The Entrance Morphodynamic Modelling and Beach Management Investigations 2013/2015

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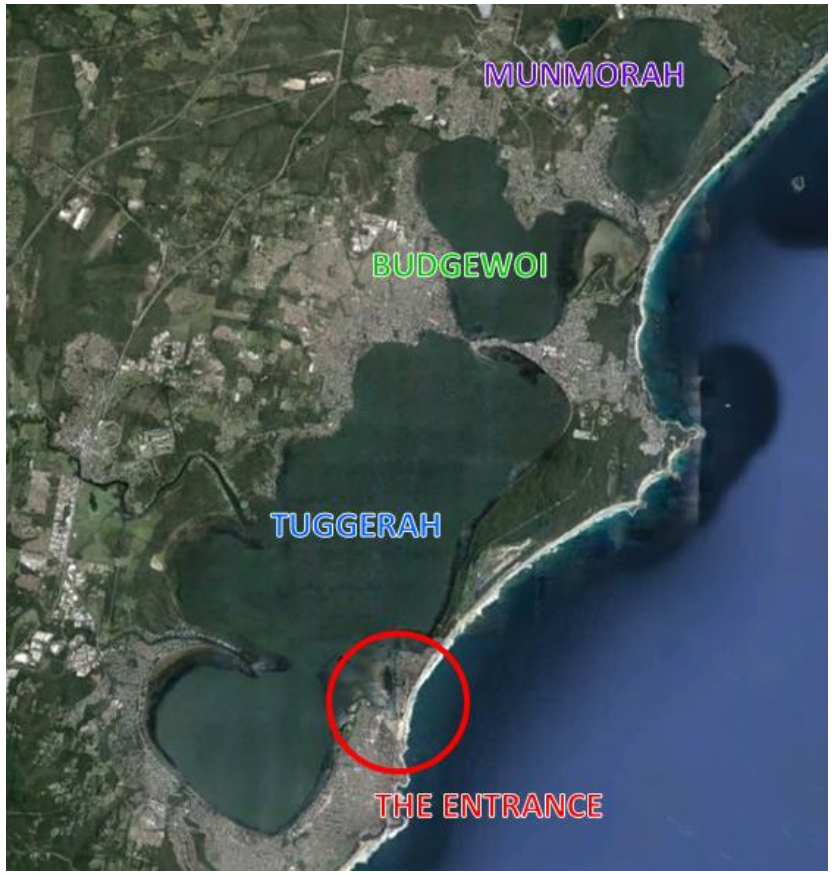
Introduction



•The Tuggerah Lakes system consists of three inter-connected shallow coastal lakes (Tuggerah, Budgewoi and Munmorah) that have a weak and intermittent connection to the ocean at The Entrance.

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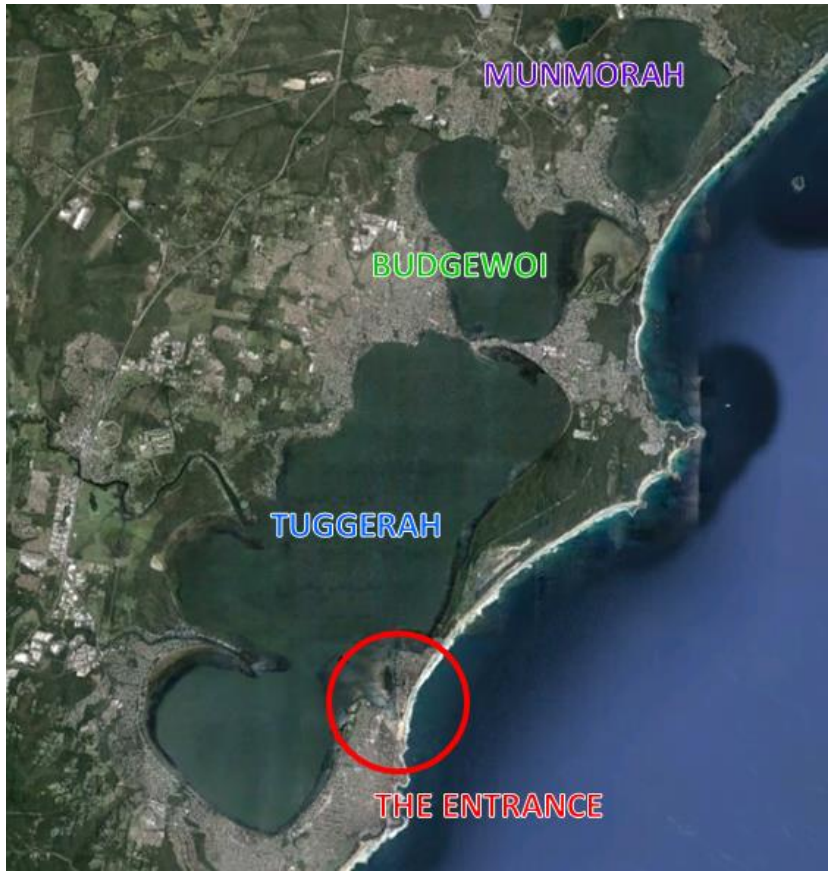
Introduction



