CURRARONG COASTAL EROSION
JUNE 2016 STORM AND RESPONSE
Hand out - public meeting 14 October 2016

1. BACKGROUND

On June 5-6, 2016 Currarong was hit by a severe coastal storm which caused beach erosion at Warrain Crescent and slumping at Beecroft Parade. All staircase beach access ways were destroyed and an estimated 20,000 m^3 of sand lost from the beach.

After the storm, Council undertook a round of beach surveys to assess the impacts. These surveys have also been used to inform the review of the coastal hazard risks currently being undertaken by the coastal consultant, Advisian.

Coastal hazard processes, and associated risks at Currarong Beach, have been extensively investigated by coastal experts since the mid 1990s and are reasonably well understood (see reference list on p 13).

Coastal erosion remediation options have been assessed and previously discussed with the community.

Community representatives requested further consultations with the Currarong community to provide information regarding the June storm event and an appropriate remedial response. It was agreed that a Friday afternoon meeting on site, followed by a public meeting in the Progress Hall, should take place.

This handout sets the scene for the current round of discussions, focusing specifically on:

- June 2016 storm
- Interim/emergency measures
- Short term coastal management measures
- Adaptive long-term response to erosion protection

2. JUNE 2016 STORM

An East Coast Low (ECL) pressure system developed off the NSW Mid North Coast on the afternoon of Saturday 4 June 2016. The system tracked south past Sydney on the Sunday afternoon and continued south towards the Victorian border on Monday/Tuesday. The event brought significant rainfall, strong NE winds, large waves, and coincided with the winter solstice king tide. The tidal residual in Sydney (the difference between the measured water level and the predicted tide level), was up to +0.34 m. This 'storm surge' is due to the low pressure system effectively sucking up the sea level and the strong onshore winds dragging across the surface and piling up water against the shoreline.

The storm was most intense off Sydney and along the South Coast. What was most unusual for an ECL was the high easterly component in the swell wave direction which led to high storm impacts at east through to north facing beaches such as Currarong. From the Saturday through to the Monday afternoon, the swell wave direction was due east at Port Kembla.

The intensity of the storm at Currarong was strongly related to its directionality.

The severity of the June storm event for nearshore waves has been investigated by Baird Australia (coastal engineers). Their modelling found the June 2016 storm to be particularly severe at Currarong ranging between a 50 and 80 year ARI event.

Based on surveys undertaken by Council, it has been estimated that 20,000 m^3 of sand was eroded from Warrain Beach in the June storm event (Advisian). Severe erosion was experienced along the Warrain Crescent shoreline and also at Beecroft Parade. All beach access stairs at Warrain Crescent were destroyed. Photos below.

East end of Warrain Crescent looking west; mid reef in middle ground

Beach access stairs destroyed at Warrain Crescent

Erosion at Beecroft Parade

Yalwal Street boat ramp approx. 9pm Sunday June 6. Wave run up debris line estimated at 3.5m AHD (Photos courtesy of Dave & Gina Thornton).

3. EMERGENCY RESPONSES

Following the storm, Council implemented safety, clean up and remedial measures including:

- temporary hazard fencing and signage
- remediation of park infrastructure around Abraham Bosom reserve carpark
- remediation at the rock pools
- beach access closure and reshaping of Peel Street access
- land survey monitoring of erosion to inform review of coastal hazard risks (Advisian review)
- engagement of Royal Haskoning to further investigate adaptive responses and to undertake community consultation

4. SHORT TERM MANAGEMENT RESPONSES – SAND AND BEACH ACCESS

A remedial project, to be implemented in the coming months (subject to approvals), aims to accelerate the return of eroded sand to the beach face and to replace two beach access stairs. This work will be carried out by the Soil Conservation Service (Nowra), and will comprise

- Removal of sand by excavator from western edge of creek inlet to reuse for beach replenishment
- Beach scraping along Warrain Crescent and placement of woody debris to high tide dune scarp
- Placement of excavated sand at toe of beach scarp at Warrain Crescent (between two reefs)
- Replacement of washed out beach access stairs at Currarong Creek and Worrigee Street.

The major elements of the remedial works involve:

- removal of approximately 2,000 m^3 of sand from the shoaled areas of the navigation channel within the creek entrance using land based plant (max depth 1m over 6m width)
- excavation of the low tide beach (beach scraping) to a maximum depth of 500mm
- sand from these two sources placed at the base of the dune scarp, to a slope of 1v:7h, and compacted.

