photo record is extensive, dating back to 1951, prior to the major coastline changes associated with the previous airport redevelopment. In particular, the nature of the changes relating to blocking of the former Serpentine Creek and creation of the Kedron Brook Floodway are evident in the photography record. It is feasible that even the (approximately) 20 years since those works were undertaken may not show the full extent of potential response of the coastal system. Thus, the trends of behaviour have been assessed with a view to ensuring that the likely future situation is considered.

It is recognised that the bathymetry of the nearshore zone in this region is complex and can only be represented in the models in an approximate way. As such, the models are used here only as a tool to provide otherwise unavailable insights into how the wave and current processes interact and result in the overall pattern of sedimentation and shoreline evolution.

4.5 Existing Conditions

4.5.1 Background

No comprehensive previous investigation describing the nature and detailed coastal processes of the shoreline and adjacent nearshore zone in the area surrounding the BAC reclamation site and/or pump-out facility have been identified. Broad geological and sedimentological investigations were undertaken for the previous airport development project (Gourlay and Hacker 1983) and these have been reviewed. Additional data and information has been sourced for the purpose of describing the existing environment in the area, as follows:

- Aerial photography;
- Boating charts;
- Detailed shoreline cross-section profile surveys;
- Investigation of sedimentation in Kedron Brook from the previous airport reclamation project;
- Geological investigations as previously published; and
- Wave data recorded within Moreton Bay.

These have been augmented with:

- Comprehensive site inspections of the shoreline and adjacent nearshore areas to gain better understanding of the processes occurring there, shoreline accretion/erosion patterns and the status of shoreline protection works;
- Modelling of wave and current processes to gain an appreciation of key causal mechanisms affecting shoreline processes; and
- Analysis of aerial photography to identify patterns and trends of historical shoreline change.

4.5.2 Water Levels

The dominant processes affecting water levels in the Bay region relate to:

- Astronomical tides;
- Storm surges associated with cyclones and low pressure systems;
- Wind stresses; and
- Sea level rise associated with climate change.

4.5.2.1 Tides

There is a significant amplification of the ocean tide as it propagates southward through the Northern Delta and into Moreton Bay. At the West Inner Bar (Brisbane River Mouth) tide recording site, adjacent to the airport, the average amplification compared to Caloundra is about 30 percent. Astronomical tide levels relative to local Lowest Astronomical Tide (LAT) Datum for the West Inner Bar are typically as shown in **Table 4.5a** (Queensland Transport 2004).

Table 4.5a: Moreton Bay Tides

MHWS	MHWN	AHD	MSL	MLWN	MLWS
2.16	1.76	1.243	1.27	0.75	0.35

The highest astronomical tide (HAT) during the largest spring tides for the area is 2.71 m above LAT.

4.5.2.2 Storm Surges and Storm Tides

Abnormally high water levels associated with storm surges together with the astronomical tide (storm tides) affect Moreton bay through propagation of the storm tide in the ocean into the Bay, much as the normal tide does, together with local wind-induced setup along the western shore due to the predominantly east to south-east sector wind direction in such events. As such, the storm tides will amplify and reach higher levels in the Bay than those in the ocean. Water levels up to about 3.2 m above LAT (about 2.0 m above AHD) have been recorded at the Brisbane River mouth (Queensland Transport 2004).

Previous investigations have been undertaken of storm surge and storm tide (tide plus surge) processes in Moreton Bay. The findings of those investigations are outlined in this section.

Blain Bremner and Williams (1979a, b) researched recurrence intervals of combined water levels resulting from surge plus tide based on both cyclone event simulations and recorded data up to that date. They present a comprehensive review of peak water levels recorded near the river mouth in Moreton Bay since recordings began in 1884. Design surge levels were derived in two ways, namely:

- Statistical analysis based on a form of Monte Carlo simulation that accounted for the joint probabilities of cyclone and related surge occurrences and associated tide levels; and
- Extraction of statistics from the recorded water level data. Surge components were determined by subtracting the predicted tide levels from the total recorded levels. Over 60 significant surge events were analysed, with peak surges up to 1.16 m and peak water levels up to 3.16 m (chart datum), approximately 1.92 m (AHD).

The BBW (1979b) study recommended design storm tide levels as shown in **Table 4.5b**.

Table 4.5b: Derived Storm Tide Levels – BBW 1979b

Recurrence Interval (years)	Storm Tide Level (m AHD)	
	BBW Simulation Study	BBW Recommendation
50	1.88	2.0
100	2.14	2.3
200	2.39	2.5
1000	3.00	3.2

WBM (2000) undertook an analysis using a different approach based on propagating the ocean surge into the Bay and adding the effect of local wind on water level setup across the Bay, using numerical modelling. The ocean storm tide statistics were based on those derived for South East Queensland at Surfers Paradise by the Beach Protection Authority (1985). The design storm tide levels derived in this manner are shown in **Table 4.5c**.

Table 4.5c: Derived Storm Tide Levels – WBM 2000

Recurrence Interval (years)	Storm Tide Level (m AHD)
50	2.08
100	2.20
500	2.45

The WBM (2000) levels are similar to those derived by BBW (1979), although slightly higher for the 50 year case. This may be due to the effect of adding the local wind-induced setup across Moreton Bay into the numerical modelling undertaken.

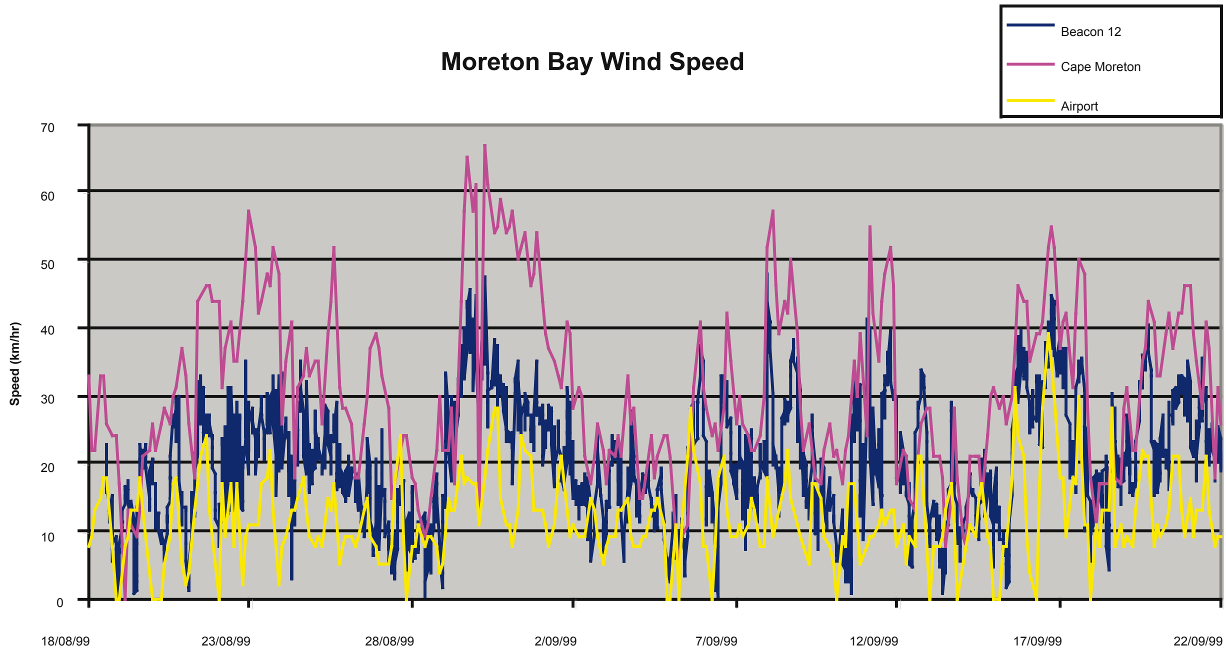
Storm tide levels have also been determined by DHI Australia for BAC as part of the flooding assessments for the present EIS and to derive the runway height as part of the project's design phase. The 100 year average recurrence interval level obtained by DHI is 3.53 m above Airport Datum, approximately 2.38 m above AHD. This is slightly higher than both the WBM and BBW results and could be considered conservative.