1. **<u>Morphodynamic Modelling Investigations</u>** - In 2011, Cardno Pty Ltd was commissioned by the NSW Government to:
    A. Develop a numerical model of the lake system,
    B. Assess the potential effectiveness of entrance training walls in addressing water quality issues.

2. **<u>Beach Management Investigations</u>** - In April 2013, Cardno Pty Ltd was commissioned by the NSW Government to:
    A. Assess the effectiveness and value of various entrance structures and beach nourishment programs on the management of North & South Entrance Beaches.

3. **<u>Additional Morphological Modelling at The Entrance</u>** – In 2014, Central Coast Council (formerly Wyong Shire Council) commissioned Cardno Pty Ltd to undertake further modelling of The Entrance Channel to investigate:
    A. the effects of deepening the entrance channel through dredging and removal of part of the underlying rock shelf at the lake entrance.

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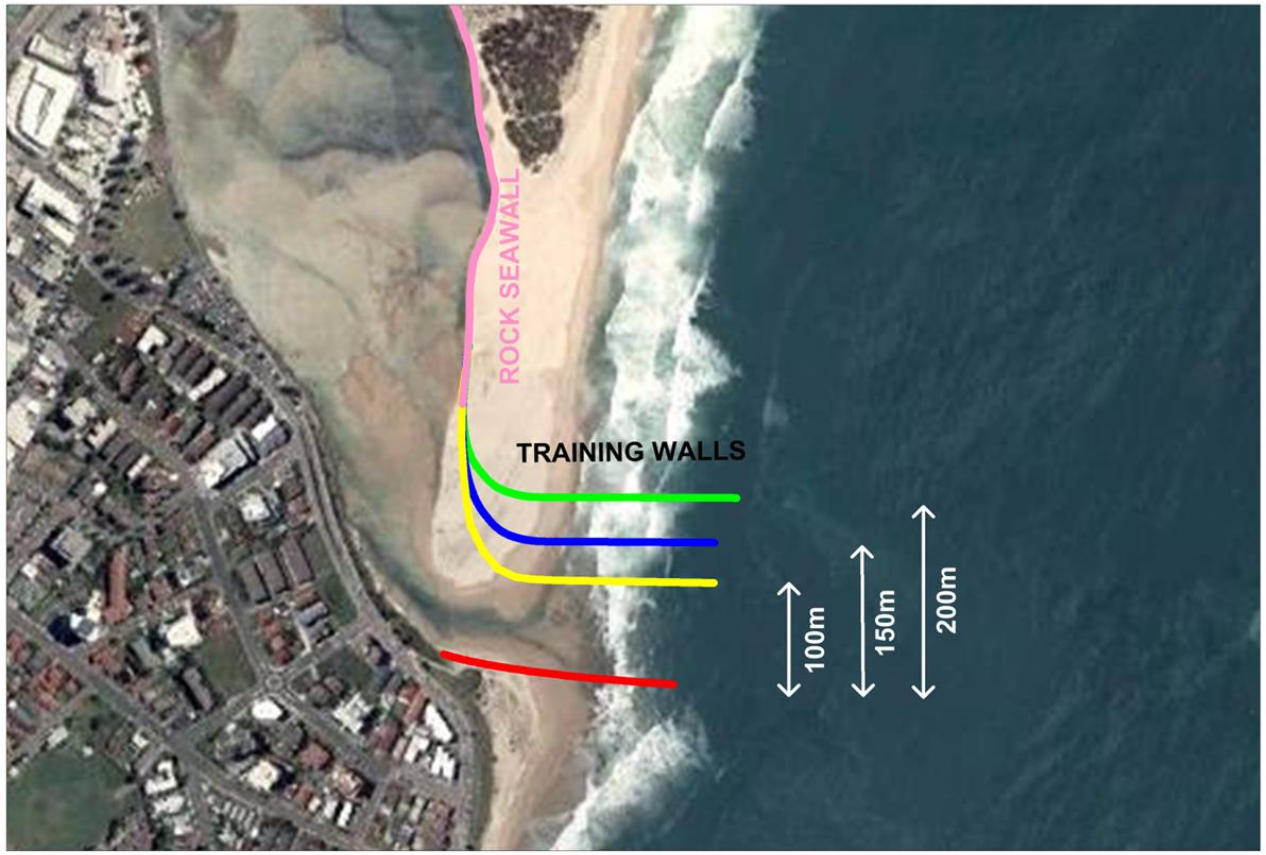
Morphodynamic Modelling Investigations

