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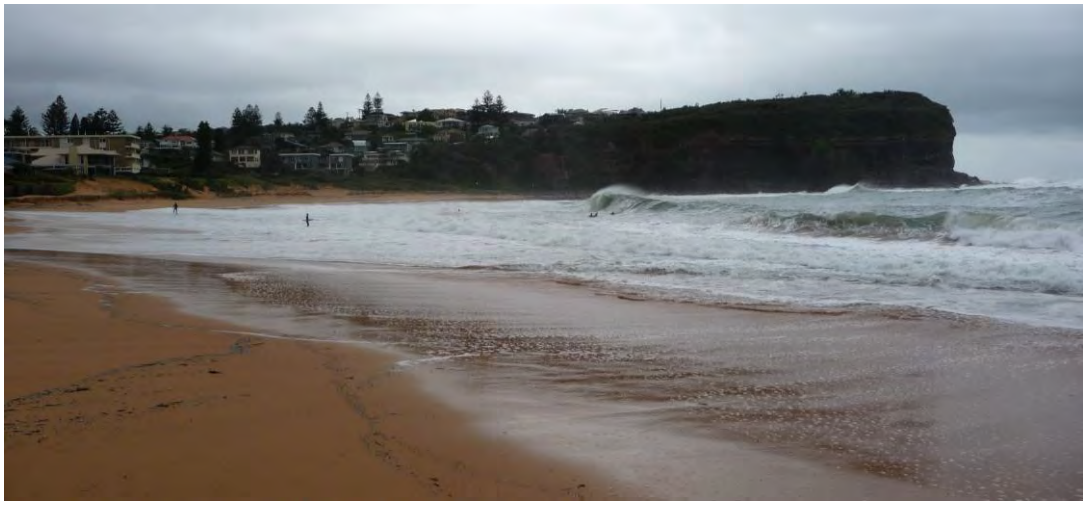

Coastal Zone Management Plan for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)

Technical Appendices Including Coastal Erosion Emergency Action Subplan

Prepared for Pittwater Council by Haskoning Australia Pty Ltd

9 December 2016

Issue E (Revised Draft incorporating Coastal Panel advice)

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Appendix A: Historical Coastal Storm Damage and Protection Works

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A1. INTRODUCTION

Northern Beaches Council undertakes and maintains foredune restoration works as its preferred method of storing sufficient volumes of sand to meet storm erosion demand. Whilst these measures are a natural “soft” option for managing beach erosion, the proximity of some assets to the active beach area has meant that during severe storms in the past, rock and other material has been placed on Bilgola Beach and Basin Beach in an attempt to prevent property damage.

Development along the former Pittwater Council open coast coastline has been most threatened, damaged or destroyed by the action of coastal storms in the mid 1940’s, 1966, 1967, 1974, 1978 and 1997. Discussion on damaging storms that have occurred and protection works that have been undertaken at Bilgola Beach and Basin Beach is provided in Section A2 and Section A3 respectively.

A2. BILGOLA BEACH

A2.1 Allen Avenue Area

Foster and Hattersley (1966) noted that storms in June 1964 and June 1966 (in combination) caused the dune at Bilgola Beach to be cut back landward by about 9m, at the northern end of the beach (inferred to be north of Bilgola Avenue). As a result of the 1966 storm, several houses were at risk of being undermined. A view of the erosion in 1966 is provided in Figure A1. Note that the seawall visible on the left hand side of Figure A1 was part of a landscaped garden and lawn area for a property known as the Bilgola Estate at that time, which had existed since the 1920's (Patterson Britton & Partners, 2005)[1].

Figure A1: Dune erosion at Bilgola Beach after June 1966 storm (derived from Wilson, 1966), with 21 Bilgola Avenue seawall evident on left hand side

To prevent future property damage, Foster and Hattersley (1966) recommended that a sloping rock wall or equivalent was constructed, supplemented or replaced by beach nourishment depending on costs and the ease of securing suitable sand. They also recommended that construction of scour protection was undertaken using rock mats at stormwater outlets.

In 1967, coastal storms further threatened property at Bilgola Beach, and as a result emergency rock protection was attempted along the seaward edge of properties seaward of Allen Avenue (Foster, 1967; Hattersley, 1968). The crest level of these works was about 2.5m AHD (Foster, 1990)[2].

[1] This seawall is now located seaward of 21 Bilgola Avenue, which had a house first constructed on it in 1994. The Bilgola Estate comprised that property, as well the adjacent 3 lots on Bilgola Avenue. That is, the estate covered the present 15, 17, 19 and 21 Bilgola Avenue.

[2] Minutes of the Bilgola Beach Preservation Committee meeting held on 15 June 1974 indicated that the 1967 works cost about $29,100, funded 75% by residents and 25% by Warringah Council (that then included the study area).

However, in the severe coastal storms of May to June 1974[3], these emergency rock works failed to provide adequate protection[4]. As a result, several houses were threatened by wave action and inundation, with one house (at 11 Allen Avenue) so badly damaged from undermining that it had to be demolished (PWD, 1985)[5]. A swimming pool at 9 Allen Avenue was also destroyed in these storms. Several views of the exposed 1967 rock works and damage at Bilgola Beach on 28 May 1974 are provided in Figure A2 to Figure A8[6]. Besides relying on the 1967 rock works, various other protection works were initially undertaken in 1974 including installation of sandbags (probably between 21 Bilgola Avenue and 1 Allen Avenue, see Figure A3) and timber poles (at 7 Allen Avenue, see Figure A4).

Further damage was prevented in 1974 through emergency protection using existing rock material from the 1967 works, as well as supplementary strengthening using imported 2 tonne basalt rock (Foster, 1990). A view of these works and the storm damage is provided in Figure A9. Based on information supplied by the Bilgola Preservation Society, these works were funded by both Council and residents.

Foster (1990) noted that some time after the 1974 storms had abated, the rock seawall was further strengthened based on advice from the Water Research Laboratory to the Bilgola Beach Preservation Committee. This was completed by placing rock in obvious weak locations and to raise the wall crest[7]. The 1967 and 1974 rock works at Bilgola Beach are usually buried under sand at present.

Foster (1990) also noted that additional approximate 2 tonne rocks were placed at and seaward of 11 Allen Avenue in 1979 based on the advice of the Water Research Laboratory, with about 28 rocks placed in total. This was undertaken to "strengthen the wall to a uniform standard" and to raise the crest to 6.5m AHD[8]. Foster (1990) considered that the wall would provide adequate protection to that property in the event of a future storm of similar magnitude to that which occurred in 1974, but noted that as it had an inadequate filter layer some settlement may be expected which may require maintenance following severe storm events.

[3] These storms are considered to be the most significant coastal storms that have been recorded to have impacted on the Sydney area. The May 1974 storm was particularly severe as it was accompanied by the highest recorded water level along the NSW coast.
[4] This may have been partly due to the relatively low crest level of the 1967 rock wall (of 2.5m AHD), compared to dune crest elevations around about 6m AHD. Foster (1990) noted that the wall was severely overtopped in the 1974 storms.
[5] Two written submissions in response to public exhibition of an earlier version of WorleyParsons (2012a, b) noted that this house was damaged by the combined effect of wind action and wave overtopping of the seawall and frontal dune, and was relocated to another property rather than being demolished.
[6] All images were derived from http://www.photosau.com.au/MonaVale/scripts/home.asp (Pittwater Image Library), and arrangements are being made to the copyright owners for permission to use the images.
[7] The emergency and supplementary works were supervised by Macdonald Wagner & Priddle Pty Ltd Consulting Engineers, with existing rock material used from 5 to 7 June 1974, and imported basalt used from 9 to 15 June 1974 (based on an invoice dated 18 June 1974). This invoice also indicated that about 843 tonnes of rock was delivered in total on 10 and 11 June 1974.
[8] A letter dated 2 January 1979 from Mr CT Brown (Tillotson Brown & Partners) to Mr Max Knight (Works Committee, Warringah Shire Council) indicated that permission was sought from Council for these works to be undertaken, and that the rocks were partly to be added to build up the wall to match existing elevations of the wall to the south. A report to the Reserves Committee Meeting of Council dated 12 March 1979 indicated that there was a recommendation to the committee that approval be granted for the works subject to the applicant meeting the full costs of the work, and that the work would be carried out under the supervision and to the satisfaction of the Shire Engineer. The Committee recommended that the application be further considered when the "full implications of the Coastal Protection Bill are known", amongst other matters.

Figure A2: Exposed rock protection at (moving left to right) present 21 Bilgola Avenue (with exposed seawall), 1 Allen Avenue and 3 Allen Avenue, 28 May 1974

Figure A3: Sandbags at Bilgola Beach on 28 May 1974, likely to be between 21 Bilgola Avenue and 1 Allen Avenue

Figure A4: Exposed rock protection and storm damage at (moving left to right) 1, 3, 5, 7 and 9 Allen Avenue (with undermined swimming pool at latter), 28 May 1974

Figure A5: Undermined swimming pool at 9 Allen Avenue Bilgola Beach, 28 May 1974

Figure A6: Damage to house at 11 Allen Avenue, 28 May 1974

Figure A7: Exposed rock protection and/or natural rock at 13 Bilgola Avenue, 28 May 1974

Figure A8: Exposed rock protection and/or natural rock at 13 Bilgola Avenue and further north, 28 May 1974

Figure A9: View looking south of storm damage and rock protection at Bilgola Beach on 11June 1974 (from PWD, 1985)

WRL (2013) completed remote sensing and borehole field investigations to assess the nature of the protection works at Bilgola Beach. However, they noted that their investigation should not be construed as a detailed assessment of the adequacy or otherwise of any of the seawalls at Bilgola Beach, and should not be used to assess the suitability or otherwise of any particular structure, nor to determine the suitability of any structure in protecting development at Bilgola Beach.

WRL (2013) considered that the Allen Avenue rock revetment had a 1:2 (vertical:horizontal) slope or flatter, with rock varying in mass from 0.05 to 4 tonnes, crest level varying from 4.5 to 6.5m AHD, and toe level varying from 0m to 1.5m AHD (it was not possible to determine the number of layers of rock). It was considered that the revetment did not have an adequate filter layer to prevent wash out of fine material through the revetment, and thus that settlement of the rock could be expected in severe storms.

In assessing the stability of the rock revetment, WRL (2013) assumed that the revetment had a slope of 1:2, was composed of two layers of rough, randomly placed 2 tonne basalt rock with an overall revetment porosity of 40%, and had a crest level of 6m AHD and toe level of 0m AHD. WRL (2013) postulated that the revetment was unlikely to fail (by undermining) for a 100 year ARI storm at present and in 2050, but was expected to fail for 10, 50 and 100 year ARI storms by 2100. Wave overtopping was not expected to be a concern for the 100 year ARI event at present and in 2050, but was expected to cause minor structural damage to infrastructure within 10m of the revetment crest for 10, 50 and 100 year ARI storms by 2100.

The crest and toe locations of the rock revetment estimated by WRL (2013) based on their investigation is shown in Figure A10[9]. The extent of rock visible in 1978 is overlaid on a 2014 aerial photograph and also shown in Figure A10.

As full details of the protection works seaward of Allen Avenue are unknown or uncertain or may be inadequate (such as crest and toe levels and rock size), future effectiveness of these protection works cannot be guaranteed. It is considered to be likely that the Allen Avenue revetment would provide some protection in a severe coastal storm over the next 100 or so years, but the level of protection cannot be guaranteed.

[9] Note that the gap between and north of the WRL (2013) toe positions in Figure A10 does not mean the revetment is not present there, just that this position was not determined.

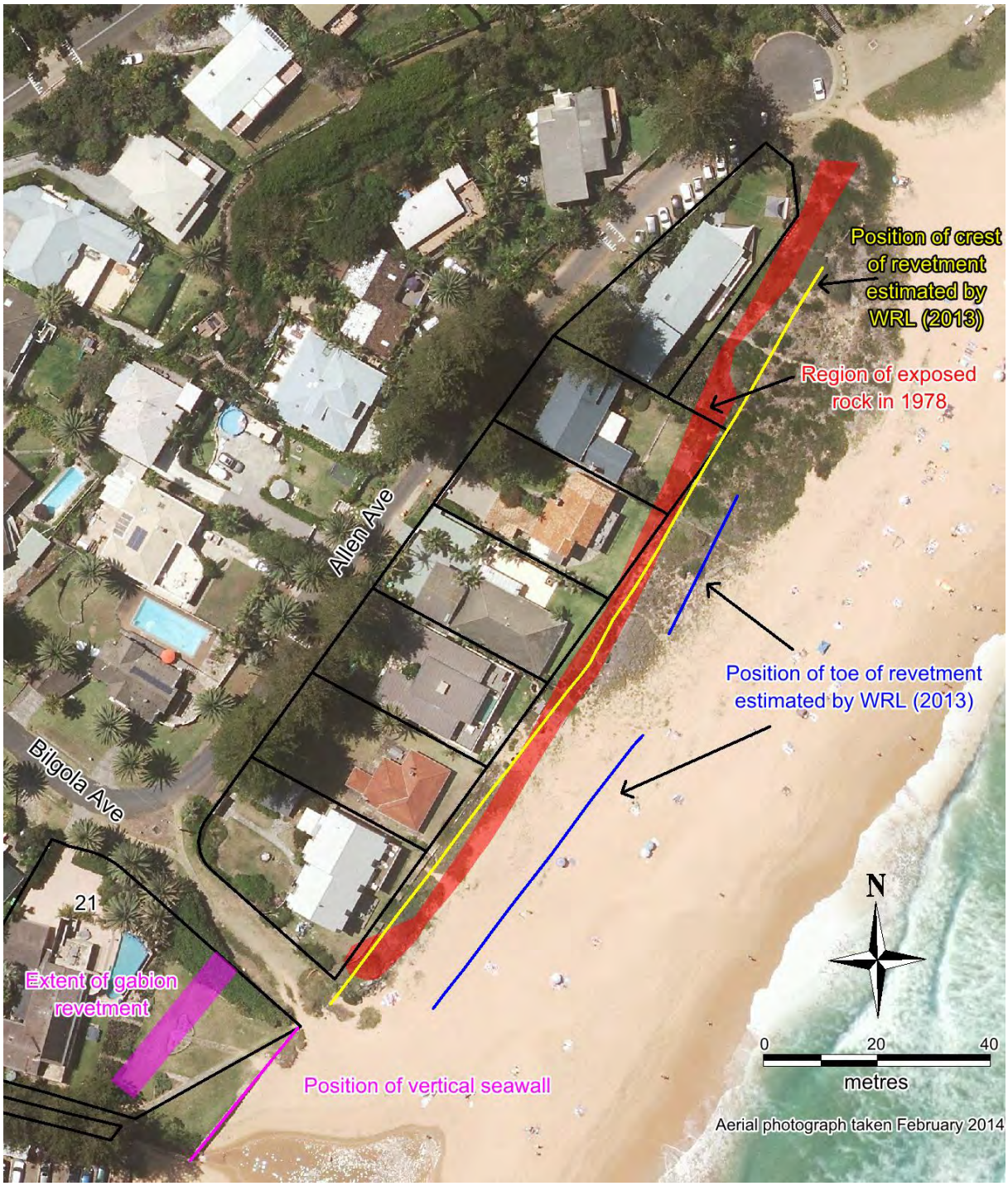

Figure A10: Extent of Allen Avenue rock revetment visible in 1978, estimated crest and toe position of rock revetment from WRL (2013), vertical seawall positon seaward of 21 Bilgola Avenue, and location of gabion revetment at 21 Bilgola Avenue

A2.2 21 Bilgola Avenue

As described in Patterson Britton & Partners (2005), a vertical stone and concrete seawall (Figure A11 and Figure A12, also see Figure A2) has been present seaward of the most southern private property at Bilgola Beach (21 Bilgola Avenue) since at least 1951, and has successfully protected this property against coastal erosion since that time. The crest of this seawall is at about 4.5m AHD, with a toe level of about 2m AHD.

Although this toe level is above typical extreme beach scour levels of -1m AHD, the seawall has maintained integrity over the years as it was constructed as a buttressed counterfort wall. Buttresses (at least 4) strengthen and stiffen the wall against overturning forces, acting in compression. A counterfort is a bracket-like wall projecting from a retaining wall on the side of the retained material to stabilise it against overturning; a counterfort, as opposed to a buttress, acts entirely in tension.

During storms in May 1997, this vertical seawall seaward of 21 Bilgola Avenue was slightly damaged at its crest, with some sandstone blocks dislodged and carried landward[10]. A photograph of the damage is shown in Figure A13 (from Mrs Irene Newport). Sand was washed into the property for a distance of about 10m landward of the vertical seawall in this event.

There is also a gabion and reno mattress revetment[11] that was constructed underground in 1993 about 15m landward of this vertical seawall (see design in Figure A14, and construction photograph in Figure A15), providing additional erosion protection at 21 Bilgola Avenue. It has a crest level of 3.9m AHD and toe level of -0.2m AHD.

The positions of the vertical seawall and gabion revetment at 21 Bilgola Avenue are depicted in Figure A10.

WRL (2013) predicted that the failure mechanism for the vertical seawall would be by toe undermining, and that this risk was present day. However, they did not consider the effect of the buttresses and counterforts in maintaining stability of the seawall at times of beach scour. Assuming that the vertical seawall had failed, WRL (2013) predicted that the failure mechanism for the gabion revetment would be by downslope sliding due to wave action for the 50 and 100 year ARI storm events by 2100.

[10] A cosmetic Besser Block wall along the northern boundary of the subject property was also damaged.
[11] A gabion is a steel wire-mesh basket to hold stones or crushed rock to protect a bank or bottom from erosion. A reno mattress is of similar construction, although less cube-shaped than a gabion, being relatively thin in the vertical dimension.

Figure A11: Vertical seawall at 21 Bilgola Avenue, partially exposed after storms on 21 July 2007

Figure A12: Vertical seawall at 21 Bilgola Avenue, partially exposed after storms on 22 April 2015

Figure A13: Evidence of damage caused to vertical seawall seaward of subject property during May 1997 storm, with blocks carried landward

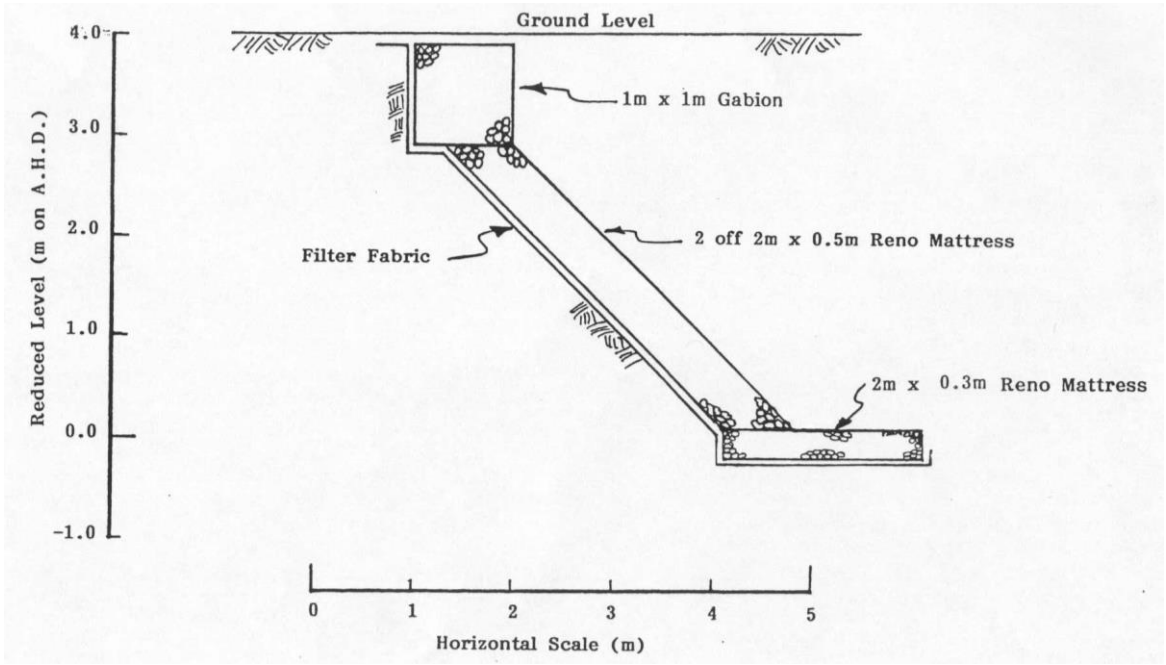

Figure A14: Typical cross section of gabion revetment at 21 Bilgola Avenue (from Patterson Britton & Partners, 2005)

Figure A15: Gabion revetment under construction at 21 Bilgola Avenue in October 1993

A2.3 Bilgola SLSC Area

Bilgola Surf Life Saving Club (SLSC) was formed in 1949 (Short, 2007). Gordon (1989) noted that the stone gravity (sandstone block) seawall (Figure A16, Figure A17) extending from Bilgola SLSC and its adjacent car park south to the rock pool (a distance of about 165m including the promenade south of the SLSC) was constructed in the late 1950's, and had an unknown toe level.

WRL (2013) found that the seawall has a variable crest level of 4.5 to 5.0m AHD, a constant toe level of about 2m AHD, and toe protection in the form of flat rock blocks (high length-to-thickness ratio) densely placed in a double layer between 2m AHD and 3m AHD.

The rock protection at the toe of the Bilgola SLSC seawall was evident in July 1978 photography (Figure A18). This Figure also shows the extent of rock protection seaward of the Allen Avenue properties, and the vertical seawall at 21 Bilgola Avenue, as exposed at that time.

The Bilgola SLSC seawall was damaged (with some blocks and steps dislodged, particularly along the promenade between the SLSC and rock pool) in the 1974 storms. A rock slide also filled part of the pool at this time (Foster et al, 1975). During storms in May 1997, the seawall at the SLSC was overtopped by waves, causing damage to the SLSC roller doors and some equipment in a ground floor storage area, but there was no damage to the building structure. Parts of the seawall were cosmetically upgraded (sandstone capping was replaced) in the late 1990's, along with construction of steps (Patterson Britton & Partners, 2005).

Figure A16: View of sandstone block seawall seaward of Bilgola SLSC, 4 June 2015

Figure A17: Oblique aerial view of Bilgola SLSC and adjacent car park, 11 October 2008

Figure A18: Aerial view of Bilgola Beach after storms in May-June 1978, in July 1978

WRL (2013) assessed the Bilgola SLSC seawall where the beach was narrowest and ignoring the effect of the rock toe protection and additional scour from Bilgola Creek and stormwater outlets. They considered that its failure mechanism would be by toe scour and it was at risk at present.

A2.4 Synthesis

In summary:

- Bilgola SLSC and its adjacent car park have a vertical sandstone block seawall (constructed in the late 1950's) with a toe level of 2m AHD, with some additional rock protection between 2m AHD and 3m AHD at the toe;
- this seawall has suffered some damage in the past, eg with some blocks dislodged in 1974;
- the SLSC seawall has been overtopped in the past, eg in May 1997 when inundation damaged some SLSC roller doors and equipment in a ground floor storage area;

- near the seaward edge of 21 Bilgola Avenue there is a buttressed counterfort vertical seawall of stone and concrete construction, that has successfully protected this property against coastal erosion since at least 1951;
- there is also an additional gabion revetment constructed about 15m to 20m landward of this buttressed counterfort seawall, that was constructed at 21 Bilgola Avenue in 1993; and,
- all properties seaward of Allen Avenue have a rock revetment constructed along their seaward edge, which was initially built in 1967 and further strengthened in 1974 (and in 1979 near 11 Allen Avenue) as a response to storms (these storms damaged one house and destroyed an adjacent swimming pool).

A summary inventory of the likely protection works and piled development at Bilgola Beach is given in Figure A19. As full details of these protection works are unknown or uncertain, or they may be undersized (if 2 tonne rocks were used at Allen Avenue[12]), or constructed with an elevated toe level (2m AHD at the SLSC and 21 Bilgola Ave seawalls), future effectiveness of these protection works cannot be guaranteed. It is considered to be likely that the Allen Avenue revetment would provide significant protection in a severe storm (but that this cannot be guaranteed),. Development at 21 Bilgola Avenue is likely to be protected from severe beach erosion at present due to having two seawalls located seaward. The elevated toe level at the SLSC seawall means that it is at risk of failure by toe undermining at present.

In 1985, the Public Works Department (PWD) prepared a Coastal Management Strategy for Warringah Shire (then covering the coast from Palm Beach to Freshwater Beach), as documented in PWD (1985).

At Bilgola Beach, PWD (1985) recommended that a revetment policy (ie upgrade if required) and development control instrument be adopted for development seaward of Allen Avenue, with the Allen Avenue revetment extended to the SLSC. Council has in effect been progressively implementing the intent of the PWD (1985) strategy to reduce the risk to private development through consent of private landowner-funded piled development at Bilgola Beach. Council does not consider that it has a responsibility to protect private development.

The only known developments that are likely to be piled (on deep foundations) at Bilgola Beach in the study area are at:

- 3 Allen Avenue, based on WorleyParsons (2013), although note that this piling was only for a new structure occupying a small portion of the lot development footprint on the landward side (and hence this lot has not been marked as 'piled' in Figure A19); and
- 5 Allen Avenue, based on SMEC (2002) and review of approved plans for a modification to the design after that report to include a piled basement structure.

As discussed in Patterson Britton & Partners (2005), 21 Bilgola Avenue is not piled.

Although there is no evidence that Bilgola SLSC is founded on rock, it would be prudent to investigate this issue further in assessing the risk of erosion/recession damaging the structure.

[12] For basalt rock, a 5 tonne armour rock size may be more appropriate. For sandstone rock, this mass approximately doubles.

Figure A19: Summary inventory of existing protection works and piled development at Bilgola Beach

A3. BASIN BEACH

A3.1 Coastal Storm Damage and Variety of Protection works

Foster et al (1975) noted that Basin Beach experienced "heavy scour" in the 1974 coastal storms, but no damage was reported. There are no known reports of damage to structures at Basin Beach from coastal storms.

That stated, numerous protection works have been constructed at Basin Beach, including vertical block-type seawalls (Section A3.2), rock revetments (Section A3.3) and contiguous grout injected pile seawalls (Section A3.4). Overall, Gordon et al (1991) considered that "temporary and ad hoc remedial measures taken by some of the property owners [at Basin Beach] in the past have not provided the required degree of protection". That stated, some of the protection works are engineer-designed as discussed in subsequent sections.

A recent oblique aerial view of Basin Beach is provided in Figure A20.

Figure A20: Oblique aerial view of Basin Beach, 24 May 2011

A3.2 Vertical Block-Type Seawalls

At Basin Beach, there are a number of vertical or near-vertical block-type seawalls (of variable construction) visible along the beach, namely at 11 (sandstone blocks), 15 (sandstone blocks), 17 (buttressed concrete bricks or "besser blocks"[13]) and 19 Surfview Road (buttressed concrete bricks or "besser blocks"), see Figure A21.

[13] This wall was considered by Carley et al (2008) "to be unlikely to withstand beach erosion and/or wave forces from a 100 year ARI event.

Figure A21: Seawalls visible at 11, 13, 15, 17 and 19 Surfview Road, 21 July 2007

Based on Coffey and Partners Pty Ltd (1990), the engineered seawall at 11 Surfview Road was constructed in late 1990 or early 1991, with a toe level of -1m AHD and crest level of 7m AHD, along with a new development being placed on piles. The seawall comprises 6 tonne sandstone blocks formed in a brickwork pattern, with a gravel and geotextile filter layer. An as-constructed drawing of the seawall is provided in Figure A22, based on Drawing S7589/1-1B of Coffey & Partners. It was to be connected to existing seawalls (presumably rock revetments) at adjacent lots.

