THE TWEED RIVER ENTRANCE SAND BYPASSING PROJECT TEN YEARS OF MANAGING OPERATIONS IN A HIGHLY VARIABLE COASTAL SYSTEM

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Introduction

The Tweed River Entrance Sand Bypassing Project (TRESBP) is a joint coastal engineering project of the New South Wales and Queensland State Governments. The Tweed River entrance training walls were extended to improve the navigability of the river entrance in the 1960s. This substantially reduced the net northerly transport of sand moving to Queensland and resulted in severe erosion, recession and vulnerability of the southern Gold Coast beaches to large swell events. By the early 1990's, North Letitia Beach, located immediately to the south of the southern training wall, had accreted so significantly that a sub-tidal delta had once again formed at the Tweed River entrance, creating a navigational hazard for vessels.

To address the coastal management issues in both NSW and Qld, the TRESBP was developed by the State governments. The objectives of the project are to establish and maintain a navigable entrance to the Tweed River; and to provide an ongoing supply of sand to the beaches that is consistent with the natural net rate of longshore drift. The permanent bypass system was commissioned in 2001 and is operated by the Tweed River Entrance Sand Bypassing Company (TRESBCo), a subsidiary of McConnell Dowell. The system consists of a sand pumping jetty that intercepts northward moving sand at Letitia Spit, pumping the sand via a buried pipeline primarily to the east snapper rocks outlet. Dredging is periodically required to maintain the navigation channel when the sand transport rate exceeds the capacity of the bypass system (Figure 1).

The project area is a complex high energy coastal/estuarine environment with various coastal processes operating over a range of temporal and spatial scales. Managing sand delivery in such a highly variable coastal system has proven to be challenging, particular when taking into consideration the needs of a wide range of stakeholders. This paper will describe some of the natural coastal processes that present particular management challenges in the TRESBP operational environment and provide examples of methodologies and tools that have been adopted for more effective coastal management.

Location

The project area is located on the border of NSW and Qld, approximately 100km south of Brisbane and 900km north of Sydney, extending from Coolangatta Creek in Qld, to Northern Letitia Beach in NSW (Figure 2). The project area falls into the jurisdiction of both Gold Coast City Council (GCCC) and Tweed Shire Council and is an area of natural beauty offering world class beaches and surfing breaks to both local residents and domestic and international tourists.

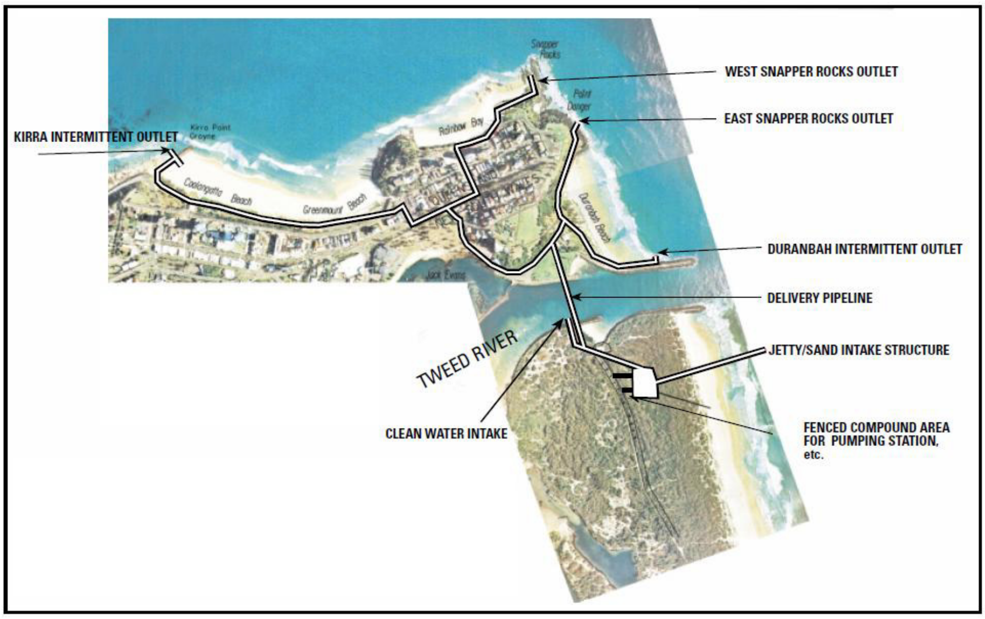


Figure 1 Sand bypassing jetty and discharge pipeline layout

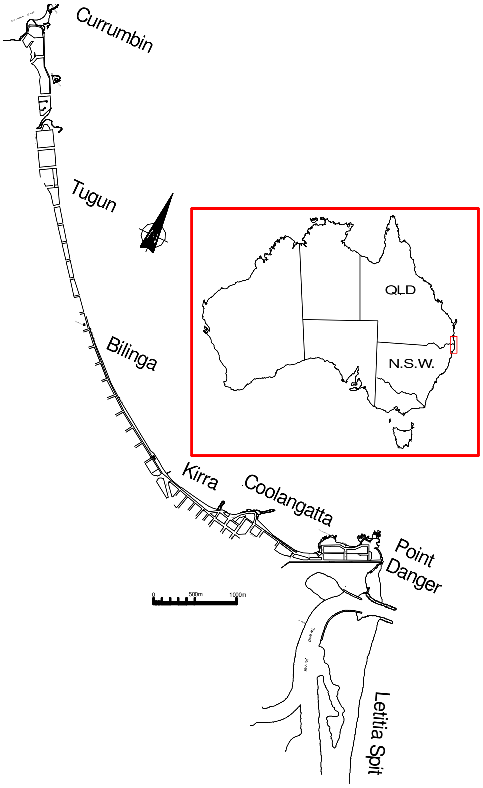


Figure 2 Location of the Tweed River Entrance Sand Bypassing Project

Coastal Processes

The state of the coastal system depends on the underlying geology, the nature and abundance of the coastal sediment and the degree to which these controls are acted on by marine and atmospheric forces. Feedback loops are inherent in coastal systems, with the beach state at any particular time depending on the incident and preceding interactions between the sediments and coastal processes. The nature of these feedback loops results in the coastal zone being highly stochastic, dynamic and very challenging to predict (Figure 3).

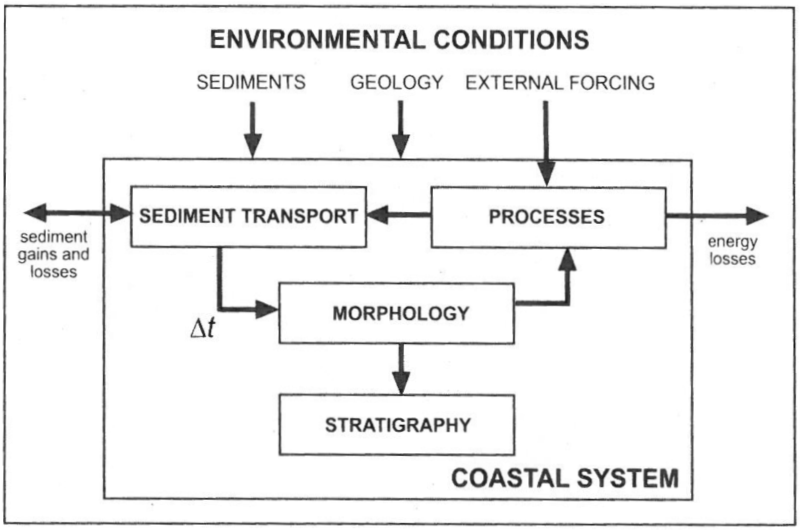


Figure 3 Primary components involved in coastal morphodynamics (Masselink and Hughes, 2003)

These components of coastal systems apply directly to the project area where a large range of coastal processes operate over various temporal and spatial scales. The following will briefly outline these processes thus providing a background into the operational environment of the Tweed River Entrance Sand Bypassing Project.