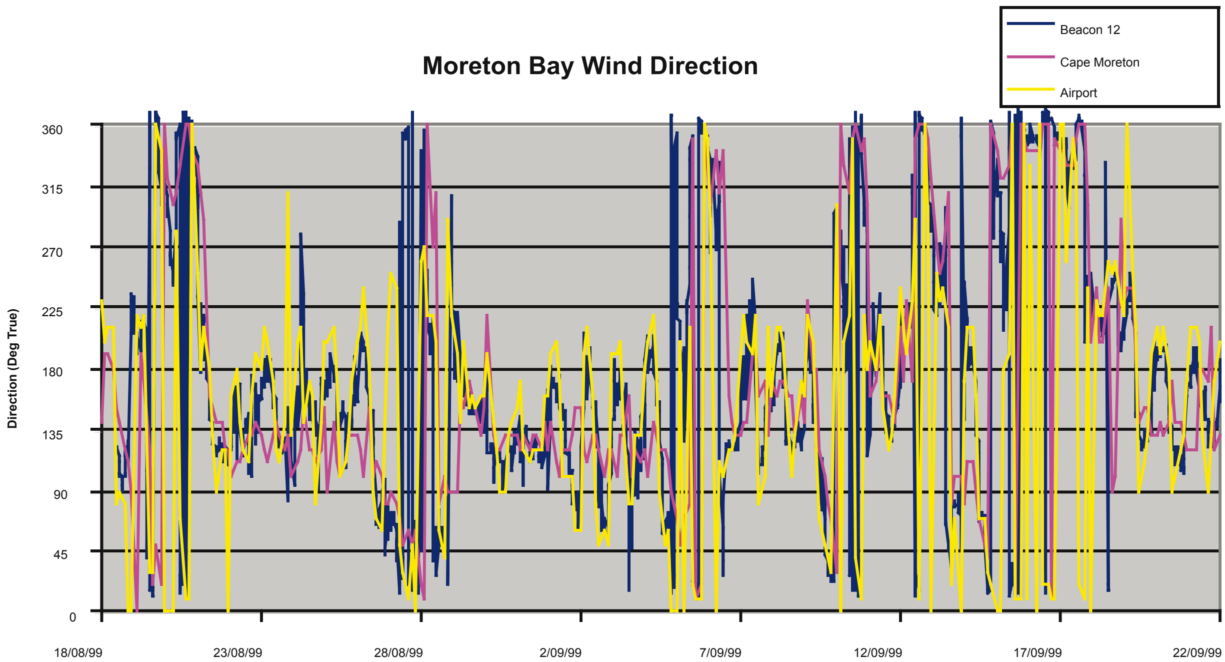
4.5.3 Moreton Bay Winds

The wind climate of Moreton Bay is driven by the synoptic winds and diurnal pattern of sea and land breezes. The prevailing synoptic winds are south to south-easterlies in summer and south westerlies in winter. The sea and land breeze effect is very pronounced in the inshore areas and significantly affects conditions at the airport, more so than across the Bay itself. Comparison of wind data recorded within Moreton Bay at navigation Beacon 12 at the outer end of the Bar Cutting with recordings from other sites in the region (**Figure 4.5a**) shows:

- Wind speeds across the exposed waters of the Bay are typically lower than those at Cape Moreton, being generally 60-80 percent of the Cape Moreton speed, but are higher than those at the Airport;
- The wind speeds at Brisbane Airport are substantially more affected by seabreeze effects, and are not representative of those over the Bay; and
- The wind directions over the Bay are generally similar to those at the Airport.

Figure 4.5a: *Comparison of Wind Speed and Direction Across Moreton Bay.*





The directional spread of wind speed occurrences over the Bay is best represented in the long term data for Cape Moreton, although the wind speeds at that site are generally higher than those over the Bay. The wind rose for Cape Moreton is presented as **Figure 4.5b**.

4.5.4 Waves

Wave action in Bramble Bay in the vicinity of the Airport is essentially exclusively 'sea' waves generated within Moreton Bay by local winds. Ocean swell waves are highly attenuated by processes of refraction, diffraction and bed friction in reaching the site via the Northern Delta entrance to the Bay, such that their heights are generally not discernible at this location.

The airport shoreline is aligned approximately NW-SE and is in the lee of Mud Island and the port with respect to predominantly occurring south-east sector winds and waves. It is directly exposed to north-east sector waves generated by winds that have relatively limited occurrence, duration and speed. Further, the nearshore bathymetry has wide, shallow inter-tidal flats such that waves at the shoreline itself occur only during the higher stages of the tide and are subject to substantial attenuation as they propagate from the deeper water to the shore.

Wave modeling has been undertaken to illustrate the typical wave patterns in the area. **Figure 4.5c** to **Figure 4.5e** illustrate high tide wave heights for SE (25 knots), E (25 knots) and NE (20 knots) wind conditions respectively.

4.5.5 Coastal Processes

4.5.5.1 Sedimentation Processes

The shoreline of Moreton Bay immediately adjacent to the Airport consists of a continuous narrow sandy beach with wide (approx. 500 m) muddy sand inter-tidal flats. The whole area is the present day result of supply of Brisbane River sediments over geological time, particularly the last 6,000 years (the Holocene) since the most recent post-glacial sea level rise, forming a river mouth delta and associated coastline. It is clear that the historical river supply has far exceeded the capacity for onshore movement and the remaining bar system remains massive and a continuing source of sediment for coastal accretion, despite curtailment of river supply of sandy sediments due to river dredging. The relative mobility of the sediments in the deeper parts of the outer delta bar is so slight that residual features such as the Francis Channel, the original river mouth channel in the mid 1800s, remains quite evident today.

Over geological time, the river mouth has not always been at its present location. The geotechnical work for this EIS has identified a former deep river channel running under the airport land. Thus, it can be surmised that there has been some switching or progressive shift of the mouth location and deposition of fluvial sediments from the river over a relatively wide area.