A similar operation at the entrance to Currarong Creek was carried out in December 2009 with the sand placed at the back of the beach along Warrain Crescent.

Council has prepared a Review of Environmental Factors, and a determination to proceed with the works was made on 5/9/16. However, Aboriginal Heritage items, exposed by the erosion, may impact on the timing and scope of works.

The sand recovery operation described above is a short term response to repair the beach and improve beach amenity. For the medium to long term, a more substantial response will be required.

5. LONG TERM RESPONSE OPTIONS

5.1 Coastal hazard summary

Coastal processes and associated erosion risks have been investigated and assessed by various coastal experts and they all concur that the beach volume has been decreasing over time and the beach has been receding over time. Their findings are based on measured data and documented evidence. The current design parameters (SMEC 2009) for assessment of coastal hazard are as follows,

• Design storm erosion demand	60 m^3/m measured above AHD (less than 5% probability of being exceeded over 50 years)
• Creek entrance instability	Limited to 250 m of creek entrance; increase in storm demand not specified
• Long-term (budget) recession	0.17 – 0.25 m/yr (based on measurements at Currarong between 0.1 and 0.34 m/yr)
• Sea level rise (SLR) recession	5.2 m (1990-2055) – 11.7 m (1990 – 2100)
• 2% wave run-up	3.6 – 4.2 m AHD

The Shoalhaven draft Coastal Zone Management Plan (Umwelt 2012), reports that immediate erosion risk at Currarong mainly affects the dune system which periodically undermines stair access ways.

Coastal experts have found that, in the longer term, the water main and the ten most easterly residences will be potentially affected by erosion and recession. The current coastal hazard zones are shown in the draft CZMP. These hazard zones, currently being updated by Advisian, draw on a range of updated information - aerial photography, sea level rise projections, photogrammetry data, LiDAR ground level information, ground survey information, information from a sediment compartment study undertaken by University of Wollongong in 2014 as well as data collated during and after the June ECL.

The Currarong Beach Erosion Remediation Study, Options Assessment Report (SMEC, 2011) forms Appendix 7 of the draft CZMP:

http://shoalhaven.nsw.gov.au/demosite/environment/coastal/documents/18_R04_Appendix_7a.pdf

http://shoalhaven.nsw.gov.au/demosite/environment/coastal/documents/19_R04_Appendix_7b.pdf

This report examined coastal management options to address the hazards as they were understood at the time. While some modification could be expected with the Advisian review, preliminary findings confirm that the broad understanding of the threat to Warrain Crescent is not expected to change.

5.2 Assessment of management options

Coastal management options essentially fall into 2 groups: retreat or protect. Adaptation is sometimes presented as a third group which recognises that the coastline is impacted by complex coastal processes and that the management strategy should be adaptable to changes in hazard prediction. Combinations of options are often part of an adaptive strategy.

The Options Assessment Report presented an assessment of nineteen options involving the following nine core options:

- Seawalls or revetments (variable lengths)
- Artificial reef
- Groyne(s)
- Beach nourishment (on its own, or stabilised)
- Planned retreat (road relocation and/ or property purchase)
- Planning controls
- Dune Management
- Relocate and train entrance to Currarong Creek
- Do nothing

The nine options were each scored against economic, social and environmental criteria, or Triple Bottom Line (TBL), where weightings were assigned to reflect importance relative to legislative requirements as follows:

- Economic 2.5
- Social 0.5 (visual impact) – 4 (effectiveness of option)
- Environmental 1.0

The important and high weight 'effectiveness of the option' criterion, relied upon an understanding of sediment transport processes. This was investigated in some detail by SMEC who modelled the swell and locally generated sea wave climate to derive sediment transport pathways and develop a conceptual model of sediment transport – see diagram below.

Conceptual model of sediment transport (SMEC, 2012)

The model shows that wind waves lead to a W to E sediment transport potential along the full length of Currarong Beach (blue arrows), while swell waves lead to transport potential both towards the E and W, with central reef forming the null point. The unidirectional transport, east of the central reef towards the creek, contributes to the relatively high rate of sand infilling.

As a result of the TBL assessment, planned retreat (road relocation) with dune management, attained the highest score, and relocation and training of Currarong Creek, the lowest.