Coastal Geomorphology

The project area forms part of a Holocene dune barrier system that was formed when rising sea levels submerged valley mouths and coastal lowlands that subsequently began filling with sediment from the land and sea during the most recent cycle of seal-level rise (Roy *et al*, 2001). This took place during the Holocene Marine Transgression, which was the most recent world wide rise in sea level that accompanied global warming and de-glaciation, bringing the oceans to their present level some 6,500 years ago (Bird, 1965).

Coastal bedrock features of Fingal Head, Cook Island and Point Danger, have provided controlling influences on the movements of sand and the coastline shape throughout the past 6,500 years of shoreline evolution. The Tweed River is naturally a wave dominated estuary and the morphology of the area has changed significantly due to the construction and subsequent extension of the training walls (Figures 4-6).

Figure 4 Point Danger and the Tweed River Entrance in 1935, before the Tweed River training walls were extended

Figure 5 Point Danger and the Tweed River Entrance in 1967 shortly after the Tweed River training walls were extended

Figure 6 Point Danger and the Tweed River Entrance in 2004 shortly after the bypass system was commissioned

Sediment Transport

The sediment reserves that were deposited during the Holocene Marine Transgression now forms the supply of sand that originates just north of the Clarence River in mid-northern NSW and flows parallel along to coast, slipping over the continental shelf, just north of Fraser Island. Each year, approximately 500,000 cubic meters of sand moves along Letitia Beach as a result of this longshore sediment transport process. Although the northward net longshore transport of sand along the project beaches is continuous, it varies both spatially and temporarily due to the effects of the predominant wave climate, currents, geomorphological control features such as heads and man-made structures such as the Tweed River entrance training walls.

Superimposed on the predominant process of longshore transport is cross-shore sediment transport. Within the TRESBP project area, significant cross shore sediment transport occurs during large swell events when sand is removed from the upper beach face and transported offshore to form a subaqueous bar. This process can be particularly damaging if exacerbated by storm surge and spring tides. Conversely, during low swell periods, the sand previously deposited in offshore bar formations migrates onshore, aided by aeolian sand transport to re-build the upper beach face.

A particularly important sand transport process in the project area is the movement of large quantities of longshore sediment transport around heads in ‘slug formations’. Slug movements can operate over various time scales, however significant movements are generally associated with periods of high wave energy, aided by accelerated longshore currents. During these conditions, episodic ‘slugs’ of sand are moved past heads, whereas longshore transport at adjacent beaches tends to be more continuous at lower rates. These movements of sand result in a temporarily imbalance in the sediment budget with a loss of sand from the updrift beach and an accumulation of sand to the immediate downdrift of the head (Patterson, 1999).

Wave Climate

The beaches of northern NSW are wave dominated with a micro-tidal current regime and an average deepwater wave height of 1-2m (Short and Woodroffe 2009). The median significant wave height is 1.3m, with severe ocean storm waves in excess of 6m (the maximum recorded at Tweed Heads is 7.5m). The dominant wave direction for the project area is from the south to south-east sector associated with high pressure atmospheric systems over the continent and low pressure systems in the southern Tasman Sea. Storm waves may approach from the northeast through to the south east as a result of easterly trough lows and more infrequent tropical cyclones (Lord and Kumar, 2000). As a consequence there is considerable daily, monthly and seasonal variation in the size and direction of the waves, as well as longer term changes, which appear to be related to the Southern Oscillation Index (SOI) (Phinn and Hastings, 1992).

Climatology

Phinn and Hastings (1992) first investigated the influence of the Southern Oscillation Index on the wave climate and resultant beach morphology of south-eastern Australia. Positive trends in the SOI (La Niña) and negative trends in the Pacific Decadal Oscillation (PDO) have been shown to represent peaks in the annual and decadal pacific oscillations that result in higher frequency and intensity storm events in eastern Australia (Proudfoot and Peterson, 2011). Goodwin (2005) also reported a change in wave direction from a predominantly south-easterly to a more easterly direction during La Niña events which causes more pronounced erosion and retreat at the southern end of zeta formed beaches (such as Kingscliff) and an increase in sea level, compounded during spring tides. More recently Proudfoot and Peterson (2011) performed a historical analysis that showed that three of the most severe erosion events to have impacted Kingscliff (northern NSW) in the last century took place during spring tides when periods of La Niña occurred in unison with a negative PDO phase.

Wave modification processes

As waves propagate from deepwater into the nearshore wave zone, they undergo various processes of modification leading to a decrease in wave velocity and wavelength and a modification of both wave height and direction (Short & Wright, 1981). These processes are controlled by the regional and local geomorphology leading to variations in wave energy and sediment transport potential both along and between coastal compartments. The project area coastline abruptly changes in orientation from the general north/south alignment of Fingal Head - Snapper Rocks to a general east/west alignment from Snapper Rocks - Kirra. Rainbow Bay through to Kirra is therefore sheltered from the predominant south-easterly waves, and the sand transport potential during these conditions is significantly less to the more open coastline to the east of Snapper Rocks (Boswood et al, 2005).

Monitoring

The nature in which sediment moves through the coastal system is the direct result of temporal and spatial variation in wave energy. The temporal scales at which coastal processes operate can be generally classified as: Instantaneous, Event, Engineering or Geological, and are illustrated in Figure 6.

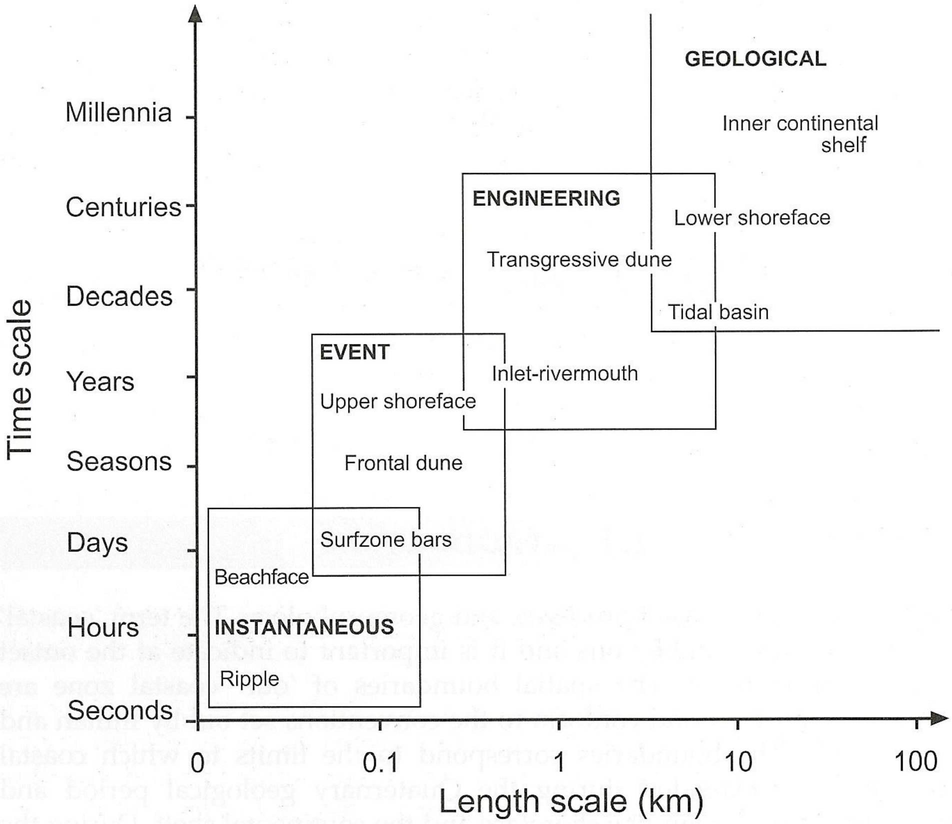


Figure 6 Definition of spatial and temporal scales involved in coastal evolution (Masselink and Hughes, 2003)

In order to accurately determine how sediment moves through the project area and morphological response to sand delivery regimes, the project has implemented a comprehensive monitoring regime that extends from Dreamtime Beach, NSW to Currumbin, Qld. The monitoring program includes beach and hydrographic surveys, aerial photography, wave and tide measurements, and video monitoring through the ARGUS coastal imaging system at Duranbah, Rainbow Bay, Coolangatta and Kirra beaches. Of this data, both the survey and ARGUS data, used in conjunction with wave measurements, provide the most effective information to examine the beach response to the bypass operations.