- Cardno established a calibrated and verified, coupled hydrodynamic and wave model of the lakes system.
- Simulations were conducted to investigate the effect of entrance training walls on:
  - Flood levels, and
  - Flushing and water quality of the lake system
- The following training wall configurations were tested:
  1. Single Northern Training Wall
  2. Dual Training Walls 100m Apart
  3. Dual Training Walls 150m Apart
  4. Dual Training Walls 200m Apart



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Morphodynamic Modelling Outcomes

1. The training walls would have to be spaced at least 150 metres apart to ensure that flooding around the lakes was not worsened;
2. At this spacing the channel would continue to fill up with sand.
3. The training wall scenarios tested would not significantly affect flushing of the lakes - and so could be expected to have minimal impact upon lake water quality.
4. However, the presence of training walls may provide some benefit to South Entrance beach in the form of improved sand retention (from the South Training Wall).

Training Wall Configuration	Impact on Flood Levels	Impact on Flood Duration	Impact on Lake Flushing
Single Northern Training Wall	Minimal	Minimal	Minimal
Dual Training Wall - 200m Apart	Minimal	Minimal	Minimal
Dual Training Wall - 150m Apart	Minimal	Minimal	Minimal
Dual Training Wall - 100m Apart	Negative	V. Negative	Minimal

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During Flood Event

Post Flood Event

Beach Management Investigations

Options Investigated:

Option	Structure(s)	South Entrance Beach Nourishment Program
1	Fully trained entrance - walls 150m apart	15,000m^3 initially
2	Northern entrance training wall and northern revetment wall	10,000m^3 per 5yrs#
3	Long groyne at South Entrance Beach	15,000m^3 per 7-10 yrs#
4	Short groyne at South Entrance Beach	10,000m^3 per 7-10 yrs#
5	None*	10,000m^3 per 5yrs#

Approximately

*The installation of a permanent sand slurry pipeline for beach nourishment was also considered. Analysis showed that due to high installation costs, this option was poor value for money compared to temporary pipe works laid during each round of nourishment.