Initial assessment by SMEC, followed by workshops with Council, Coastal Management Committee, community representatives and OEH officers, shortlisted three options for further consideration and concept design;

- Beach nourishment
- Groyne
- Geotextile protection for repair of localised erosion and access ways

A trial geotextile groyne with companion beach nourishment was favoured.

It has been estimated that 15,000 m^3 of sand is required to develop an efficient beach nourishment and groyne design, and that compatible sand of sufficient quantity could be sourced from Currarong Creek and Plutus Creek. If required, some sand may also be available from nearby Abraham Bosoms Beach.

A general arrangement for the preferred groyne and nourishment concept is shown in below.

Groyne and beach nourishment scheme

There has been some discussion on the positional detail for the groyne between the central reef and the creek entrance. OEH has suggested that the groyne position should be about 60 m closer to the creek than is recommended by SMEC. This can be addressed in the detailed design.

The final recommendation by SMEC was to construct a geotextile groyne at the narrowest part of the spit and place the 15,000 m^3 of nourishment sand. This would reduce the risk of a breakout of the creek through the spit, prevent loss of sand into Currarong Creek by trapping the west to east movement along the beach and provide a storm erosion buffer to the eastern end of Warrain Crescent which is most exposed to wave erosion.

The geotextile groyne would have a relatively short design life. SMEC suggests around 5 years, although recent experience from Stockton Beach and Maroochydore indicates that a 10 to 15 year life, with suitable maintenance, is probable.

The intention would be for the geotextile container structure to operate as a trial scheme, with regular surveys to monitor its effectiveness. If the groyne and nourishment scheme proves to be successful in mitigating storm erosion to Warrain Beach, and the community is satisfied that beach amenity is not unduly impacted, then there would be a strong case for Council to consider replacing the geotextile container groyne with rock at the end of its useful life.

If unforeseen issues emerge with the performance of the groyne, then the structure could be readily removed and the beach should quickly return to its current condition.

An environmental assessment would be required to confirm the acceptability of the proposal, develop mitigative measures where required, and set a firm framework for monitoring and review.

6. DISCUSSION OF OTHER OPTIONS

6.1 Dune reshaping

Some community members have suggested that dune reshaping operations, similar to those undertaken at two beaches in Wollongong LGA, would be appropriate for Currarong.

Council was referred to a video posted by Beach Care Illawarra following the June 2016 storm, entitled 'After the Storm, the Healing'. The video shows the effect of the storm on Woonona Beach, the first of the beaches to have undergone dune reshaping.

In summary, the video claims that a sand dune free of vegetation guards against erosion and recovers more quickly following a storm.

Wollongong City Council prepared a Dune Management Strategy which was adopted in March 2014. The dune reshaping (or reprofiling) operations were mainly in response to concerns regarding sight lines for lifesaving operations and the strategy examined parts of 17 patrolled beaches in the Wollongong LGA.

Council sought comment on this issue from the NSW Office of Environment and Heritage (OEH). Aimee Beardsmore, Natural Resource Officer in the Coast & Estuaries group, provided a response (7/7/16), which is summarised below;

- The dune works undertaken in the Wollongong region were done for a specific purpose and the impact of these works is still being tested and monitored by that Council.
- The conclusions drawn in the video cannot be transferred to other areas and should not be relied upon for decision making.
- While the video footage of the beaches (Woonona and Towradgi) is well orchestrated, it appears that several aspects have been overlooked when drawing conclusions.
- The video suggests that as a result of clearing some vegetation from the dunes, the width of the lower beach has since increased. However, this gain in width cannot be attributed to these works alone as data collected after the event by the Council's beach monitoring program shows the lower portion of the beach increased in width at many beaches in the region, both at recently cleared and non-cleared beaches.
- The direction of the recent storm swell, which came predominantly from the north-east, has been overlooked. The cleared portions of Woonona and Towradgi beaches are located at the northern end of the beach compartments and would have been sheltered from the full force of the swell by the adjacent headlands and rock shelves. The storm caused erosion scarps along the middle and southern section of these beaches, whereas the northern ends showed little impacts. This was evident on many beaches along the south coast.

Royal Haskoning DHV concurs with the response provided by OEH i.e. managing beach erosion at Currarong will not be achieved through the removal of dune vegetation.

6.2 Dune vegetation

Dunes are a fundamental component of a dynamic beach system which extends from the nearshore zone in around 15 m of water depth, to the edge of the hind dunes which are naturally well setback from the beach. The width of the whole beach system at Currarong could be as much as 1,000 m including a dune width of 60 m or more.