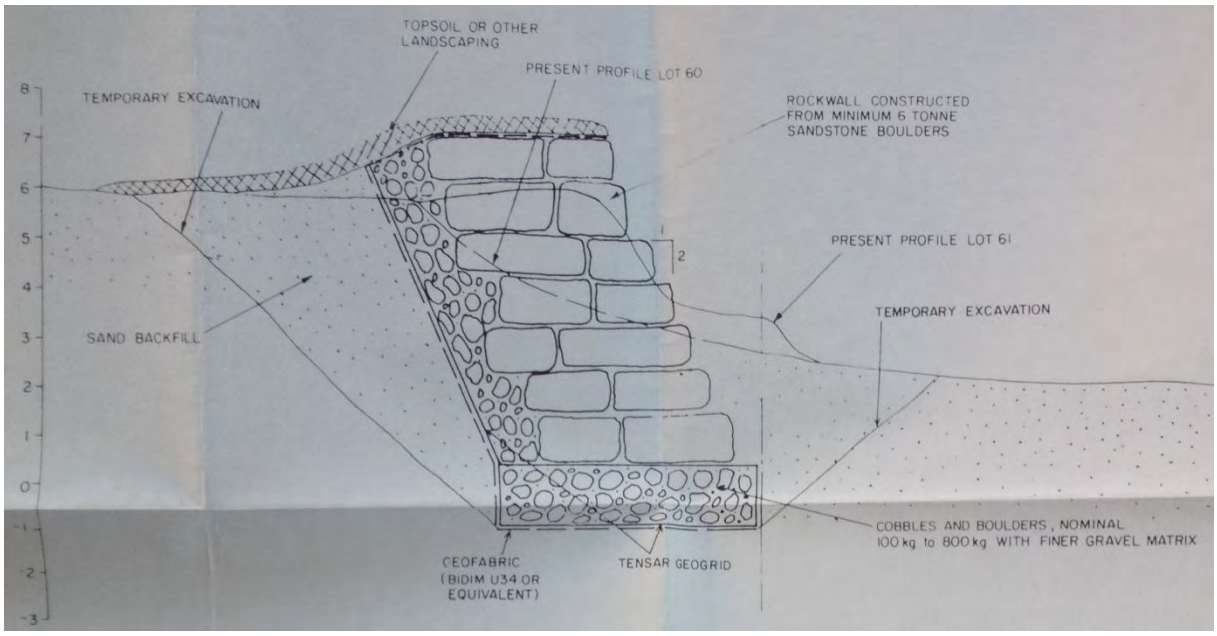

Figure A22: As-constructed drawing of seawall at 11 Surfview Road

As discussed in Horton and Couriel (1997) and based on Couriel (1996) and Gary Blumberg & Associates (2007), the seawall at 15 Surfview Road is engineer designed. It has an anchored wall system comprising a pinned sandstone block wall founded on a contiguous grout–injected pile wall extending below –1m AHD, with a crest level of about 6.3m AHD, and also has returns of 4m length along each side boundary. The new development proposed there in 1996 was also to be founded on piles.

A3.3 Rock Revetments

There is some current visual evidence of rock in the dune at 3, 5, 7, and 9 Surfview Road (particularly visible at present at 7 Surfview Road) and reference to rock at these locations in previous correspondence (such as Taylor, 1983), see further discussion below. Rock is also partially visible at 13 Surfview Road.

Mr William Vallack, owner of 5 Surfview Road, has provided photographs of a rock revetment after construction in 1980 extending from 5 to 9 Surfview Road, see Figure A23 and Figure A24. He considered that the revetment comprised 1 tonne rocks founded on underlying bedrock and was also constructed at 3 Surfview Road. Crozier Taylor Geotechnical (2013) completed a test pit at 9 Surfview Road and identified randomly stacked sandstone boulders of medium to high strength and of various shapes and dimensions that were generally 1.0m in diameter (about 1.5 tonnes in mass) with a few 0.5m diameter (200kg) boulders in between, sloping at 32° (1:1.6 vertical:horizontal). They identified a crest level of 6m AHD and toe level of 1m AHD.

These 3-9 Surfview Road works were recognised by Council of the Shire of Warringah (1991) as being unlikely to be structurally adequate to withstand future storms, and this has been recognised by others, namely:

- Patterson Britton & Partners (2000) considered “that it is unlikely that the rock is sufficiently large and there is unlikely to be a suitable filter or toe level to prevent it [the wall] being undermined and damaged in a severe storm. While it may provide temporary protection, it is likely that it could not be relied upon to prevent erosion…in a severe storm”.
- WorleyParsons (2014) considered that the revetment did “not constitute an adequate seawall to protect properties 3, 5, 7 and 9 Surfview Road”.

Based on WRL (1999), Council approved an engineer designed rock revetment at 23 Surfview Road in 1978, located along the seaward property boundary and extending over the most seaward 4m cross-shore at the property. Based on Horton and Nielsen (1999), the rock mass in this revetment is about 1 tonne[14]. A section of the revetment from WRL (1999) is provided in Figure A25.

[14] Horton and Nielsen (1999) considered that although not engineered according to current standards in coastal engineering practice, the revetment at 23 Surfview Road would provide significant resistance to storm erosion at that property. There is also a buried timber fence at this property, partially visible at present.

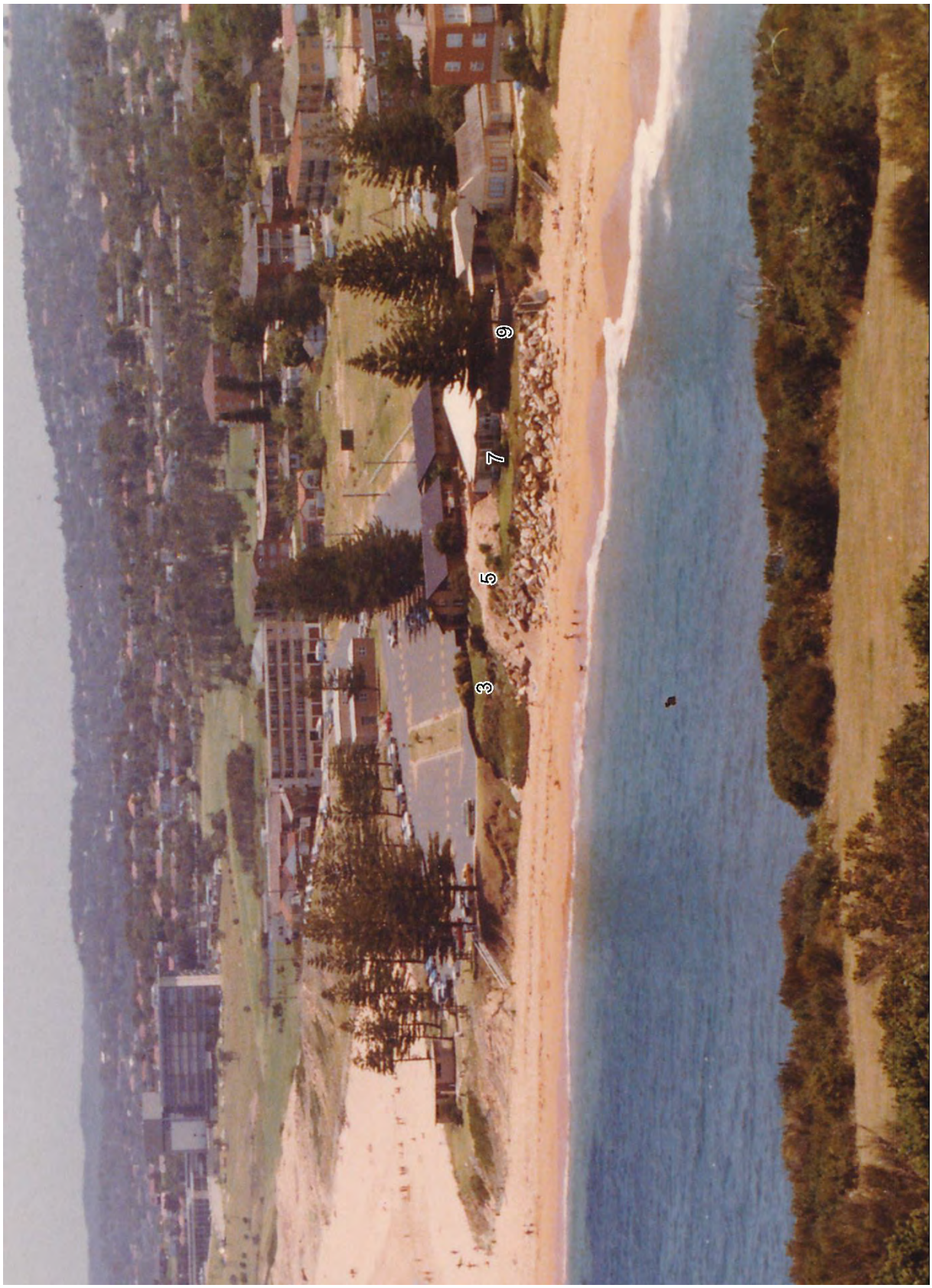

Figure A23: Rock revetment visible at 5 to 9 Surfview Road in 1980

Figure A24: Closer view of rock revetment at 7 and 9 Surfview Road in 1980

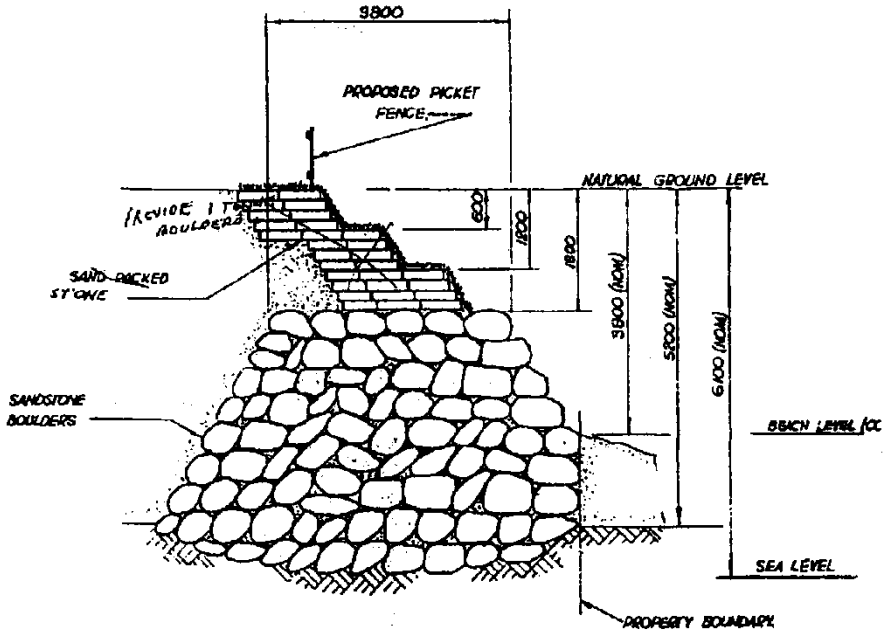

Figure A25: 1978 design drawing for 23 Surfview Road revetment from WRL (1999), note upper section as drawn has hand written notes showing this was deleted and replaced by boulders

A3.4 Contiguous Grout Injected Pile Seawalls

There have been (currently buried) contiguous grout injected pile seawalls extending below -1m AHD (and with a crest level of about 8m to 8.5m AHD) constructed in recent years at 29, 31 and 33 Surfview Road, but with only the new development at 29 Surfview Road being piled (Horton and Couriel, 1997; Horton and Nielsen, 1999; WRL, 2001; Cardno, 2010). These are vertical structures. As they were constructed at different times, it is uncertain how well these three structures were connected, but it was the intention to link the structures to form a continuous seawall.

A3.5 Synthesis

A summary inventory of the likely protection works and piled development[15] at Basin Beach is given in Figure A26. As full details of these seawalls are generally unknown or uncertain (such as crest and toe levels and rock size where relevant), or may be undersized or constructed with an elevated toe level, future effectiveness of many of these protection works cannot be guaranteed (except where a specialist coastal engineer can certify that the works have been designed and constructed in accordance with standard coastal engineering practice for a specified design life)[16].

Only the properties at 35, 37, and 39 Surfview Road are not known to have protection works.

[15] Note also that 9 Surfview Road had a piled dwelling approved on 26 February 2015.
[16] Seawalls at 11, 15, 29, 31 and 33 Surfview Road are more likely to be effective as they are understood to have been designed with coastal engineering input. However, as Haskoning Australia did not observe the construction and has not confirmed that the construction complied with the design, it is unable to certify these structures.

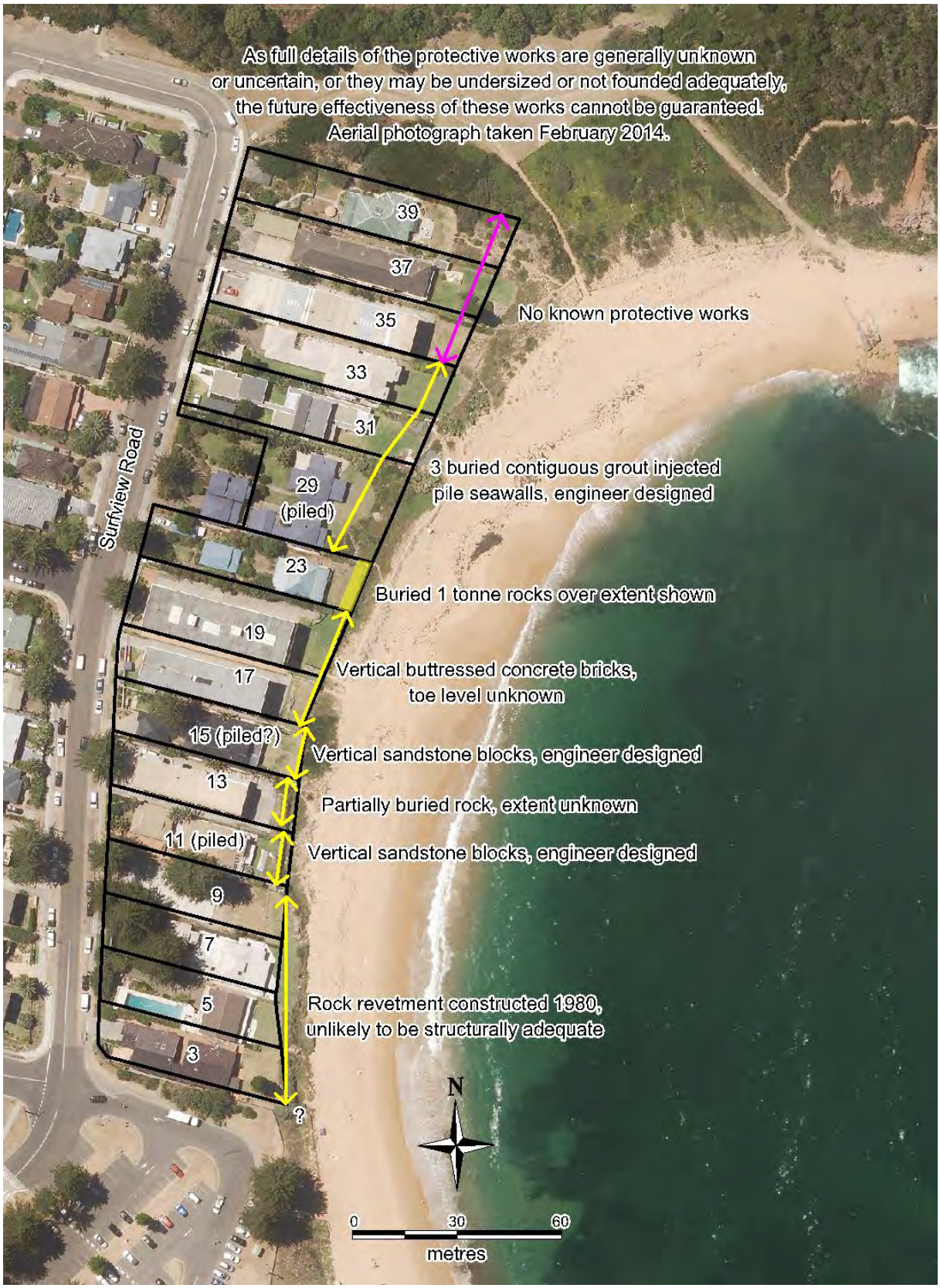

Figure A26: Summary inventory of likely existing protection works and piled development at Basin Beach

As described in PWD (1985), Council adopted a draft Development Control Plan (DCP) for the construction of seawalls at Basin Beach in February 1984, and it was recommended that a continuous rock revetment was constructed at the beach. DCP No. 4 “Development of Seawalls, Basin Beach, Mona Vale” was adopted in December 1994, in which it was stated that all seawalls in the Basin Beach area should generally conform with a plan prepared by PWD (which included a rock revetment design).

Council in effect has been progressively implementing the intent of the PWD (1985) strategy through consent of private landowner-funded protection works and piled development. That stated, DCP No.4 no longer applies following the adoption of a recent revision of Pittwater 21 DCP by Council.

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Appendix B: Threats to and Management of Coastal Ecosystems in Study Area

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ECO LOGICAL AUSTRALIA PTY LTD
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Ref/Job No.: 15SYD-1408

11th May 2015

Dear Peter,

RE: Provision of ecological advice for the preparation of a Bilgola Beach and Basin Beach Coastal Zone Management Plan (CZMP)

Please find below a concise description of the ecology of Bilgola Beach and Basin Beach including potential threats to biodiversity values. The extent of the study area was provided by Peter Horton on 20th March 2015 and the study area was inspected on 24th March 2015, with observations described herein at that date.

Description of Coastal Ecosystems:

Bilgola Beach is an east-southeast facing sand beach, with a sandy benthos/wave zone. Steep cliffs are present at each end of the beach and a rocky reef occurs at the southern end beyond an ocean-fed sea pool. The landward side of the beach contains some dune vegetation and residential development (8 lots). South of the residential development is a carpark and Bilgola Surf Life Saving Club (SLSC). A steep cliff extends from the SLSC to the sea-pool. The northern landward edge of the beach contains some dune vegetation and a grassy mown area around a cul-de-sac at Allen Avenue.

Basin Beach is an east facing sandy beach with a sand wave-zone and a deep-water rocky reef benthos. The northern end of the beach rises steeply into Mona Vale Headland Reserve (Council managed), with dune vegetation on the lower slopes, which continues south seaward of residential development (17 lots). South of the residential development is a car park, with dune vegetation and sand that extends seaward forming a sand spit connected to a rocky reef and an ocean-fed sea-pool. This sand spit and rocky reef forms the southern end of Basin Beach. Mona Vale Beach extends south from here to Turimetta Head.

Flora, Fauna and Ecological Significance

Vegetation Type and Condition:

Sydney Metro CMA (SMCMA) vegetation mapping (OEH 2013a,b) was used and cross referenced with Pittwater Council's vegetation mapping and vegetation profiles (Bangalay 2011). Bilgola Beach and Basin Beach vegetation mapping is shown in **Figure 1** and **Figure 2** respectively. The vegetation communities were validated in the field on 24th March 2015 and maps were amended accordingly.

Figure 1. Vegetation mapping and NSW Wildlife Atlas threatened species records for Bilgola Beach.

Starting from the northern extent of the Bilgola Beach study area, the vegetation below the steep cliffs appears unmanaged, most likely due to the risk of rock fall. This area is relatively weed infested with Asparagus Fern *Asparagus aethiopicus* (class 4 Noxious Weed), Mirror Bush *Coprosma repens* and *Hydrocotyle bonariensis*. The mown area to the immediate north of the Allen Ave cul-de-sac is managed by Pittwater Council, with the section of foredune seaward of this containing a dense cover of the succulent Pigface *Carpobrotus glaucescens,* with Spinifex *Spinifex sericeus* less common. This Beach Spinifex Grassland community grades into Coastal Foredune Wattle Scrub on the landward side below the cliff area. A beach access path from the cul-de-sac separates this area from the vegetation seaward of the residential area. There were scats and shallow scrapings across the mown grass from rabbits.

The vegetation mapped as Coastal Foredune Wattle Scrub and Beach Spinifex Grassland (**Figure 1**) seaward of the northern most houses is being actively managed once a month by bush regeneration contractors, funded by residents. A number of weeds have been targeted in this area including Mother-of-Millions *Bryophyllum delagoense* (class 4 Noxious Weed), Asthma Weed *Parietaria judaica, Ehrharta erecta, Acetosa sagittata, Gazania* sp., *Hydrocotyle bonariensis,* Cape Daisy *Dimorphotheca ecklonis* and Sea Spurge *Euphorbia paralias.*

The weed control in this location has allowed the native ground covers and shrubs to dominate, assisted by plantings of local provenance natives. Native species comprising the Coastal Foredune Wattle Scrub include Coastal Wattle *Acacia longifolia* subsp. *sophorae,* Coast Teatree *Leptospermum laevigatum, Banksia integrifolia* subsp. *integrifolia, Leucopogon parviflorus* and *Rhagodia candolleana.*

Coastal Foredune Wattle Scrub is extensive along the coastal foredune on most beaches within the Pittwater LGA (Bangalay 2011). However, compared to the predicted pre-1750's distribution, this community is estimated to have decreased in extent by 63% (Bangalay 2011).

The Coastal Foredune Wattle Scrub grades into Beach Spinifex Grassland along the foredune and is comprised of grasses and herbs on mobile sands. This community forms an important first line of defence in protecting the dunes from wind and wave erosion. The dominant species is Hairy Spinifex *Spinifex sericeus*, and also contains the succulent Pigface *Carpobrotus glaucescens*, *Ficinia nodosa* (previously known as *Isolepis nodosa*), Wild Geranium *Pelargonium australe,* the naturalised Sea Rocket *Cakile* sp. and *Scaevola calendulacea.*

Beach Spinifex Grassland is common throughout NSW and occurs along most beaches within Pittwater Council and has an estimated decrease in extent of 5% compared to the predicted pre-1750's distribution (Bangalay 2011).

At the widest section of foredune vegetation, seaward of the northern-most houses there is a foredune, swale, high-dune profile emerging, before the high-dune drops down into the seaward gardens of the houses. Moving south along the residential area of Bilgola Beach, the dune vegetation becomes increasingly narrower and steeper until it becomes absent seaward of the southern-most house and continues to be absent seaward of the car-park, SLSC and below the cliff to the sea-pool. Hard structures including constructed sandstone walls and the southern cliff are present. The Beach Spinifex Grassland community in the central section of the beach appears to be largely unmanaged and contains a higher abundance of weeds including *Gazania* sp. and *Hydrocotyle bonariensis* and a sparser coverage of vegetation, with more bare sand. Moving south, the width of the dune vegetation decreases down to a narrow foredune rising up to gardens with exotic species. Rock was visible at the southern corner of the second house from the south (1 Allen Avenue), where the public access path meets the beach. There is also a stormwater outlet at this location.

Figure 2. Vegetation mapping and NSW Wildlife Atlas threatened species records for Basin Beach.

Basin Beach vegetation mapping is shown in **Figure 2**. Like Bilgola Beach, the areas below the northern cliff are relatively weed infested with *Senna pendula* var.*glabrata*, Mirror Bush *Coprosma repens*, *Acetosa sagittata* and Asparagus Fern *Asparagus aethiopicus* (class 4 Noxious Weed).

The northern-most part of the study area contains a flat mown area and access to the northern end of the beach, present as two narrow fenced tracks through Coastal Foredune Wattle Scrub. Rabbit scats and shallow scrapings were present in the mown area and scats were also seen throughout the dunes.

An area adjacent to the northern-most house (39 Surfview Road) and closest to the road was mapped as Coastal Foredune Wattle Scrub by the SMCMA, but has recently been cleared by Pittwater Council, with evidence of spot spraying, revegetation and mulching with wood chips. Some large native species have been retained including Coast Teatree. Moving towards the sea, this section of vegetation which would naturally occur as Coastal Foredune Wattle Scrub is heavily weed infested with thickets of Lantana and Asparagus Fern *Asparagus aethiopicus* (both class 4 Noxious Weeds). Also present were the weed species Green Cestrum (*Cestrum parqui)* (class 3 Noxious Weed), *Senna pendula* var. *glabrata, Yucca* sp., *Gazania* sp. and *Hydrocotyle bonariensis.* Native species present within this community include coastal wattle (*Acacia longifolia* subsp. *sophorae*), Coast Teatree *Leptospermum laevigatum, Monotoca elliptica,* and *Breynia oblongifolia.* The patch of vegetation on the northern side of the beach access track is in similar condition, with heavy weed infestation.

As the dune slopes down to the sea, these degraded areas of Wattle Scrub grade into degraded Beach Spinifex Grassland. This community is dominated by weed species including *Gazania* sp., Cape Daisy *Dimorphotheca ecklonis* and Asparagus Fern. Mother-of-Millions *Bryophyllum delagoense* (class 4 Noxious Weed) was present in small numbers. Native species present included *Spinifex sericeus,* Pigface *Carpobrotus glaucescens, Ficinia nodosa,* Sea Rocket *Cakile* sp. and *Scaevola calendulacea*. The vegetated foredune in this location extended seaward of the existing fence line.

The situation at Basin Beach is similar to Bilgola, where the dune vegetation becomes narrow and steep towards the southern end of the beach, and the plant species become more dominated by weeds and garden exotics including *Yucca* sp. and a cultivated prostrate conifer. In the vicinity of the sand spit, the width of the dune increases and is once again fenced. However, the plant composition is dominated by weeds including *Gazania* sp. and *Acetosa sagittata*.

Threatened Species Records

The NSW Wildlife Atlas was searched on March 20th 2015 and the only record occurring within the study area was the Common Noddy at the rocky reef on the southern end of Bilgola Beach. This species is not listed under the NSW Threatened Species Conservation Act (TSC Act), but is a listed marine and listed migratory species under the Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act).

Basin Beach had only one record, the Caspian Tern, which like the Common Noddy is not listed as a threatened species under state or federal legislation, but is a listed marine and listed migratory species under the EPBC Act.

An EPBC Act protected matters report was generated on 20th March 2015 and listed a large number of protected matters that are likely to occur within 1km of both study areas. **Table 1** lists threatened species

considered likely to utilise habitat at Bilgola Beach and Basin Beach, based on the field inspection, database records and a previous study by Smith and Smith (2000).

Table 1. Threatened species likely to utilize habitat at Bilgola and Basin Beach

Species	Conservation Status		Potential Habitat	Bilgola Beach	Basin Beach
	EPBC Act	TSC Act			
Sooty Oystercatcher *Haematopus fuliginosus*	-	V	Low tide foraging habitat on rock platforms, in particular, South Bilgola and Mona Vale Headlands (Pittwater Council 2011)	Y	Y
Pied Oystercatcher *Haematopus longirostris*	-	E	Rare visitor – low tide foraging habitat along beaches and rock platforms	Y	Y
Sand Spurge *Chamaesyce psammogeton*	-	E	Prostrate perennial herb, which grows on foredunes and exposed sites on headlands often with Spinifex.	Y	Y
Osprey *Pandion haliaetus*	-	V	Potential foraging over the sea	Y	Y
Little Tern *Sterna albifrons*	M	E1	Potential foraging along the sea shore. Only 1 record in Pittwater (Pittwater Council 2011)	Y	Y
Sanderling *Calidris alba*	M	V	Potential foraging along sea shore	Y	Y
Great Knot *Calidris tenuirostris*	M	V	Potential foraging habitat – more likely to occur in Pittwater estuary		Y
Lesser Sand-plover *Charadrius mongolus*	Ma	V	Potential foraging or high-tide roosting (if available) – more likely to occur in Pittwater estuary		Y
Greater Sand-plover *Charadruis leschenaultii*	Ma	V	Potential foraging or high-tide roosting (if available) – more likely to occur in Pittwater estuary		Y
Little Penguin in the Manly Point Area	-	E2	Foraging habitat within the sea. Potentially come ashore but unlikely to breed.	Y	Y

Threatened Species Conservation Act 1995*: E1:** Endangered **V:** Vulnerable **E2:** Endangered Population ***Environment Protection Act 1999: **M:** Migratory **Ma:** Marine

Threatened Species Habitat

The dune vegetation provides foraging and shelter habitat for native small birds (eg. Superb Fairy-wren) and reptile species. Small bird activity can be particularly high in the dense shrubby areas including the dense lantana thickets at Basin Beach.

Bilgola and Basin Beach provide potentially suitable foraging habitat for shorebirds such as the endangered Pied Oystercatcher *Haematopus longirostris*, vulnerable Sooty Oystercatcher *Haematopus fuliginosus* and the vulnerable migratory Sanderling *Calidris alba*. Potential breeding habitat for the endangered migratory Little Tern *Sterna albifrons*, and roosting habitat for the vulnerable migratory Sanderling is unlikely given the heavy recreational usage on the beach, particularly during the birds' spring-summer breeding season.

An endangered population of Little Penguin *Eudyptula minor novaehollandiae* occurs at Manly. Penguins swimming off the beach could be from either the Manly breeding population or from the Lion Island breeding population but they are unlikely to come ashore unless sick or injured.