Option 1 – Trained Entrance + Nourishment

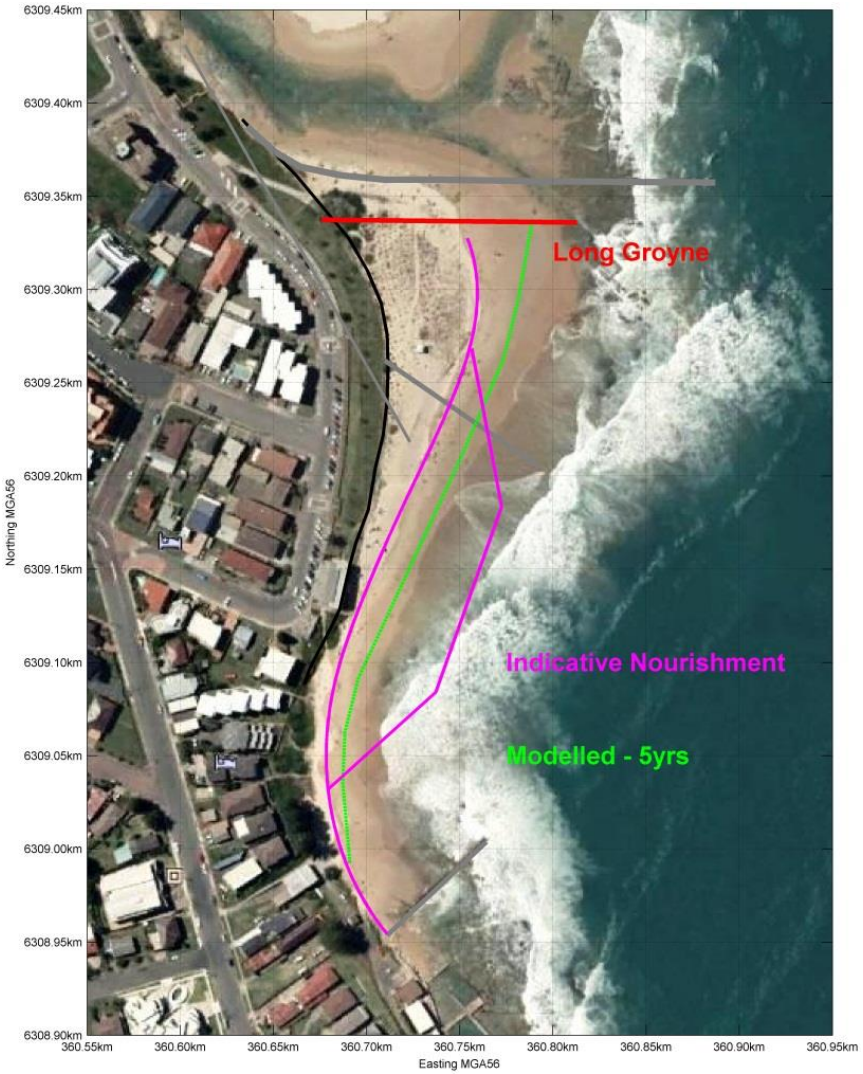
DESCRIPTION	Complete training of the entrance – includes Northern and Southern Training Walls (150m apart as specified by pervious study). Includes ongoing sand nourishment for South Entrance Beach – as required.
COST	Northern Training Wall Construction: $23,440,000 Northern Revetment Wall Construction: $7,230,000 Southern Training Wall Construction: $12,830,000 Beach Nourishment: Approx. $385,000 initially. **50 years NPV Cost: $46.9 Million** (including maintenance).
PROS	Would increase the length of time that sand is retained on South Entrance Beach post nourishment by 5-10 years. Modelling shows that the Southern Wall would accumulate sand on its southern side in the long term. Would very gradually accumulate sand on its northern side without sand nourishment (although this would be very localised). Would prevent dredged sand placed near Hutt Road from re-entering The Entrance. Revetment would prevent erosion / shoreline recession inside the Entrance at Karagi Park.
CONS	Construction would require 15,400 Truck and Dog movements → consequent road damage, congestion and social impacts. Significant costs involved. Visual impact. Would have negative impact on Little Tern habitat near Karagi Point. Some Loss of beach amenity & pedestrian obstruction inside the entrance – northern side (revetment wall) Some loss of beach amenity & pedestrian obstruction of South Beach (high crest level). Loss of beach amenity along southern bank of entrance channel (inside walls).
COMMENTS	Morphodynamic Modelling suggests that the training walls are unlikely to significantly affect water quality, or flooding in the lakes system (provided that the walls are spaced 150m apart or more). Would require that maintenance dredging of the type already undertaken by Council continue to be placed at North Beach & occasionally South Beach.

Option 2 – Nth Training Wall + Nourishment

DESCRIPTION	The training wall would be built to a high crest level, and be of substantial design. Its intent would be to very gradually trap sand on its northern side after each significant flood. In order to prevent short circuiting or a breakout of the channel through Karagi Point north of the Northern training wall due to a large flood, the northern training wall structure includes a revetment along the shoreline up to Karagi Park and then to the Entrance Bridge
COST	Northern Training Wall Construction: $23,440,000 Northern Revetment Wall Construction: $7,230,000 Beach Nourishment: Approx. $256,000 ongoing @ approx. 7-10yr intervals. **50 years NPV Cost: $33.6 Million** (including maintenance).
PROS	Would very gradually accumulate sand on its northern side without sand nourishment (although this would be very localised at its southern end). Revetment would prevent erosion / shoreline recession inside the Entrance at Karagi Park. Would prevent dredged sand placed near Hutt Road from re-entering The Entrance.
CONS	Construction would require 8,000 Truck and Dog movements → subsequent road damage, congestion and social impacts. Significant costs involved. Visual impact. Loss of beach amenity & pedestrian obstruction inside the entrance (revetment wall) Zone of sand accumulation very localised - there would be no reduction in shoreline recession and erosion hazards as far north as Hutton Road for many decades. Would have negative impact on the Little Tern habitat near Karagi Point.
COMMENTS	Morphodynamic Modelling suggests that single northern training wall is unlikely to significantly affect water quality or flooding in the lakes system. Unlikely to affect sand accumulation/erosion at South Entrance Beach. Would require that maintenance dredging of the type already undertaken by Council continue to be placed at North Beach & occasionally South Beach.