Select survey lines of the upper beach and river entrance are undertaken quarterly by the Operator. In addition, the governments complete a comprehensive annual survey of the entire project area including the upper beach, intertidal zone and Tweed River. Analysis of the survey data provides detailed information on sand shoal progression as well as beach and nearshore evolution over Event and Engineering time scales. The ARGUS coastal monitoring system is a coastal imaging service provided by the University of New South Wales, which collects and analyses images taken by sixteen cameras at four locations. This service allows the project team to view hourly images of beaches within the project area beaches. In addition, ARGUS provides analytical information on beach width and shoreline movement, allowing the beach morphology to be assessed over smaller time scales.

This information allows the project team to quantitatively predict morphological trends and shoreline movement, providing more confidence when making decisions regarding sand delivery regimes. The monitoring strategies have indicated that the most effective way to manage the project area is to divide it into 'management compartments'. These include Letitia Spit/Tweed River Entrance, Coolangatta Bay and Kirra. Duranbah is also a significant management compartment but will not be addressed in this paper due to comprehensive work undertaken by Lawson *et al* (2010). The following section will give some specific examples of coastal processes operating in each management compartment.

Coastal Dynamics in the Project Area

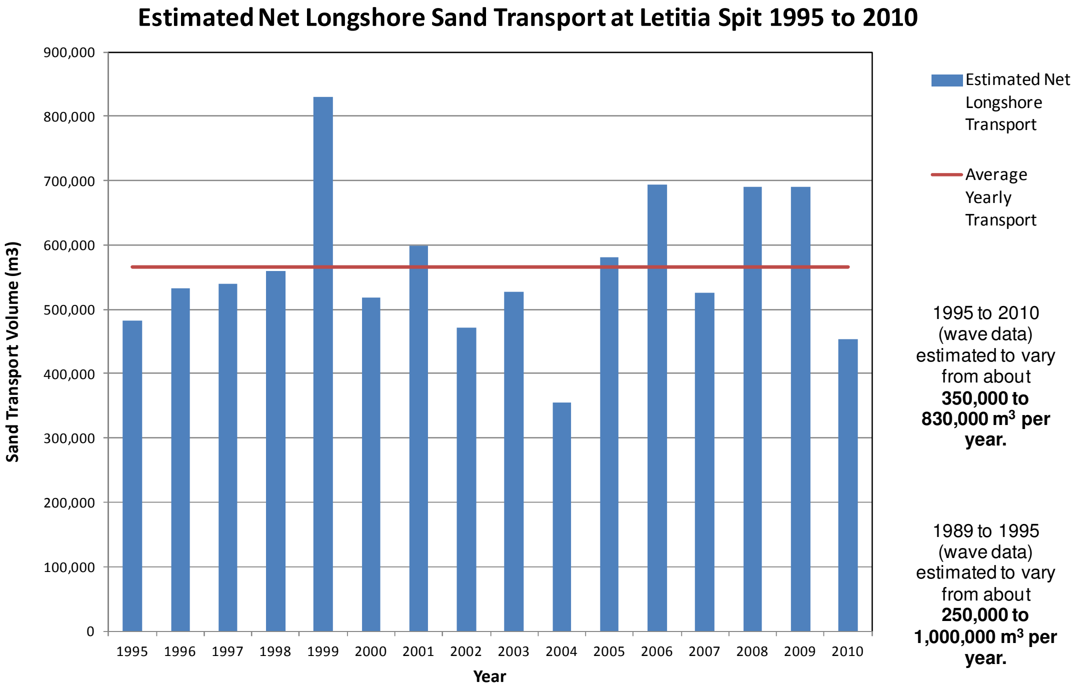
The three coastal compartments in the project area of Letitia Spit/Tweed River Entrance, Coolangatta Bay and Kirra present differing localised coastal dynamics and responses to sand bypassing operations that present particular challenges for the management of TRESBP operations.

Letitia Spit and Tweed River Entrance

Longshore Sediment transport

The Letitia Spit Beach compartment is a slightly curved embayment about 3.5 km in length, extending from Fingal Head in the south to the Tweed River entrance in the North. The Cook Island and offshore reefs near Fingal Head provide some protection to the southern section of beach from ocean waves approaching from the more southerly sectors. However the central and northern sections of beach face east north-east (bearing of 72° - 75 °) and are fully exposed to the predominant south easterly wave energy. The longer term average energy weighted mean wave direction of the region is approximately 137° (BMT-WBM, 2011) and as such, there is a substantial net northward longshore sand transport along Letitia Spit.

The longshore sand transport along Letitia Spit is highly variable temporally and while the predominant wave direction is from the south east and net transport is to the north, ocean waves approach from all seaward directions. The estimated annual net longshore transport along Letitia varies significantly and has been shown to range from 250,000 m^3/yr to 1,000,000 m^3/yr calculated with data from 1989 to 1995 (Hyder et al, 1997) and 350,000 m^3/yr to 830,000 m^3/yr with data from 1995 to 2010 (BMT-WBM, 2011) (Figure 7). The average estimated value is 550,000 m^3/yr and this variability presents significant management issues for the daily operation of sand bypassing system.



1995 to 2010 (wave data) estimated to vary from about **350,000 to 830,000 m^3 per year.**

1989 to 1995 (wave data) estimated to vary from about **250,000 to 1,000,000 m^3 per year.**

Figure 7 Estimated Net Longshore Sand Transport at Letitia Spit 1995 to 2010

Sand Slug formation

The mass movement of large pulses of sand (in the order of 200,000 m^3 or more), moving from Dreamtime Beach around Fingal Head to Letitia Spit has been shown to occur periodically. This ‘slug-like’ sand transport behavior has been noted at Letitia Spit during 2003 and 2007 (BMT-WBM, 2011) and again in 2011 by the project team (Figure 8). The migration of large sand slugs along Letitia Spit can contributes to increased sand transport conditions near the jetty which requires increased pumping to minimise the risk of sand moving into the river entrance, particularly under ocean storm conditions.