Only one threatened flora species, Sand Spurge *Chamaesyce psammogeton* (also known as Coastal Spurge), is likely to occur on Bilgola Beach and Basin Beach. This colonising species was formerly known as *Euphorbia sparrmanii*, *Euphorbia psammogeton* and *Chamaesyce sparrmanii* (PlantNET, 2015). It is a perennial prostrate herb forming mats to 1m across, often from a woody rootstock. Leaves are smooth, to 30mm long and 15mm wide with tiny flower heads surrounded by white leaf-like bracts (OEH 2015). Flowering occurs in summer and seeds float, so dispersal between beaches may occur. Plant growth occurs in spring and summer and the longevity of individuals is approximately 5-30 years with a primary juvenile period of less than 1 year (OEH 2015).

Sand Spurge occurs sporadically, north from Jervis Bay on unstable sands, and was formally regarded as widespread. In 1991 it was noted as being at risk of extinction (Carolin and Clarke 1991). It is now considered to be uncommon on sand dunes near the sea and is endangered in NSW (PlantNET, 2015).

Populations have been recorded in Wamberal Lagoon Nature Reserve, and Myall Lakes and Bundjalung National Parks (OEH 2015). Within Pittwater LGA, the species has been previously recorded at Whale Beach and Palm Beach (Smith and Smith 2000) and at Avalon Beach in 1987 (Pittwater Council 2012). In 2004, a population of greater than 100 individuals was recorded in the dune bays at Gardens Reserve Narrabeen by a bush-regeneration company undertaking a dune restoration and revegetation program. In 2009, a survey carried out by Warringah Council biodiversity staff in the same area recorded 89 plants and in February 2011, only two plants were recorded (ELA 2011).

Populations of Sand Spurge may be dynamic over time, existing as seedbank in the dune system and regenerating in relatively large numbers after disturbance (such as weed control works) with plants dying out over a short period. Consultation with botanists from the Sydney Royal Botanic Gardens and a coastal dune vegetation expert suggests that while a soil seed-bank within the dunes may contain seeds of this species there is no way to determine the presence/absence of the plant in the soil seed-bank unless a disturbance event was simulated which stimulated germination.

Sand Spurge is threatened by excessive trampling due to its small size and prostrate growth habit. It appears that although the plant is short-lived it has a soil seed-bank that remains viable within a desiccated sand-dune environment for many years.

Key habitat values

In summary, the key habitat values within the study areas are:

- The dune vegetation, which provides habitat for native plant species and small birds in the Coastal Foredune Wattle Scrub and potential habitat for endangered Sand Spurge.
- The rock platforms, which provides foraging habitat for shore birds including threatened species.
- The dry and intertidal sandy beach area, which provides foraging habitat for shorebirds including threatened species.

Potential Threats to Habitat Values:

Potential threats to the habitat values of Bilgola and Basin Beach include:

- Loss of foredune habitat through the erosion of the dunes resulting from coastal storms, informal and formal dune accessways from private properties, recreational activity, dumping of rubbish and building materials (as seen at the northern end of Basin Beach seaward of residential areas) or other disturbance events.
- Degradation of dune vegetation from rabbit activity including herbivory (eating) of native plants, erosion and spread of weed seed through fur and scats.
- Prolific weed invasion, in particular the highly invasive lantana and asparagus fern at Basin Beach.
- Cultivated garden “escapes” within the dunes competing with native vegetation and in some cases comprising most of the vegetation in the foredune.
- Disturbance to shorebird foraging and roosting on the rocky platforms and sea shore caused by recreational use, although it is acknowledged that this threat is difficult to manage on the beach given the high usage by the surrounding large urban population.
- Fencing
    - At Basin Beach, there is fencing along the northern dunes and southern dune seaward of the carpark. However, the fencing is old and rusted and not effective in some areas. At the northern end of Basin Beach, gaps in the fencing and/or lack of fencing is allowing local residents to make their own tracks to the beach, even laying hard surfaces, including pavers, sandstone and concrete blocks.
    - In some locations, in particular the northern end of Basin Beach, the foredune vegetation has extended beyond the fenced area, but is unprotected from trampling.
    - Lack of any fencing at Bilgola Beach and most of Basin Beach, which leaves the foredune vulnerable to encroachment, recreational trampling and disturbance.

Management recommendations in order of priority:

1. All dune restoration plans and any dune works are prepared / undertaken in consultation with the Bushcare Groups operating at each beach.
2. Fencing at the northern end of Basin Beach should be upgraded and extended to include the foredune containing the Beach Spinifex Grassland, where sufficiently landward of frequent erosion events.
3. Education of local residents of the importance of the dune vegetation for asset protection, retention of windblown sand, and growth in beach sand volumes. The wider and more vegetated the dunes, the more protection that is offered during coastal storms and high winds.
4. Removal of tables and other furniture within the dunes – such furniture should be contained within private property.
5. Preparing a restoration plan for the dunes at Basin Beach, particularly in the northern mapped Coastal Foreshore Wattle Scrub. The plan should address ongoing management including weed control and replacement/replenishment planting, monitoring and maintenance of vegetation structure and species diversity for small bird habitat.
6. Removal of exotic garden plants from the dunes, some of which become weed species. Residents should be informed about what garden plants to avoid planting due to risk of encroaching and escaping into the dunes. However, weed removal needs to be undertaken in a staged approach, with bare areas being replanted, to maintain the integrity of the dunes and avoid sand blow-outs during storm events.
7. Any works involving disturbance to the dune system such as weed control or movement of sand have the potential, albeit limited, to trigger germination of the endangered Sand Spurge and operators should be educated to ensure that they monitor for this possibility.
8. Rabbit control to reduce the impacts of herbivory, weed seed dispersal and erosion.
9. Council should negotiate with the residents at both Bilgola Beach and Basin Beach to formalise and/or consolidate access tracks so that the number of informal tracks is reduced and the vegetation can be fenced and protected. Following this, all informal tracks should be removed and revegetated.

Photos of Bilgola Beach

Coastal Foredune Wattle Scrub – note the bare trampled area of sand in between the scrub and the Beach Spinifex Grassland. Fencing would prevent this and allow the vegetation to colonise bare patches.

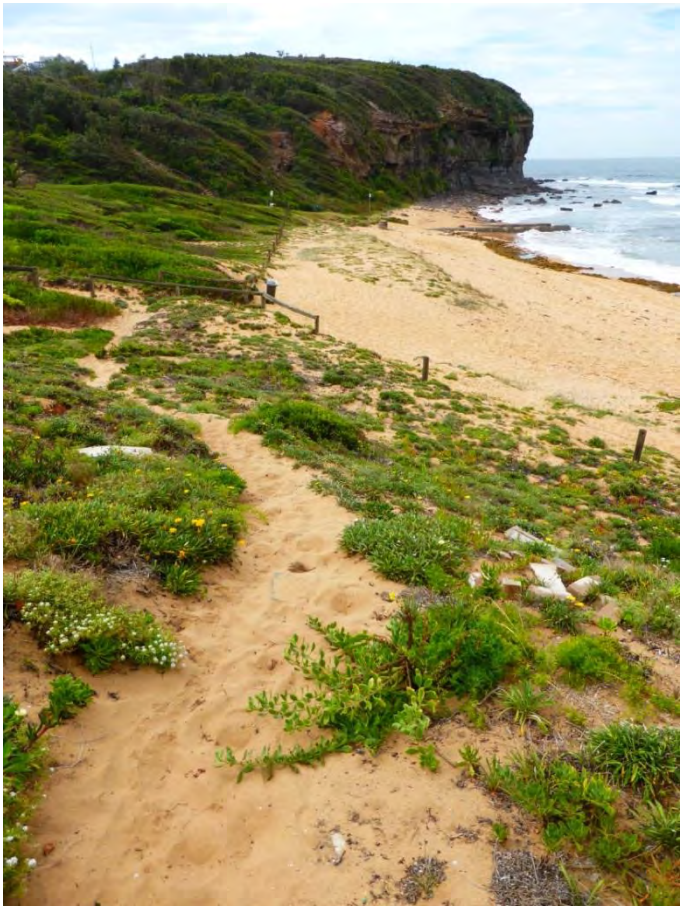
Showing the bare “access way” between the wattle scrub and spinifex grassland

The rock revetment and lack of dunes towards the southern end of Bilgola Beach

Absence of dunes at the southern end of Bilgola Beach (next 2 photos)

Photos of Basin Beach

Coastal Foredune Wattle Scrub – gaps in the beach access track allow neighbours to access the beach through the dune via their own tracks (next 2 photos)



Revegetation area – north end of Basin Beach near corner of Bassett Street and Surfview Road.

Dumped building waste – north end of Basin Beach

Coastal Foredune Wattle Scrub (fenced) with Spinifex Grassland extending seaward of the fence line at North Basin Beach (next 2 photos)

Tracks constructed in the dunes (next 2 photos)

The dunes at Basin Beach become steeper and narrower towards the southern end of the beach

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Appendix C:
Legislative and Planning Context

CONTENTS

C1. INTRODUCTION

In this Appendix, key planning/guideline documents (see Section C2) and legislation (see Section C3) relating to the investigation herein are described.

C2. DOCUMENTS

C2.1 Guidelines for Preparing CZMPs

The document *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) was gazetted in the *Government Gazette of the State of New South Wales* dated 19 July 2013 as:

- a manual relating to the management of the coastline pursuant to section 733(5)(b) of the *Local Government Act 1993*; and
- Minister's guidelines for the purposes of preparing draft coastal zone management plans pursuant to section 55D of the *Coastal Protection Act 1979*.

A previous version of the document (Department of Environment, Climate Change and Water [DECCW], 2010a) had been similarly gazetted on 25 February 2011. The main changes in OEH (2013) compared to DECCW (2010a) reflected the removal of the 2009 *NSW Sea Level Rise Policy Statement* (DECCW, 2009a, b) from use as NSW Government policy and were as follows:

- removal of references to the *NSW Sea Level Rise Policy Statement*;
- removal of references to the *Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments* (DECCW, 2010b);
- removal of references to the *Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood risk assessments* (DECCW, 2010c);
- removal of references to the *NSW Coastal Planning Guideline: Adapting to Sea Level Rise* (Department of Planning, 2010);
- removal of "under projected 2050 and 2100 conditions" in relation to assessment of hazards from shoreline recession, coastal inundation, coastal cliff or slope stability and tidal inundation and replacement with "projected future conditions"; and
- replacement of "NSW Sea Level Rise Policy Statement" with "Council's adopted sea level rise projections or range of projections".

Other than the above changes, the current guidance document is generally identical in structure and content to that issued previously.

C2.2 *NSW Coastal Policy 1997*

The *NSW Coastal Policy 1997* (NSW Government, 1997) is based on two fundamental principles, namely ecologically sustainable development and integrated coastal zone management. It is structured in a framework of 9 main "goals" and 9 main "objectives", as shown in Figure C1.

Each objective is met with a number of 'strategic actions' which were assigned to local governments and state government departments and agencies as appropriate. These include the consideration of CZMPs in the preparation of LEPs and DCPs.

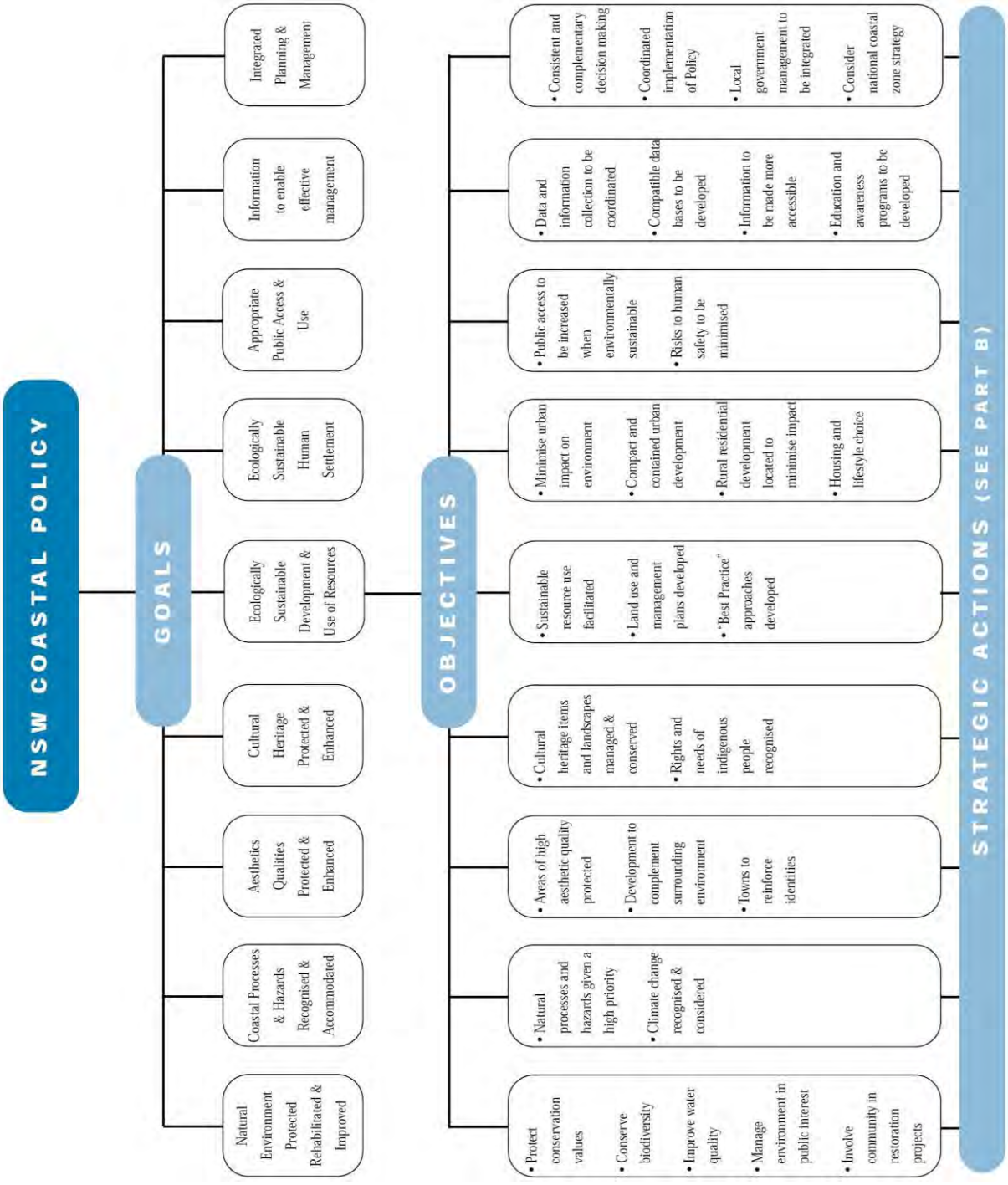

Figure C1: NSW Coastal Policy Framework

It is noted in Department of Planning (2009) that "The Minister for Planning has issued a Direction under section 117 of the *Environmental Planning and Assessment Act 1979* to all local councils in the coastal zone regarding the *NSW Coastal Policy 1997*. In preparing a draft local environmental plan (LEP), councils are required to include provisions that give effect to and are consistent with the Coastal Policy, unless the inconsistency is justified by an environmental study or strategy".

C2.3 NSW Coastal Planning Guideline

The *NSW Coastal Planning Guideline* (Department of Planning, 2010) was prepared to provide guidance on how sea level rise was to be incorporated into land use planning and development assessment in coastal areas. The guideline was based on the implementation of six coastal planning principles for consideration of sea level rise, namely:

1. assess and evaluate coastal risks taking into account the sea level rise planning benchmarks[1];
2. advise the public of coastal risks to ensure that informed land use planning and development decision making can occur;
3. avoid intensifying land use in coastal risk areas through appropriate strategic and land use planning;
4. consider options to reduce land use intensity in coastal risk areas where feasible;
5. minimise exposure of development to coastal risks; and
6. implement appropriate management responses and adaptation strategies.

C2.4 Plans of Management

C2.4.1 Preamble

Plans of management contain information on the natural environments, Aboriginal heritage, history, and recreational opportunities in park or reserve areas and explain how these open space areas will be managed by councils. Plans of management are legal documents that are issued in draft by councils and following a period of public exhibition, are adopted by the Minister for the Environment or Minister for Lands (for Crown Reserve areas).

Pittwater's Ocean Beaches Plan of Management applies to the study area. This document includes separate chapters covering the management of Mona Vale Beach (including Basin Beach) and Bilgola Beach, as discussed in Section C2.4.2 and C2.4.3 respectively.

C2.4.2 Mona Vale Beach (Chapter 10)

In the plan of management for Mona Vale Beach it is noted that the public usage of Basin Beach includes swimming, snorkelling, walking and kite flying and that the beach is particularly popular with bodyboarders. It is also noted that surf schools are currently prohibited from using the Basin Beach area.

The land classifications defined in the Basin Beach area were as follows:

- dune, beach and rock platform (northern end of beach) areas were 'Natural Area – Foreshore';
- the foreshore reserve area seaward of Bassett Street was 'Park'; and
- a portion of the headland at the northern end of Basin Beach was 'Natural Area – Escarpment'.

The proposed improvement works that are relevant to coastal management at Basin Beach included:

[1] "Sea level rise planning benchmarks" was referring to the now repealed *NSW Sea Level Rise Policy Statement* (which is no longer NSW Government policy), and should be replaced with "Council's adopted sea level rise projections".

- improvement of the quality of the Northern Reserve by providing additional shade trees, picnic furniture, upgraded facilities, and upgrading existing access points, steps and post and rail fences as required;
- investigation of opportunities to upgrade existing pathways and timber clatter boards which provide beach access from the Northern Reserve;
- dune regeneration works, weed eradication and replanting of native species;
- maintaining and repair (as required) of the existing stormwater outlet at the northern end of the beach, including investigation of opportunities to extend or divert the pipeline; and
- implementing signage to address directional, safety and interpretive information.

C2.4.3 Bilgola Beach (Chapter 12)

In the plan of management for Bilgola Beach, public usage of Bilgola Beach was described in relation to available facilities including Bilgola SLSC, an amenities building, kiosk, rock pool and vehicular access and parking areas.

The land classifications defined in the Bilgola Beach area were as follows:

- dune, beach and rock platform (southern end of beach) areas were 'Natural Area – Foreshore';
- the vehicular access, parking areas and rock pool was 'General Community Use';
- the seaward frontage of the headlands at the northern and southern ends of the beach were 'Natural Area – Escarpment'; and,
- the foreshore reserve landward of the dune revegetation area at the northern end of the beach was 'Park'.

The proposed improvement works that are relevant to coastal management at Bilgola Beach included:

- ensuring car parking and disabled parking bays are well-marked and carrying out general maintenance of road surface material as required;
- investigating implementation of traffic calming devices to improve pedestrian safety and access through the main car park;
- refurbishment of the kiosk, including the provision of a new roof structure for the existing building and covering of the outdoor seating area with a shade structure and open pergola;
- maintaining and upgrading the rock pool as required;
- continued monitoring of the geotechnical hazards on the cliff face and rock slopes above the rock pool and access walkway, and implementation of maintenance and remediation measures as recommended by geotechnical consultants;
- maintaining and upgrading Bilgola SLSC as required;
- maintaining and upgrading the amenities building as required;
- maintaining the existing grass strip along the southern carpark boundary, installing two additional seats/picnic tables, continuing to monitor the stability and safety aspects of the existing seawall, and implementation of maintenance and remediation measures (for the seawall) as recommended by geotechnical consultants;
- investigating the feasibility of installing a Gross Pollutant Trap (GPT) upstream of Bilgola Creek to reduce the likelihood of sediment and rubbish depositing on the beach;
- maintaining and upgrading the pathway connection to Bilgola Avenue and Allen Avenue as required having regard to public safety and drainage issues;
- re-profiling the remnant foredune adjoining residences along the central portion of the beach as required, having regard to public safety, ongoing maintenance and regeneration works

including removal of weed species, supplemental planting with salt tolerant local species and installation of temporary/low key dune fencing where required;
- stabilising the dune area north of Allen Avenue with planting and use of temporary fencing and establish a landward dune reserve area;
- maintaining and upgrading the existing northern stairway and path access to the beach, having regard to public safety, drainage issues and weed control;
- investigating two possible pathway connections to the northern stairway access including one along the northern headland and the other along The Serpentine; and
- implementing signage containing interpretive, directional and safety information.

C2.5 Coastal Management Strategy, Warringah Shire (PWD, 1985)

The Public Works Department (PWD, 1985)) prepared a Coastal Management Strategy for Warringah Shire, then covering the coast from Palm Beach to Freshwater Beach.

At Bilgola Beach, PWD (1985) recommended several management actions, including:

- development of a revetment policy and development control instrument for properties east of Allen Avenue;
- extension of the Allen Avenue revetment to the south to protect Bilgola SLSC;
- landscaping of protection works with a covering dune, stabilising vegetation, maintaining fencing and access tracks, and establishing secondary dune vegetation;
- extension of the dune covering the protection works to the northern and southern ends of the beach, including fencing and access tracks;
- in conjunction with the above protection works, diversion of the stormwater outlet near the northern end of Allen Avenue to the natural fissure in the rock face to the east;
- investigation of schemes for diverting stormwater from the three drains south of Bilgola Avenue (namely at the SLSC, car park and Bilgola Creek) to the rock shelf at the southern end of the beach;
- upgrading car parking facilities at the southern end of the beach by expanding the parking area into the flatter section of the reserve area adjacent to the access road;
- upgrading the car park at the northern end of Allen Avenue;
- upgrading the reserve landward of Bilgola SLSC with additional landscape plantings and picnic and barbeque facilities;
- pending the construction of the revetment to the southern end of the beach, reviewing the stability of the seawall seaward of Bilgola SLSC if it suffers further storm damage or if the SLSC building is to be replaced, extended or renovated; and
- purchasing the eastern section of the land owned by the then Bilgola Estate (that is, the present 21 Bilgola Avenue) and landscaping as public park land.

At Basin Beach, PWD (1985) recommended several management actions, including:

- adoption of a policy for the construction of a continuous revetment along Basin Beach, in accordance with the rock revetment design specified by PWD;
- reconstruction of the stormwater outlet at the northern end of the beach to discharge on the rock shelf further to the east;
- upgrading and maintaining the existing dune stabilisation vegetation, fences and access tracks at the northern end of the beach, and establishing secondary dune vegetation; and

- upgrading the park area between the northern end of the beach and Bassett Street east with additional landscape plantings, shade trees and public facilities.

C2.6 Development Control Plan No.4 – Development of Seawalls, Basin Beach, Mona Vale

Development Control Plan No.4 (DCP No.4) was adopted by Pittwater Council on 12 December 1994 and came into force on 24 December 1994. It has since been superseded by the *Pittwater 21 Development Control Plan* (refer Section C2.7).

DCP No.4 was prepared to establish design criteria and an alignment for a revetment to provide coastal storm protection to properties along Surfview Road at Basin Beach. This was based on a design plan and cross-section prepared by PWD. The PWD revetment design comprised the following key elements:

- crest level at 7.5m AHD;
- revetment slope at 1:1.5 (vertical to horizontal);
- toe level at -1.0m AHD;
- crest and toe width of 3 metres;
- two layers of 6.5 tonnes armour rock placed over an optional secondary underlayer comprising a single layer of 0.3tonne to 0.5tonne rock and a geotextile fabric filter blanket; and
- rock density of 2,650 kg/m^3 and aspect ratio of less than 2:1.

As part of the PWD design it was also proposed that the revetment was covered with sand and vegetated with dune grasses, and that three beach access tracks were constructed over the revetment.

The proposed rock revetment has not been constructed and it is not intended that it is constructed by the NSW Government or Council.

C2.7 Pittwater 21 Development Control Plan

The *Pittwater 21 Development Control Plan* (denoted as "P21 DCP" herein) was first adopted on 8 December 2003. Clause B3.3 of the P21 DCP is relevant to coastal hazards. This section refers to the Coastal Hazards Map, the *Coastline Risk Management Policy for Development in Pittwater* included as Appendix 6 of P21 DCP, and in relation to development controls it is stated that:

- development must be designed and constructed to ensure that every reasonable and practical means available is used to remove risk to an acceptable level for the life of the development; and
- the development must not adversely affected or be adversely affected by coastal processes nor must it increase the level of risk for any people, assets and infrastructure in the vicinity due to coastal processes.

As noted above, Appendix 6 of P21 DCP contains the *Coastline Risk Management Policy for Development in Pittwater* (denoted as the "Coastline Policy" herein). In this document a number of development controls were outlined that applied to coastal land identified on the Coastline Hazard Map 97-003 (MDCP016). In the Coastline Policy it is stated that "applicants will need to seek their own professional advice on the identification of coastline hazards affecting property and the

associated risk to existing dwellings (where retained) or proposed development, and measures to reduce this risk to an acceptable level (including the adequacy of any existing rock revetments or other property protection works)". The measures that are suggested within the Coastline Policy to reduce risk include appropriate setbacks and buffer zones, appropriate floor levels and freeboard allowances and appropriate foundation design.

In the Coastline Policy definitions were provided of key parameters in the assessment of coastline hazards at a property, including the:

- Coastline Hazard Line – the extent to which a beach may erode as a result of a design storm event (100 year ARI storm), taking into consideration:
    - any shoreline recession due to sediment loss;
    - shoreline recession due to sea level rise over the designated planning period (taken to be 100 years unless specified otherwise and justified);
    - beach erosion due to design storm demand; and
    - slope adjustment.
- Coastline Management Line – a setback line that equates to the Coastline Hazard Line plus the addition of a landward buffer zone, generally 10 metres wide unless specified otherwise and justified; and
- Coastline Planning Level – the 100 year ARI elevated water level due to astronomical tide, storm surge, local wind setup, sea level rise, wave runup and wave setup, plus a freeboard, generally 500 mm unless specified otherwise and justified.

A number of development controls were specified in relation to the definition of a Coastline Management Line and Coastline Planning Level. These are summarised below:

- Coastline Management Line:
    - new development and major additions to existing development must be sited on the landward side of the 100 year Coastline Management Line;
    - minor additions (value less than $10,000) to existing dwellings may be permitted between the 50 year and 100 year Coastline Management Line provided that the addition is not located seaward of the existing dwelling and that the combined additional Gross Floor Area seaward of the 100 year Coastline Management Line does not exceed a maximum total area of 30 m^2;
    - ancillary structures may be permitted seaward of the 100 year Coastline Hazard Line where their destruction by coastal processes is unlikely to exacerbate property damage during a storm event; and
    - subdivision of land will not be permitted where building platforms will be created on the seaward side of the 100 year Coastline Management Line.
- Coastline Planning Level:
    - all structures below the Coastline Planning Level shall be constructed from flood compatible materials;
    - all electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the Coastline Planning Level;
    - the storage of toxic or potentially polluting goods, materials or other products, which may be hazardous or pollute waters during property inundation, will not be permitted below the Coastline Planning Level;
    - for existing structures, a tolerance of up to minus 100 mm may be applied to the Coastline Planning Level in respect of compliance with these controls;

- building heights must not exceed 8.0m above the Coastline Planning Level or 8.5m above existing ground level, whichever is higher;
- where land is also subject to the provisions of the Flood Risk Management Policy for Development around Pittwater, the higher of the Coastline Planning Level and Flood Planning Level shall apply;
- all floor levels for new development, additions to existing dwellings and enclosed garages shall be at or above the Coastline Planning Level;
- covered basement (i.e. below natural ground level) or covered bunded car parking facilities must have all access, ventilation and any other potential water entry points above the Coastline Planning Level and a clearly signposted inundation free pedestrian evacuation route from the basement or bunded area separate to the vehicular access ramps;
- for development involving more than 2 dwellings, the floor level of open carpark areas and carports for residential car parking shall be at or above the Coastline Planning Level; and
- subdivision of land will not be permitted where the building platforms of residential allotments will be created below the Coastline Planning Level.

Coastal protection works (that modify oceanic inundation and wave action behaviour, such as seawalls and revetments) may be permitted by the Policy[2] subject to the preparation of a Coastal Risk Management Report by a Coastal Engineer with chartered professional status and an appropriate level of professional indemnity insurance (at least $2 million). A Coastal Risk Management Report is also required to be submitted if floor levels are below the Coastline Planning Level or if existing or proposed development is seaward of the 100 year Coastline Management Line. In relation to coastal protection works, the Coastal Risk Management Report must demonstrate that:

- the works do not have an adverse impact on any surrounding properties or coastal processes;
- a Section 88B notation under the *Conveyancing Act 1919* is to be placed on the title describing the location and the types of mitigation works with a requirement for their retention and maintenance;
- hazard mitigation works will result in the protection of the proposed development from coastal processes;
- the position of existing coastal protection structures has been used to determine the location and alignment of any new terminal revetment or coastal protection works; and
- a suitably qualified professional has certified the structural integrity and competency of existing protection structures for their intended purpose and design storm event.