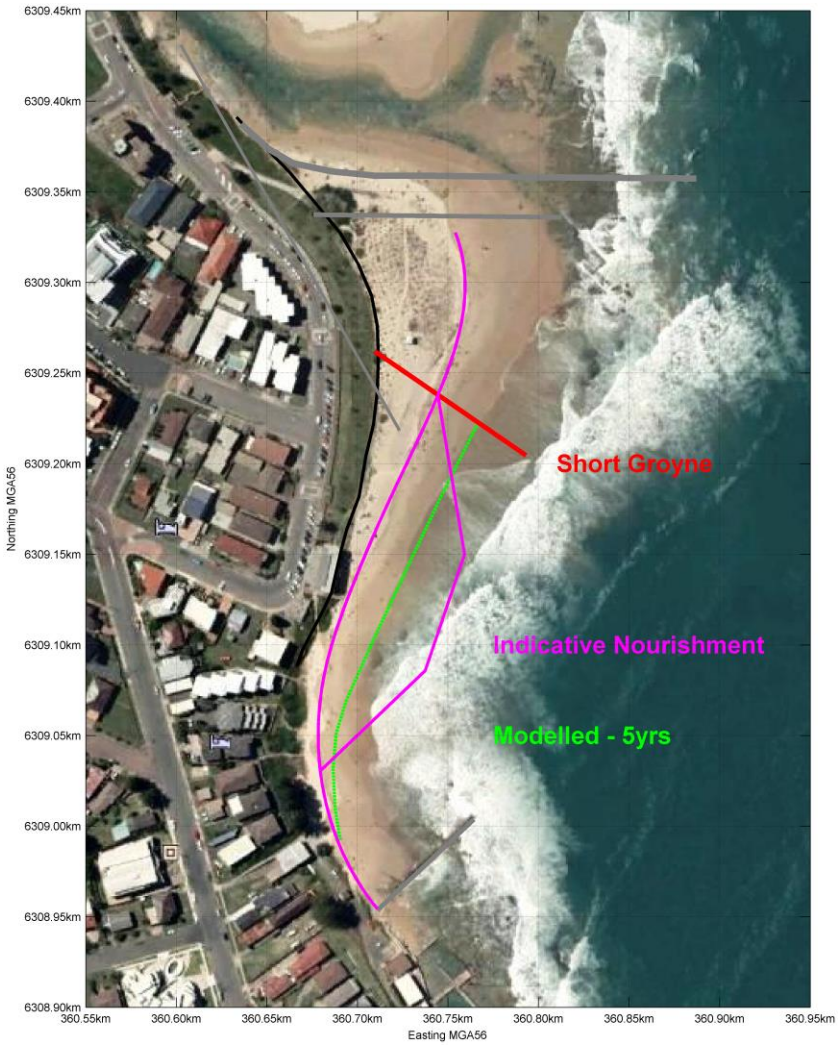
Option 3 – Long Groyne + Beach Nourishment

DESCRIPTION	This structure would have different intent and design to a southern training wall. The long groyne would be built to a lower crest level, would be narrower and of less substantial design. The intent of the long groyne would be to very gradually trap sand on its southern side after each significant flood, as sand is transported back onshore under wind and wave action. In order to improve beach amenity in a shorter timeframe this option could be accompanied by 15,000m^3 of initial beach nourishment.
COST	Construction: $2,540,000 Beach Nourishment: Approx. $385,000 ongoing @ approx. 7-10yr intervals. **50 years NPV Cost: $3.8 Million** (including maintenance)
PROS	Would increase the length of time that sand is retained on South Entrance Beach post nourishment by 2-5 years. Low crest level means significant part of structure would be buried in back beach dunes, reducing visual impact & impact on beach amenity. Modelling shows that the Long Groyne would accumulate sand on its southern side in the long term.
CONS	Construction would require 600 Truck and Dog movements → consequent road damage, congestion and social impacts. Loss of beach amenity & pedestrian obstruction. Visual impact.
COMMENTS	Beach outcomes essentially the same as for the short groyne but would provide a bigger beach with addition of long term sand accumulation.