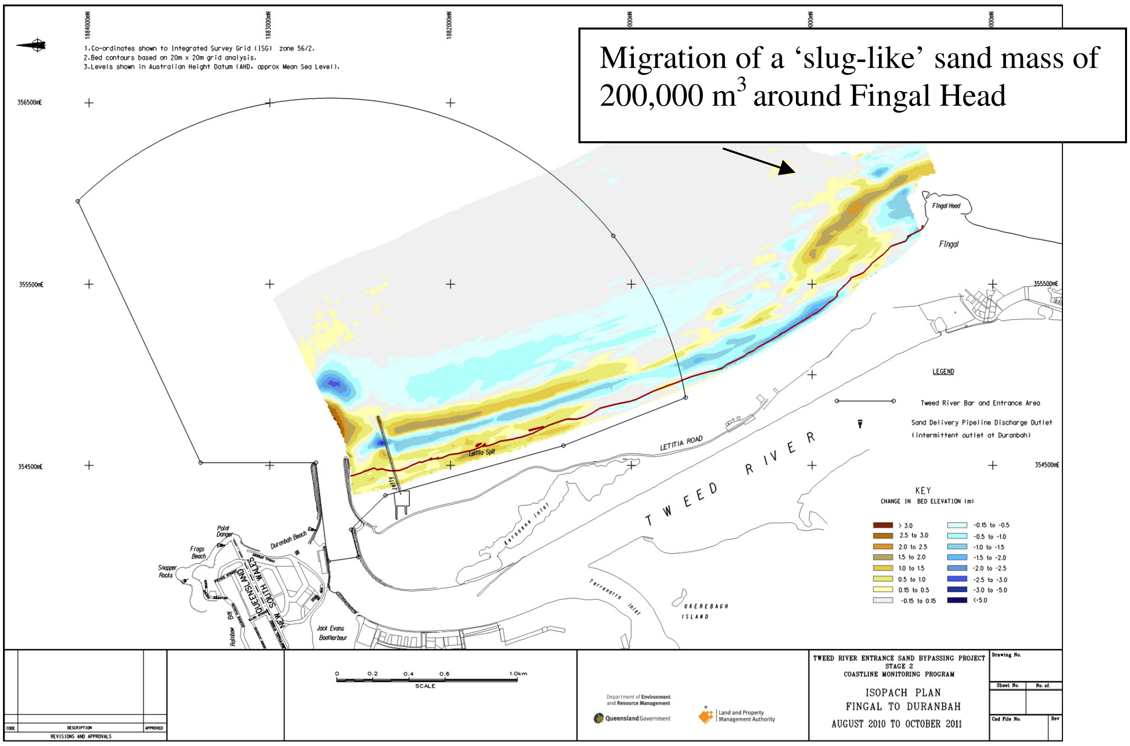

Migration of a ‘slug-like’ sand mass of 200,000 m^3 around Fingal Head

Figure 8 Isopach Plan showing changes in surface level along Letitia Spit - Aug 2010 to Oct 2011

Jetty Efficiency and Infilling of the Tweed River Entrance

Modelling indicates that approximately 80% of the longshore sand transport typically occurs in shallow waters of up to 4m depth, with less than 5% in deeper waters of 8 - 15m (Hyder et al, 1997, BMT-WBM, 2011). During storm-induced high transport events, there is pronounced sediment suspension across the extended surf zone. Natural sand drift has been estimated to be 20,000 m^3/day during significant storms (Hs= 3-4m) and in excess of 40,000 m^3/day under severe ocean storms (Hs= 5-6 m). During these events the jetty operations are not able to intercept all of the natural sand drift which naturally moves northwards into the entrance area.

During the initial years of jetty operation, there was an increased local transport condition near the jetty due to changes in local beach alignment associated with the drawback of the beach in the vicinity of the jetty to develop the jetty beach sand trap. During this time the jetty was less effective at capturing littoral drift as it was also removing sand from the in situ sand store. As a consequence, the infeed of sand into the entrance area was still substantial during the initial years of operation and shoaling in the entrance area (above the dredge design profile) was in the order of 250,000 m^3/yr in the first two years of operation (Figure 9). This was still significantly less than the pre-pumping infill rate of more than 400,000 m^3/yr in 2000/01.

The entrance area short-term sand trapping (shoaling) behavior varies, depending on the leakage of sand past the jetty, tides, entrance depths and wave conditions. This infilling behavior has generally reduced over time as the jetty operation has become more effective at capturing the natural little drift (Figure 10). This has required less dredging in recent years and the maintenance of a moderately deep entrance condition has contributed to some natural bypassing of sand across the entrance to feed Duranbah Beach on the northern side.

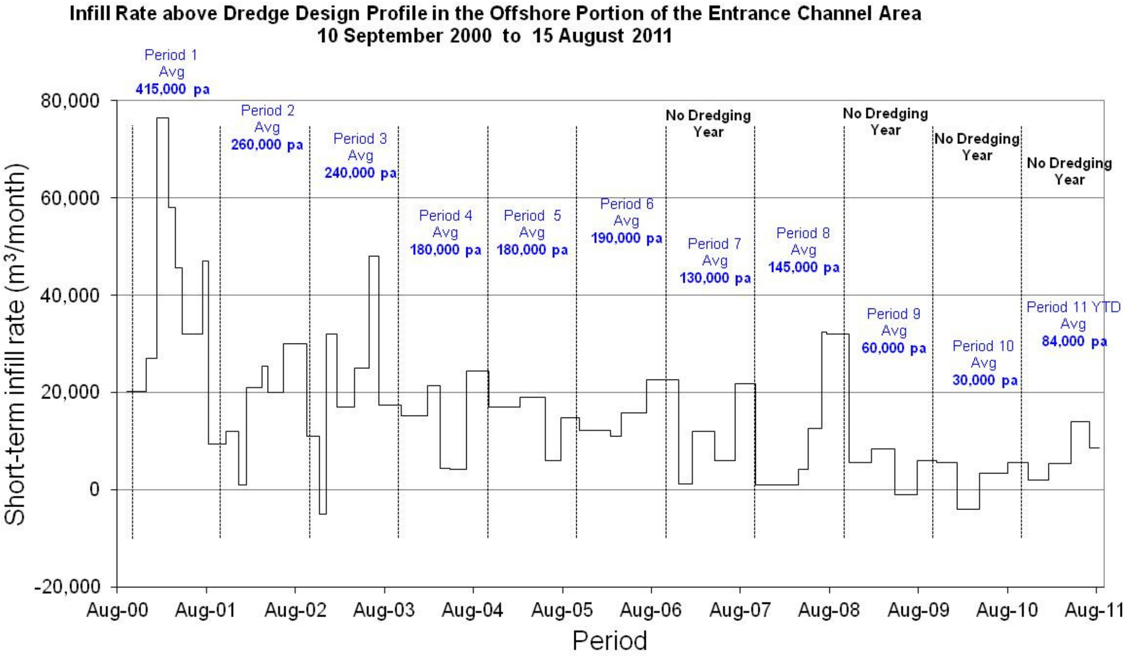


Figure 9 Short-term Infill rates above the dredge design profile in the entire offshore entrance channel area between September 2000 and August 2011

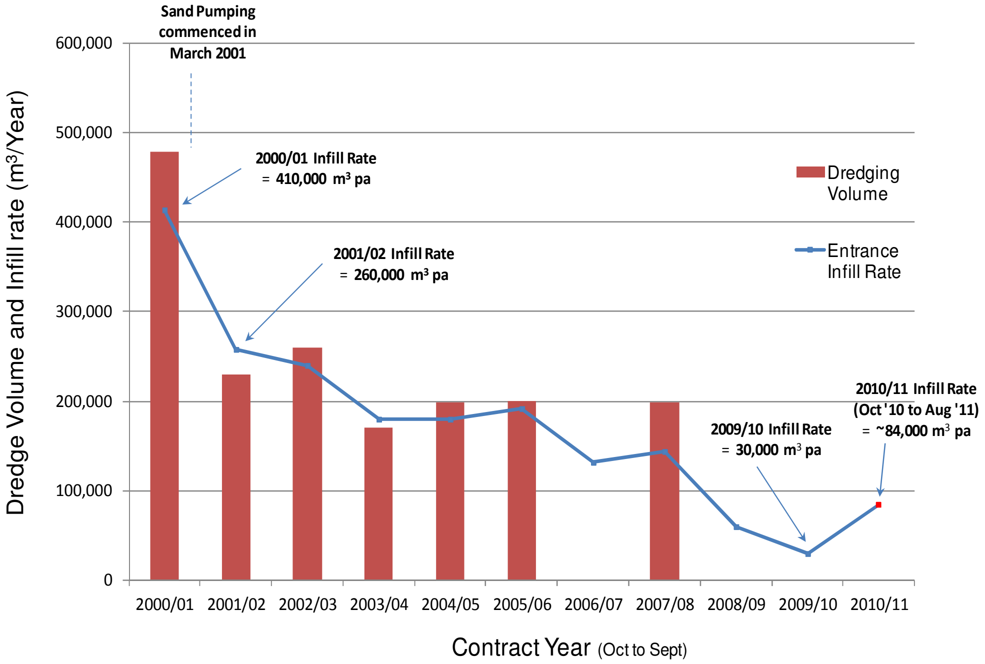


Figure 10 Annualised Infill rates above the dredge design profile in the entire offshore entrance channel area between September 2000 and August 2011

Coolangatta Bay

There is a major change in coastal alignment at Snapper Rocks and along the southern Gold Coast beaches compared to the sand collection area of Letitia Spit. These beaches generally face northwards and the longshore sand transport is directed westward along the beaches from Snapper Rocks towards North Kirra. This change in alignment also contributes to alongshore sand transport differentials from the south-eastern side of Snapper Rocks (Point Danger/Snapper Rocks East primary sand delivery outlet and dredge placement area) to the western side of Snapper Rocks (Coolangatta Bay and Kirra beach areas).