The dunes at Currarong are not particularly well developed because the beach is located at the

southern end of the compartment and is protected from the predominant dune-forming south to south-easterly weather.

Coastal dune management is an integral part of ensuring the resilience of the coast to wave erosion. It is therefore vital to guard the integrity of the dunes and the vegetation that they support.

The Dune Management Manual prepared in 2001, by the then Department of Land and Water Conservation (now part of OEH), addresses management and protection of coastal dunes to guard against coastal erosion.

A number of relevant extracts from the Dune Management Manual are provided below:

"Vegetation cover is a crucial element in the evolution of dune landscapes. Wind velocity is generally reduced by plant cover encouraging deposition and trapping of wind borne sand." (Section 2.5, p11)

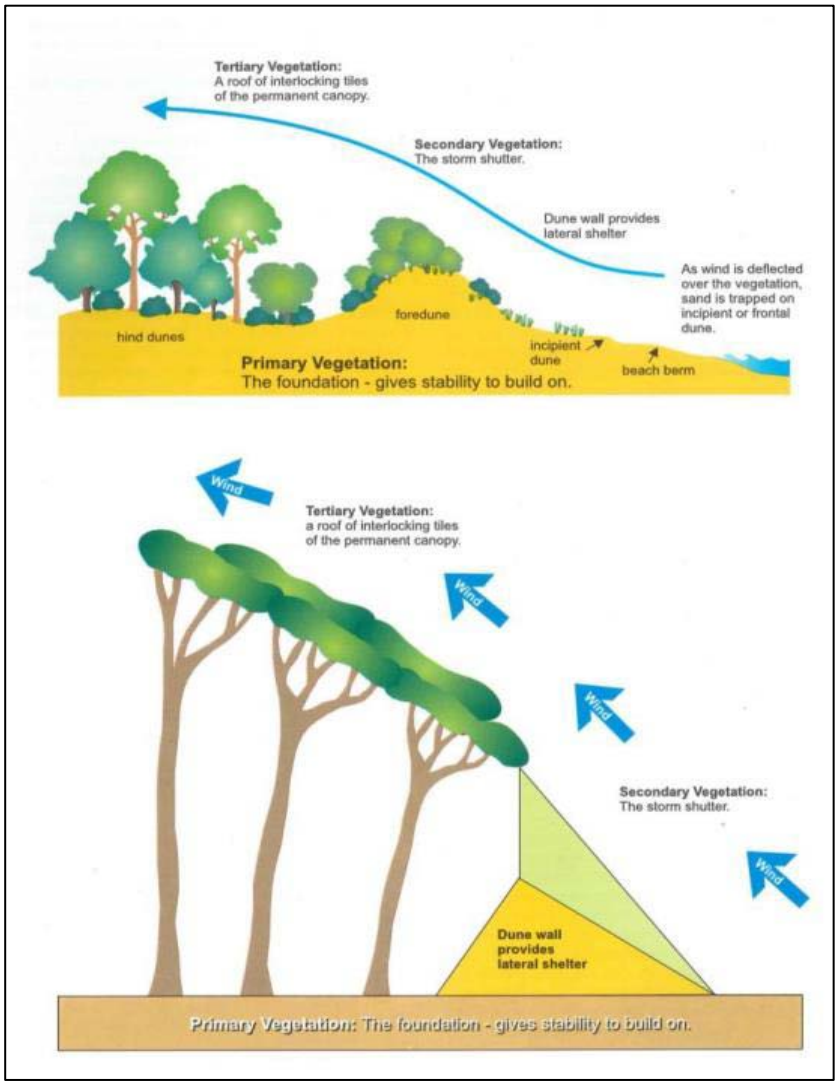
"Without the stabilising effect of vegetation, sand is easily moved by the wind and the resultant sand drift can progressively bury both natural and built environments." (Section 2.5, p 11)

"Dune vegetation is recognised widely as an integrated botanical system exhibiting interdependence in both community structure and floristics and providing food and shelter for a variety of fauna. The need to protect, maintain, and restore these intrinsic ecosystem values is a key element in conserving biodiversity." (Section 2.8, p20)

"The spread of weeds is often favoured by disturbance….Controlling weeds should be seen as part of a wider obligation to retain, protect and restore natural dune systems." (Section 5.3, p74)