Figure 4.5b: *Cape Moreton Wind Rose.*

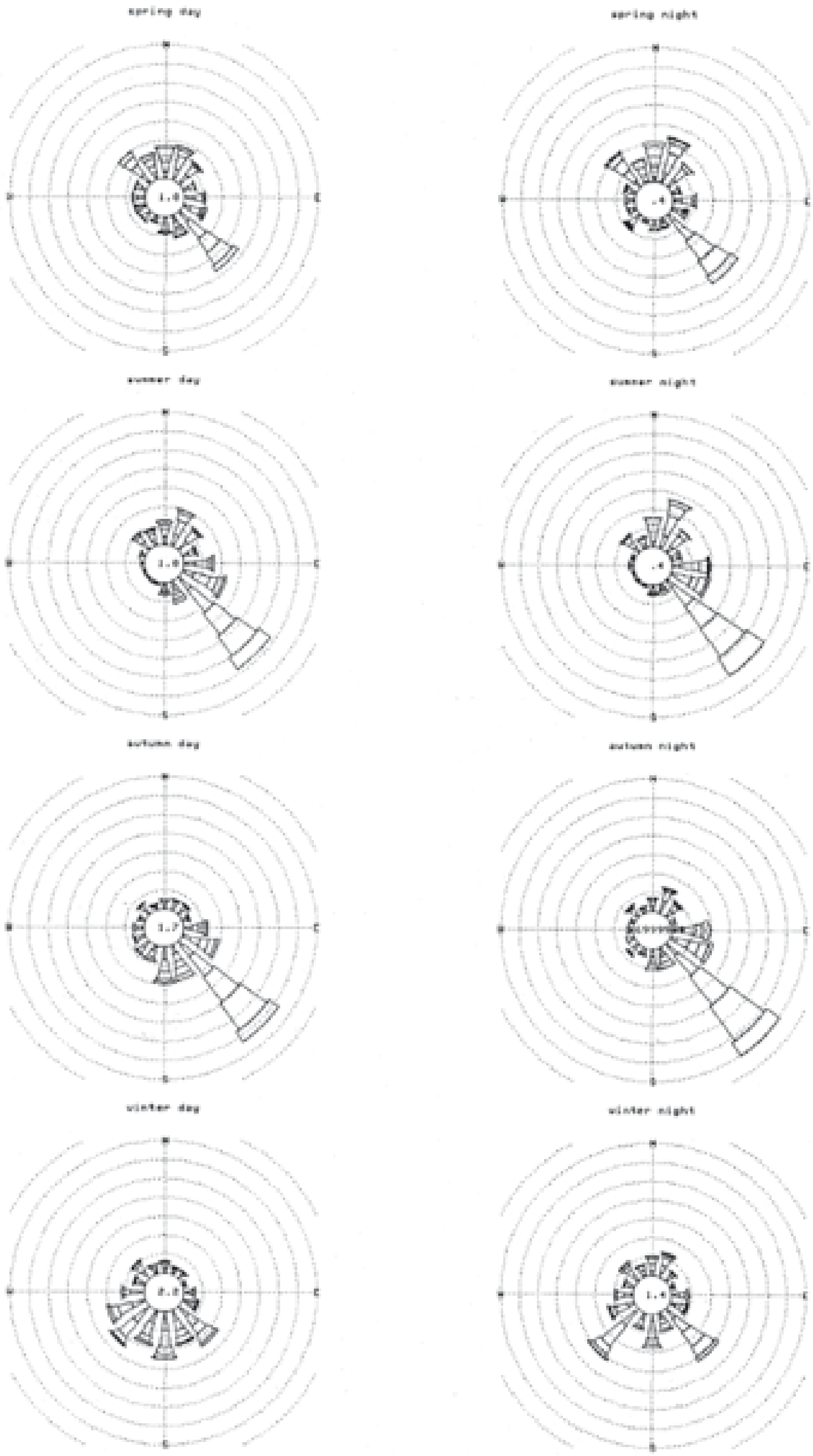


Figure 4.5c: *Wave Heights for 25 Knot SE Wind.*

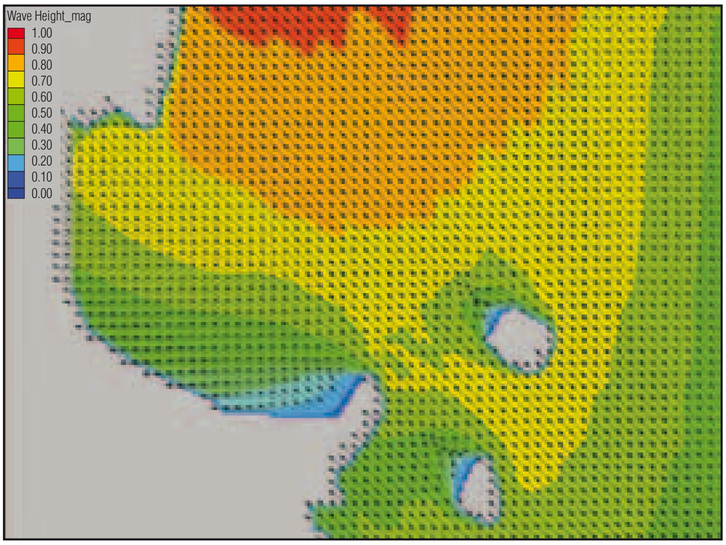


Figure 4.5d: *Wave Heights for 25 Knot E Wind.*

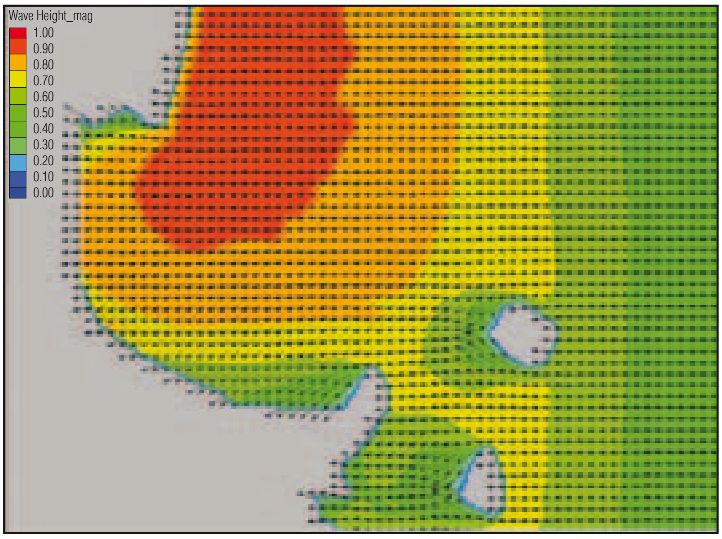
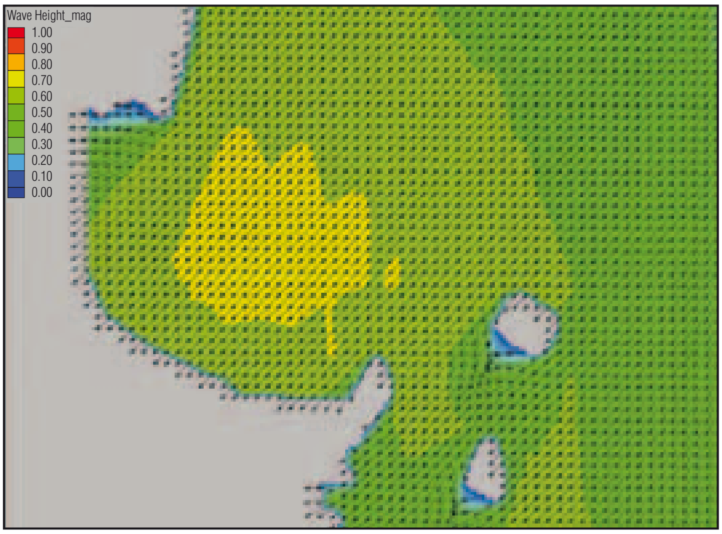


Figure 4.5e: *Wave Heights for 20 Knot NE Wind.*



The present shoreline has formed through a two-stage process of deposition of the fluvial sediments in the nearshore delta bar system and subsequent onshore and alongshore movement of the sandy components of that sediment onto the shoreline system predominantly by wave action (**Figure 4.5f**).

A dominant feature along the entire coastal region adjacent to the Airport is the wide inter-tidal zone, clearly evident in **Figure 4.5f** as the broad expanse of inter-tidal sand flats extending out from the shoreline. These contain large seabed sand waves that indicate active sand transport.

Surveys of the nearshore zone were undertaken in February 2006 in the form of cross-section profiles at the locations shown in **Figure 4.5g**. Representative examples of those profile surveys are presented in **Figure 4.5h**.

Sand in the nearshore inter-tidal flats and that moved onshore by wave action is transported towards the north by the action of waves in conjunction with wave and wind induced currents. Most of this transport appears to occur across the inter-tidal zone, with relatively small transport at the upper beach itself. This occurs because of the limited duration of wave/current action there, occurring only at high tides and the substantial attenuation of the wave energy across the shallow nearshore flats. The dominant or modal zone for wave action and currents is expected to be across the zone from around low to mid tide level.