Snapper Rocks

The Snapper Rocks inner nearshore sandy bed profile is very dynamic. During the initial years of sand bypass operations (2001-2006), large volumes of sand were delivered and a major portion of this sand quantity was delivered to the project's primary placement area of Snapper Rocks East / Point Danger. This delivered sand was naturally reworked around Snapper Rocks and along the southern Gold Coast beaches contributing to the development of an alongshore beach bar on the west side of Snapper Rocks (Figure 11). This bar promoted a consistent peeling high-quality surfing wave break known as the ‘Superbank’ which was ranked in the top 10 surfing sites in the world and became the venue for the staging of the Quicksilver professional surfing contest.

Figure a (29 May 2001)

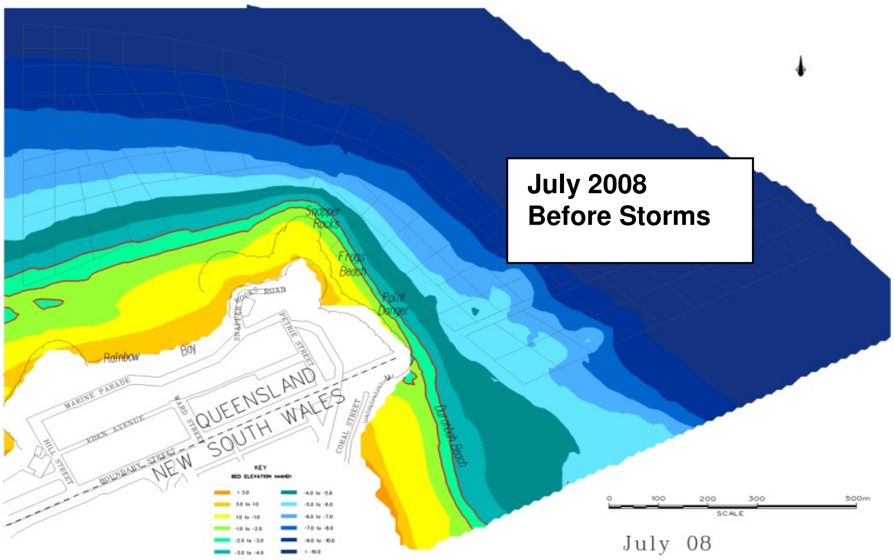
Figure b (30 August 2002)

Figure 11 beach and "superbank" development occurring from 29 May 2001 (a), 30 August 2002 (b) and 11 May 2003 (c) (Boswood et al, 2005)

Erosion of the Snapper Rocks Surfing Bank

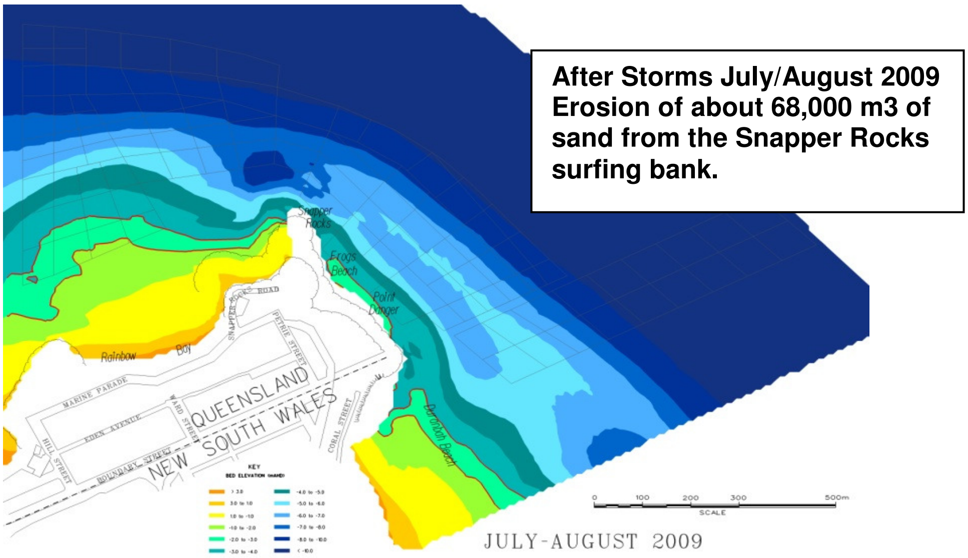
During northerly wave conditions there can be a divergent, or large differential of longshore sand transport at Snapper Rocks and the tendency for scouring on the west side of due to reduced flow of sand around the point. The depleted nearshore profile offshore and to the east of Snapper Point increases the vulnerability for scour of the Snapper Rocks surfing bank. Such conditions were experienced during the major storm in May 2009 which approach just north of east (080°-090°).

Shortly after the storm, concerns were raised by surfing stakeholders because of the scouring of the Snapper Rocks surfing bank which had depleted wave quality (Figures 12 and 13). Although sand was pumped to both the Snapper Rocks east and west outlets in an effort to restore the head of the sand bank, it took almost 2 years for full recovery. In recent years pumping alone has not been able to maintain a nearshore profile in the area of Point Danger because the sand delivery is less than the sand transport potential. It is likely that the nearshore area will continue to erode and some dredge placement will be required to replenish the sand store to pre-project conditions.



July 2008
Before Storms

Figure 12 Snapper Rocks surfing bank before the May 2009 storms



After Storms July/August 2009
Erosion of about 68,000 m3 of sand from the Snapper Rocks surfing bank.

Figure 13 Snapper Rocks surfing bank after the May 2009 storms

Rainbow Bay

Seasonal Fluctuations

Rainbow Bay Beach is located in the immediate lee of Snapper Rocks and is sheltered from the predominant south easterly waves. The shoreline and beach area are dynamic and have historically exhibited substantial seasonal fluctuations. There is pronounced beach growth typically during the autumn and winter months where the beach width can vary from less than 30m to more than 100m. Under more persistent north east waves, which typically occur from spring to summer, the beach retreats due to the reduced sand flow around Snapper Rocks. This seasonal fluctuation is still pronounced even under reduced sand delivery to Snapper Rocks and the substantial overall reduction in sand volumes across the beach and nearshore profile over recent years.

Figure 15 Seasonal Changes during 1999 (prior to sand pumping)

Kirra

Sediment Transport Variability

Northward facing Kirra Beach is located on the western side of Kirra Point groyne, and lies in the deepest section of the southern Gold Coast embayment that extends from Snapper Rocks to Currumbin Head. Historically the beaches from Kirra to North Kirra have exhibited major shoreline fluctuations associated with the episodic nature of sand slug migration around Kirra Point and through the inshore area of Kirra.