Development controls in the Coastline Policy relating to dune management include:

- return of uncontaminated sand excavated during construction activities to the active beach zone as directed by Council;
- rehabilitation and maintenance of remnant foredunes (where present) throughout the life of the development; and
- maintenance and protection of vegetated dunes from damage during construction and as a result of subsequent use during the life of the development.

[2] As discussed in Section 2.2 of the main CZMP, coastal protection works are not a permissible land use in the current LEP. However, based on *State Environmental Planning Policy (Infrastructure) 2007*, coastal protection works are permitted with consent for landowners, and permitted without consent for Council. An action is included in the CZMP for Council to investigate how this anomaly may be resolved, so that the LEP is consistent with *State Environmental Planning Policy (Infrastructure) 2007* and coastal protection works are a permitted use.

In Clause B3.4 of P21 DCP, hazards associated with coastal bluffs were addressed with reference to the *Geotechnical Risk Management Policy for Pittwater* included as Appendix 5. However, coastal bluffs are excluded from the study area herein.

In Clause B3.23 of P21 DCP, hazards associated with climate change (sea level rise and increased rainfall volume) were addressed. Control measures apply to land identified as Beach Management Areas on the Coastline Hazard Map 97-003 (MDCP016) and where intensification of development is proposed. The controls require two climate changes scenarios to be considered:

- Scenario 1: impact of sea level rise only; and
- Scenario 2: impacts of sea level rise combined with increased rainfall volume.

For land identified as a Beach Management Area, this is to be assessed for climate change hazards in accordance with Clause B3.3 of P21 DCP (as outlined above).

C2.8 Risk Management Policy for Coastal Public Buildings and Assets in Pittwater (Policy No. 186)

This policy was adopted on 2 May 2011 and therein it is acknowledged that certain public buildings and assets may need to be located in areas influenced by coastal processes and affected by coastal hazards in order to fulfil their intended function. It is also acknowledged that these structures may be subject to a higher level of risk from coastal processes than other coastal development and be more likely to suffer damage as a result of coastal processes. These structures on or near beaches may include coastal protection works[2], ocean rock pools, surf lifesaving clubs, parking areas, amenity buildings and other recreational structures.

In the policy the following requirements for development proposals for building improvements, additions and alterations to Council owned buildings in the Pittwater coastal zone are outlined:

- All development proposals for building improvements and additions and alterations to Council owned buildings in the Pittwater coastal zone must be consistent with any redevelopment proposal adopted in a relevant plan of management. Any risk management measures proposed in response to coastal hazards must also be consistent with the provisions of the relevant, certified coastal zone management plan and agreed by Council or the relevant management authority.
- All development applications (DAs) for building improvements and additions and alterations to Council owned buildings in the Pittwater coastal zone[3] must be supported by a coastal risk assessment for the existing building prepared in accordance with the requirements of Section 4 of Department of Planning (2010) and the DECCW (2010b).
- The coastal risk assessment must outline, as a minimum, the following:
    - a description of all relevant coastal hazards affecting the subject property;
    - the coastal hazard zones at the subject property (including the immediate hazard line as well as hazard lines for the 50 and 100 year planning periods);
    - an explanation of how the proposal complies with applicable NSW coastal legislation, statutory coastal guidelines and all relevant policies; and

[3] Note that based on *State Environmental Planning Policy (Infrastructure) 2007*, some building works are permissible without consent and hence are Part 5 matters that do not require a DA. On land under the control of or vested in councils, visitor centres, amenity facilities and maintenance depots (and a range of ancillary buildings and associated structures) are permissible without consent.

  - justification for the proposed design life of the building and details as to how the risks from coastal hazards will be managed to an acceptable level for that period of time (this may include measures such as emergency coastal protection works, emergency evacuation plans, beach nourishment works, allowing discrete parts of the building to be sacrificial in the event of a major storm and decommissioning the building when agreed trigger conditions are met).
- Where an existing Council owned building is located entirely seaward of the immediate hazard line, major additions and alterations will not be considered under these circumstances. Minor refurbishment and internal reconfigurations may be considered if it can be demonstrated that the risks from current coastal hazards can be satisfactorily managed for the remaining design life of the building.
- Where the majority of an existing Council owned building is landward of the immediate hazard line but seaward of the 50 year hazard line, the DA[3] will be assessed on merit and against the planning criteria in Department of Planning (2010). The same criteria will also apply where the majority of a Council owned building is landward of the 50 year hazard line but seaward of the 100 year hazard line.
- No additions or alterations will be permitted to be founded seaward of the building footprint of an existing Council owned building that is itself located partially seaward of the immediate hazard line.

C2.9 Pittwater Sustainability Policy No. 164

This policy was adopted on 19 June 2006, and in it Pittwater Council's commitment to sustainability was documented. Sustainability was defined as "development that improves the quality of life, both now and into the future, in a way that maintains the ecological processes on which life depends". The principles of ecologically sustainable development were noted as being obligations under the NSW *Local Government Act 1993* and comprised:

- inter-generational equity;
- the precautionary principle;
- improved valuation, pricing and incentive mechanisms; and
- conservation of biological diversity and ecological integrity.

C2.10 Climate Change Policy No. 176

This policy was adopted on 6 April 2009 and complements and supports Council's Sustainability Policy (No. 164, see Section C2.9). In the policy it is acknowledged and accepted that there is a growing body of convincing scientific research supporting climate change and that local government has an important role in helping to reduce greenhouse gas emissions and manage climate change impacts at the local level. It is also acknowledged that Council has a vital role to play in educating, mobilising and responding to the public to promote community climate action. In the policy it is stated that "climate change and its potential impacts must feature as a primary consideration in every aspect of Council's business whilst appropriate actions in response to the causes and effects of global warming must be integrated as a core part of every strategic and operational management activity undertaken by Council".

C2.11 Beach and Rockpool Management Policy No. 88

The use of beaches, beach reserves, beach rockpools and baths by groups is controlled by this policy, which was adopted on 11 September 2009. The policy covers arrangements and conditions for booking of rockpools and baths and exclusive use of beach areas for a range of activities such as contests or competitions, promotions, commercial filming, corporate functions, powerboat racing and fireworks.

C3. LEGISLATION

C3.1 *Coastal Protection Act 1979*

The *Coastal Protection Act 1979* is administered by the NSW Office of Environment and Heritage (OEH). The broad objectives of the *Coastal Protection Act 1979* are to make provisions relating to the use and occupation of coastal regions whilst encouraging sustainable use of these areas, and the facilitation of certain coastal protection works.

In Part 4A (Sections 55A to 55L) of the *Coastal Protection Act 1979*, information is given on various issues relating to CZMP's, including matters to be dealt with, public consultation, certification, gazettal, amendment, availability and breaches.

In particular, it can be noted that in Section 55K(1)(a) it is stated that "a person must not carry out work for the purpose, or that has the effect, of preventing or remediating beach erosion, or for protecting property affected or likely to be affected by beach erosion, unless the work is in accordance with the relevant CZMP".

In Section 55L(1) it is stated that "The Minister or a council may bring proceedings in the Land and Environment Court for an order to remedy or restrain a breach of a CZMP" where a breach means "a contravention of or failure to comply with a CZMP" as per Section 55L(4)(a) or "a threatened or apprehended contravention of or a threatened or apprehended failure to comply with a CZMP" as per Section 55L(4)(b).

Reference to CZMP's is also made in a number of other locations in the *Coastal Protection Act 1979*, namely:

- in Section 37B(c) it is stated that "The concurrence of the Minister under this Part is not required in relation to the carrying out in the coastal zone of any development (within the meaning of the *Environmental Planning and Assessment Act 1979*) that is carried out in accordance with a CZMP under Part 4A of the *Coastal Protection Act 1979*"; and
- in Schedule 1, Sections 3 and 4.

In Section 55M of the *Coastal Protection Act 1979*, conditions for the granting of development consent relating to coastal protection works under the *Environmental Planning and Assessment Act 1979* are described. These conditions relate to public access and safety, impacts caused by presence of the works and arrangements for maintenance of the works.

C3.2 *Environmental Planning and Assessment Act 1979*

C3.2.1 General

The *Environmental Planning and Assessment Act 1979* is the primary legislation for planning and land use within NSW.

In Part 3 of the *Environmental Planning and Assessment Act 1979*, key environmental planning instruments for use by the NSW Government and local Councils are established. These comprise State Environmental Planning Policies (SEPPs), Local Environmental Plans (LEPs) and Development

Control Plans (DCPs). Also, the process for lodgement and assessment of development applications is described in the Act.

In Part 4 of the *Environmental Planning and Assessment Act 1979*, development that requires consent by a local authority (typically Council) is described. Section 79C outlines matters for consideration when evaluating a development application, which include environmental planning instruments (SEPPs, LEPs), DCPs and CZMPs. Section 79C(1) is reproduced below:

> "In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:
>
> (a) the provisions of:
> (i) any environmental planning instrument, and
> (ii) any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Director-General has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and
> (iii) any development control plan, and
> (iiia) any planning agreement that has been entered into under section 93F, or any draft planning agreement that a developer has offered to enter into under section 93F, and
> (iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), and
> (v) any coastal zone management plan (within the meaning of the *Coastal Protection Act 1979*),
>
> that apply to the land to which the development application relates,
> (b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,
> (c) the suitability of the site for the development,
> (d) any submissions made in accordance with this Act or the regulations,
> (e) the public interest".

Part 5 of the *Environmental Planning and Assessment Act 1979* relates to activities that are permissible without consent under Part 4 but require approval from a Minister or Public Authority, or are proposed to be carried out by a Minister or Public Authority (such as a Council). A Public Authority undertaking or consenting to activities under Part 5 is required to consider the environmental impact of the activity, even if they are also the "determining authority"[4] (as may be the case with Council). This consideration is typically in the form of a Review of Environmental Factors (REF) unless significant impacts were expected, in which case an Environmental Impact Statement (EIS) would be required[5].

C3.2.2 Section 149 Certificates

Under Section 149 of the *Environmental Planning and Assessment Act 1979*, Council is obliged to issue a planning certificate (known as a "Section 149 Certificate") to notify property owners about matters affecting their land. This may be requested at any time by a property owner but is typically

[4] The Public Authority that is required to approve an activity.
[5] An REF has no statutory basis, but a determining authority usually decides (as part of standard practice in NSW) whether to require a full EIS by considering a preliminary environmental assessment in the form of an REF.

requested when a property is redeveloped or sold. When land is bought or sold, the *Conveyancing Act 1919* requires that a Section 149 Certificate be attached to the Contract for Sale.

There are two types of planning certificates that can be issued by Council, namely under Section 149(2) or Section 149(5) of the *Environmental Planning and Assessment Act 1979*. A planning certificate issued under Section 149(2) provides information about the zoning of the property, the relevant state and local planning controls and various other property affectations. The matters addressed by Section 149(2) certificates are governed by Schedule 4 of the *Environmental Planning and Assessment Regulation 2000* (refer Section C3.3). A planning certificate issued by Council under Section 149(2) and Section 149(5) includes "advice on such other relevant matters affecting the land of which it may be aware".

Inclusion of a Section 149(2) planning certificate in a contract for the sale of land is a mandatory part of the property conveyancing process in NSW. Section 149(5) planning certificates do not form part of the contract for the sale of land, are optional, and restrictions on development cannot be listed on them. Section 149(2) and Section 149(5) planning certificates may be purchased by anyone, from the relevant Council, at any point in time.

A planning circular "Coastal hazard notations on Section 149 planning certificates" (PS 14-003) was released by the NSW Department of Planning & Infrastructure on 13 November 2014. This was based on the NSW Government identifying a need to improve the way Councils disclose coastal hazard information (coastal erosion, tidal inundation, coastal inundation and coastal flooding) in planning certificates.

In the planning circular, it is emphasised that in providing information on planning certificates it is important to clearly distinguish between current and future exposure to a coastal hazard. The recommended notation for Section 149(2) certificates is:

- "This land has been identified in the [insert name of council policy or development control] as having a current exposure to [insert type of hazard(s)]. The [insert name of council policy or development control] is based on a study dated [insert date adopted by council] and reflects information available at the time. Contact council for more information" (for current exposure); or
- "This land has been identified in the [insert name of council policy or development control] as having a future exposure to [insert type of hazard(s)]. The [insert name of council policy or development control] is based on a study dated [insert date adopted by council] and reflects information available at the time. Contact council for more information" (for future exposure)[6].

In the planning circular, it is noted that a Section 149(5) certificate provides the opportunity for the Council to advise of a known hazard during the time between the Council coming into sufficiently reliable knowledge regarding the existence and extent of that hazard and the Council having the opportunity to develop and implement a policy or planning instrument to manage that hazard. That is, if sufficiently reliable information on a hazard is available, then Council should adopt a policy or planning instrument that manages development on the land. This would then require disclosure on the Section 149(2) planning certificate.

[6] It is noteworthy that the timeframe for expression of the future exposure is not specified in this advice, and it is recommended that this be included in some form if possible.

C3.3 *Environmental Planning and Assessment Regulation 2000*

In Schedule 4 of the *Environmental Planning and Assessment Regulation 2000*, the information that must be disclosed by Council on a Section 149(2) planning certificate under the *Environmental Planning and Assessment Act 1979* (refer Section C3.2) is specified. Required information that is relevant to coastal management includes:

- names of relevant planning instruments and DCPs;
- zoning and land use under relevant LEPs;
- zoning and land use under *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*;
- whether or not the land is land on which complying development may be carried out under each of the codes for complying development because of the provisions of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008* and the reasons why complying development may not be carried out if this is the case;
- whether or not the land is affected by the operation of Section 38 or Section 39 of the *Coastal Protection Act 1979*;
- whether an order has been made under Part 4D of the *Coastal Protection Act 1979* in relation to temporary coastal protection works on the land (or on public land adjacent to that land);
- whether Council has been notified under Part 55X of the *Coastal Protection Act 1979* that temporary coastal protection works have been placed on the land (or on public land adjacent to that land) and whether Council is satisfied that the works have been removed and the land restored in accordance with the *Coastal Protection Act 1979*;
- whether the owner (or any previous owner) of the land has consented in writing to the land being subject to annual charges for coastal protection services under section 496B of the *Local Government Act 1993*;
- whether or not the land is affected by a policy that restricts the development of the land because of the likelihood of land slip, bushfire, tidal inundation, subsidence, acid sulphate soils or any other risk (other than flooding); and
- whether or not any environmental planning instrument or proposed environmental planning instrument makes provision in relation to the acquisition of the land by a public authority.

C3.4 *Local Government Act 1993*

In the *Local Government Act 1993*, the legal, financial and governance framework of local Councils in NSW is outlined. Provisions in this legislation that are relevant to the implementation and funding of coastal management activities include:

- Section 495, which allows councils to levy 'special rates' on rateable land that benefits from council services other than domestic waste management services;
- Sections 496B and 553B, which allows an annual levy to be charged on rateable land benefitting from the provision of 'coastal protection services' by councils defined as maintenance and repair of coastal protection works and managing the impacts of these works; and
- Section 733(2), in which it is stated that "a council does not incur any liability in respect of:
  (a) any advice furnished in good faith by the council relating to the likelihood of any land in the coastal zone being affected by a coastline hazard…or the nature or extent of any such hazard or

(b) anything done or omitted to be done in good faith by the council in so far as it relates to the likelihood of land being so affected".

It is also noted in Section 733(3) that without limiting Section 733(2) above, this exemption from liability also applies to:

(a) the preparation or making of an environmental planning instrument, including a planning proposal for the proposed environmental planning instrument, or a development control plan, or the granting or refusal of consent to a development application, or the determination of an application for a complying development certificate, under the *Environmental Planning and Assessment Act 1979*, and
(b) the preparation or making of a coastal zone management plan, or the giving of an order, under the *Coastal Protection Act 1979*, and
(c) the imposition of any condition in relation to an application referred to in paragraph (a), and
(d) advice furnished in a certificate under section 149 of the *Environmental Planning and Assessment Act 1979*, and
(e) the carrying out of flood mitigation works, and
(f) the carrying out of coastal management works, and
(f2) anything done or omitted to be done regarding beach erosion or shoreline recession on Crown land, land within a reserve as defined in Part 5 of the *Crown Lands Act 1989* or land owned or controlled by a council or a public authority, and
(f3) the failure to upgrade flood mitigation works or coastal management works in response to projected or actual impacts of climate change, and
(f4) the failure to undertake action to enforce the removal of illegal or unauthorised structures that results in erosion of a beach or land adjacent to a beach, and
(f5) the provision of information relating to climate change or sea level rise, and
(f6) anything done or omitted to be done regarding the negligent placement or maintenance by a landowner of temporary coastal protection works, and
(g) any other thing done or omitted to be done in the exercise of a council's functions under this or any other Act.

In Section 733(4) of the *Local Government Act 1993* it is noted that "without limiting any other circumstances in which a council may have acted in good faith, a council is, unless the contrary is proved, taken to have acted in good faith for the purposes of this section if the advice was furnished, or the thing was done or omitted to be done, substantially in accordance with the principles contained in the relevant manual most recently notified under subsection (5) at that time". This manual is *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013).

C3.5 *Crown Lands Act 1989*

The study area contains areas of Crown Land that are not within Council's land register, and also Crown Land that is under the care and management of Council. The *Crown Lands Act 1989* governs how Crown Land is to be managed based on a number of principles as per Section 11 of the Act, which include that:

- environmental protection principles be observed;
- natural resources be conserved wherever possible (including water, soil, flora, fauna and scenic quality);

- public use and enjoyment, and multiple use (where appropriate) be encouraged;
- it is used and managed in such a way that the land and its resources are sustained in perpetuity; and
- it be occupied, sold, or otherwise dealt with in the best interests of the State consistent with these principles.

Crown Lands is directly responsible for the Crown Waterway to 3 nautical miles offshore of the study area (that is, the South Pacific Ocean). A licence is required for sand extraction in this area under Section 49 of the *Crown Lands Act 1989*, subject to the approval and consideration of the Minister for Resources and Energy under the *Offshore Minerals Act 1999*. Further discussion on the *Offshore Minerals Act 1999* is provided in Appendix G and Appendix H.

C3.6 *State Environmental Planning Policy No.71 - Coastal Protection*

State Environmental Planning Policy No. 71 – Coastal Protection (denoted as "SEPP 71" herein) is the main SEPP applying to development within the coastal zone of NSW. The coastal zone is defined on maps by the NSW Government and includes the study area, as indicated on the Greater Metropolitan Region Maps No.11 and No.13. Within these coastal zones a 'sensitive coastal location' is defined in SEPP 71 as:

- land within 100 metres above mean high water mark of the sea, a bay or an estuary;
- a coastal lake, or within 100m of the water's edge of a coastal lake;
- a declared Ramsar Wetland, or within 100m of a declared Ramsar Wetland;
- a declared World Heritage Property, or within 100m of a declared World Heritage Property;
- land declared as an aquatic reserve under the *Fisheries Management Act 1994*, or within 100m of a declared aquatic reserve;
- land declared as a marine park under the *Marine Parks Act 1997*, or within 100m of a declared marine park;
- land within 100m of the items listed above or within 100m of land reserved or dedicated under the *National Parks and Wildlife Act 1974*;
- land within 100m of SEPP 14 Coastal Wetlands; and
- residential land within 100m of SEPP 26 Littoral Rainforests.

In Clause 8 of SEPP 71, matters that are to be taken into consideration when councils are preparing an LEP or determining a development application are listed. These include:

- retaining, improving or providing new public access to coastal foreshore areas;
- aesthetic impacts of development on the surrounding area;
- public amenity impacts of development on the coastal foreshore;
- fauna and flora conservation;
- protection of wildlife corridors;
- impacts of coastal processes and hazards on the development and any likely impacts of development on coastal processes and hazards;
- impacts on water quality;
- reducing conflict between land and water based activities; and
- protection of heritage features.

For subdivision of land zoned rural or residential in a 'sensitive coastal location' (defined above) or exceeding a certain number of lots, Master Plans are required to be prepared and placed on public exhibition before they can be approved by the Minister for Planning.

C3.7 *State Environmental Planning Policy (Infrastructure) 2007*

Division 25 of *State Environmental Planning Policy (Infrastructure) 2007* (denoted as "SEPP Infrastructure" herein) relates to waterway or foreshore management activities, including:

- coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways; and
- coastal protection works.

In SEPP Infrastructure, the types of development that are permitted without and with consent are described in Clauses 129 and 129A respectively. Clause 129 applies to public authorities (such as a Council), and Clause 129A applies to private landowners. In both cases, the provisions of any relevant CZMP must be considered prior to development (for Council works) or prior to determining a development application (for a Council considering a development application from a private landowner).

The NSW Coastal Panel must be notified (for Council works) or is the consent authority (for private landowner works) where no CZMP applies to the land. These provisions do not apply once a certified CZMP is in force relating to the land where the works would be located.

C3.8 Pittwater Local Environmental Plan 2014

Clause 7.5 of *Pittwater Local Environmental Plan 2014* (noted as "LEP 2014" herein) is relevant to coastal hazards. Clause 7.5 of LEP 2014 is reproduced below:

(1) The objectives of this clause are as follows:
  (a) to avoid significant adverse impacts from coastal hazards,
  (b) to ensure uses of land identified as coastal risk are compatible with the risks presented by coastal hazards,
  (c) to enable the evacuation of land identified as coastal risk in an emergency,
  (d) to avoid development that increases the severity of coastal hazards.
(2) This clause applies to land identified on the Coastal Risk Planning Map as:
  (a) Wave Inundation, or
  (b) Coastal Erosion/Wave Inundation, or
  (c) Bluff/Cliff Instability.
(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:
  (a) is not likely to cause detrimental increases in coastal risks to other development or properties, and
  (b) is not likely to alter coastal processes and the impacts of coastal hazards to the detriment of the environment, and
  (c) incorporates appropriate measures to manage risk to life from coastal risks, and

(d) is likely to avoid or minimise adverse effects from the impact of coastal processes and the exposure to coastal hazards, particularly if the development is located seaward of the immediate hazard line, and
(e) provides for the relocation, modification or removal of the development to adapt to the impact of coastal processes and coastal hazards, and
(f) has regard to the impacts of sea level rise, and
(g) will have an acceptable level of risk to both property and life, in relation to all identifiable coastline hazards.

(4) A word or expression used in this clause has the same meaning as it has in the NSW Coastal Planning Guideline: Adapting to Sea Level Rise (ISBN 978-1-74263-035-9) published by the NSW Government in August 2010, unless it is otherwise defined in this clause.

(5) In this clause: *coastal hazard* has the same meaning as in the *Coastal Protection Act 1979*.

Clause 7.5(3) is likely to be one of the most important Clauses for Council assessing future development applications in the study area.

Coastal Risk Planning Map Sheets CHZ_016 and CHZ_017 cover the Bilgola Beach area. These maps indicate that the properties along the entire beach frontage of Allen Avenue and at 21 Bilgola Avenue have been identified as being subject to Coastal Erosion/Wave Inundation hazards for the purposes of LEP 2014.

Coastal Risk Planning Map Sheet CHZ_018 covers the Basin Beach area. This map indicates that the properties along the entire beach frontage of Surfview Road have been identified as being subject to Coastal Erosion/Wave Inundation hazards for the purposes of LEP 2014.

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Appendix D: Risk Assessment to Define Appropriate Beachfront Development Setbacks and Controls in Relation to Coastline Hazards

CONTENTS

D1. INTRODUCTION

D1.1 Background

Coastal development setbacks in NSW have traditionally been defined through delineation of coastal hazard lines, using a variety of planning periods and hazard zones. However, until recently, there has been no rigorous assessment of the validity of traditional hazard lines in terms of leading to an acceptable risk to property if used as setbacks for new development.

Haskoning Australia developed a methodology for defining 'acceptable risk' as part of completion of the *Collaroy-Narrabeen Beach and Fishermans Beach CZMP* for Warringah Council in 2014. As part of that investigation , it was agreed between the study team (which included coastal engineer and former Pittwater Council General Manager Mr Angus Gordon, as well as a legal firm), Council staff (including Council's corporate lawyer), Councillors, Office of Environment and Heritage (OEH) staff and an external peer reviewer (Mr Bruce Walker of JK Geotechnics) that defining appropriate development setbacks using the 'acceptable risk' approach developed was valid, reasonable and an improvement on traditional hazard line approaches to defining setbacks. As such, 'acceptable risk' lines were delineated at Collaroy-Narrabeen and Fishermans Beach to define setbacks for future beachfront development.

The 'acceptable risk' methodology was also applied at Old Bar in 2014 as part of the completion of a CZMP addendum for Greater Taree Council. The methodology has also been described by the author of the study herein in Horton et al (2014).

The 'acceptable risk' methodology is considered to be consistent (in principle) with *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) and papers by OEH staff such as Kinsela and Hanslow (2013). In OEH (2013), one of the Coastal Management Principles is to "adopt a risk management approach to managing risks to public safety and assets". The approach is also considered to be consistent (in principle) with the joint Australian, New Zealand and International Organisation for Standardization Standard AS/NZS ISO 31000:2009, "Risk management - Principles and guidelines" and Australian Standard AS 5334-2013, "Climate change adaptation for settlements and infrastructure - A risk based approach".

It was considered that adopting an 'acceptable risk' approach for the Bilgola Beach and Basin Beach CZMP, as set out herein, was a valid approach for defining setbacks for new beachfront development in the study area. It is emphasised that the setbacks derived herein are applicable to new development. Any setbacks and controls adopted for new development would have no effect on (already approved) existing development.

Setbacks were developed for two scenarios, namely for new structures on conventional foundations (such as slab-on-ground, strip footings or shallow piers) and new structures on (deep) piles. It is recognised that although a piled structure may be at an acceptably low risk of damage, other matters such as a consistent building alignment and beach amenity need to be considered in determining the suitability of piled development at a particular site.

D1.2 Scope

The 'acceptable risk' setbacks developed herein are based on coastal erosion caused by meteorological events ('coastal storms') leading to large waves and elevated water levels, and

recession due to net sediment loss and sea level rise . Tsunamis, which have rarer frequencies of occurrence and different driving processes to coastal storms[1], have not been considered.

D1.3 Framework

The framework of the adopted 'acceptable risk' approach came from Australian Geomechanics Society (AGS) procedures for landslide risk management (AGS, 2007a, b), which were developed over a period of more than a decade via a Working Group of experts[2], and have been widely applied in geotechnical engineering practice since 2000[3]. The AGS procedures were also subject to peer review and discussion through the AGS Landslides Taskforce, with 23 members. That is, the AGS procedures can be considered to be an established, recognised and peer reviewed methodology for defining landslide risk for development assessment. With modification to be appropriate for 'sandy beach' coastline hazards, it is considered that the same principles of the AGS procedures can be applied to define 'acceptable risk' for beachfront development, as has been undertaken herein.

D1.4 Recognition of Uncertainty

It is important to recognise that future climate cannot be predicted precisely, and is subject to not only storm variability, but longer term cycles such as the El Nino / La Nina Southern Oscillation, Pacific Decadal Oscillation, and Interdecadal Pacific Oscillation (IPO).

For example, Helman (2007) has postulated that during negative Interdecadal Pacific Oscillation (IPO) phases, the NSW coast experiences wet periods, major floods, sea level above the long term trend and coastal erosion. Using an 11 year Chebychev filter annual series from 1871 to 2008 (Folland, 2008), a significant past continuous negative IPO period was from 1945 to 1977, and IPO was positive from 1978 to 2000, returning to negative from 2001 to 2008 (although the nature of the filtering was such that the 2004 to 2008 period should be regarded with caution). A return to negative IPO combined with additional future projected sea level rise could lead to a future period of enhanced erosion compared to the 1978 to 2000 period.

Future climate can also not be predicted precisely due to ongoing climate change caused by the enhanced greenhouse effect. Climate change effects such as sea level rise are projected by researchers based on various scenarios as to how greenhouse gases and aerosols will be emitted anthropogenically in the future, that is so called "representative concentration pathways" as described by the Intergovernmental Panel on Climate Change (IPCC), for example in IPCC (2013a). These scenarios represent a range of 21st century climate policies and cannot be precisely predicted as they largely depend on political decisions and economic growth.

Furthermore, storm events more severe than adopted design events can occur, or a structure could remain in place for longer than the design life considered herein (thus potentially being exposed to more severe conditions, for example because sea level rise is projected to be ongoing).