Figure 4.5f: *Sediment Distribution and Shoreline Characteristics along Airport Foreshore.*

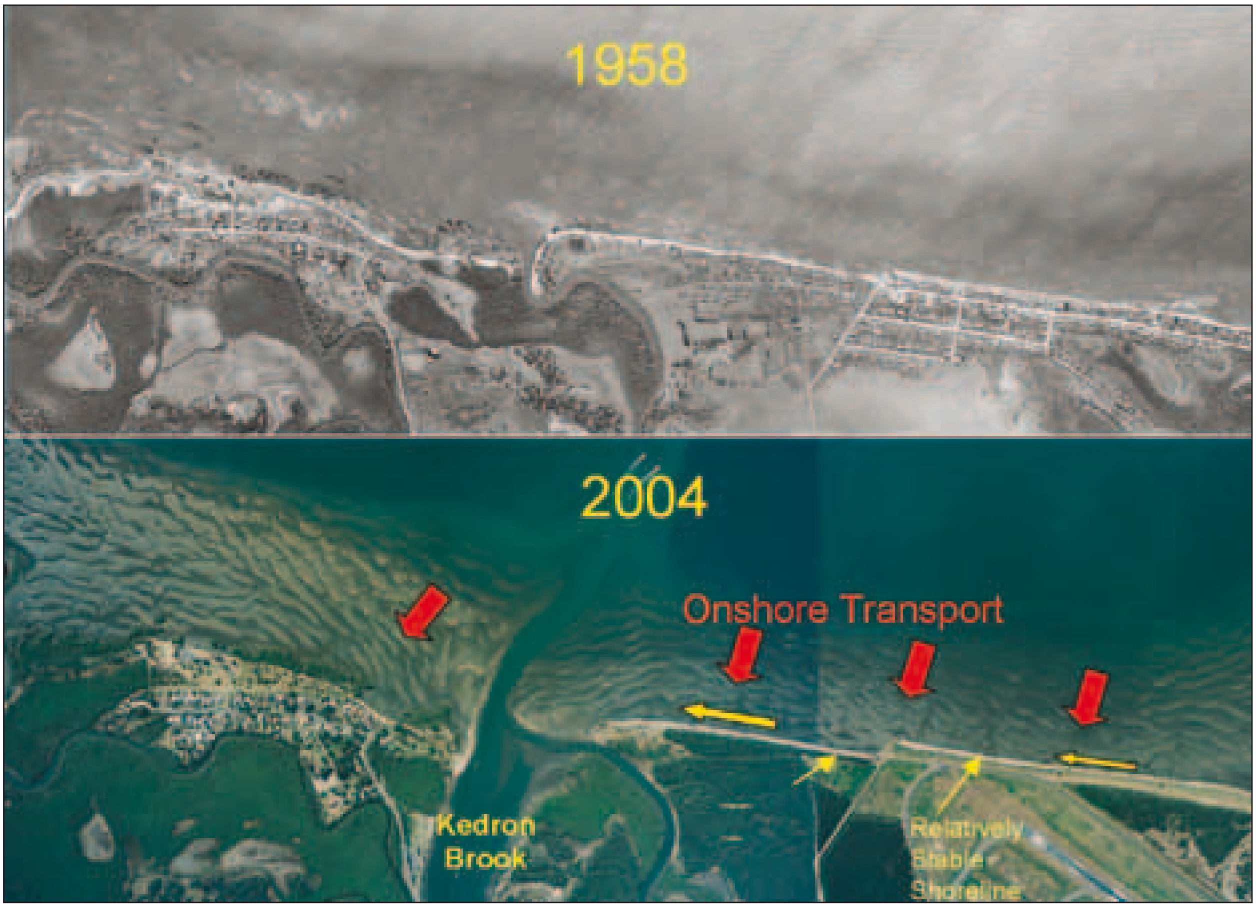
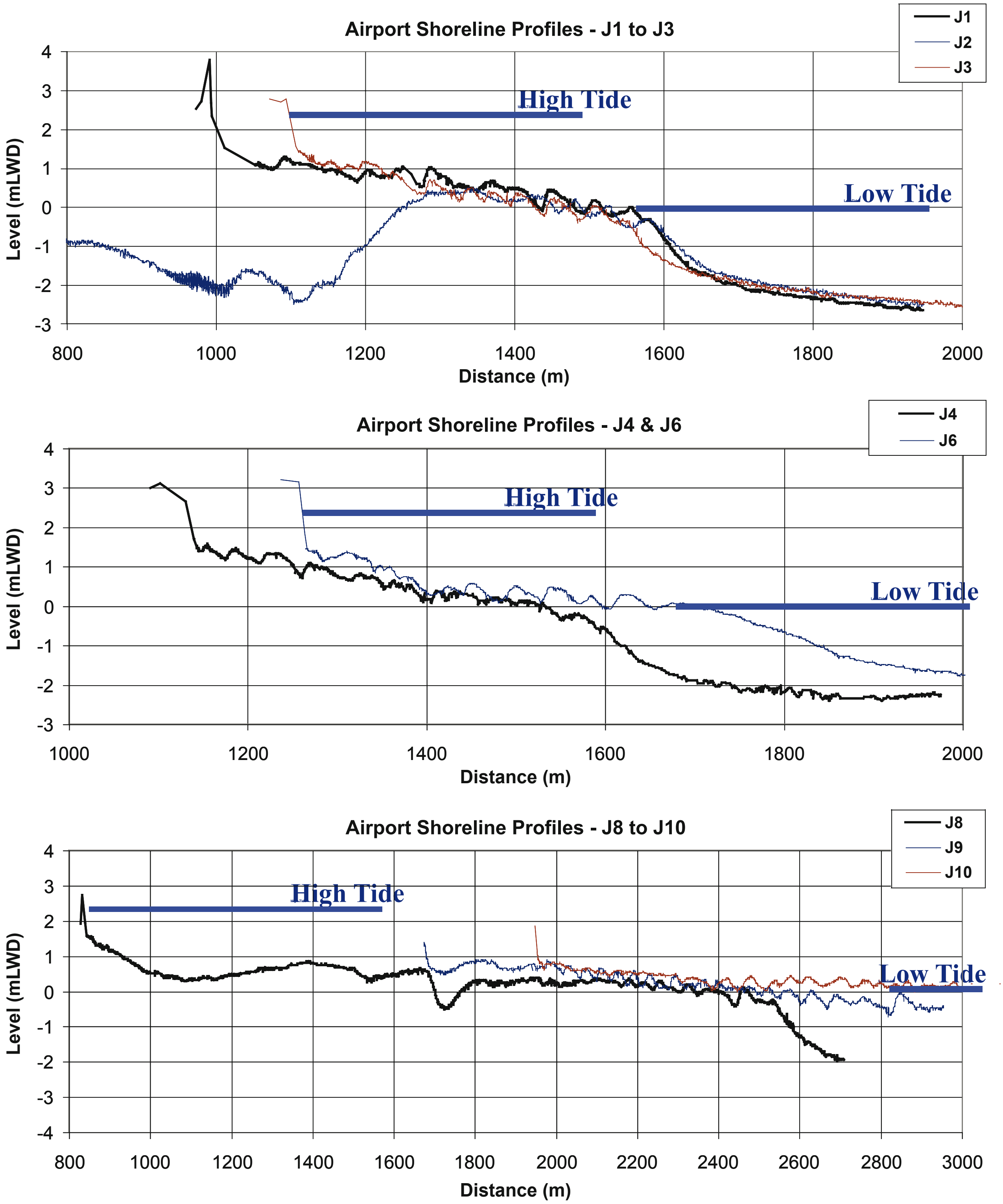


Figure 4.5g: Location and Extent of Survey Cross-Section Profiles.