The project’s EIS found that the total sand transport potential at Kirra is highly dependent on the occurrence of major ocean storm events. These storm events can cause large mass movements of sand, taken from the beach and inner nearshore, and moved westwards towards North Kirra. Due to Kirra's Northward facing alignment and wave refraction patterns, there is relatively lower sand transport potential at Kirra during ocean storms from the south east compared to east facing beaches such as Letitia spit. This is due to the wave shadow zone created by Snapper Head and the geometry of the southern Gold Coast embayment. Conversely, relatively high sand transport occurs at Kirra during storms which approach from east to north-east and major beach erosion is typically observed.

The condition of the beach and inner nearshore bar profile at Kirra is particularly dependent on the occurrence of major storms from the east to the north-east (such as cyclones) and the transport of sand past Kirra Point. Such storm events have been estimated to cause short term net longshore transport of up to 200,000 to 300,000 m^3. This can be seen historically in Figure 19 where Kirra exhibited large shoreline fluctuations, depending on the occurrence of cyclonic north-easterly ocean storms. This dependence on the occurrence of such infrequent storm events for the total time-averaged longshore transport of sand through the Kirra area can contribute to significant variability of sand volume at Kirra compared to other beaches within the project area.

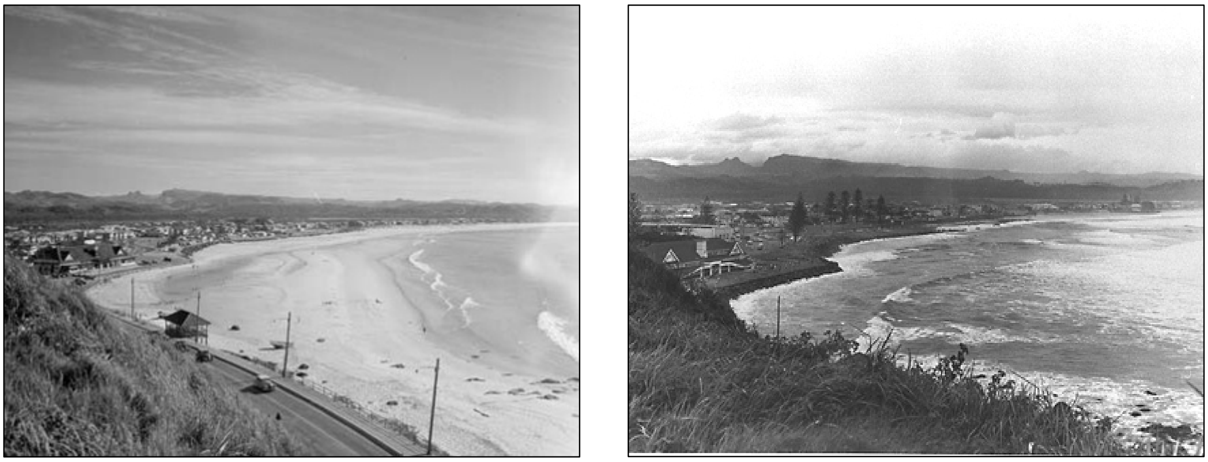


Figure 19 Kirra in 1952 (left) following a number of relatively calm years and in 1954 (right) following a recent Tropical Cyclone

Sand Reduction at Kirra

The Coolangatta Bay (Snapper Point to Coolangatta Beach) coastal compartment has shown progressive reduction in sand volume in each year following the completed delivery of the initial supplementary quantity, with an average loss of 190,000 m^3/yr over the last 3 years. Overall beach and offshore volumes have approached pre-pumping conditions surveyed in 2000 (Figure 20).

While there has been a trend of reduction in sand volume at Kirra since 2008, a significant portion of this occurred in the May 2009 severe storms which approach from just north of east, being the only case of a northerly sector major storm event for a protracted number of years. Over 200,000 m^3 of sand was removed from Kirra beach and inner nearshore area, between Kirra Point groyne and Miles Street groyne during the May 2009 storm (Figure 21).

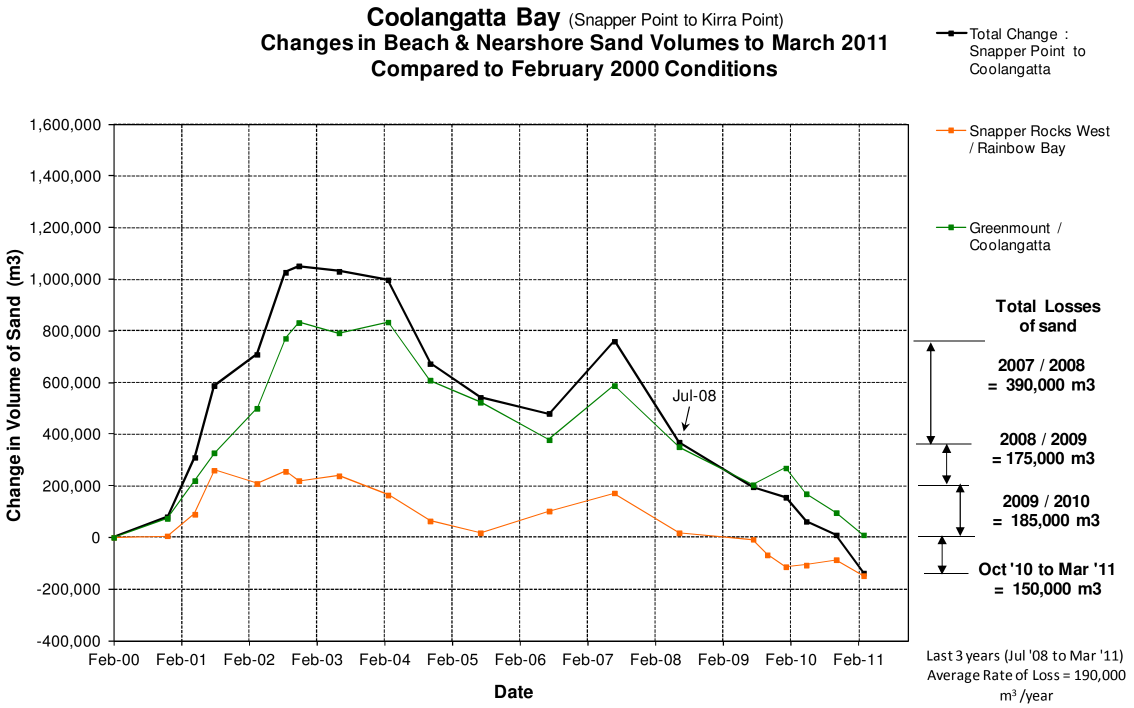


Figure 20 Changes in beach and nearshore sand volumes in Coolangatta Bay between February 2000 and March 2011