[1] Tsunamis are typically driven by earthquakes, landslides, large scale collapse of volcanic islands, or asteroid impacts, with earthquakes being the dominant tsunami source in NSW for events more frequent than 500 year average recurrence interval (Somerville et al, 2009).
[2] Mr Bruce Walker, who peer reviewed the 'acceptable risk' assessment in the *Collaroy Narrabeen Beach and Fishermans Beach CZMP*, was the Working Group Convenor.
[3] Using preceding AGS documents as discussed in AGS (2007a).

Therefore, it must be recognised that any development landward of a particular 'acceptable risk' line is not at zero risk (but at acceptably low risk), and damage may be possible both during and particularly beyond the design life. Council should not (and could not) guarantee that development given consent to be sited landward of a particular 'acceptable risk' line would never be damaged by coastal processes.

That stated, the approach developed herein is considered to be reasonable and valid for defining acceptable risk to property for new development in the study area, and an improvement on traditional methods of hazard definition. It is recommended that the CZMP covering the study area is updated at least every 10 years to enable improved understanding to be incorporated as required.

D1.5 Risk to Life

Only risk to property is evaluated herein, not risk to life. In the coastal beach context, risk to life related to development in the study area was considered to be acceptably low as:

- coastal storms (large waves and elevated water levels) are generally foreseeable at least 24 hours in advance, with warnings issued by the Bureau of Meteorology;
- a large component of elevated water levels is astronomical tide, which can be accurately predicted decades into the future;
- erosion would generally be expected to be greatest for a few hours near the peak of the tide;
- the progress of erosion on a beach is visible and perceptible, and would not generally be expected to proceed undetected to damage development;
- it is highly unlikely that a landowner would be occupying a dwelling and would be unaware (or would not have been made aware) that this dwelling was at imminent threat of damage;
- the State Emergency Service (SES), if mobilised, has powers to warn and evacuate residents if required (as does NSW Police);
- Council could request that the SES takes on a Combat Agency role if an actual emergency was occurring and it had not already been mobilised; and
- beachfront landowners have been consulted and informed with regard to coastal erosion and inundation emergencies through completion of the *Coastal Erosion Emergency Action Subplan for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)* in 2012, as documented in WorleyParsons (2012a, b).

These factors mean that residents would have a low probability of occupancy and/or loss of life during an actual storm event that could threaten development, and hence have a low risk to life in such an event, which would satisfy the acceptance criteria given in AGS (2007a).

D1.6 Non-Sandy Subsurfaces

The recommendations herein have been made assuming an entirely sandy subsurface within the area of active coastal erosion/recession. If geotechnical investigations indicate that there are non-sandy surfaces (just as stiff clay or rock) that would limit coastal erosion/recession in the study area, then there may be consideration of adjustment to the recommendations given herein.

Consideration has been made herein for the effect of existing protection works in potentially limiting coastal erosion/recession.

D1.7 Appendix Structure

The Appendix herein is set out as follows:

- design life is considered in Section D2;
- in Section D3 to D6, risk is considered in the context of ignoring existing protection works (such as seawalls and revetments):
    - risk is defined as the product of likelihood and consequences, with likelihood discussed in Section D3 and consequences (on a structure situated immediately landward of a particular setback position) outlined in Section D4;
    - 'acceptable risk' is defined in Section D5;
    - likelihood lines are delineated for the study area in Section D6, including comparison to traditional hazard lines;
- consideration of the effects of existing protection works (as are present along much of the study area) is made in Section D7;
- plots of the determined acceptable risk lines are provided in Section D8;
- the implications of these acceptable risk lines on development controls are outlined in Section D9; and
- discussion on other approaches to risk determination are provided in Section D10.

D2. DESIGN LIFE

The risk assessment must be undertaken in the context of a specified design life. This design life governs the planning period over which risks are assessed. That is, risks to structures will be determined as being acceptable or not acceptable on the basis of the risk of damage to the structure at the end of the design life.

Selection of a suitable design life is discussed in Section 9 of AGS (2007a) and Section C9.3 of AGS (2007b), in which it is noted that:

- a design life of at least 50 years would be considered to be reasonable for permanent structures used by people; and
- there is a community expectation that a residential dwelling frequently, with appropriate maintenance, will have a functional life well in excess of 50 to 60 years.

The design life of a structure should be related to the typical design life of its components, such as concrete, steel, masonry and timber. The design life used in various Australian Standards is as follows:

- in *AS 3600 - Concrete Structures*, a 50 years ± 20% design life[4] (that is, 40 year to 60 years) is used in devising durability requirements for concrete structures;
- in *AS 2870 - Residential Slabs and Footings*, for design purposes the life of a structure is taken to be 50 years for residential slabs and footings construction;
- in *AS 1170.0 - Structural Design Actions - General Principles*, the design life for normal structures is generally taken as 50 years[5];
- in *AS 4997 - Guidelines for the Design of Maritime Structures*, the design life for a normal commercial structure is specified as 50 years[6], and
- in *AS 4678 - Earth-Retaining Structures*, the design life for earth-retaining structures (structures required to retain soil, rock and other materials) is noted as 60 years for river and marine structures and residential dwellings.

The cost of new residential development is amortised for tax purposes over 40 years based on Subdivision 43-25 of the *Income Tax Assessment Act 1997*.

Based on the above, it is considered that a reasonable design life to adopt for devising setbacks and controls for new beachfront development in the study area is between 40 and 60 years. Given the uncertainty in future climate, it is considered to be more appropriate to choose the upper end of this range, and hence a design life of 60 years has been adopted herein. The design life has been applied in 2015, and thus 2075 represents the end of the design life.

[4] Period for which a structure or a structural member is intended to remain fit for use for its intended purpose with appropriate maintenance.
[5] In AS 1170.0, it is noted that for a design life of 50 years and normal structures (Importance Level 2), design event probabilities for structural actions should be 500 year ARI for wind, 150 year ARI for snow and 500 year ARI for earthquake.
[6] For a "special structure/residential" the specified design life in *AS 4997* is 100 years, but this was in the context of overwater structures (typically multi-unit, such as Walsh Bay 6/7, Woolloomooloo Finger Wharf, and Pyrmont), where the implications for having to carry out repairs over water are different to structures on land such as beachfront development.

Note that currently for beachfront development in the former Pittwater Council Local Government Area, "development must be undertaken in accordance with the acceptable risk management criteria defined in this document [the *Coastline Risk Management Policy for Development In Pittwater*, which is Appendix 6 of the Pittwater 21 Development Control Plan] for a design project life, taken to be 100 years, unless otherwise justified by the applicant and acceptable to Council". That is, the former Pittwater Council currently has adopted a more conservative design life than 60 years, namely 100 years.

A landowner may choose to design a structure for a longer design life than 60 years, in which case a site specific risk assessment could be completed by a coastal engineer on behalf of the applicant to define acceptable risks over the selected life.

It should also be recognised that future development applications (after 2015) that reference the acceptable risk lines developed herein would be applying a design life of less than 60 years. On this basis, it is recommended that applicants in the study area be required to obtain coastal engineering advice to ensure that acceptable risk has been addressed over a 60 year design life at the time of any development application.

An action recommended in the CZMP herein is also for the document to be updated at least every 10 years. This would enable the acceptable risk lines to remain relevant as understanding of coastal processes and climate change effects (such as sea level rise) develops in the future.

D3. LIKELIHOOD (IGNORING EXISTING PROTECTION WORKS)

D3.1 AGS Terminology

AGS (2007a, b) used 6 likelihood descriptors, as set out in Column 1 of Table D1[7], along with associated annual exceedance probabilities (AEPs). The AEP is given as both the indicative (single) value reported by AGS (2007a, b) in Column 2, as well as the range (based on notional boundaries between the likelihoods) in Column 3.

For a design life of 60 years, the cumulative probability of an event of a particular AEP occurring at least once over the design life was determined as per Column 4 of Table D1, using the formula[8]:

$$J = 1 - (1 - P)^L \quad (1)$$

where *P* is the AEP, *L* is the design life (years) and *J* is the probability of the event with an AEP of *P* occurring over the design life. The lower probability limit was associated with each descriptor herein, as per Column 5 of Table D1, which is conservative.

Table D1: Likelihood descriptors and associated probabilities used by AGS (2007a, b)

1 Descriptor	2 Annual Exceedance Probability (indicative value)	3 Annual Exceedance Probability	4 Cumulative probability of event occurring over 60 year design life (range)	5 Designated cumulative probability of event occurring over 60 year design life
Almost Certain	10%	> 5%	> 95.4%	95.4%
Likely	1%	0.5 to 5%	26.0 to 95.4%	26%
Possible	0.1%	0.05 to 0.5%	3.0 to 26.0%	3%
Unlikely	0.01%	0.005 to 0.05%	0.3 to 3.0%	0.3%
Rare	0.001%	0.0005 to 0.005%	0.03 to 0.3%	0.03%
Barely Credible	0.0001%	< 0.0005%	< 0.03%	not used

D3.2 Long Term Scenarios Considered

For sea level rise and long term recession , three scenarios have been considered herein, namely:

- a “mild case” estimate, taken to have a 95% probability of exceedance (leading to lower recession);
- a “best” estimate, taken to have a 50% probability of exceedance; and
- a “severe case” estimate, taken to have a 5% probability of exceedance (leading to higher recession).

Calculations to determine the magnitude of the long term recession associated with each of the three scenarios are provided in Sections D3.3.4 and D3.3.5. Rotation was considered but not allowed for as discussed in Section D3.3.7. An uncertainty allowance was also included for each of the three scenarios as described in Section D3.3.8. Storm demand and the spatial extent of erosion, which

[7] The heading of each column shows the column number.
[8] For example see Laurenson (1987).

were not determined in this scenario based manner, are considered in Section D3.3.1/D3.3.2 and Section D3.3.3 respectively.

D3.3 Coastal Hazard Line Components

D3.3.1 Storm Demand

During storms, large waves, elevated water levels and strong winds can cause severe erosion to sandy beaches. Storm demand represents the volume of sand removed from a beach (defined herein as the volume lost above 0m AHD) that could be expected due to a severe storm or from a series of closely spaced storms.

Based on measurements at NSW beaches, Gordon (1987) derived relationships between storm demand and average recurrence interval, in both "high demand" (at rip heads) and "low demand" (away from rip heads) areas. He estimated that the storm demand above 0m AHD was about 220m^3/m for the 100 year average recurrence interval (ARI) event, for exposed NSW beaches at rip heads, and depicted a relationship between storm demand (plotted vertically) and the logarithm of ARI (plotted horizontally) that was linear (Figure D1).

In WorleyParsons (2012c), the 100 year ARI storm demand adopted at Bilgola Beach was 250m^3/m[9], while a storm demand of 150m^3/m was adopted at Basin Beach[10]. These values have also been adopted herein. The red and blue lines in Figure D1 represent the Bilgola Beach and Basin Beach storm demand relationships respectively for a range of ARIs[11]. As noted by Woodroffe et al (2012), coastal zone managers are increasingly seeking beach erosion hazard (storm demand) predictions within a probabilistic framework to facilitate risk informed decision making. Use of Figure D1 to define storm demand for various ARIs herein facilitates such an approach.

It is recognised that it has been assumed that the wave climate is stationary in this procedure, and that wave heights and directions may change in the future (compared to the past) under climate change. However, it is considered that insufficient information is presently available to enable any reliable estimation of what these changes may be. Based on our experience investigating open coast NSW beaches, it is considered that the storm demand values adopted herein are likely to be conservative at present for a given ARI, and an uncertainty allowance has been included (Section D3.3.8) to partially account for future potential changes to storm demand. In addition, as noted previously, the CZMP should be reviewed every 10 years, allowing the opportunity to refine hazard parameters as new information comes to light.

That stated, it can be noted Woodroffe et al (2012) considered potential variations to storm wave direction and height in probabilistically assessing future recession at Narrabeen Beach, and did not find significant effects in the scenarios assessed. This gives some indication that altered wave climate may be relatively insignificant in terms of hazard definition.

[9] However, based on analysis of the hazard lines delineated by WorleyParsons (2012c), a lower storm demand value may have been applied.
[10] In Table 5 of WorleyParsons (2012c) it was stated that 200m^3/m was adopted at Basin Beach, but in Appendix C of that document it was stated that 150m^3/m was adopted, and it was assumed that the latter was applied.
[11] For Bilgola Beach, this was obtained by factoring up Gordon (1987) by 250÷223=1.12, where 223m^3/m is the 100 year ARI storm demand value from Gordon (1987). For Basin Beach, this was obtained by factoring down Gordon (1987) by 150÷223=0.67.

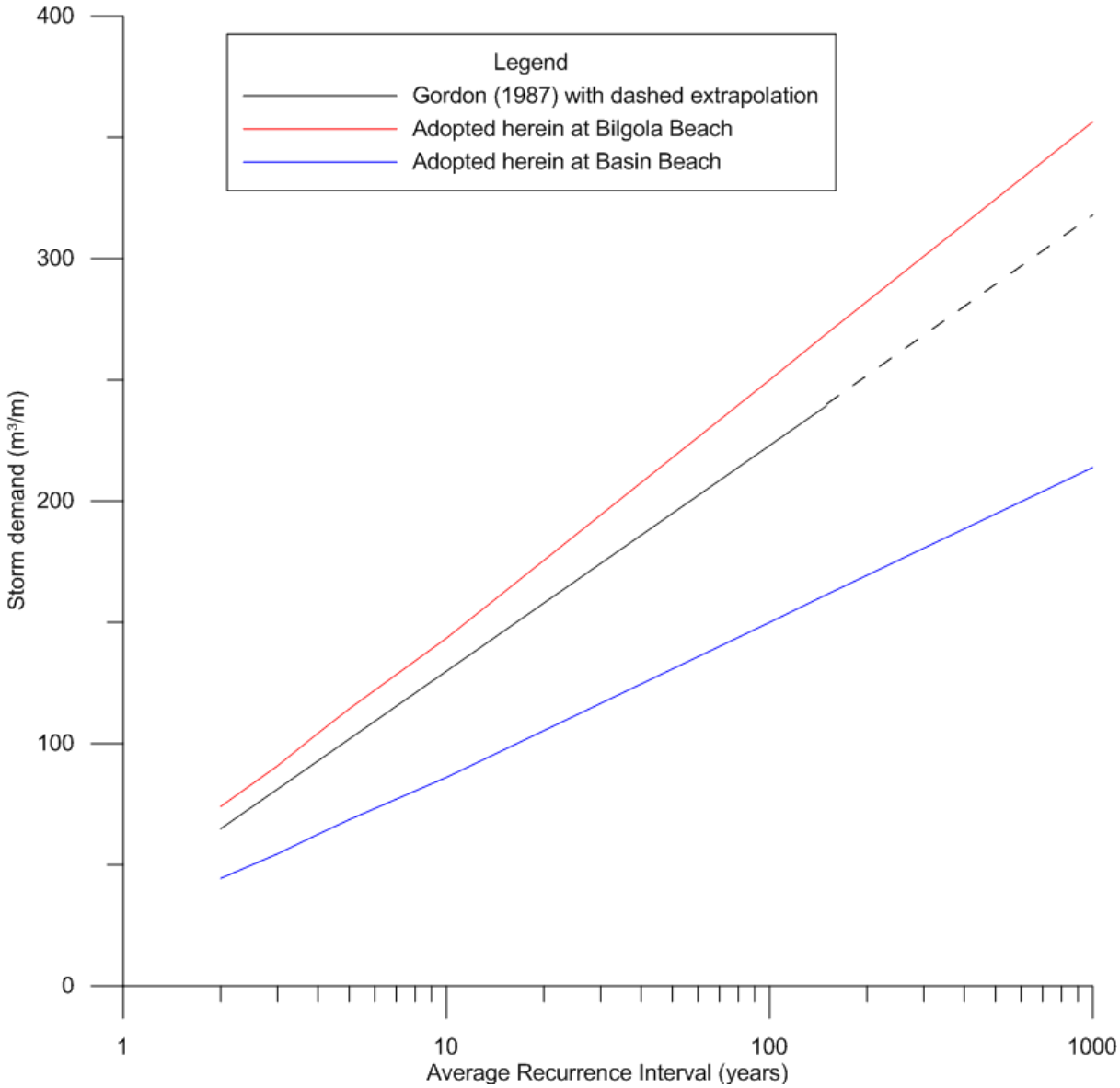

Figure D1: Relationship between storm demand and ARI as developed by Gordon (1987) for "high demand" (rip head) areas, along with adopted values for investigation herein

The question may be asked as to whether Gordon (1987) is sufficiently reliable for use herein. To compare other investigations, Callaghan et al (2008, 2009) developed a method for estimation of storm demand based on joint probability distributions of wave height, storm duration, wave period, tidal anomaly, and wave direction, a so-called Joint Probability Method (JPM) . It can be inferred from these papers that 100 year ARI storm demand values (as applied at Narrabeen Beach in these references) using this JPM were in the order of 220m^3/m to 250m^3/m, consistent with the Bilgola Beach value adopted herein. However, there was uncertainty in extrapolating their results to such rare events.

Callaghan et al (2013) extended the original Callaghan et al (2008, 2009) papers with consideration of two additional storm erosion models, and other developments. They noted an expectation that there was an upper limit to beach erosion on the basis that there was a finite amount of energy available to

drive geophysical systems (atmospheric events generating erosion). For the best fitting model, the relationship between storm demand and the logarithm of ARI was found to be linear as per Gordon (1987), up to 1,000 year ARI, although it was considered that a downward concave tail was the most physically realistic. On this basis, adopting a straight line tail as per Figure D1 is likely to be conservative.

There is a "self-limiting" characteristic to beach erosion in that as sand is removed from the upper beach it tends to deposit in offshore bars, which reduces the wave energy reaching the beach. That is, beaches in an eroded state have lower storm demands due to dissipation of wave energy on offshore bars formed during previous erosion events (Harley et al, 2009)[12]. This is evident with the logarithmic horizontal axis in Figure D1.

D3.3.2 Application of Storm Demand to Beach Profiles

Nielsen et al (1992) has delineated various coastline hazard zones as discussed below and depicted in Figure D2, assuming an entirely sandy (erodible) subsurface.

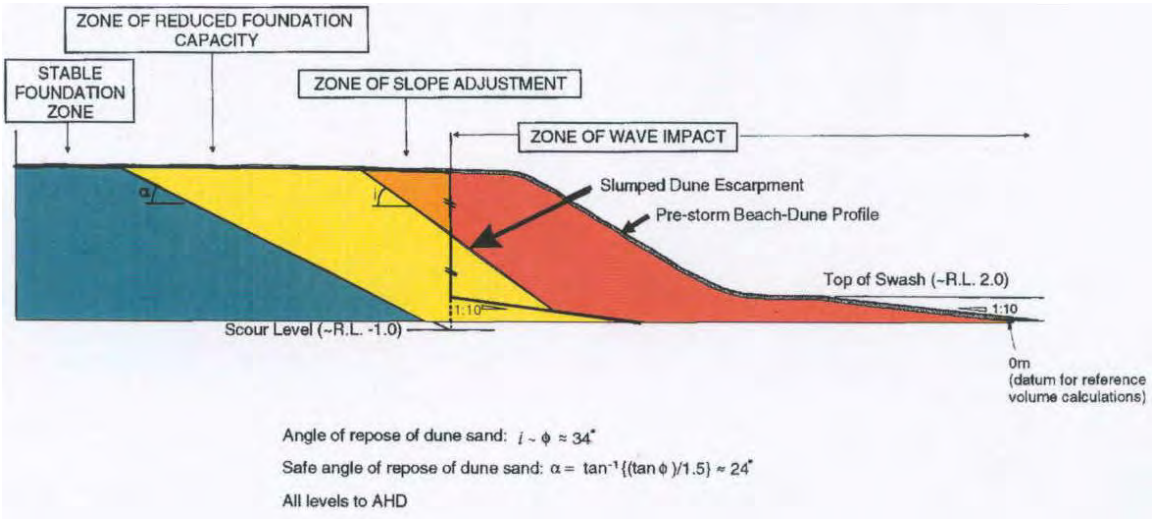

Figure D2: Schematic representation of coastline hazard zones (after Nielsen et al , 1992)

The *Zone of Wave Impact* (ZWI) delineates an area where any structure or its foundations would suffer direct wave attack during a severe coastal storm. It is that part of the beach which is seaward of the beach erosion escarpment.

A *Zone of Slope Adjustment* (ZSA) is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of the beach sand following removal by wave erosion of the design storm demand. It represents the steepest stable beach profile under the conditions specified.

A *Zone of Reduced Foundation Capacity* (ZRFC) for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment. Nielsen et al (1992) recommended that structural loads should only be transmitted to soil foundations outside of this

[12] Or to state it in a different way, relatively more wave energy is required to erode an already eroded beach (Yates et al, 2009).

zone (ie landward or below), as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the escarpment. In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled and located with the ZRFC would be considered to have an inadequate factor of safety.

In applying a storm demand volume at a particular beach profile to determine the position of a hazard line (for example defined at the landward edge of the ZSA, the hazard line position can vary depending on what date profile is used. This is because beach volumes regularly change in the study area as a result of short term erosion/accretion cycles.

The most recent available photogrammetric data (beach profiles derived from aerial photography) was captured for dates of 10 September 2001, 3 July 2008 and 31 December 2011. Beach profiles can also be derived from Airborne Laser Scanning (ALS) data, which for the study area was captured on 15 and 16 March 2007. In WorleyParsons (2012c), the 2007 ALS data was used to define base profiles for hazard definition, at an alongshore shore-normal profile spacing of 5m. The photogrammetric data had an alongshore profile spacing of 25m at Bilgola Beach and 50m at Basin Beach. At Basin Beach, a limitation of the photogrammetric profiles was that they were not always shore-normal, particularly at the northern and southern ends of the beach, so a trigonometric adjustment was applied to correct this.

The difference in position of the landward edge of the ZSA at Bilgola Beach applying 250m^3/m for either 2001, 2008 or 2011 dates was up to about 10m, and typically about 5m. In general, the landward edge of the ZSA was furthest landward in 2001 (most eroded profiles), and furthest seaward in 2008 (most accreted profiles). The WorleyParsons landward edge of the ZSA defined using 2007 ALS data was further seaward than the photogrammetric data for all of these 3 dates, and typically about 10m further seaward for the six most southern profiles at the beach.

The difference in position of the landward edge of the ZSA at Basin Beach applying 150m^3/m for either 2001, 2008 or 2011 dates was typically about 5m. In general, the landward edge of the ZSA was furthest landward in 2001 or 2011 (most eroded profiles), and furthest seaward in 2008 (most accreted profiles). The WorleyParsons landward edge of the ZSA defined using 2007 ALS data was generally further landward than the photogrammetric data for all 3 of these dates.

A key to appropriately defining the limit of erosion for a particular storm demand volume is the selection of a pre-storm profile (beach state). It is most appropriate to select a relatively accreted profile as the base (pre-storm) profile for hazard definition, typically known as an “average beach-full” profile in NSW coastal engineering practice, as storm demands in the order of 250m^3/m (or 150m^3/m at Basin Beach) would only be expected to occur at accreted beach profiles. As noted previously, this is because eroded profiles have lower storm demands due to dissipation of wave energy on offshore bars (Harley et al, 2009). It is also advantageous to select a recent profile, where possible, such that the base profile is relatively similar to the current general shape of the beach.

It is beyond the scope of the investigation reported herein to assess the 2007 ALS data in detail (it may have a datum shift compared to the photogrammetric data), and this being the case the 2008 photogrammetric data was adopted to provide base profiles for hazard definition. The 2008 date was considered to provide a suitable average beach-full condition. An allowance was also made for the obliquity of the Basin Beach photogrammetric profiles as noted above.

Therefore, throughout the Appendix herein, 2008 profiles were used as the base (pre-storm) profiles, with the storm demand volume removed from each photogrammetric profile using the method of Nielsen et al (1992) to determine the position (landward edge) of the ZSA.

In the method of Nielsen et al (1992), a ϕ value (natural angle of repose of sand, also known as the friction angle) of 33° was adopted, as per WorleyParsons (2012c). Kinsela and Hanslow (2013) have suggested that a risk averse approach would be to consider a range of ϕ values between 30° and 35°. However, note that (for example) for a 6m AHD dune elevation, the difference in ZSA position over this ϕ range is only 0.6m, with lower ϕ values giving further landward positions[13]. That is, the ϕ value has a relatively insignificant effect on hazard definition, with effects of the order of 1m in magnitude not of significance herein. Therefore, no allowance was made for variability in ϕ values herein.

D3.3.3 Spatial Extent of Erosion

Although the entire beach is unlikely to be eroded uniformly (erosion tends to be concentrated at rip heads, which are typically a few hundred metres apart), it was conservatively assumed that all locations in the study area would be equally likely to be eroded in any particular storm.

D3.3.4 Long Term Recession Due to Net Sediment Loss

WorleyParsons (2012c) found that both Bilgola Beach and Basin Beach had been prograding over the photogrammetric data record, determining volume derived progradation rates of 0.36 and 0.04m/year respectively at these beaches (based on the 1961 to 2008 period). It is not expected that these rates would continue, particularly the progradation at Bilgola Beach, which is likely to have been related to the success of dune restoration in the 1980's and maintenance of a healthy vegetated dune to the present. Net sediment gain cannot necessarily be expected in the future as the beaches recede due to sea level rise (thus diminishing the width of dune vegetation and hence the capacity of the dune to capture sand) and due to other climate change effects such as ocean acidification (that may affect sediment production and structure).

Three scenarios were considered and applied for long term recession due to net sediment loss at both beaches in the study area, namely:

- a "mild case" estimate (95% probability of exceedance) of zero;
- a "best" estimate (50% probability of exceedance) of zero as adopted in WorleyParsons (2012c); and
- a "severe case" estimate (5% probability of exceedance) of 0.05m/year recession, consistent with typical maximum recession rates measured at nearby beaches.

The adopted rates were assumed to be constant over the design life. In reality, recession would be linked to the occurrence of storms (which can in turn be related to medium term climate variability), but this would be complex to allow for in a statistically meaningful manner, and hence constant rates are considered to be reasonable. This is common practice.

Given that the base beach profiles for hazard definition were dated 2008, to project long term recession due to net sediment loss to the end of the design life at 2075 gives a period of 67 years. Accordingly, long term recession due to net sediment loss values at 2075 are as listed in Table D2.

[13] For a 10m AHD dune elevation the difference is 1.2m, and for a 4m AHD dune elevation the difference is 0.3m.

Table D2: Adopted long term recession due to net sediment loss values at 2075

Scenario	Long term recession due to net sediment loss at 2075 (m)
95% exceedance ("mild case")	0
50% exceedance ("best" estimate)	0
5% exceedance ("severe case")	3.4

D3.3.5 Sea Level Rise

Global mean sea level rise projections in IPCC (2013b)[14] from 1 January 2008 to 1 January 2075 for 4 representative concentration pathways (RCP) scenarios as well as the Special Report on Emissions Scenarios (SRES) A1B scenario used in the previous IPCC assessment (Meehl et al, 2007) are presented in Table D3. It is relevant to use 2008 as the starting year as base profiles for hazard definition were derived in 2008.

The projections were based on results from 21 Atmosphere-Ocean Global Circulation Models for each scenario, with 95% and 5% exceedances also shown (based on the range of model results). Assuming each scenario is equally likely, averages over all scenarios are also shown in Table D3. These averages were adopted as the global sea level rise values for use herein.

Table D3: Global mean sea level rise (m) from 2008 to 2075 from IPCC (2013b)

Emissions Scenario	Exceedance Probability		
	95% exceedance	Median	5% exceedance
SRES A1B	0.26	0.37	0.49
RCP2.6	0.20	0.30	0.40
RCP4.5	0.24	0.35	0.45
RCP6.0	0.24	0.33	0.44
RCP8.5	0.32	0.43	0.56
Average	0.25	0.36	0.47

Note that a key assumption in Table D3 is that the 95%, 5% and median exceedances of climate model results represent the corresponding probabilities of future sea level rise. This is considered to be reasonable until any information becomes available from the IPCC to enable an alternative assumption. It is recognised that if future anthropogenic greenhouse gas emissions are closer to any of the particular SRES or RCP scenarios, then averaging all scenarios becomes less appropriate. That stated, the variability in model results between the various scenarios is considered to be relatively small.