Figure 4.5h: *Cross-Section Profile Surveys of Coastal Zone Adjacent to Airport.*



The nature and general behaviour of the coastal processes along the shoreline adjacent to the Airport were investigated as part of studies and monitoring associated with the previous airport development project during the 1980s. Gourlay and Hacker (1983) undertook a detailed investigation involving:

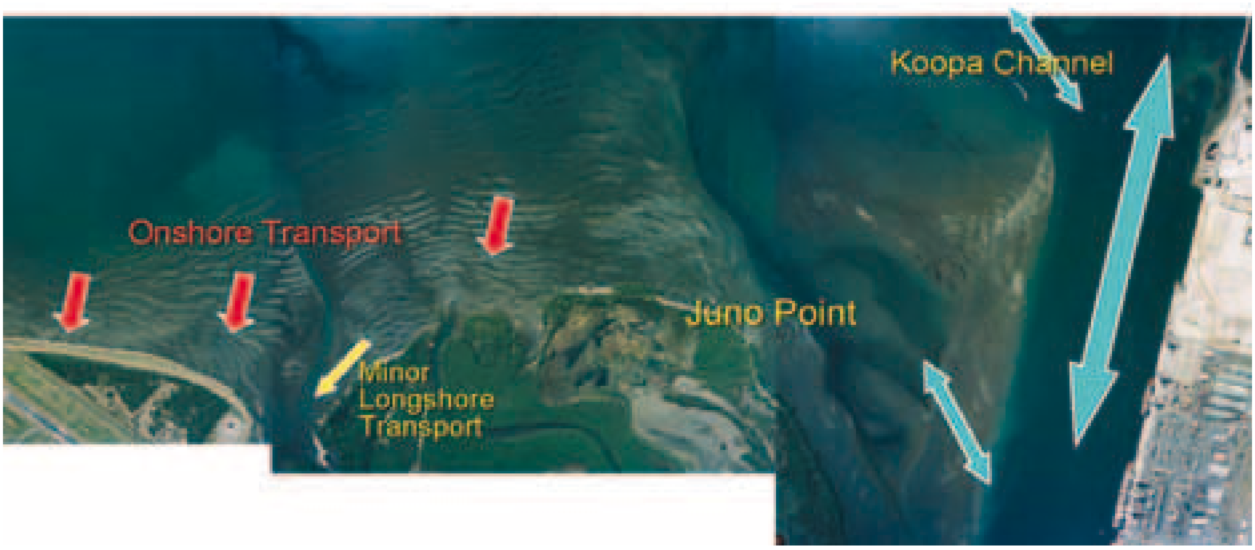
- Geological and historical sedimentation study of the Serpentine area;
- Coastal processes between Juno Point and Shorncliffe;
- Sedimentological investigation of sediments from Serpentine Creek; and
- Overall assessment of sedimentation processes influencing the stability of the Kedron Brook Floodway.

They note that deposition has been occurring continuously within the area since the sea level attained its approximate present elevation some 6,500 years ago. During the last 2,000 to 3,000 years, marine processes, largely wave action interacting with minor oscillations in sea level, have been responsible for the formation of a succession of beach ridges along the foreshore. Thus, the shoreline is accretionary in the longer term, although it will have experienced erosion and accretion from time to time at various locations.

Gourlay and Hacker (1983) report sedimentation in the outer portion of the entrance channel to Cabbage Tree Creek from coastal sediment transport processes of about 1,000 m^3/year, with major events capable of depositing 1,500–3,000 m^3 at a time. Thus the longshore transport process is relatively minor and is distributed across the nearshore profile.

The shoreline area closer to the Brisbane River mouth near Juno Point is even more sheltered from the predominant south-east winds and waves and experiences less wave-induced mobility. As a result, the shoreline itself has not developed a well defined alignment relative to the incident waves, but is shaped more by the shape of the nearshore shoals (**Figure 4.5i**). Further north, the tidal currents are less significant and the low energy wave action is moving sand shoreward at a very slow rate. Sand that has formed sections of shoreline there is transported alongshore slightly. Thus, the old mouth of Serpentine Creek is slowly receiving sand inflow along its edges, as evidenced by the recurved spits there.

Figure 4.5i: *Sediment Distribution and Shoreline Characteristics at Juno Point.*



In and adjacent to the river mouth from Juno Point to Boggy Creek, the sedimentation behaviour is distinctly different in the zones above and below the tidal zone. The river channel processes are controlled almost exclusively by the tidal and flood flows. Because of extensive river dredging in the past, predominantly fine muddy sediments rather than sands and gravels are now brought down the river to the mouth in floods. This fine material largely passes out to Moreton Bay in suspension in the water column, however a significant proportion of it also deposits in the dredged mouth area where the tidal currents are not sufficient to prevent deposition.

Along the shoreline adjacent to Luggage Point, from Juno Point to Boggy Creek, the formation and stability of the foreshore is determined predominantly by river channel movements, potentially undermining the upper inter-tidal zone, and the minor wind and/or boat wake wave action that may erode the finer sediments and leave a residual beach. It is unlikely that the foreshore in this area is receiving a supply of sand from other parts of the shoreline or offshore.

4.5.5.2 The Existing Shoreline

The nature of the shoreline in the area adjacent to the Airport, viewed from the Old Jetty location, is illustrated in **Figure 4.5j** to **Figure 4.5l**. The shoreline west from the Old Jetty is illustrated in the series of photographs in **Figure 4.5m**.

Figure 4.5j: *Foreshore Looking South From Old Jetty.*

Figure 4.5k: *Old Jetty.*

Figure 4.5l: *Foreshore Looking North From Old Jetty.*

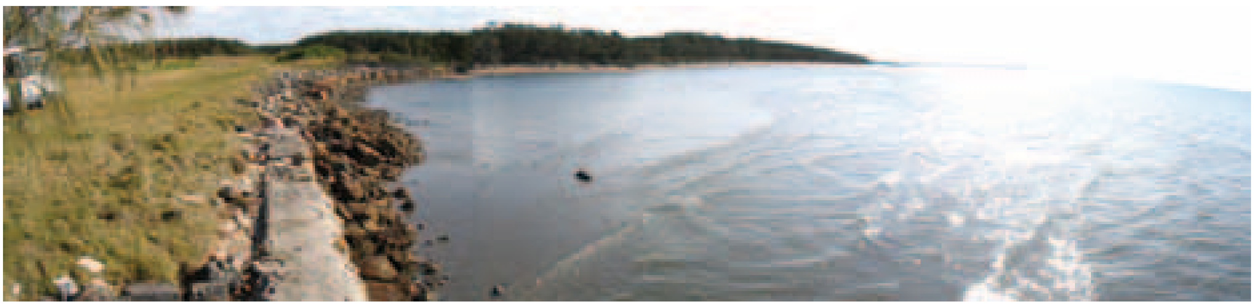


__Figure 4.5m:__ Shoreline West From Old Jetty.

4.5.5.3 Historical Shoreline Changes

The historical changes of the coastal system in the area of the Airport are illustrated in **Figure 4.5n**.

Significant changes occurred in the alignment of the foreshore between Serpentine Creek and Cabbage Tree Creek during the past 1–2 centuries. The major change is closure of the mouth area of Serpentine Creek and creation of the Kedron Brook Floodway channel further to the west at the former mouth of Jacksons Creek. Gourlay and Hacker (1983) note the following additional shoreline changes:

- Erosion along most of Cribb Island;
- Deposition at the mouth of Jacksons Creek;
- Accretion on the beach east of the Jacksons Creek mouth where a new beach ridge had formed since the 19th century; and
- A new beach ridge formed in front of the previous shoreline at Nudgee Beach.

Examination of the aerial photographs in **Figure 4.5n** and other dates of photography dating back to 1941 show that the shoreline south from the old jetty is relatively stable, subject to short term fluctuations associated with storm erosion and/or the effects of the nearshore bed forms in modifying the beach shape. Also clearly evident from analysis of the photography is a progressive erosion of the shoreline north from the old jetty, assessed at an average rate of 0.54 m/year.