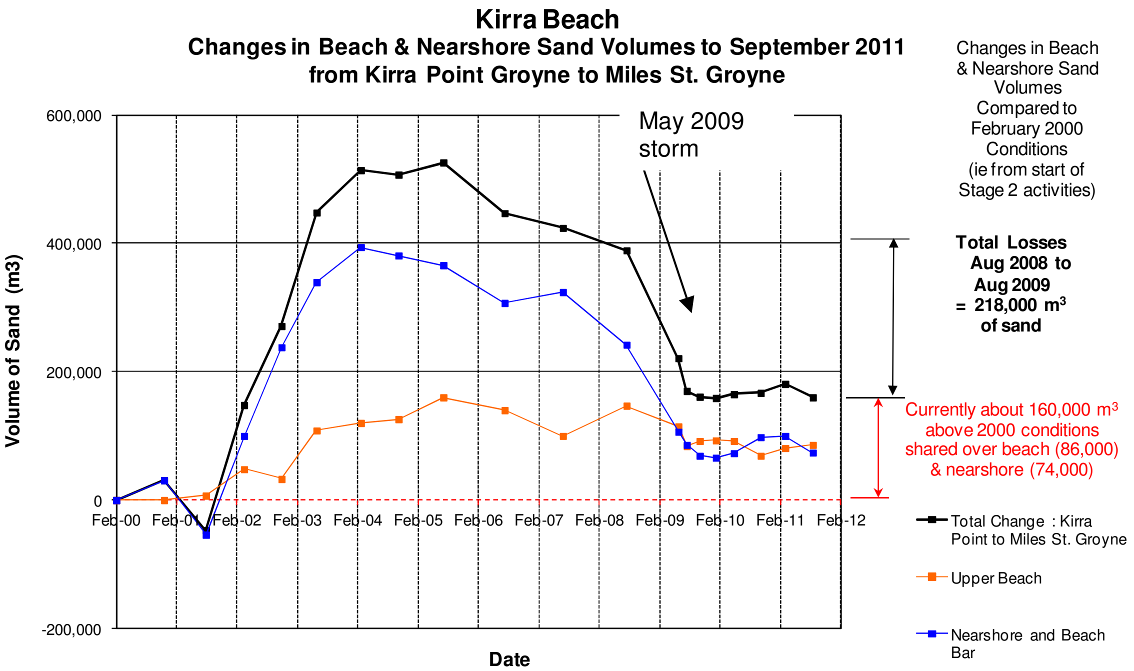


Figure 21 Changes in beach and nearshore sand volumes from Kirra Point groyne to Miles Street groyne between February 2000 and March 2011

Management Challenges and Operational Strategies

Refining Jetty Pumping Regimes

Following the delivery of the supplementary quantity in 2007, the sand bypassing operations have been aimed at matching the natural littoral drift that arriving at the jetty. The jetty pumping procedures have also been refined over time to be as effective as possible in capturing the variable net longshore sand drift on a daily basis. The jetty operates four pumps at a time to maintain the sand trap at the jetty extending across the zone of littoral drift. As part of the ongoing system improvements, the TRESBP Operator has installed flowmeter/densometer instrumentation on each of the jet pumps to enable monitoring of individual jet pumps. In addition, since 2007, the two most landward jet pumps have not been utilised, in order to promote beach progradation at north Letitia Spit and sand pumping is carefully managed to capture and deliver sand quantities that are consistent with the natural daily drift.

Jetty Efficiency

The jetty facility is the primary means for the artificial sand bypassing of the entrance. During a relatively lower than average transport year, the jetty intercepts almost all of the net sand drift. For example in 2009/10, the jetty captured 320,000 m^3 of sand compared to the estimated sand drift of 325,000 m^3 (Figure 22). In average transport years, the jetty may intercept about 70 to 80% of the estimated sand drift depending on the nature of storm activity over the year. During higher than average sand transport years, the interception rate is less. For example in 2008/09 the jetty captured about 420,000 m^3 of sand compared to the estimated net transport of about 730,000 m^3 (60% interception).

Consequently, dredging is required every two to three years to help maintain entrance navigation conditions. The dredge quantity of up to approximately 200,000 m^3 per occasion is required for the project operations to deliver a quantity of sand to the Queensland beaches that is similar to the natural sand drift over the longer term (Figure 22). This is particularly important for higher transport years to match the natural sand drift but may create a short-term supply imbalance depending on the timing of dredging. The dredging component of the project presents operational management challenges due to the infrequent availability of a suitable dredge and calm weather conditions for a particular year.

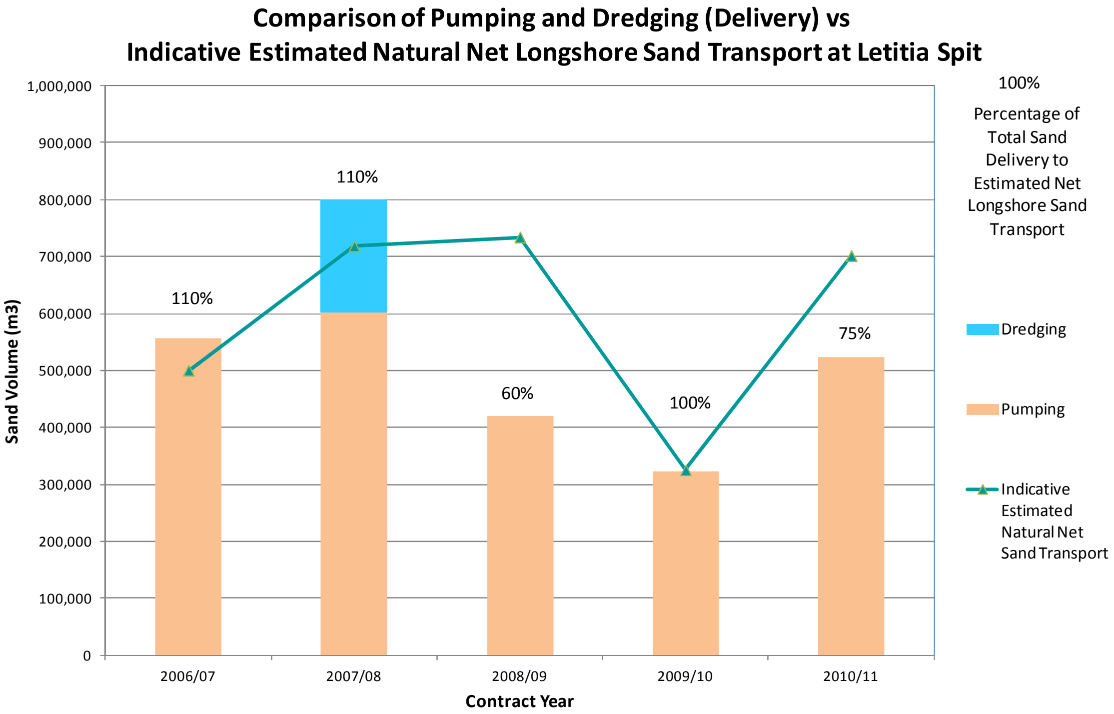


Figure 22 comparison of pumping and dredging against the indicative estimated natural net longshore sand transport at Letitia Spit

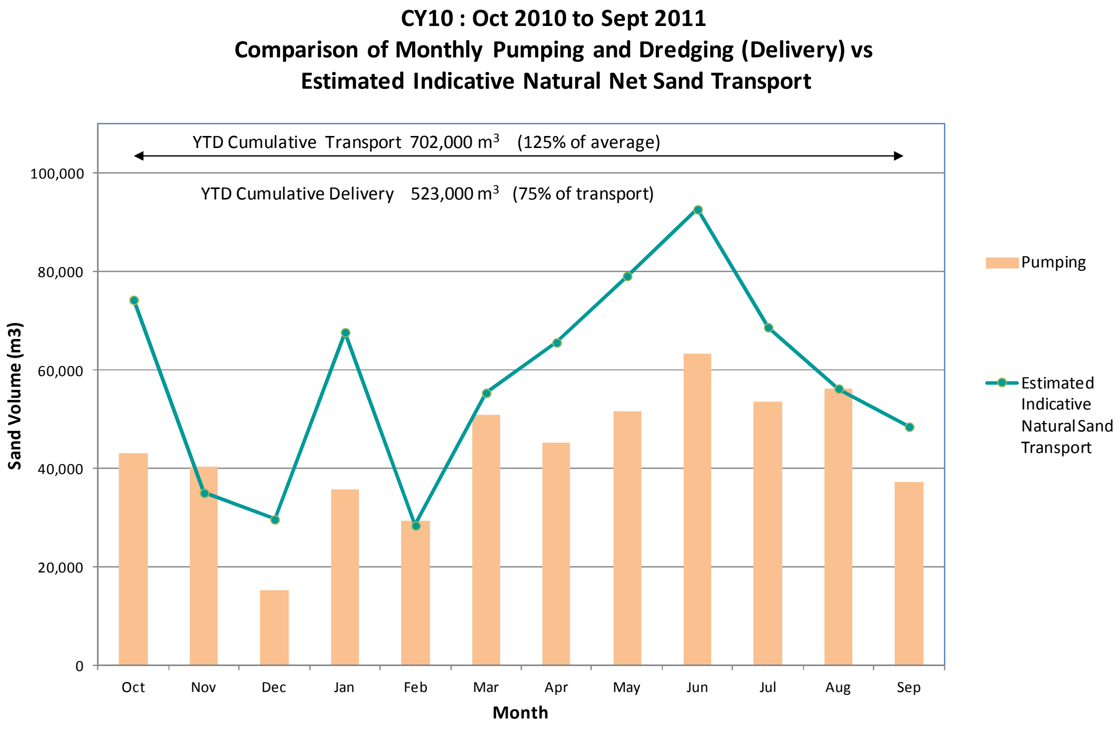


Figure 23 comparison of monthly pumping and dredging against the indicative estimated natural net longshore sand transport at Letitia Spit

Dredge Placement Strategies

Sand dredged from the entrance is placed in nearshore placement areas offshore from Duranbah to Coolangatta Beach. Up until 2006, dredge sand was used to replenish and maintain the nearshore bed profile offshore of Snapper Point. This was carried out to minimise the seasonal reduction of the Snapper Rocks surfing bank during persistent north-easterly waves each year and following storm erosion.