It is also relevant to consider regional sea level rise variation, that is how the study area sea level rise may vary from the global mean. From Figure 13.21(a) of IPCC (2013b), although the resolution is coarse, it can be estimated that sea level rise in NSW is projected to be 10-20% larger than the global mean at 2081 to 2100. Assuming these increases also apply at 2075 relative to 2008, the following scenarios were adopted from the IPCC (2013b) information, as also summarised in Table D4:

- "mild case" estimate of 10% increase in sea level rise (0.03m) above 95% exceedance global mean in study area (that is, 0.28m sea level rise at 2075);

[14] Based on Table AII.7.7 in IPCC (2013b),

- "best" estimate of 15% increase in sea level rise (0.05m) above median global mean in study area (that is, 0.41m sea level rise at 2075); and
- "severe case" estimate of 20% increase in sea level rise (0.09m) above 5% exceedance global mean in study area (that is, 0.56m sea level rise at 2075).

Table D4: Adopted sea level rise at 2075 (relative to 2008)

Scenario	Global mean sea level rise from Table D3 (m)	Additional local sea level rise (m)	Adopted total sea level rise at 2075 (m)
95% exceedance ("mild case")	0.25	0.03	0.28
50% exceedance ("best" estimate)	0.36	0.05	0.41
5% exceedance ("severe case")	0.47	0.09	0.56

In Department of Environment, Climate Change and Water [DECCW] (2009a),there was also discussion on regional variation in sea level rise in the context of derivation of NSW sea level rise benchmarks at that time. DECCW (2009a) adopted increases in NSW sea level rise above the global mean of 0.1m at 2050 and 0.14m at 2100 based on upper limit projections.

From examination of the source of this information, namely McInnes et al (2007), it is evident that from 1990 to 2070 the following projections were made of regional increases in NSW sea level rise above the global mean based on two different climate models (with no information provided as to which model could be considered most likely):

- "Low Mark 2": 0 to 0.04m at both Wooli and Batemans Bay; and
- "High Mark 3" 0.08 to 0.12m at both Wooli and Batemans Bay.

These values are consistent with the IPCC (2013b) values adopted above. Woodroffe et al (2012) used a quadratic polynomial equation to define the variation in local sea level rise at Narrabeen relative to the global mean, and found that at 2075 (relative to 2008) the increase was 0.09m, as per the 5% exceedance value applied herein.

Linearly interpolating between the 2050 and 2100 sea level rise benchmarks in the former *NSW Sea Level Rise Policy Statement* (DECCW, 2009b)[15], which were relative to 1990, and adjusting to be relative to 2008, the equivalent sea level rise at 2075 from DECCW (2009b) is 0.60m. This is more severe than the 5% exceedance "severe case" value of 0.56m adopted herein. This emphasises that the former *NSW Sea Level Rise Policy Statement* sea level rise benchmarks were closer to upper limit projections. It is considered that the sea level rise probabilities and risk based framework applied herein is more appropriate than the direct adoption of the former sea level rise benchmarks[16].

[15] Which is no longer NSW Government policy. However, these benchmarks have been adopted by the former Pittwater Council, as per http://www.pittwater.nsw.gov.au/environment/climate_change/what_about_sea_level_rise (last updated 3 March 2015, accessed 15 April 2015). That stated, the study herein was not constrained to these benchmarks as the IPCC values adopted herein were considered to be widely accepted by competent scientific opinion and suitable to use in a probabilistic framework.

[16] Also note that the sea level rise values derived herein were based on the latest 5th IPCC assessment (IPCC, 2013a, b), whereas the DECCW (2009b) benchmarks were derived from the previous 4th IPCC assessment (Meehl et al, 2007).

D3.3.6 Long Term Recession Due to Sea Level Rise

Bruun (1962) proposed a methodology to estimate shoreline recession due to sea level rise, the so-called Bruun Rule. It can be described by the equation (Morang and Parson, 2002):

$$R = \frac{S \times B}{h + d_c} \quad (2)$$

where R is the recession (m), S is the long term sea level rise (m), h is the dune height above the initial mean sea level (m), d_c is the depth of closure of the profile relative to the initial mean sea level (m), and B is the cross-shore width of the active beach profile, that is the cross-shore distance from the initial dune height to the depth of closure (m). This equation is a mathematical expression that the recession due to sea level rise is equal to the sea level rise multiplied by the average inverse slope of the active beach profile, with the variables as illustrated in Figure D3.

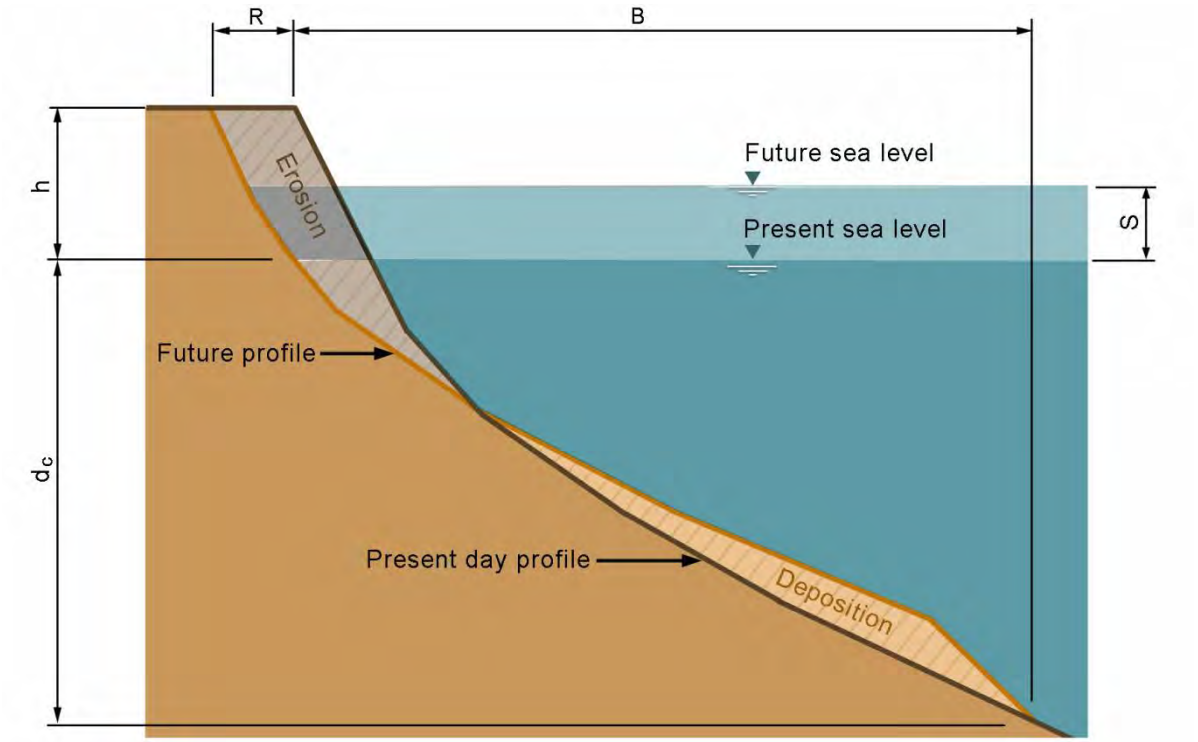

Figure D3: Illustration of variables in the Bruun Rule

There are a number of methods available to estimate the depth of closure, including techniques based on:

- wave (and sediment) characteristics;
- sedimentological data; and
- field measurements.

These techniques are discussed below.

For methods based on wave characteristics, Hallermeier (1981, 1983) defined three profile zones, namely the littoral zone, shoal or buffer zone[17], and offshore zone. This thus defined two closure depths (defined to be relative to the mean low water level), namely:

- an "inner" (closer to shore) closure depth at the seaward limit of the littoral zone, termed d_l by Hallermeier (1981) and d_s by Hallermeier (1983), and d_{inner} herein; and,
- an "outer" or "lower" (further from shore) closure depth at the seaward limit of the shoal/buffer zone, termed d_i by Hallermeier (1981) and d_o by Hallermeier (1983), and d_{outer} herein.

From Hallermeier (1981):

$$d_{inner} = 2.28H_e - 68.5\left(\frac{H_e^{\,2}}{gT_e^{\,2}}\right) \qquad (3)$$

where H_e is the effective significant wave height exceeded for 12 hours per year (that is, the significant wave height with a probability of exceedance of 0.137%), and T_e is the corresponding significant wave period or "typical period of measured high waves" (Hallermeier, 1978). Based on measured Sydney offshore wave data as analysed by Shand et al (2011), H_e is 5.6m and the equivalent T_e is about 12s[18] at the Sydney offshore Waverider buoy at about 92m depth.

WorleyParsons (2012c) transformed the offshore deep water wave climate to nearshore, which is valid in theory, but only allowed for refraction (considered to be overestimated, with low refraction coefficients based on uncalibrated numerical modelling) at 4m water depth that did not fully account for shoaling. It is considered that the local H_e to use in Equation 3 can be taken as the same as offshore, that is 5.6m. Therefore, from Equation 3 the inner closure depth is about 11.7m relative to AHD.

From Hallermeier (1983):

$$d_{outer} = 0.018H_mT_m\sqrt{\frac{g}{D(s-1)}} \qquad (4)$$

where H_m and T_m are the median significant wave heights and significant wave periods respectively, D is the median sediment diameter, and S is the specific gravity of sand (about 2.6). Based on measured Sydney offshore wave data as analysed by Shand et al (2011), H_m is about 1.5m and T_m (peak spectral) is about 9.8s at the Sydney offshore Waverider buoy at about 92m depth. It is considered to be valid to apply these offshore wave conditions in Equation 4[19], but using T_m (significant) equal to 8.9s based on the ratio in Footnote 18.

Based on measurements by Dr Andrew Short as part of the NSW Beaches Database, the mean sediment diameter (taken to be equal to the median herein) is 0.28mm at Bilgola Beach and 0.34mm at Basin Beach. Therefore, from Equation 4 the outer closure depth is about 35m at Bilgola Beach and 32m at Basin Beach, relative to AHD.

[17] Shoal zone in Hallermeier (1981) and buffer zone in Hallermeier (1983).
[18] In Shand et al (2011), T_p varies between about 9s and 15s at the Sydney offshore Waverider buoy at an H_s value of 5.6m, with an approximate graphical central estimate of 13s. T_p is about 1.1 times T_s (Takahashi et al, 1979; Lawson et al, 1987) thus giving a T_s and hence T_e value of about 12s.
[19] WorleyParsons (2012c) transformed the wave height to 4m depth, which is not valid.

For methods based on sedimentological data, it can be noted that sedimentological data consistently shows distinct changes in the characteristics of sediments with water depth offshore of NSW (Nielsen, 1994). These changes include variations in grain size, sorting, carbonate content and colour.

There are two distinctive sediment units immediately offshore of the NSW shoreline, namely Nearshore Sand, and (further offshore and coarser) Inner Shelf Sand (also known as Shelf Plain Relict or Palimpsest Sand). Nearshore Sand is further subdivided into Inner and Outer Nearshore Sand units.

For beaches fully exposed to the offshore wave climate, the boundary between Inner and Outer Nearshore Sands is typically found at about 11m to 15m depth (relative to AHD), while the boundary to the nearshore edge of Inner Shelf Sand is usually at 18m to 26m depth. The boundary between Nearshore Sands and Inner Shelf Sands corresponds to those parts of the seabed considered to be active and relict respectively. That is, there is no exchange of Nearshore Sands with those of the Inner Shelf.

In relation to field measurements, Nielsen (1994) found that, based on a synthesis of field and laboratory data and analytical studies (particularly offshore of SE Australia), there were consistent limits of subaqueous beach fluctuations, namely water depths (relative to AHD) of:

- 12m $\pm$ 4m being the limit of significant wave breaking and beach fluctuations (consistent with the Inner/Outer Nearshore Sand Boundary and inner Hallermeier depth);
- 22m $\pm$ 4m being the absolute limit of sand transport under cyclonic or extreme storm events (consistent with the inshore Inner Shelf Sand boundary); and,
- 30m $\pm$ 5m being the limit of reworking and onshore transport of beach sized sand under wave action (consistent with the outer Hallermeier depth).

Based on the Seabed Information Chart *82310-575 (Broken Bay)* published by the Public Works Department in 1989 (developed from surveys undertaken between 1979 and 1985):

- no Inner/Outer Nearshore Sand Boundary was depicted for Bilgola Beach and Basin Beach, but it was at about -12m AHD at the northern end of Mona Vale Beach (consistent with the inner Hallermeier depth); and
- the inshore Inner Shelf Sand boundary was at about -25m AHD at Bilgola Beach and Basin Beach, consistent with Nielsen (1994).

At Bilgola Beach, the 50% exceedance ("best" estimate) depth of closure was considered to be the inner Hallermeier depth at -12m AHD, with the average inverse slope of the active beach profile corresponding to this depth equal to 40[20]. The 5% exceedance value depth of closure was based on using the inshore Inner Shelf Sand boundary at -25m AHD, with the inverse slope also equal to 40 at this location[21]. The 95% exceedance inverse slope was estimated based on the inverse slope of the natural subaerial beach face and dune in the photogrammetric data, equal to about 20.

On the Seabed Information Chart the area offshore of Basin Beach was generally shown as rocky. OEH have recently undertaken bathymetric surveys at Basin Beach as part of investigations related to

[20] This is similar to the value used by WorleyParsons (2012c) of 39.
[21] If the outer Hallermeier depth at -35m AHD was used as a depth of closure, the inverse slope would be about 50.

the Coastal Processes and Responses Node of the Adaptation Research Hub launched by OEH in August 2013 (in association with the Sydney Institute of Marine Science and Australian Climate Change Adaptation Research Network for Settlements and Infrastructure). Based on analysis of this data for a survey in May 2014, bathymetric contours at 1m interval are depicted in Figure D4, with plots of chainage versus elevation for the 6 profiles depicted in Figure D4 given in Figure D5.

It is evident that there is an underwater rock sill extending north-east from the rock platform at Mona Vale rock pool, with a crest elevation of about -3m to -5m AHD. Water depths initially increase moving seaward of the Basin Beach shoreline, with bed elevations down to about -6m AHD, and then water depths reduce moving further seaward to the sill. This adds further complexity to consideration of appropriate depths of closure and application of the Bruun Rule at Basin Beach.

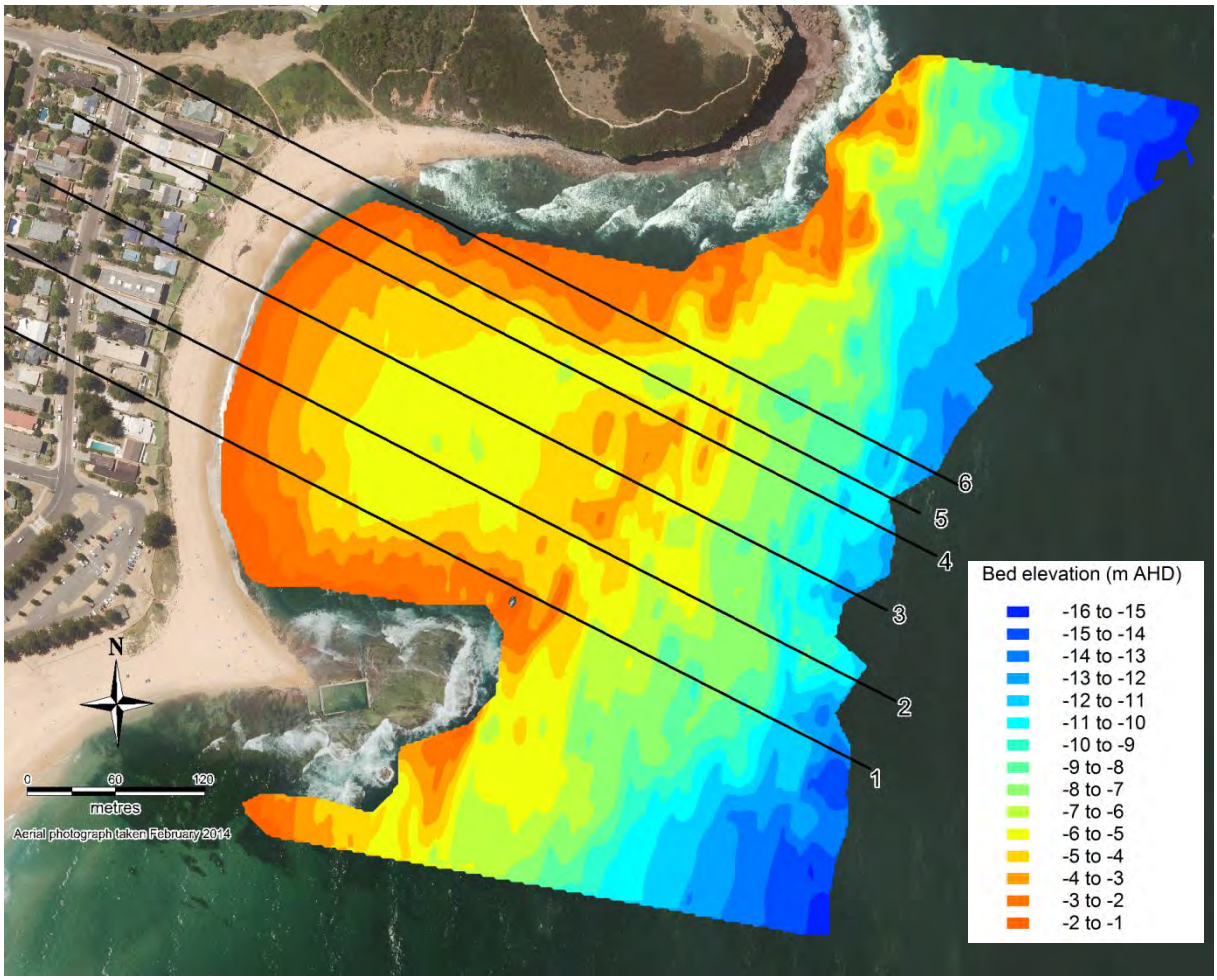

Figure D4: Bathymetric contours (relative to AHD) at Basin Beach from May 2014 OEH survey (1m contour interval)

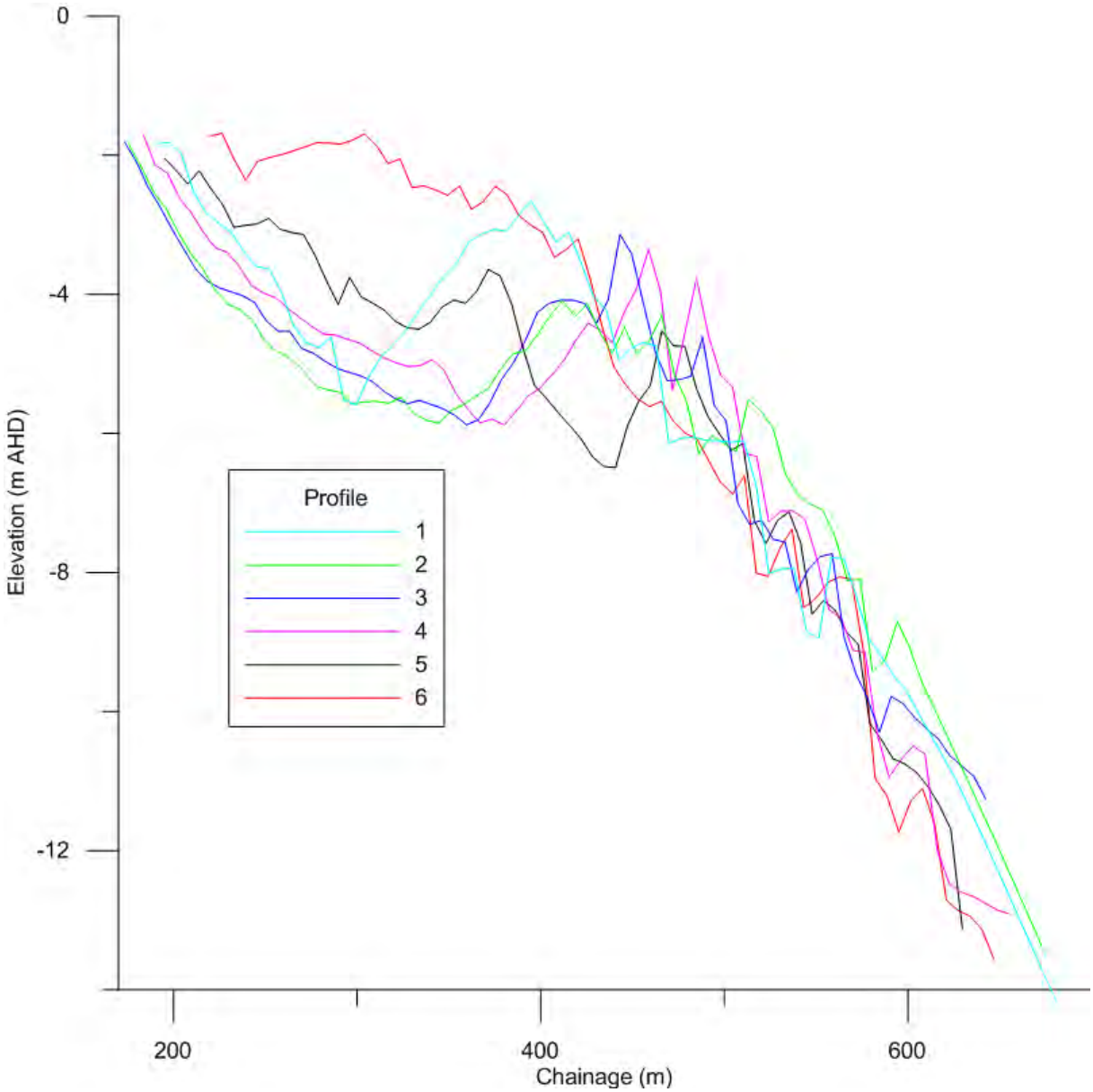

Figure D5: Plots of chainage versus elevation for 6 profiles in Figure D4 (zero at western end of profile lines)

At Basin Beach, the 50% exceedance ("best" estimate) depth of closure was estimated to be at the inshore edge of the sill, where elevations first begin to rise moving offshore. This at an average elevation of -5.0m AHD, with the average inverse slope of the active beach profile corresponding to this depth equal to 20[22]. The 5% exceedance value depth of closure was based on using the inner Hallermeier boundary (and Inner/Outer Nearshore Sand Boundary at Mona Vale Beach) at -12m AHD, with the inverse slope also equal to 30 at this location[23]. The 95% exceedance inverse slope was estimated based on the inverse slope of the natural subaerial beach face and dune in the photogrammetric data, equal to about 13.

[22] This is similar to the value used by WorleyParsons (2012c) of 17.
[23] It appears that sand could exchange between offshore and inshore of the sill as there is a deeper channel to the north of the sill (Figure D4), such that a depth of closure offshore of the sill can be validly considered.

For the investigation reported herein, long term recession calculations were completed using the Bruun Rule as outlined in Table D5 (Bilgola Beach) and Table D6 (Basin Beach).

Table D5: Long term recession due to sea level rise calculations for Bilgola Beach

Scenario	Average inverse slope of active beach profile	Sea level rise at 2075 from Table D4	Long term recession due to sea level rise at 2075 (m) from Equation **2**
95% exceedance ("mild case")	20	0.28	5.6
50% exceedance ("best" estimate)	40	0.41	16.4
5% exceedance ("severe case")	40	0.56	22.4

Table D6: Long term recession due to sea level rise calculations for Basin Beach

Scenario	Average inverse slope of active beach profile	Sea level rise at 2075 from Table D4	Long term recession due to sea level rise at 2075 (m) from Equation **2**
95% exceedance ("mild case")	13	0.28	3.6
50% exceedance ("best" estimate)	20	0.41	8.2
5% exceedance ("severe case")	30	0.56	16.8

The values in Table D5 and Table D6 were adopted as long term recession due to sea level rise estimates for use herein.

Ranasinghe et al (2012), updating Ranasinghe et al (2009), has developed an alternative method to the Bruun Rule, using a process based model of dune erosion and recovery to derive probabilistic estimates of sea level rise driven coastal recession[24]. They applied a so-called Probabilistic Coastline Recession (PCR) model at a profile at Narrabeen Beach (south of the study areas herein), and estimated long term recession due to sea level rise at 2100 for exceedance probabilities varying between 1% and 100%.

Ranasinghe et al (2012) used a sea level rise value of 0.92m in their modelling, and a comparison of their results by Haskoning Australia as part of the *Collaroy-Narrabeen Beach and Fishermans Beach CZMP* indicated that Ranasinghe et al (2012) gave generally similar results to the Bruun Rule[25]. That stated, the approach herein differs to Ranasinghe et al (2012) in that different sea level values were used for different exceedance scenarios, which is considered to be more appropriate given the uncertainty in future sea level rise.

D3.3.7 Future Beach Rotation

Based on studies of Palm Beach and Collaroy-Narrabeen Beach in Sydney, there have been attempts (Ranasinghe et al, 2004) to explain beach realignment/rotation in terms of shifts in the Southern

[24] Note that OEH does not support the use of this methodology (Mr Peter Evans, personal communication, April 2014)..
[25] Ranasinghe et al (2012) considered that Bruun Rule estimates were far larger than using their PCR model, but this was not found to be the case in the analysis of Haskoning Australia.

Oscillation Index (SOI)[26]. Specifically, Ranasinghe et al (2004) proposed that these beaches rotate clockwise (with the northern end accreting and southern end receding) in El Niño phases (negative SOI). Conversely, it was proposed that these beaches rotate anti-clockwise (with the northern end receding and southern end accreting) in La Niña phases (positive SOI)[27]. In both cases, the beach response at the northern end lagged SOI trend shifts by about 3 months, while the beach response at the southern end lagged SOI trend shifts by about 17 months.

WorleyParsons (2012c) did not note that there was any evidence for beach rotation in the photogrammetric data record at Bilgola Beach and Basin Beach. This is not unexpected given the relatively short lengths and compartmentalised nature of these beaches. On this basis, no allowance for future beach rotation has been included herein.

D3.3.8 Uncertainty Allowance

Three scenarios were considered and applied in the study area to account for uncertainty over the design life (for example, in future changes to storminess and wave directions), namely:

- a “mild case” estimate (95% probability of exceedance) of zero additional translation;
- a “best” estimate (50% probability of exceedance) of 5m additional landward translation; and
- a “severe case” estimate (5% probability of exceedance) of 10m additional landward translation.

These values were adopted based on consideration of historical variability in beach profiles in the photogrammetric data record.

D3.3.9 Combined Effects

The combination of long term recession due to net sediment loss (Section D3.3.4), long term recession due to sea level rise (Section D3.3.6) and uncertainty (Section D3.3.8) gives the total landward translations listed in Table D7[28].

Table D7: Adopted landward translations of immediate hazard lines at 2075

Scenario	Landward Translation at 2075 (m)	
	Bilgola Beach	Basin Beach
95% exceedance (“mild case”)	5.6	3.6
50% exceedance (“best” estimate)	21.4	13.2
5% exceedance (“severe case”)	35.8	30.2

[26] The SOI is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. The method used by the Australian Bureau of Meteorology is the Troup SOI which is the standardised anomaly of the Mean Sea Level Pressure difference between Tahiti and Darwin (Bureau of Meteorology, 2005).
[27] It was also found that La Niña phases were associated with more energetic (erosive) conditions.
[28] It is recognised that several events of the same probability (eg 5% exceedance) were combined to define an overall scenario with the same probability (eg 5% exceedance long term recession due to net sediment loss, combined with 5% exceedance long term recession due to sea level rise and 5% exceedance uncertainty allowance, to define the overall 5% exceedance scenario. This is not statistically valid (the combination of events has a lower probability that the individual events themselves), but more rigorous statistical analysis would need to be undertaken (such as bivariate analysis, see Footnote 34 on page 27) for this to be addressed. It should be recognised that the scenario probabilities adopted herein are only approximate.

The translations were included after the storm demand was applied as discussed in Section D3.3.2. It is recognised that this approach is simplistic as it assumes that the storm erosion and recession occur instantaneously, whereas in reality recession would occur first (with some uncertainty as to how the dune morphology may change over time, for example whether it would 'roll back' the dune or cut into it[29]) and then the storm demand volume would be removed from profiles different to those in 2008.

Kinsela and Hanslow (2013) have discussed this issue, noting that "it may not be conservative to expect that the development of coastal morphology will maintain pace with projected rapidly accelerating sea level rise". However, areas landward of the dune crest in the study area are generally at similar elevations (that is, the areas landward of the dune crest are generally relatively flat), and recession would be constrained while protection works are in place (as applies over most of the study area). Therefore, the issue is likely to be relatively insignificant in the study area and has not been allowed for herein. That stated, this issue could be considered in future revisions of the CZMP if further information becomes available on potential dune responses to sea level rise.