The mouth of Kedron Brook is subject to significant change as a result of coastal processes, with sand tending to flow in from the southern side (**Figure 4.5o**). The mouth tends to reduce in size as a result and requires maintenance if the full floodway capacity is to be preserved. This is consistent with the findings of Gourlay and Hacker (1983):

> *"the shape of the proposed channel required to achieve adequate flood carrying capacity is not compatible with that of a self-formed/maintained tidal estuary. …The floodway channel consequently could be expected to become narrower and shallower under normal tidal processes…"*

Stable tidal channels, unless otherwise geologically restricted or subject to strong external influences such as input of sediments by other processes, have been shown to exhibit a well-defined relationship between the volume of tidal flow (tidal prism) and the cross-section area of the flow; a consequence of the fact that they tend to adjust their geometry until a certain equilibrium is achieved. A great many river entrance channels have been studied throughout the world and a number of stability expressions have been developed. The best known of these are those of O'Brien (1969) and Bruun (1966). The expression suggested by O'Brien is commonly adopted, as follows:

$A = 0.91 \times 10^{-3} P^{0.85}$

Where A is the river mouth cross-section area below mid-tide level and P is the tidal prism volume between Mean High High Water and Mean Low Low Water (approximately Mean Spring Tide range).

Similar types of regime equilibrium expressions have been found to apply along the tidal reaches of estuaries, upstream of the mouth. Using numerical models of various tidal streams in Eastern Australia, WBM has developed a clear equilibrium relationship that applies to a wide range of stream sizes from minor creeks to large rivers. This relationship is given as:

$A = 3.1 \times 10^{-3} P^{0.81}$

Numerical modeling has been used to determine the regime status of Kedron Brook and Jacksons Creek, with a view to assessing the impact of the proposed works on the existing condition. The results are presented in **Figure 4.5p** and confirm the conclusion of Hacker and Gourlay (1983) that the Kedron Brook Floodway channel is not self-sustaining and will tend to silt up. However, it reveals that the previous airport development works that connected Jacksons Creek to the remnant parts of Serpentine Creek have added tidal flow to the extent that the channel of Jacksons Creek is under erosional stress, with too much tidal flow for the channel to accommodate without the tendency for erosion. This analytical finding has been confirmed by field inspection that shows the creek banks to be steep and subject to erosion.

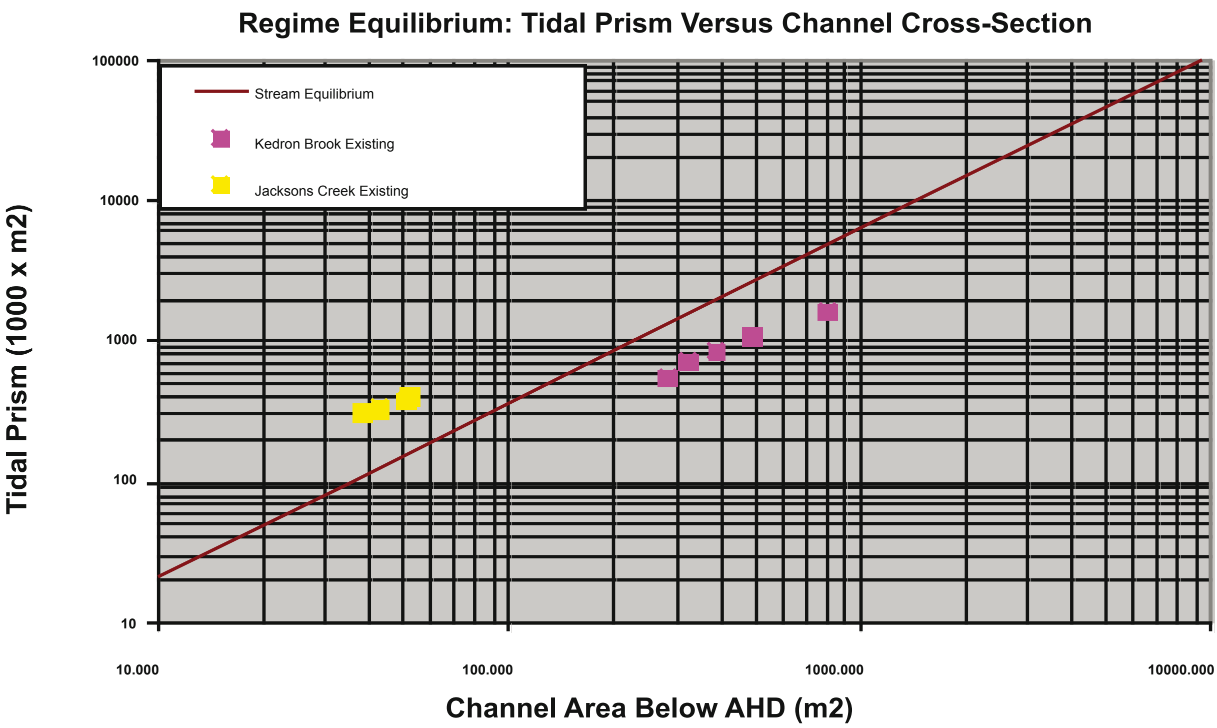
Figure 4.5n: *Historical Shoreline Erosion North of the Old Jetty.*

1941

2004

Figure 4.5o: *Recent Changes to the Kedron Brook Mouth.*

Figure 4.5p: *Status of Relationship Between Tidal Prism and Channel Cross-Section for Kedron Brook and Jacksons Creek.*



4.6 Consultation

A source of the considerable information for the present studies relating to coastal and Kedron Brook processes has been the investigation reports and monitoring data relating to the previous airport development. These were sourced largely via Dr M Gourlay at the University of Queensland.

4.7 Policies and Guidelines

Refer to Chapter B2 for details of the relevant policies and legislation that relate to coastal processes.

4.8 Impact Assessment

4.8.1 General Considerations and Significance Criteria

The behaviour and stability of the shoreline of Bramble Bay in the vicinity of the airport are determined by sand supply and transport that are controlled predominantly by tide and wind generated currents together with locally generated 'sea' waves impinging on that area. In this area, the coastal processes have been modified by works associated with the previous airport development, with blocking of the original Serpentine Creek, creation of the Kedron Brook Floodway and construction of the Old Jetty and seawall structures that act to control the shape of the shoreline.

The coastal system continues to evolve in response to the natural conditions and the works undertaken. Potential impacts of the proposed works need to be considered in that context, providing also for assessment of the cumulative effects.

For the works to adversely affect the behaviour or stability of the coastal system adjacent to the Airport, they would have to:

- Alter the tidal and/or wind induced currents in the nearshore region;
- Alter the prevailing wave conditions at the foreshores; and/or
- Alter the supply of sand, along or onto the foreshore.

The only works proposed as part of the project that will impinge on the coastal system are:

- Construction and operation of the dredge pump-out facility at Luggage Point;
- A piled structure for navigation lighting, to extend about 660 m across the inter-tidal flats along the alignment of the proposed runway; and
- Upgrade of the existing rock seawall along the upper beach south from the old jetty.

Additionally, changes to the tidal exchange through the mouth of Kedron Brook were investigated to determine if there is the potential for siltation of the tidal channel there, with sediment inflow from the adjacent inter-tidal shoals.

The impact assessment undertaken herein has been based on these considerations, as outlined in this Chapter. Specifically, each of the processes described above has been assessed and extent and consequences of any likely impacts identified.

To assist in determining the local and regional significance of any impacts that may be caused by the activities associated with works on airport and surrounds on coastal processes, a set of significance criteria has been developed as presented below.

Table 4.8: Coastal Processes Significance Criteria.