Option 4 – Short Groyne + Beach Nourishment

DESCRIPTION	A short groyne south of the rocks with periodic 10,000m^3 of sand nourishment.
COST	Construction: $2,000,000 Beach Nourishment: Approx. $256,000 ongoing @ approx. 7-10yr intervals. **50 years NPV Cost: $2.9 Million** (including maintenance)
PROS	Would increase the length of time that sand is retained on South Entrance Beach post nourishment by 2-5 years. Semi Permanent.
CONS	Construction would require 500 Truck and Dog movements → consequent road damage, congestion and social impacts. Loss of beach amenity & pedestrian obstruction. Visual impact.
COMMENTS	It is unlikely that the short groyne would accumulate sand in the long term and so would require periodic sand re-nourishment.



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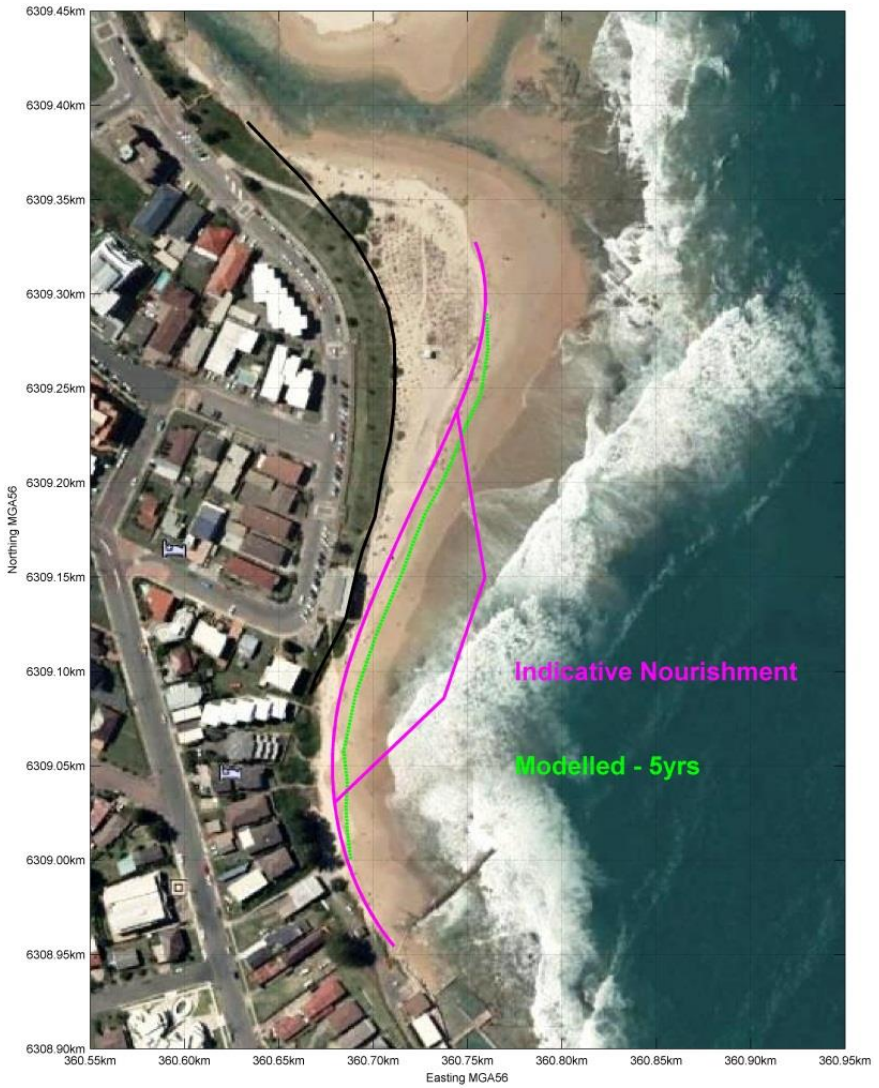
Option 5 – Sth Entrance Beach Management