[29] In addition, sea level rise would be expected to cause the dune crest to rise in elevation in response as it translates landwards, where not constrained by development.

D4. CONSEQUENCES (IGNORING EXISTING PROTECTION WORKS)

AGS (2007a, b) used 5 consequence descriptors. These descriptors were related to the percentage of damage caused to a property due to a landslide event, relative to the market value of the property (land plus structures), as listed in Table D8.

Table D8: Consequence descriptors from AGS (2007a, b)

Descriptor	Approximate cost of damage	Description
Catastrophic	> 100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
Major	40% to 100%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
Medium	10% to 40%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage
Minor	1% to 10%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works
Insignificant	< 1%	Little damage

For the investigation reported herein, it was considered that the appropriate consequence descriptor for storm erosion leading to a slumped erosion escarpment immediately seaward of a structure on conventional foundations[30] (such as slab-on-ground, strip footings or shallow piers) was "minor". Although a structure immediately landward of a slumped escarpment may not be damaged at all, in recognition of the structure being in a Zone of Reduced Foundation Capacity (Nielsen et al, 1992) and hence having a lower factor of safety, it was considered that there was the potential for some damage.

For development on appropriately engineered piled foundations, it was considered that the appropriate consequence descriptor for structures immediately landward of the slumped erosion escarpment was "insignificant". Indeed, a structure could be well seaward of the slumped erosion escarpment and be designed with piled foundations to not be damaged for a suitably low probability event (structures can be designed to be at acceptable risk in the ocean itself) [31].

Given that hazard lines are defined herein at the landward edge of the Zone of Slope Adjustment, if used as setback lines for development this is thus equivalent to setting the consequences at that line as "minor" for development on conventional foundations and "insignificant" for development on piled foundations.

AGS (2007a, b) defines the approximate cost of damage (as per Table D8) to include:

- the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the erosion which has occurred and professional design fees; and
- consequential costs such as legal fees and temporary accommodation.

[30] Note that some practitioners distinguish "foundations" from "footings", with the latter being the structural element (such as a pier) and the former being the ground material that this structural element bears upon. However, to be consistent with Nielsen et al (1992), the term "foundations" is used herein to refer to the structural element.

[31] However, this does not mean that such piled development is suitable. There needs to be consideration of how such development could be accessed and serviced.

It is recognised that the land seaward of a structure sited landward of a particular setback line (for example, backyards of beachfront development) may be eroded in coastal storms, and that this does have consequences on the use of that land and landowner beach access, and may damage minor structures such as fences, decks, clothes lines and the like. This loss of land may also affect land values (a consequential loss) and have some reinstatement costs[32].

However, given that the focus of the investigation reported herein was on defining acceptable risk for new structures approved as part of the development assessment process, it was considered most appropriate to only consider risk to those structures that would be considered as part of a development application to Council, for which consequential losses are likely to be minimal given limited damage to the approved structures. Any loss of land amenity was assumed to be mitigated by natural recovery.

In adopting the consequences descriptors of "minor" for development on conventional foundations and "insignificant" for development on piled foundations, it is assumed that there are no additional coastal hazards landward of the slumped erosion escarpment. Such hazards could include wave runup and overtopping forces on structures, or inundation of floor areas, that lead to damage. It is recognised that these hazards would need to be managed as part of defining acceptable risk to development, for example through ensuring ground floor levels are at least 0.5m above adjacent natural ground levels and appropriate regard has been made for these effects in the design. It is recommended that applicants in the study area be required to obtain coastal engineering advice to address issues of acceptable risk to new development from inundation in relation to design and construction.

[32] However, it should be recognised that coastal land "naturally" recovers after storm events, with sand that had moved offshore in the storm returning to build the beach back up under calmer conditions after the storm. That is, any loss of land values may be temporary, and reinstatement costs may not be significant if the landowner can wait for natural recovery.

D5. ACCEPTABLE RISK (IGNORING EXISTING PROTECTION WORKS)

A risk matrix is presented in AGS (2007a, b), as shown in Figure D6. For example, if the consequences of a particular "unlikely" event were "minor", then the risk would be considered "low".

Likelihood	Consequence				
	Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	Very High	Very High	Very High	High	Medium
Likely	Very High	Very High	High	Medium	Low
Possible	Very High	High	Medium	Medium	Very Low
Unlikely	High	Medium	Low	Low	Very Low
Rare	Medium	Low	Low	Very Low	Very Low
Barely Credible	Low	Very Low	Very Low	Very Low	Very Low

Figure D6: AGS (2007a, b) risk matrix

AGS (2007a, b) defined "acceptable risk" as follows:

> "A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable".

A key aspect of the AGS (2007a, b) approach is that they defined the acceptable level of risk for new development as being "low" risk (or lesser, that is "very low") as per the matrix in Figure D6. This was based on review of the limited literature available, extensive discussion amongst the AGS Working Group, and consideration of the annualised cost of damage to property. AGS (2007a, b) concluded that:

> "most informed home owners are likely to be risk averse as a result of appreciation of the consequences at a family or personal level, almost regardless of the likelihood of the event. This risk aversion suggests that Low Risk to Property is an appropriate recommendation for acceptable risk to the regulator for domestic dwellings which are of Importance Level 2 (as defined in the BCA [Building Code of Australia])".

Note that AGS (2007a, b) considered that the acceptable risk level was "low" for structures of both:

- Importance Level 2 (such as low-rise residential construction)[33]; and
- Importance Level 3 (such as buildings and facilities where more than 300 people can congregate in one area, schools of greater than 250 people, health care facilities with a capacity of 50 or more residents, power generating facilities, water treatment and waste water treatment facilities).

For structures of Importance Level 4 (such as buildings and facilities designated as essential facilities or with special post-disaster functions, medical emergency or surgery facilities, emergency service facilities (fire, rescue, police etc.), the designated acceptable risk level was "very low". There are not any known structures of Importance Level 4 in the study area.

[33] For structures of Importance Level 1 (such as minor temporary facilities), the designated acceptable risk level was "medium".

Given that “low” risk can be considered acceptable for typical structures in the study area, it follows from Figure D6 that:

- the “unlikely” likelihood line can define the acceptable risk setback for new development that is constructed on conventional foundations (since, as noted in Section D4, this has “minor” consequences); and
- the “likely” likelihood line can define the acceptable risk setback for new development that is constructed on piled foundations (since, as noted in Section D4, this has “insignificant” consequences).

D6. DELINEATION OF LIKELIHOOD LINES IN STUDY AREA (IGNORING EXISTING PROTECTION WORKS)

D6.1 Procedures Considered

Two procedures were applied to define likelihood lines ("almost certain", "likely", "possible", "unlikely" and "rare" as per Table D1) in the study area, namely:

- Type 1: a storm event occurring at any time over the design life, ignoring recession[34]; and
- Type 2: a storm event occurring in the last year of the design life, after the full magnitude of recession as per Table D7 had been realised.

The storm event probabilities are different in these procedures. For Type 1, the event can occur at any time over the design life, so for example a 0.5% AEP (200 year ARI) event has a 26% probability over the design life in Type 1 for a 60 year life. However, a 0.5% AEP event is treated as 0.5% probability for Type 2, which when multiplied by the recession scenario probability (for example 50% for the "best" estimate) gives the probability over the design life (0.25% in this example).

That is, once recession is included, the probability of the event occurring in the last year (only) of the design life is considered (as per Type 2), and the event probability is much lower than the probability of occurring at any time during the design life (as per Type 1).

As noted in Section D3.3.2, likelihood lines were defined at the landward edge of the Zone of Slope Adjustment, with the storm demand volume (Section D3.3.1) applied to 2008 profiles. At Bilgola Beach, the northern and southern limit of the likelihood lines was clipped to the extent of sandy beach (that is, the lines were not extended into the rocky cliff/bluff areas).

The calculation methodologies for the Type 1 and Type 2 procedures are described in Section D6.2 and Section D6.3 respectively.

It is recognised that more advanced statistical approaches and Monte Carlo modelling could be undertaken to refine the estimates provided herein. It is recommended that these approaches are considered in the future as understanding develops of the appropriate probability distributions to adopt in these analyses.

D6.2 Storm Event Occurring any Time Over Design Life, Ignoring Recession (Type 1)

Based on the relationships between likelihood and AEP from Table D1, the conversion from AEP to ARI as follows[35]:

[34] Recession was not included in the Type 1 procedure adopted herein. It was assumed that the design event occurred at any time over the design life, but the recession component was not included. In reality, the design storm can occur at any time over the design life, and the recession depends on the year of the event. For example, a 0.5% AEP event could occur in say Year 1, or Year 20, or Year 60, and the probability of that event occurring is 0.5% in each case. However, the recession component would vary in each case. As a future refinement to this investigation, it may be possible to model the bivariate distribution of the joint probability of the storm erosion and recession to consider both processes in a Monte-Carlo modelling exercise.

[35] Where ARI is in years, and AEP is expressed as a decimal (for example, 6.6% becomes 0.066).

$$ARI = \frac{-1}{ln(1-AEP)} \quad (5)$$

and the relationships between ARI and storm demand from Figure D1, storm erosion volumes for the "almost certain", "likely", "possible", "unlikely" and "rare" likelihoods were determined as shown in Table D9.

Table D9: Storm demands at Bilgola Beach and Basin Beach corresponding to various likelihoods for Type 1 procedure

Likelihood	Cumulative probability over design life (%)	AEP (%)	ARI (years)	Storm demand (m^3/m)	
				Bilgola Beach	Basin Beach
Almost Certain	95.4%	5	20	170	100
Likely	26%	0.5	200	280	170
Possible	3%	0.05	2,000	390	230
Unlikely	0.3%	0.005	20,000	500	300
Rare	0.03%	0.0005	200,000	600	360

These respective storm demand volumes were applied at Bilgola Beach and Basin Beach as per Section D3.3.1 and D3.3.2. This defined the landward edge of the Zone of Slope Adjustment, which in turn defined the likelihood line for the 5 likelihoods considered. These likelihood lines are depicted in Figure D7 for Bilgola Beach and Figure D8 for Basin Beach. For each likelihood line, the description applies at the line and seaward to the next seaward line. For example, the "possible" line has a "possible" likelihood, as does the area seaward of that line to immediately landward of the "likely" line[36].

[36] Note that the "barely credible" likelihood is represented by the area landward of the "rare" likelihood line.

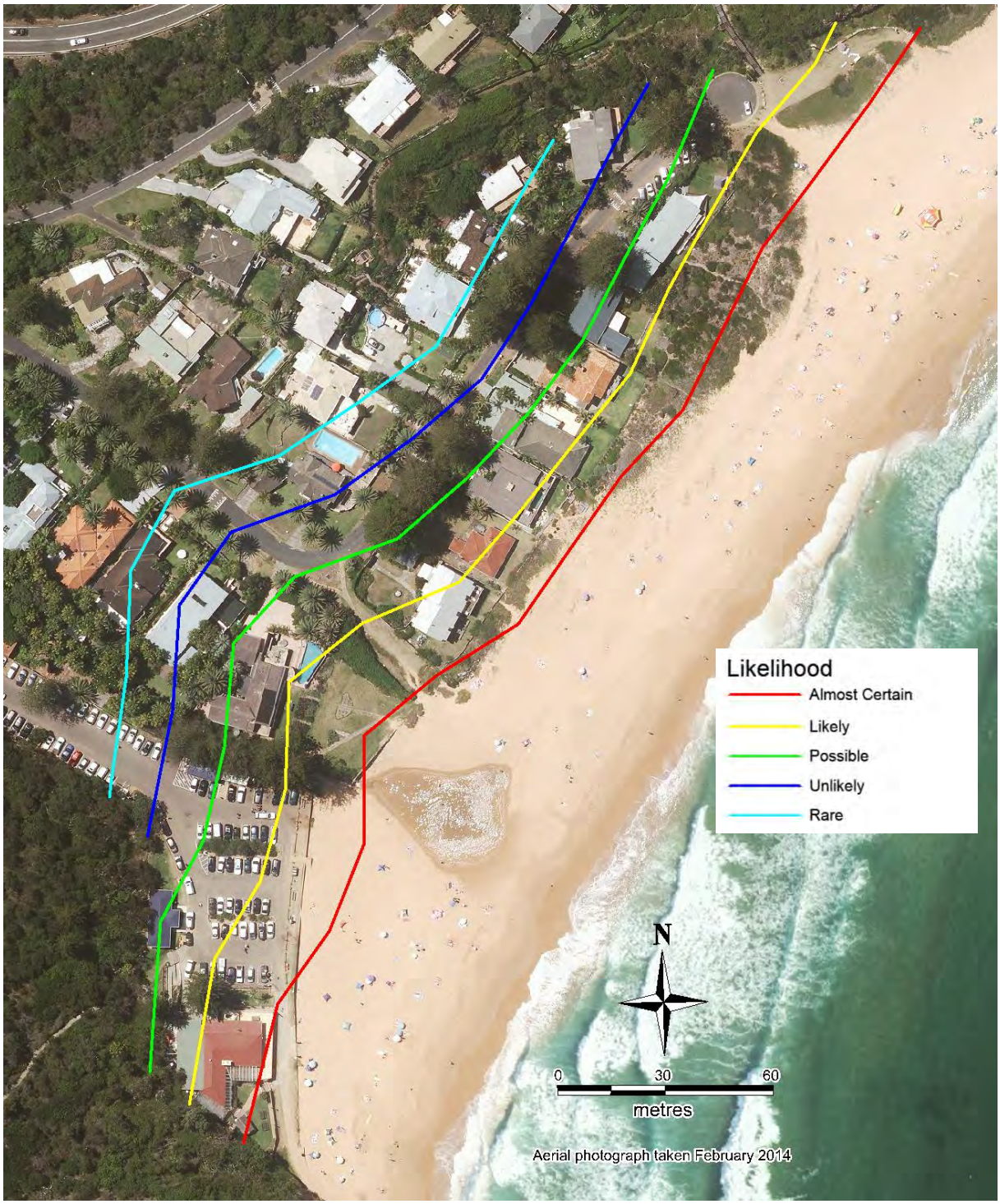

Figure D7: Likelihood lines at Bilgola Beach for Type 1 procedure (no recession included) for 60 year design life (to 2075)

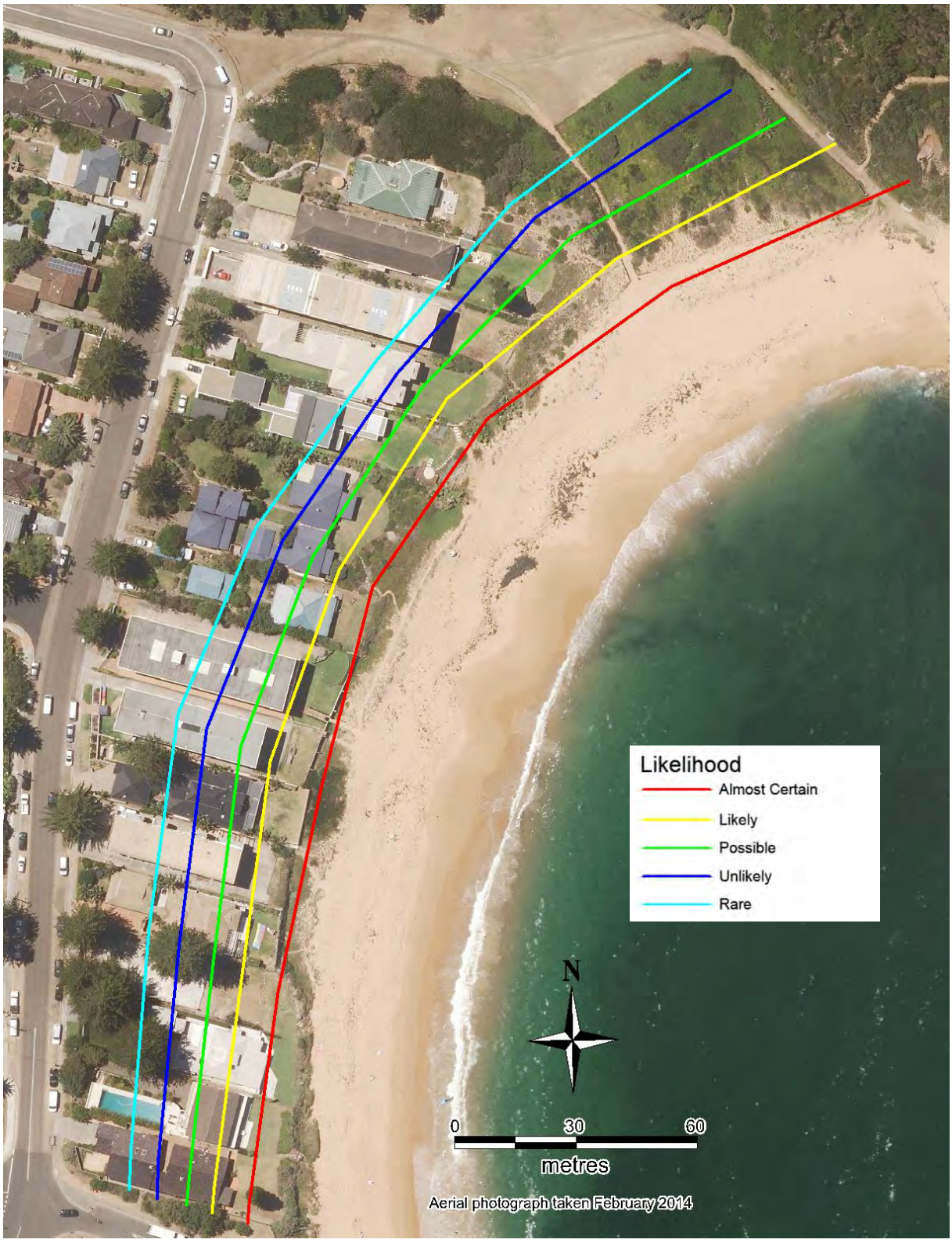

Figure D8: Likelihood lines at Basin Beach for Type 1 procedure (no recession included) for 60 year design life (to 2075)

D6.3 Storm Event Occurring in Last Year of Design life, With Recession (Type 2)

For Type 2, the procedure adopted herein has been to consider the probability of a particular storm erosion volume occurring in the last year of the design life (after long term recession has been realised). This is appropriate as it is equally likely that a particular storm of probability *P* occurs in 2015 or 2075 (ignoring any potential increases in the severity or frequency of storms under climate change), and the later a storm of probability *P* occurs in the design life the further landward it would extend due to greater prior recession.

The first step in this procedure was to define the storm event probability (AEP) for a storm occurring in the last year of the design life after recession had occurred. This required the storm event AEP (probability), when multiplied by the relevant probability for the scenario (for example, 50% for the 50% exceedance "best" estimate scenario), being equal to the cumulative probability over the design life associated with the particular likelihood (see Table D10).

For example, for the "unlikely" likelihood, the required cumulative probability over the design life is 0.3%. For the 50% exceedance ("best" estimate) scenario, the storm demand event AEP is 0.6% (0.006 × 0.5 ×100 = 0.3%). "N/A" entries in Table D10, denoting "not applicable", mean that the AEP was greater than 100% and hence undefined.

In multiplying the probabilities together it was assumed that the storm event and recession scenarios are independent. These processes are not completely independent, as coastal storms are mostly driven by weather patterns leading to large waves and elevated water levels, while recession would mostly be driven by sea level rise, and water level is a factor in both. However, assuming independence is considered to be a conservative approach.

Table D10: Storm event probabilities that would achieve particular likelihood probabilities for the three exceedance scenarios considered

Likelihood	Cumulative probability of event occurring over design life	Storm demand event AEP (%)		
		95% exceedance	50% exceedance	5% exceedance
Almost Certain	95.4%	N/A	N/A	N/A
Likely	26%	27	52	N/A
Possible	3%	3	6	59
Unlikely	0.3%	0.3	0.6	6.0
Rare	0.03%	0.03	0.06	0.60

In Table D11, the storm event probabilities in Table D10 were converted to ARIs using Equation 5. The "Almost Certain" likelihood was not included as it cannot be defined using the Type 2 procedure given that AEP's exceed 100%.

Table D11: Storm event ARIs corresponding to events in Table D10

Likelihood	Cumulative probability of event occurring over design life	Storm demand event ARI (years)		
		95% exceedance	50% exceedance	5% exceedance
Likely	26%	3	1	N/A
Possible	3%	32	16	1
Unlikely	0.3%	320	170	16
Rare	0.03%	3170	1670	170

Based on Figure D1, the storm demand volumes corresponding to these events were determined as shown in Table D12 (Bilgola Beach) and Table D13 (Basin Beach).

Table D12: Storm demand volumes for Bilgola Beach corresponding to events in Table D11

Likelihood	Cumulative probability of event occurring over design life	Storm demand volume (m^3/m)		
		95% exceedance	50% exceedance	5% exceedance
Likely	26%	90	50	N/A
Possible	3%	200	170	40
Unlikely	0.3%	300	270	170
Rare	0.03%	410	380	270

Table D13: Storm demand volumes for Basin Beach corresponding to events in Table D11

Likelihood	Cumulative probability of event occurring over design life	Storm demand volume (m^3/m)		
		95% exceedance	50% exceedance	5% exceedance
Likely	26%	50	30	N/A
Possible	3%	120	100	30
Unlikely	0.3%	180	160	100
Rare	0.03%	250	230	160

These respective storm demand volumes were applied at Bilgola Beach and Basin Beach as per Section D3.3.1 and D3.3.2. This defined the landward edge of the Zone of Slope Adjustment. The setback for the particular scenario (95%, 50% or 5% exceedance) was then applied as per Table D7, to define the various likelihood lines.

The likelihood lines for the 95%, 50% and 5% exceedance recession scenarios are shown in Figure D9 for Bilgola Beach and Figure D10 for Basin Beach. It is evident that:

- the 5% line (Basin Beach) or 50% line (Bilgola Beach) is most landward and the 95% line is most seaward (both beaches) for the “rare” and “unlikely” likelihoods;
- the 50% line is most landward and the 5% line is most seaward for the “possible” likelihood at both beaches; and
- the 95% and 50% lines are similar for the “likely” likelihood at both beaches.

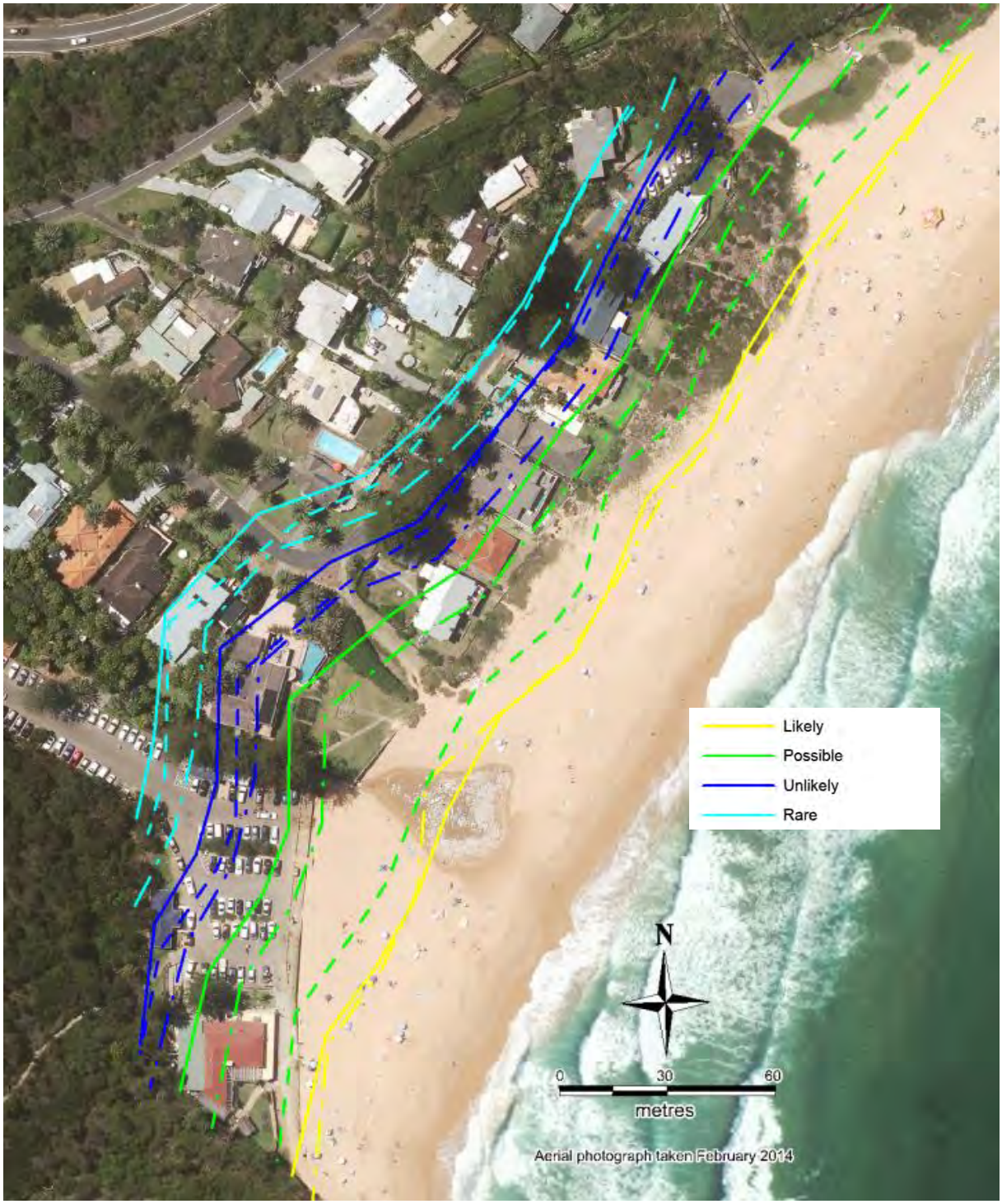

Figure D9: 95% (dash dot line), 50% (solid line)and 5% (dashed line) exceedance recession scenario likelihood lines at Bilgola Beach for Type 2 procedure for 60 year design life (at 2075)

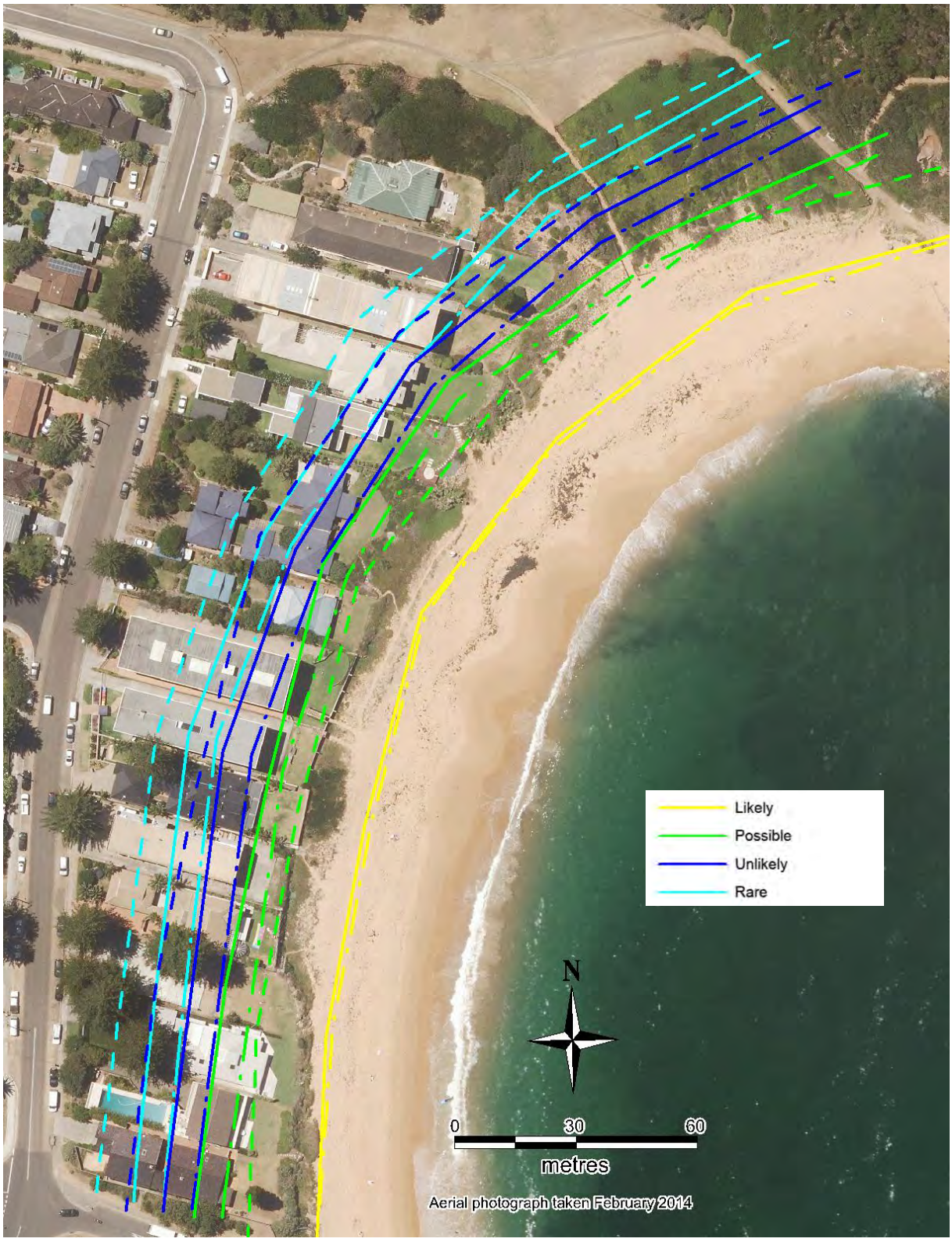

Figure D10: 95% (dash dot line), 50% (solid line)and 5% (dashed line) exceedance recession scenario likelihood lines at Basin Beach for Type 2 procedure for 60 year design life (at 2075)

D6.4 Adopted Likelihood Lines

Note that each likelihood line (ie line of particular colour in Figure D9 and Figure D10) theoretically has the same probability of occurrence for each of the three (95%, 50% and 5%) exceedance recession scenarios, even though they are in different positions. That is, it is statistically valid to choose any of the recession scenarios to be adopted as the particular likelihood line. Variability in the line positions for a particular likelihood over the recession scenarios is related to the approximate nature of the statistical analysis. This could be overcome by more advanced statistical modelling such as Monte Carlo simulations, but this is beyond the scope of the investigation reported herein.