Significance	Criteria: Coastal Processes
Major Adverse	Direct or indirect adverse impact on the hydrodynamics or shoreline of Moreton Bay to the extent that tide levels, major flow patterns, wave propagation or sand transport are altered, such that there would be potential for consequent adverse impacts on adjacent shorelines or elsewhere in the Bay. In particular, extensive or acute disturbance (major impact) occurring to the shorelines bordering Moreton Bay, causing increased erosion that would affect township property and/or significant environmental habitat values.
High Adverse	Irreversible changes to tides, currents, waves and/or sand transport causing adverse impacts on significant parts of the shorelines bordering Moreton Bay, causing increased erosion that would affect township communities and/or significant environmental habitat values. Also, substantial changes to the seabed morphology such that: • the majority of the regional distribution of a habitat type for ecological communities protected by national or state legislation is lost or substantially depleted; or such that • the sediment pathway for sand flow to important other areas of the Bay is intercepted.
Moderate Adverse	Changes to tides, currents, waves and/or sand transport affecting parts of the shorelines bordering Moreton Bay, causing short term increased erosion that would affect township communities or habitat values, such that natural recovery or mitigation measures would alleviate adverse impacts. Also, substantial changes to the seabed morphology such that the local distribution of a regionally uncommon seabed habitat type is permanently lost or substantially depleted.
Minor Adverse	Lesser disturbance than moderate adverse (moderate impact) to tide levels, currents, waves and/or sand transport processes causing changes in shoreline stability of limited or temporary nature, or potentially increased shoreline erosion in areas where such erosion is of little consequence. Also, significant changes to the seabed morphology that would be temporary or of only local spatial extent with no impacts elsewhere.
Negligible	No perceptible impacts on regional Moreton Bay hydrodynamics beyond the immediate works area. Local hydrodynamic changes that have no consequent adverse impacts elsewhere. Little or no changes to water level, current, wave or sand transport processes at shorelines such that any impacts to shoreline stability would be imperceptible.
Beneficial	Any effects or measures that are expected to result in reduced shoreline erosion where that is presently a problem, or design features or management activities that would make a long term positive contribution to shoreline amenity or coastal environmental values.

4.8.2 Assessment of Impacts

With regard to the component works that directly impinge on the coastal zone near the airport, the following general points are significant:

4.8.2.1 Pump-Out Facility at Luggage Point

Construction and operation of the pump-out facility (see Chapter A5) will not involve any substantial interference with the coastal processes in that area. Piles will be driven in the existing relatively deep water of the turning basin, offshore from the foreshore, to form the basis of the dredge berth facility. While this construction phase may have some temporary impact on the shoreline, the existing hydrodynamic and morphological processes will not be disturbed in any way that would impact on shoreline stability in the area.

The shoreline at the pump-out site has a relatively wide inter-tidal nearshore profile separating it from the deeper part of the dredged turning basin and river channel. It is presently subject to some wave and current forces associated with tidal action, local wind and a range of shipping and boating activity and has adapted to those processes. The movements and pump-out activities of the dredge will not cause increases in those forces on the shoreline. As such, the mooring structure and pipeline will not increase the vulnerability of the foreshore at that location to erosion.

Boreholes GC 18 and 23 assessed as part of the geotechnical investigations for the EIS (refer to Chapter B3) are representative of the soils present in the deeper part of the underwater slope near the pump-out berth. The soil information from these borehole indicates:

- From the seabed at the top of the slope (-0.5 to -1.20 m LAT to -8 m LAT), the materials are:
  - Silty Clayey Sand (10 percent fines, loose);
  - Clayey Silt (Silt content 47 percent, very soft, weakly plastic);
  - Silty clayey sand (No density info);
  - Sand (Coarse, angular, fines 2 to 5 percent);
  - Slope angle top (-1 m to -3 m LAT) 1:5 (v:h); and
  - Slope angle (-3 m to -8 m LAT) 1:1.5 (v:h).
- From -8 m LAT to -14 m LAT:
  - Silty Clay (Soft to firm);
  - Silty Clay (Firm, plastic); and
  - Slope angle (-8 m to -14 m LAT) 1:1.5 (v:h).

This would indicate that there is a likelihood of some scour from propeller wash and bow thrust operations of a large to very large dredge mooring in this area on the sandy and silty materials in the slope below RL –1.0 m (Low Water Datum). To a lesser extent, scour may extend below RL –8 m, where soft to firm clay occurs. The rather steep slope angle of 1:1.5 (v:h) of the dredged turning basin profile is another contributing factor for such scour to occur. The dredge will moor and unmoor approximately 50 percent bow in and 50 percent bow out and is likely to create two scour spots on the slopes below approximately RL -1.0 m (LWD).

The hydrographic survey of the nearby Tanker Berth - Pocket (MHS Drawing MH 1080-18, November/December 2005) indicates that propeller scour is noticeable to RL -16.5 m (LWD) in the flat area of the swinging basin.

Nevertheless, the area likely to be affected in this way is the submerged side-slope of the dredged turning basin, removed from the shoreline itself, and any such scour is likely to be of little significance in terms of shoreline stability. It is normal practice worldwide that, unless it causes slope instability or exposure of submerged/trenched pipelines, the scour of vessels is accepted in channels, swinging basins and berth pockets. As such, it can be accommodated at the pump-out facility without problems arising.

4.8.2.2 Lighting System

The structure on which the lighting system would be installed has piled supports and will not act as a barrier to either wave propagation or to the transport of sand along the coastal zone. The pile spacing would not be sufficiently close to cause any significant attenuation of wave energy. As such, there will be no impacts on coastal processes by this structure.

4.8.2.3 Seawall Upgrade

The seawall upgrade is not new work, but rather is a beneficial improvement in the appearance and function of a structure that has been in place for many decades, at the back of the sandy foreshore beach, on the boundary of BAC property. The shoreline where it is located is essentially stable in the long term. The purpose of upgrading the structure is to provide a visually and structurally more sound last line of defence should there be temporary erosion from time to time. The existing structure is of poor construction and may not function adequately in storm erosion events.

There will be no change in the stability of the beach itself, or any impacts to adjacent shoreline areas. A buried structure could be considered, but would offer only a short term and limited benefit. On those occasions when it is impinged on by storm waves, the covering sand would be largely removed and would need to be replaced, involving disturbance to the sandy beach and an unnecessary maintenance commitment. Further, shorebirds are likely to favour the rock structure for roosting from time to time.

4.8.2.4 Foreshore Protection North-west from Old Jetty

The shoreline extending north-west from the Old Jetty towards Kedron Brook is eroding at a rate assessed at up to about 0.5 m/year (refer section B4.5).

This is cutting into old sedimentary deposits exposing clay and other material. A section of rock revetment already exists in the short section extending immediately north from the Old Jetty.

There is no proposal to undertake works along this section of foreshore as part of the present project. BAC will continue to monitor the shoreline changes there.