Finally, the Dune Management Manual highlights the importance of vegetation zonation to the integrity and function of the dune system:

"The analogy is drawn between the (wind) protection afforded by a well vegetated dune system and that of a well constructed and maintained cyclone-proof house. Primary zone species (grasses and creepers) colonise the lower parts of the beach and trap abrasive sand particles forming a "foundation". The foundation represents an elevated "wall" that can be colonised by secondary zone species (mainly shrubs) to provide a wind deflecting "shutter" near the shoreline. Finally a "roof" forms from the growth of tertiary species (taller shrubs and trees), further elevating the wind and providing increased shelter to vegetation further inland…..Dune stability relies on keeping the whole structure – "foundations", "wall", "shutter" and "roof" – intact. Damage to any component can cause deterioration in other parts." (Section 2.8.1, p20). See below.



Functional model of dune vegetation (DLWC, 2001)

Two other sources of information provide relevant advice;

- OzCoasts, on their website, highlight the importance of dune vegetation and beach and dune systems.

  "The loss of dune vegetation is a major trigger for dune erosion. Dune vegetation traps windblown sand and holds it on the fore dunes. The exposed, dry sand is easily mobilised by high-velocity winds and large volumes of sand can be rapidly transported, sometimes forming large depressions in the dunes termed blowouts. Downwind from blowouts, drifting sand can smother the surrounding vegetation and cover roads and properties. Dune vegetation also contains many native species and is valued as habitat and for its own intrinsic biodiversity."

- *Erosion of Vegetated Coastal Dunes*, (Figlus et al 2014), examines the influence of dune vegetation on wave erosion. Using small scale physical modelling, they found that vegetation does lead to a reduction in eroded dune volume and dune scarp retreat rate. They also found that more mature plants with better developed roots are able to reduce eroded dune volume by a greater amount than plants with less mature root systems.

Note; the authors point out that further research is necessary to substantiate their observations.

6.3 Conclusion – dune reshaping

Reshaping of the incipient dune and parts of the fore dune, as has taken place at Woonona, is not a recommended strategy for Currarong.

RHDHV is not aware of any scientific literature which suggests that reprofiling of dunes, with associated loss of dune vegetation, would reduce exposure to coastal erosion hazard.

7. ARTIFICIAL REEFS

Artificial reefs, referred to in the literature as Submerged Constructed Reefs (SCR's), are often proposed as a 'softer' protection option due to their simulation of natural processes and negligible visual intrusion. SCR's are also frequently proposed as multi-purpose reefs (MPR's), sharing a protective and surfing amenity function. The Water Research Laboratory (WRL) undertook a comprehensive review of the use of SCRs for coastal protection in NSW. The study was based on an extensive review of international literature that considered in excess of one hundred and fifty references (WRL, 2013).

Based on the worldwide review of existing reef structures, WRL drew the following seven key conclusions:

(i) "Of the thirty-two (32) SCR structures reviewed, twenty-nine (29) were intended to provide coastal protection as a primary or secondary objective.

(ii) Approximately half of the "protection" structures had no significant accretionary impact on shoreline alignment compared to their predicted performance.

(iii) 55% of submerged breakwaters were successful at providing increased coastal protection.

(iv) 1 of 5 MPRs may be providing a reasonable level of coastal protection but this structure has only been monitored for two to three years. Three other MPRs provide only minor or negligible coastal protection compared to design, and the performance of the newest MPR (Borth) is yet to be determined.

(v) Eight artificial reefs were constructed with the objective of improving surfability and approximately half of these were considered at least partially successful.

(vi) The resulting shoreline shape behind reef structures often differed significantly from the design predictions, even when the best available design methods were applied.

(vii) Most structures settled and/or suffered from localised scour which resulted in an actual crest level which differed (was lower) from that specified by design and subsequently led to further maintenance and top up costs."

WRL go on to conclude:

"On a relatively simple, straight coastline, it is likely that an emergent offshore breakwater designed in accordance with published methods would form a locally widened beach, provided there is sufficient available sand. The uncertainty in beach response increases as the crest elevation is lowered and the structure becomes submerged. This appears to stem from the present lack of understanding of the morphological response to reef structures in a naturally variable environment, and as a result there is inherently a larger uncertainty associated with these structures. This uncertainty needs to be considered in any feasibility analysis, as it presents a significantly higher risk in comparison with other forms of coastal protection.