However in the last dredge campaign in 2008, a significantly reduced quantity was deposited in the Snapper Rocks East area and the majority of the dredge sand was placed in deeper, less active reserve areas offshore of North Duranbah as a trial placement. The purpose of this trial was to delay the reworking of deposited sand around Snapper Rocks for a number of years. The nearshore bed offshore and to the immediate south east of Snapper Point has exhibited ongoing net losses at a rate of about 45,000 m^3/yr. Following this trial placement and as no dredging has occurred since 2008, it is likely that a future dredge placement strategy will include some placement to replenish the Snapper Rocks East nearshore areas to reduce the vulnerability of the Snapper Rocks surfing bank to major storm losses.

Dispersion of Excess Sand Volumes

Excess sand volumes in the Rainbow to Coolangatta coastal compartments have progressively reduced following the initial delivery of the supplementary quantity and are approaching pre-pumping levels surveyed in 2000 (see Figure 24). While sand build-up has reduced at Kirra Beach, there is still a significant quantity of excess sand that impacts on beach width, Kirra Reef and surfing conditions at Kirra Point. The project has undertaken a number of strategies to reduce the sand supply around Snapper Rocks to promote the natural dispersal of sand from Kirra. This includes the careful management of pumping operations to capture and deliver sand quantities consistent with the daily sand drift, while also providing opportunities to promote rebuilding of Letitia Spit beach following storm erosion. The Queensland Government has recently undertaken the first two stages of the Kirra Beach Restoration Project which saw a total of approximately 230,000 m^3 of sand excavated from the shoreline to reduce the beach width and restore a vegetated sand dune buffer.

A further strategy to reduce the sand flow around Snapper Rocks has been the trial placement of dredge sand in deeper reserve areas offshore Duranbah in the last campaign in 2008. Monitoring has shown that this has been successful, with only partial shoreward reworking of placed sand over 3 years at intermediate depths of 10 to 15m, and stability with little reworking in deeper areas of 15 to 20m water depth.

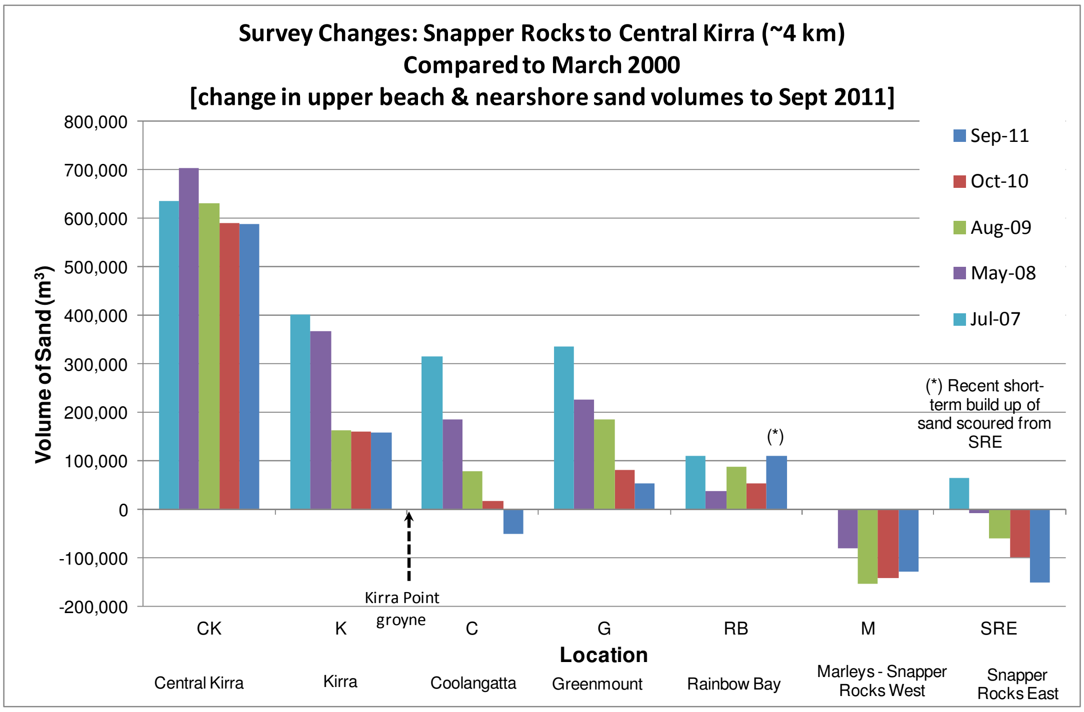


Figure 24 Survey changes from Snapper Rocks to Central Kirra compared to March 2000 Conditions

These strategies have helped promote the reworking of excess sand along the southern Gold Coast beaches towards the Bilinga and Tugun beaches, to restore long-term depleted coastal sand volumes downdrift of the project area. Sand volumes in the Rainbow Bay, Greenmount and Coolangatta compartments are approaching conditions surveyed in 2000 prior to the start of pumping.

In 2009 the TRESBP commissioned feasibility studies into four options for enhancing system operations and providing greater flexibility to manage the highly variable sediment transport rates. These options include a new sand delivery outlet at North Kirra, additional dredge placement areas, a once off delivery of sand dredged from the Tweed River entrance to Kingscliff and sand backpassing southwards to Letitia Spit Beach. The results of the feasibility assessment have recently been released and community feedback on these options has been invited.

Conclusions

Ten years of monitoring has emphasised that the natural coastal processes within the project area are highly variable both temporally and spatially, over short-term (months) and long-term cycles (5 to 10 years). The coastline is exposed to high wave energy and associated strong northward sand transport. There are often major differences in short-term sand transport conditions at the different beaches and short-term pulsing of sand around heads or points, leading to variable sand drift along the coastline and beach variability, particularly during storm events.

The monitoring program has been highly valuable for the development of an understanding of the particular local short-term fluctuations and medium term trending behavior at the various compartments. This understanding is crucial for the management of the sand bypassing operations, as they are impacted by and in turn impact on the local coastal processes. Storm-driven longshore sand transport represents a significant portion of the natural littoral drift occurring at the TRESBP jetty and entrance area, as well as within the sand placement areas in the southern Gold Coast. The severity and frequency (or infrequency) of ocean storms presents particular management challenges for sand bypassing interception as well as placement operations.

To address the variability and complexities of sand transport at different locations, sand volumes need to continue to be delivered in a flexible way. This involves managing dredge placement operations to minimise pulsing in sand delivery, which is inconsistent with natural transport conditions. TRESBP recognises the importance of providing flexible management options to achieve the optimum mode of operation to match natural littoral drift to volumes of pumping, dredging and natural bypassing and it is anticipated that the chosen feasibility option will greatly assist with this process.

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