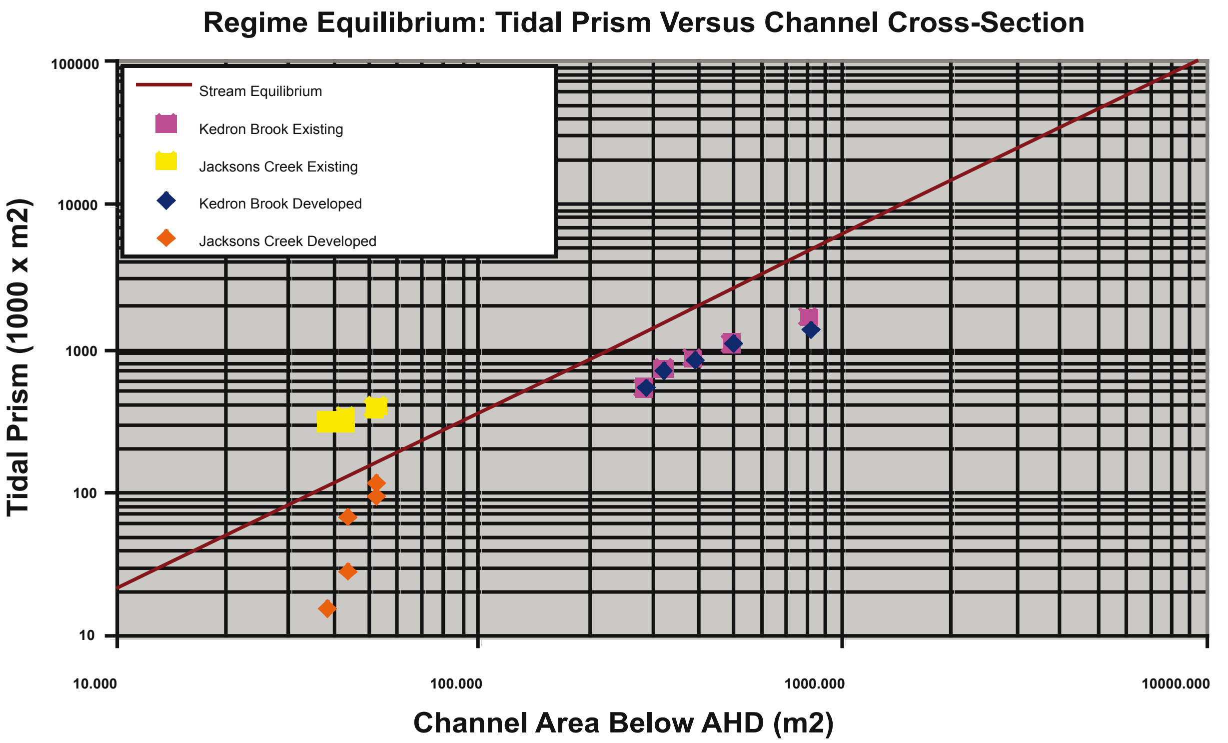
4.8.2.5 Kedron Brook Mouth Design

Numerical modelling has been used to assess the potential change in the tidal flow through the Kedron Brook mouth resulting from the effect of the proposed runway construction in infilling part of the tidal waterway of Jacksons Creek. Assessment of potential effects on mouth stability has been based on the concept of regime equilibrium in which the cross-section of tidal inlets is determined by the quantity of tidal flow (the tidal prism), with a consistent natural relationship as discussed in section B4.5.

It has been shown in section B4.5 that the design for Kedron Brook has a cross-section size that is larger than that for equilibrium with the tidal prism as it presently exists. Accordingly, the mouth has a tendency to become shallower and narrower through siltation processes.

The hydrodynamic modelling shows that the project will reduce the tidal flow through the Kedron Brook mouth by about 13 percent and along Jacksons Creek by 70-80 percent near its mouth, as illustrated in **Figure 4.8q**. Further upstream in Kedron Brook, there is no discernible effect on the tidal prism and the present status of the floodway in terms of likely siltation.

Figure 4.8q: *Impact on Status of Relationship Between Tidal Prism and Channel Cross-Section for Kedron Brook and Jacksons Creek.*



Thus, the effect of infilling part of the Jacksons Creek system will be a marginally higher potential for siltation at the mouth of Kedron Brook. However, at the mouth there is presently silting at a rate that relates essentially to that of the available sediment supply, being substantially out of regime equilibrium already. As such, it is unlikely that the rate of mouth siltation will increase discernibly.

The reduction in tidal flow in Jacksons Creek will remove the existing tendency for erosional stress and shift the regime condition to one subject to siltation, although reasonably close to equilibrium near its mouth. Thus, it would be expected that Jacksons Creek channel will be subject to siltation by fine muddy material, increasingly further upstream from the mouth. This would persist until a new somewhat silted equilibrium cross-section is reached in Jacksons Creek, involving a reduction in the channel size by about 20 percent near the mouth and up to about 60 percent further upstream.

The rate of siltation of Jacksons Creek will be slow, although difficult to predict quantitatively. It will occur as a result of regular tidal inflow to the waterway carrying suspended sediment, some of which will settle out. The siltation rate will depend on the tidal prism, the suspended sediment concentration and the proportion of the suspended load that settles out during each tide. As a broad indication, using a mean tidal prism of about 80,000 cubic metres (m^3) from the modelling, an ambient suspended sediment concentration of 20 mg/L (based on the measured 19.5 mg/L from the BCC Kedron Brook Waterway Quality Assessment as documented in Chapter B8) and a settling proportion of 50 percent, approximately 800 kg could be deposited per tide, equivalent to 560 tonnes per year. At a typical deposited dry bulk density of 0.75 tonnes per m^3, this corresponds to about 750 m^3 siltation per year. This represents less than 1.5 cm per year in average creek bed accumulation.

It is expected that this change in the siltation pattern will occur in the main tidal channel below mean sea level, associated with the change in the peak tidal flow that occurs at close to mean sea level. There is expected to be no change in these processes above mean sea level, particularly in the upper tidal areas of mangrove and other marine flora.

4.9 Cumulative and Interactive Impacts

Changes to the natural coastal processes along the shoreline abutting the eastern boundary of the BAC land are largely in response to works dating back many decades, most particularly construction of the Old Jetty structure that acts as a groyne providing a stable control point for the shoreline. The presently proposed works will not alter the existing coastal processes or ongoing patterns of shoreline evolution occurring in this area.

It is likely that there are some effects of the previous airport development works that are continuing to cause slow changes, including gradual infilling of Serpentine Inlet and siltation in Jacksons Creek and at the Kedron Brook Floodway mouth. As a result of the New Parallel Runway (NPR) there will be only slight or negligible impact on the behaviour of Kedron Brook, associated primarily with reduction in tidal flow in Jacksons Creek.

4.10 Mitigation Measures

As outlined above, there is expected to be no discernible impact on the rate of siltation of the Kedron Brook Floodway. The NPR project would not affect existing processes and thus require not specific mitigation measures in that regard.

At the dredge pump-out, the speed of the dredge when approaching and departing from the pump-out facility will be very low with low revolutions on the propellers which would reduce scour effects.

4.11 Residual Effects

The reduced flow in Jacksons Creek is likely to result in some permanent gradual siltation with muddy material until the new regime equilibrium is reached, involving channel size reduction by about 20 percent near the mouth and up to about 60 percent further upstream. The rate of siltation of will be slow, although difficult to predict quantitatively, likely to be about 750 m^3 siltation per year, representing less than 1.5 cm per year in average creek bed accumulation.

4.12 Assessment Summary Matrix

Based on the above assessments, a summary of potential impacts is provided in the following matrix.

Table 4.12: Coastal Processes Assessment Summary Matrix.

EIS Area: Coastal Processes Feature/Description	Current Value + Substitutable Y:N	Description of Impact			Additional Compensation (Beyond Standard Practice)
		Impact	Mitigation Inherent in Design/Standard Practice Amelioration	Significance Criteria	
Moreton Bay hydrodynamics	Impacts would affect other parts of Moreton Bay. Not substitutable.	Changes in tide levels and/or tidal currents as well as wave heights and/or wave propagation processes.	No works are proposed that could affect the hydrodynamics of the Bay. Any lighting structure would be piled and transparent to waves and currents.	Negligible, -ve, LT, I	Nil
Adjacent shorelines	Socio-economic value to owners and residents of adjacent properties. Coastal amenity value.	Increased erosion or change in character of shorelines.	No proposed works would adversely affect any existing amenity or habitat. Existing foreshore protection works will be enhanced. Any lighting structure would be piled and transparent to waves and currents.	Negligible, -ve, LT, I	Nil

Key:

Significance Criteria: Major; High; Moderate; Minor; Negligible

+ve positive; -ve negative

D – direct; I – indirect

C – cumulative; P – permanent; T – temporary

ST – short term; MT – medium term; LT long term

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