Consideration of SCRs built to date shows a relatively large number of failures, even for cases where significant effort was put into very technical designs. This cannot be ignored when considering the current ability to be able to successfully predict the processes surrounding a SCR with required accuracy. Furthermore, many failures have been as a result of structural problems due to complexities of building a structure in an active surf zone on loose unconsolidated materials. These conclusions confirm that considerable improvements are still needed in the design and construction of submerged reef structures.

Regardless of these current limitations, the benefits of SCRs mean that they should continue to be considered as an option for hard coastal protection, so long as the design and expectations take into consideration the lower level of certainty in performance."

7.1 Conclusion - artificial reefs

Artificial reefs must be located in the surf zone to function properly. They need to be very large in order to dissipate wave energy and protect the beach or modify the sediment transport behaviour. Artificial reefs are expensive to design and build and often fail to deliver their intended function. Attempting to meet multiple objectives with MPRs increases the likelihood of not meeting the primary objective.

With a viable groyne and nourishment option available for Currarong, RHDHV believes it would be unwise to consider an artificial reef option given its significantly higher risks and costs.

8. OVERALL CONCLUSION

Currarong is prone to coastal erosion with storms causing regular beach recession over the past 40 years. Coastal process and hazard studies, as well as data collected over more than 60 years, confirm the beach is receding with Warrain Crescent, sewage and water infrastructure at risk of coastal erosion and private properties potentially affected in the longer term.

The June 2016 event destroyed all beach access stairs and left a major erosion scarp. The beach is now vulnerable to future events and the opportunity exists to implement works to restore and enhance the natural defense provided by the dune system. Various options to manage erosion in the long term have already been investigated, including community supported options (do nothing, artificial reefs, dune reshaping).

Beach scraping and dune management alone will not address long term coastal erosion risks.

The preferred option for Currarong is a five year trial geotextile groyne associated with beach nourishment and dune management. This option strikes a compromise between expert advice and environmental and social concerns and is financially achievable. The detailed design of the trial groyne structure would proceed in consultation with the community

Should the monitoring of the trial structure reveal that it does not help to protect against coastal erosion, or that it creates unacceptable environmental or social impacts, the structure could be easily removed with no residual debris left on the beach, and the beach would relatively quickly resume its pre-groyne condition. If the trial proves successful, further consultation with the community on a more permanent structure would be conducted.

Community feedback on the option of a trial, geotextile groyne is welcomed. You can send your comments at council@shoalhaven.nsw.gov.au, please quote reference number 7514E.

9. REFERENCES

Willing & Partners Geomarine (1995)
Warrain Beach Coastal Process Overview
Prepared for Shoalhaven City Council, March 1995

NSW Department of Land and Water Conservation DLWC (2001)
Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques
Prepared by Rod Kidd Coastal Unit, Ecosystems Branch NSW Department of Land and Water Conservation ISBN 0 7347 5202 4

Coastal Engineering Solutions (2002)
Currarong Beach Foreshore Erosion & Management Options Study

Lex Nielson (2004)
Currarong Creek Entrance Stability

SMEC (2007)
Currarong Beach Coastal Hazard Study
Draft report 3001209-015, prepared for SCC Coastal Zone Management Study and Plan, May 2007

SMEC (2011)
Currarong Beach Erosion Design Study
Project No 3001859, prepared for SCC, 11/5/11

Umwelt (2012)
Shoalhaven Coastal Zone Management Plan (draft)
Prepared for SCC

Blacka MJ, Shand TD, Carley JT and Mariani A (2013)
A Review of Artificial Reefs for Coastal Protection in NSW
WRL Technical Report 2012/08, March 2013

Figlus J, Sigren JM, Armitage AR, and Tyler RC (2014)
Erosion of Vegetated Coastal Dunes
Proceedings of 34th Conference on Coastal Engineering, Seoul, Korea, 2014

Royal HaskongDHV (2014)
Shoalhaven Coastal Erosion Remediation – adaptive works strategy for transitioning from 'make-safe/make good' to 'end state' protection
Prepared for Shoalhaven City Council, July 2014

Wainwright D, Lord D, Watson P, Lenehan N and Ghetti I (2016)
Widely Accepted by Competent Scientific Opinion, Sea Level Rise Predictions for the Shoalhaven and Eurobodalla Coast, NSW Coastal Conference, Coffs Harbour, November 2016