DESCRIPTION	Sand Nourishment (10,000m^3) performed in conjunction with Council's dredging program
COST	Cost Per Nourishment: $256,000 – ongoing @ approx. 5yr intervals. **50 years NPV Cost: $0.9 Million**
PROS	Would provide enhanced beach amenity in front of the surf club and other areas of the beach.
CONS	Requires periodic replenishment and approvals. Requires temporary pipeline to be sited along the southern channel shoreline – may be vulnerable to storm damage.
COMMENTS	Has been done in the past (circa 2006) with satisfactory results (the previous occasion provided enhanced beach amenity for a number of years – about 30,000m^3).



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Beach Management Options - Impacts

	Trained Entrance + South Beach Renourishment	Northern Training Wall and Northern Revetment + South Beach Renourishment	Long Groyne + South Beach Renourishment	Short Groyne + South Beach Renourishment	South Beach Renourishment
Approx 50 years NPV Cost (7% Discount Rate)	$46.9 Million	$33.6 Million	$3.8 Million	$2.9 Million	$0.9 Million
Impact on Lake Water Quality	Minimal	Minimal	Minimal	Minimal	Minimal
Impact on Entrance Navigation	Minimal	Minimal	Minimal	Minimal	Minimal
Impact on Lake Flooding	Minimal	Minimal	Minimal	Minimal	Minimal
Impact on Beach Amenity North Entrance Beach	✓	✓	Minimal	Minimal	Minimal
Impact on Beach Amenity South Entrance Beach	✓✓	✓	✓✓	✓✓	✓
Construction Impact on Community	✗✗✗	✗✗✗	✗✗	✗✗	✗
Value for money	✗✗✗	✗✗✗	✗	✗	✓✓

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Positive	Measure	Negative	Measure
✓	Minimally Positive	✗	Minimally Negative
✓✓	Moderately Positive	✗✗	Moderately Negative
✓✓✓	Extremely Positive	✗✗✗	Extremely Negative

Additional Modelling

- Central Coast Council (formerly Wyong Shire Council) commissioned Cardno Pty Ltd to undertake further modelling of The Entrance Channel:

  Entrance training walls and four dredged depth options were investigated to describe the following matters:-

  A. The likely changes in lake flushing;
  B. The rate of dredged area infill and the characterisation of that process;
  C. The likely effect of the training walls on flushing, water levels and dredged area infill rate;
  D. The likely effect on tidal planes in the lakes; and
  E. The likely effects on salinity in the lakes.

Additional Modelling

Based on the results of the modelling, the following conclusions have been made:-

Morphology:

- The dredged channels would begin to infill almost immediately from both the upstream and downstream ends;
- The rate of infill from the downstream end (the ocean) would be slower if training walls were constructed;

Water Quality:

- Comparison of simulations undertaken with and without the training walls showed little difference with regards to water quality and water levels in the lakes system;
- The dredged channel schemes would increase the conveyance and tidal exchange between the lake and ocean, and increase lake salinity (at least in the short term). Conveyance increases with channel depth, but such increases are limited by the shoaled region upstream of the bridge, which continues to act as a tidal constriction. For this reason significant changes to mean lake water level and salinity would be observed by dredging to -1.5m AHD or -2.5m AHD, but any additional effects observed by dredging deeper than that would likely be minor.
- The dredged channel schemes would decrease the mean lake level (at least in the short term) by up to 10-20cm, but would result in higher high tide levels (and lower low tide levels) by increasing the lake tidal range.

Additional Modelling

Additional Impacts:

- The increase in conveyance provided by the dredged channels would result in higher tidal current speeds upstream of the Entrance Bridge, which in turn:-
  - May result in scour around the Entrance Bridge foundations;
  - May result in shoreline and channel change along Terilbah Reserve (in the long term);
- A reduction in mean lake water level may have a number of ecological and recreational consequences, in the form of exposure of the mudflat areas and potentially reduced recreational opportunities and commercial fishing catch. Navigational issues within the lakes would need to be considered, notably at jetties and boat-ramps where less draft would be available.
- Note that the scale of dredging investigated is much greater than Council undertakes presently.
- Should one of the test cases prove attractive to Council, then additional, detailed investigations of the rock sill need to be undertaken before undertaking more detailed modelling.

Thankyou for your time

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