It is also necessary to consider the Type 1 scenarios. Comparing Figure D9 and Figure D10 to Figure D7 and Figure D8 respectively and assessing the overall distribution, reliability and physical realism of the lines, at Bilgola Beach it was decided to use the:

- Type 1 lines to define the “almost certain” and “likely” likelihoods;
- Type 2 lines for the 50% exceedance scenario to define the “unlikely” and “rare” likelihoods; and
- a line midway between the adopted “likely” and “unlikely” lines as per the dot points above to define the “possible” likelihood.

At Basin Beach, it was decided to use the:

- Type 1 lines to define the “almost certain”, “likely” and “possible” likelihoods; and
- Type 2 lines for the 5% exceedance scenario to define the “unlikely” and “rare” likelihoods.

The adopted likelihood lines are depicted in Figure D11 for Bilgola Beach and Figure D12 for Basin Beach.

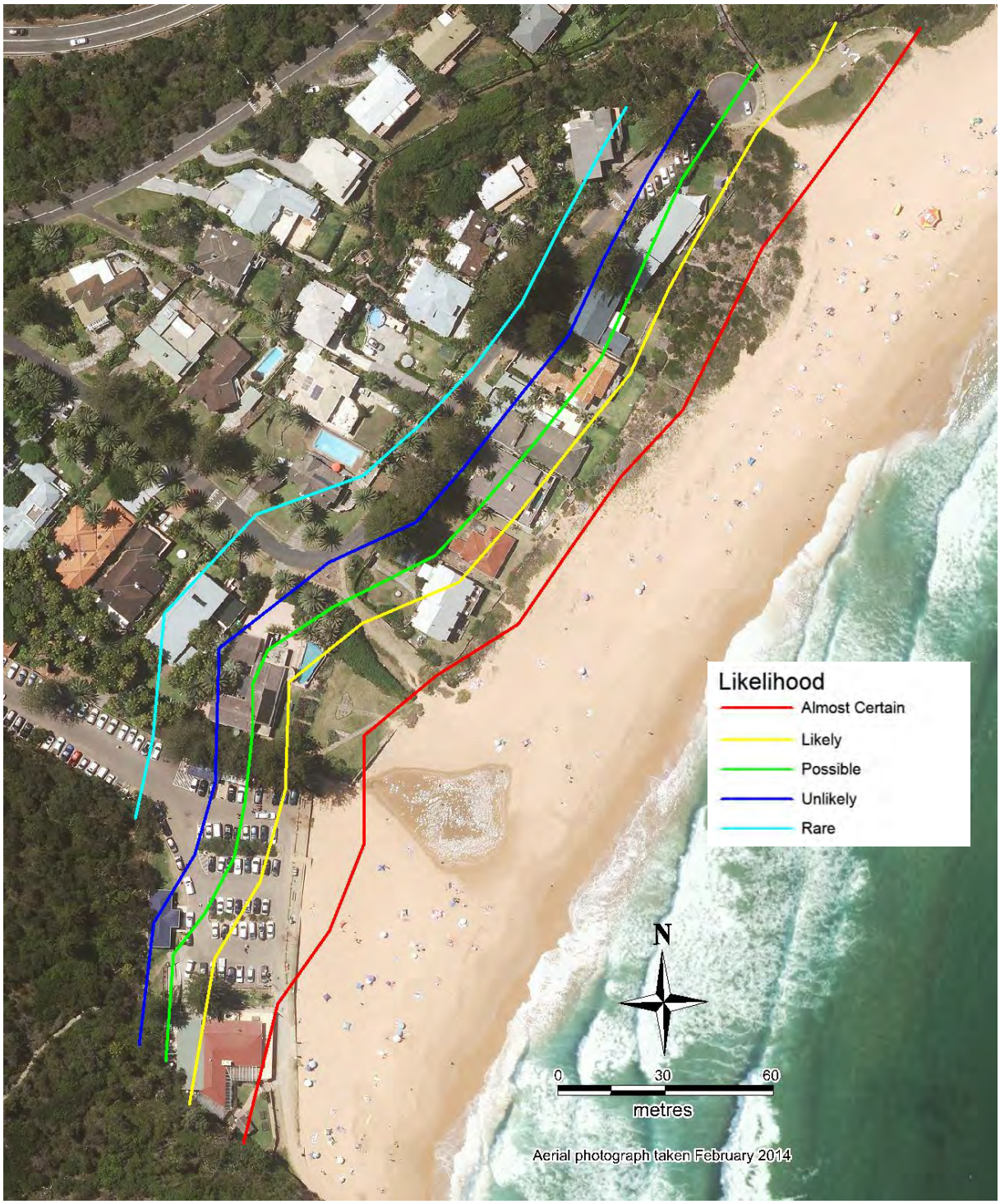

Figure D11: Adopted likelihood lines (ignoring existing protection works) at Bilgola Beach for 60 year design life (at 2075)

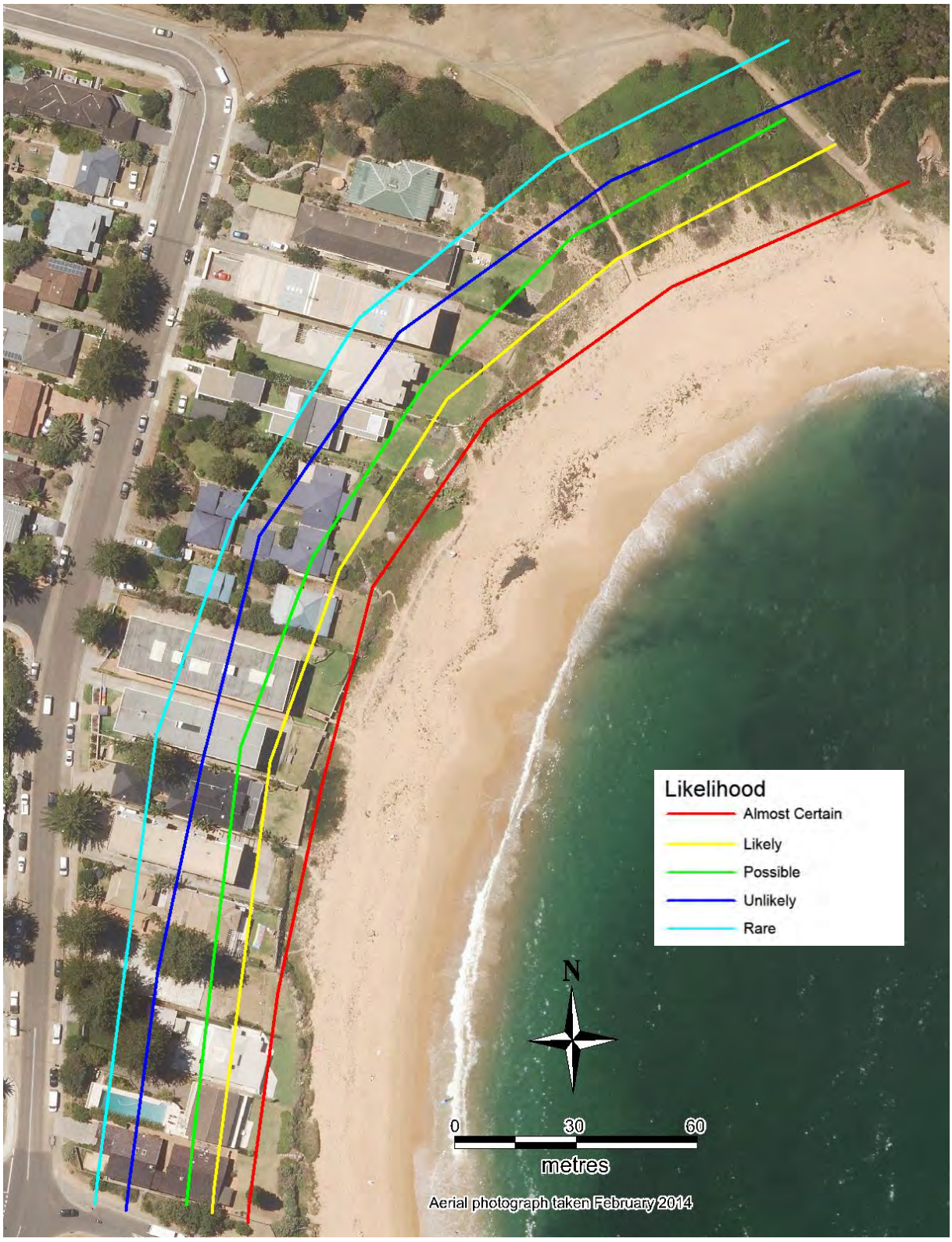

Figure D12: Adopted likelihood lines (ignoring existing protection works) at Basin Beach for 60 year design life (at 2075)

D6.5 Comparison to Traditional Hazard Lines

The adopted likelihood lines from Figure D12 are compared to traditional Immediate, 2050 and 2100 coastline hazard lines defined at the landward edge of the Zone of Slope Adjustment (ZSA) as derived by WorleyParsons (2012c) in Figure D13 for Bilgola Beach and Figure D14 for Basin Beach. A comparison of the adopted likelihood lines and corresponding Zone of Reduced Foundation Capacity (ZRFC) lines is made in Figure D15 for Bilgola Beach and Figure D16 for Basin Beach.

At Bilgola Beach, it is evident that the traditional Immediate ZSA is between the “almost certain” and “likely” likelihood lines, the “likely” (in the south) and “possible” (in the north) likelihood lines are similar to the traditional 2050 ZSA, and the “unlikely” likelihood line is similar to the traditional 2100 ZSA. The Immediate ZRFC is similar to the “likely” or “possible” likelihood lines, the 2050 ZRFC is similar to the “possible” or “unlikely” likelihood lines, and the 2100 ZRFC is similar to the “rare” likelihood line.

At Basin Beach, the “likely” likelihood line is similar to the traditional Immediate ZSA, the “possible” likelihood line is similar to the traditional 2050 ZSA, and the “unlikely” likelihood line is similar to the traditional 2100 ZSA. The Immediate ZRFC is similar to the “possible or “unlikely” likelihood lines, the 2050 ZRFC is similar to the “unlikely” or “rare” likelihood lines, and the 2100 ZRFC is generally landward of the “rare” likelihood line.

Therefore, adopting the “unlikely” likelihood line as the acceptable risk setback for new development on conventional foundations is similar to adopting the 2100 ZSA, which (it turns out) is consistent with traditional coastal engineering practice. Adopting the “likely” likelihood line as the acceptable risk setback for new development constructed on piled foundations is similar to adopting the Immediate ZSA, which generally conforms with the current seaward building alignment at Bilgola Beach and Basin Beach (except at 1 and 3 Allen Avenue Bilgola) .

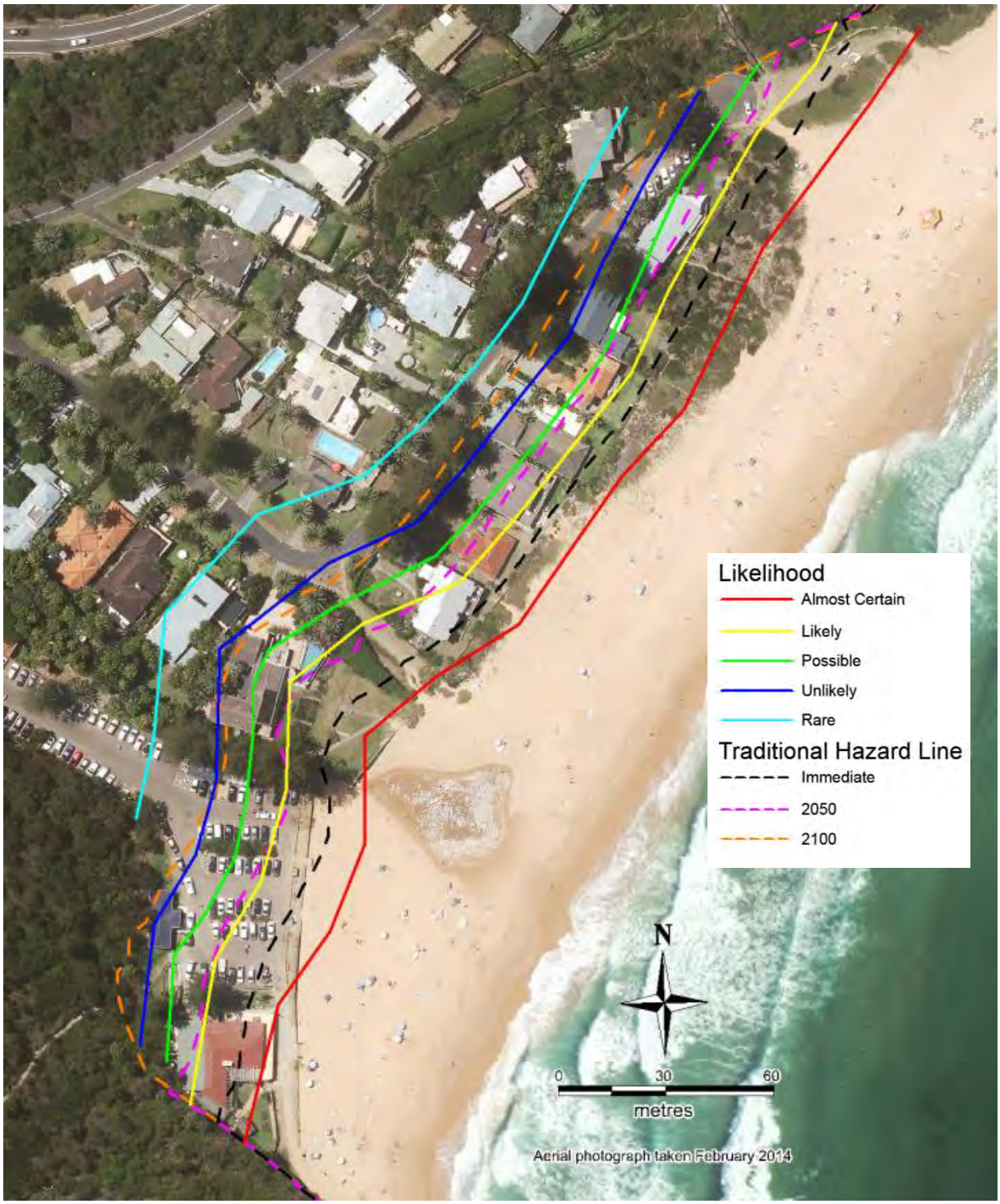

Figure D13: Adopted likelihood lines (ignoring existing protection works) for 60 year design life (at 2075), and traditional ZSA hazard lines from WorleyParsons (2012c), at Bilgola Beach

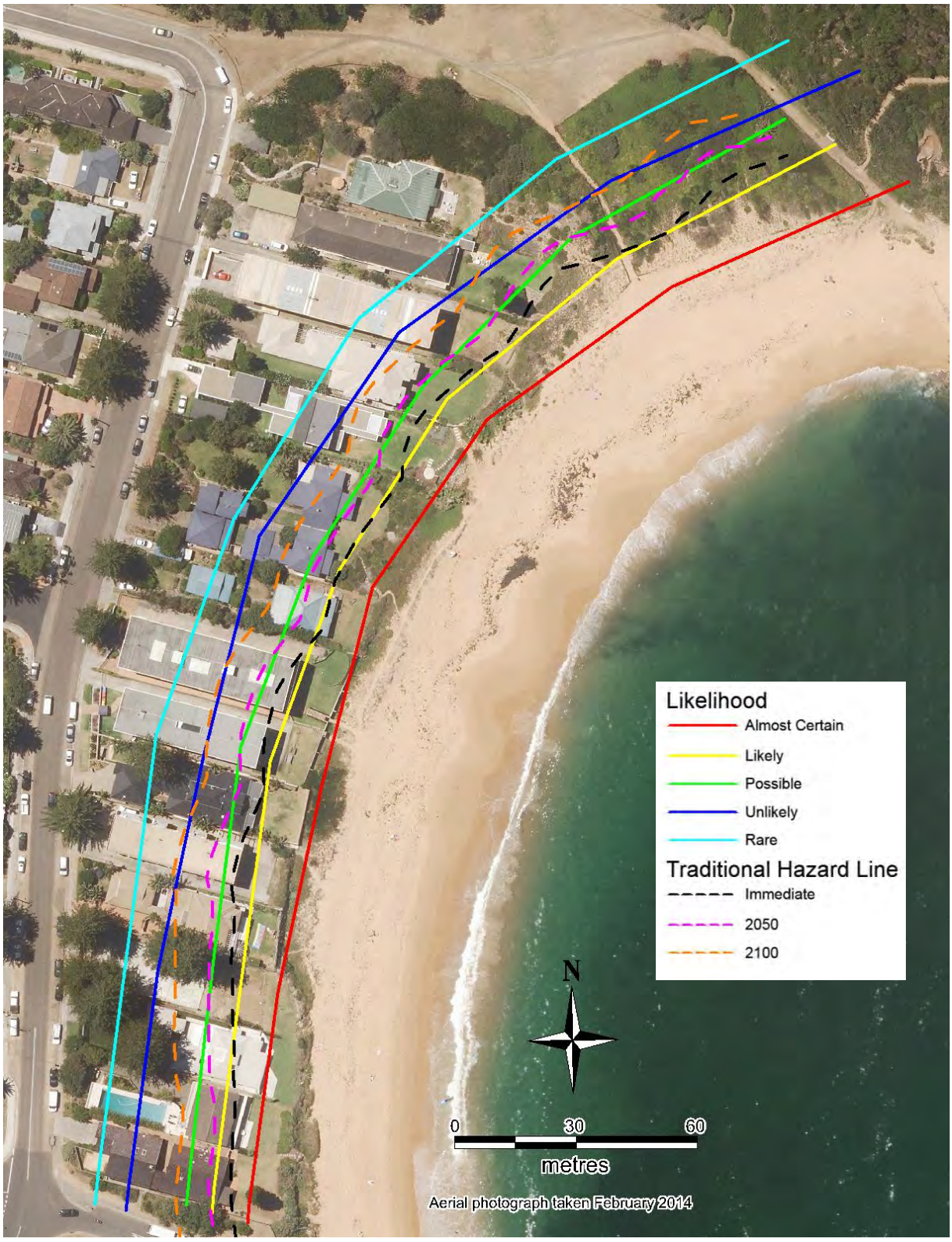

Figure D14: Adopted likelihood lines (ignoring existing protection works) for 60 year design life (at 2075), and traditional ZSA hazard lines from WorleyParsons (2012c), at Basin Beach

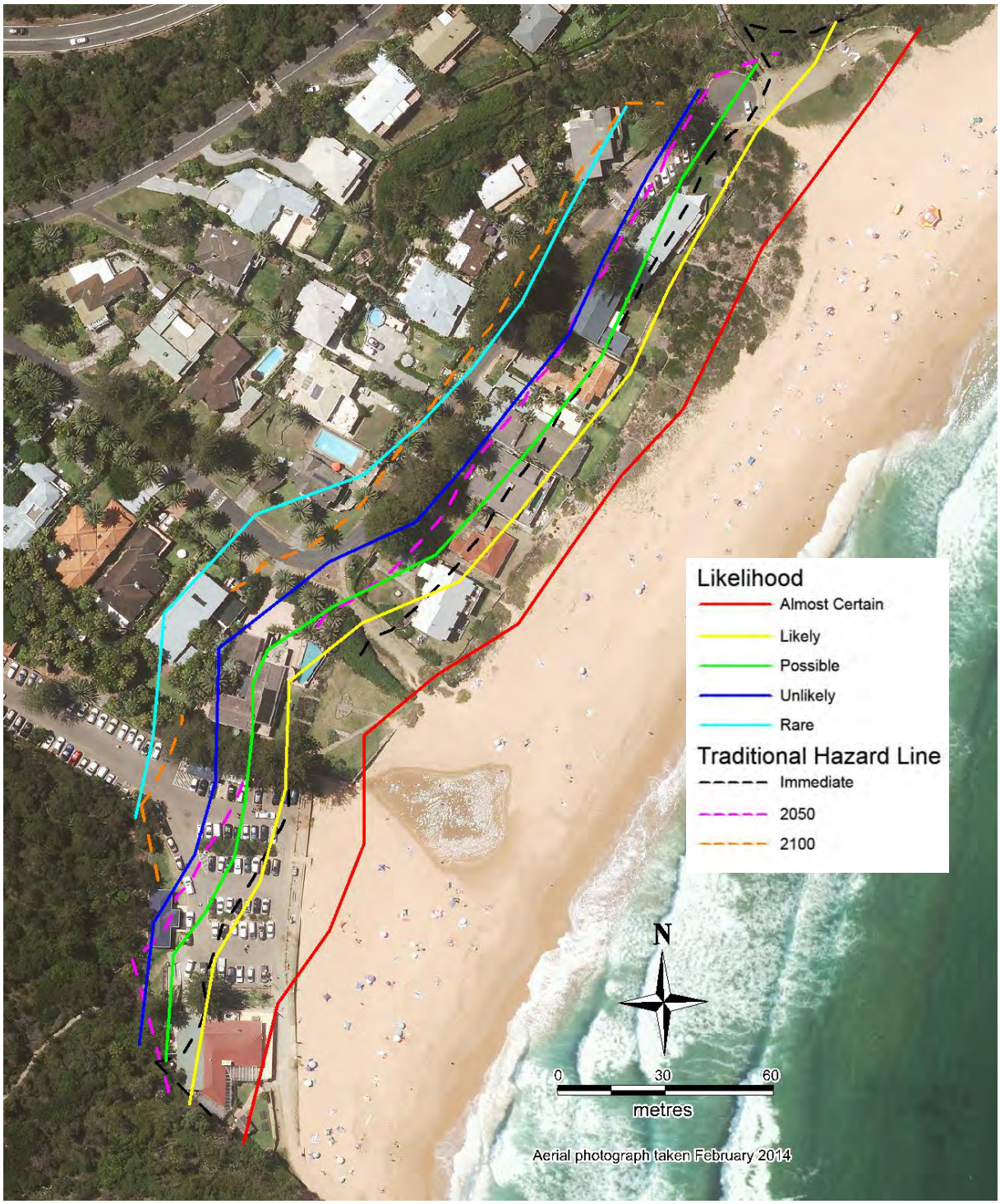

Figure D15: Adopted likelihood lines (ignoring existing protection works) for 60 year design life (at 2075), and traditional ZRFC hazard lines from WorleyParsons (2012c), at Bilgola Beach

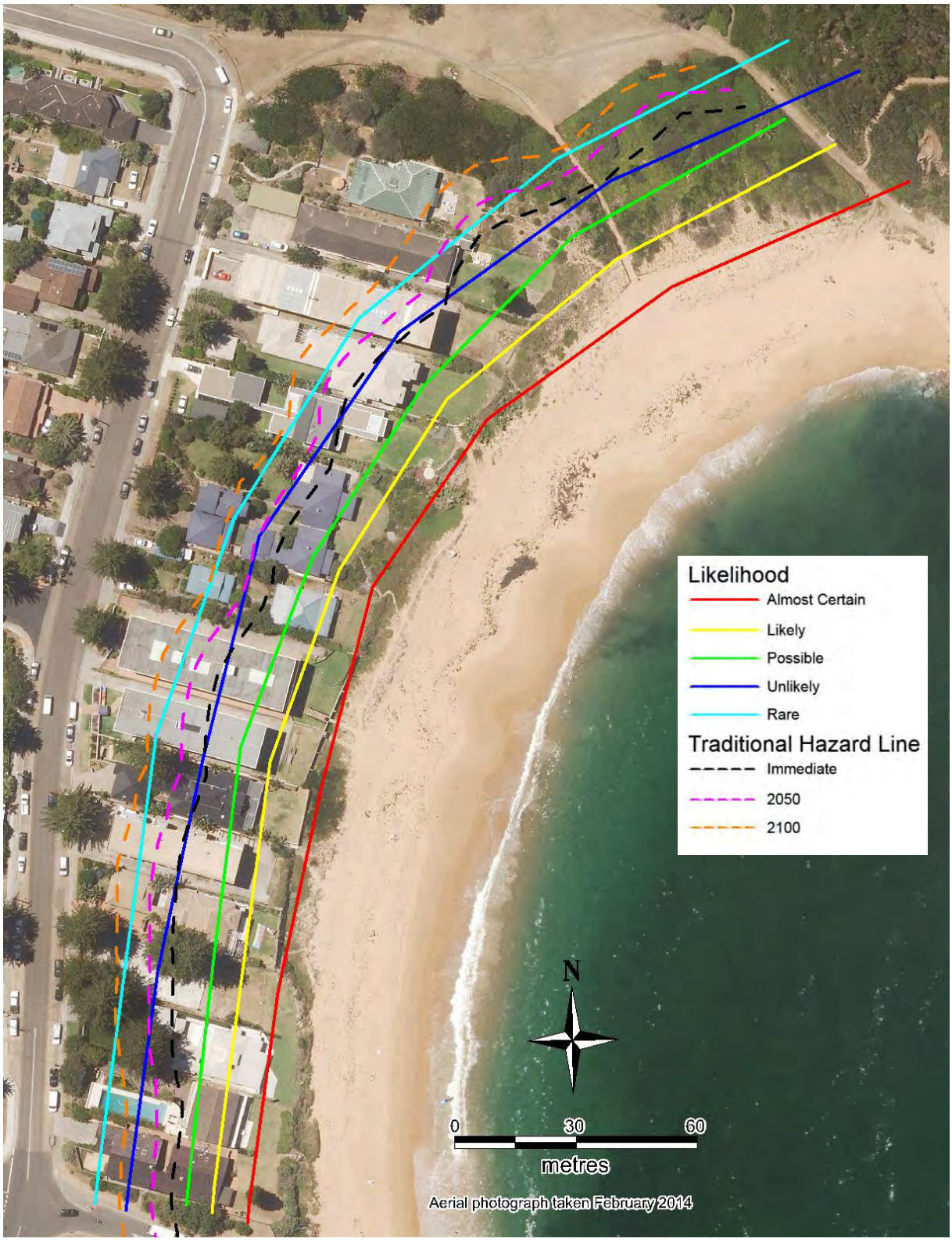

Figure D16: Adopted likelihood lines (ignoring existing protection works) for 60 year design life (at 2075), and traditional ZRFC hazard lines from WorleyParsons (2012c), at Basin Beach

D7. CONSIDERATION OF EXISTING PROTECTION WORKS

D7.1 General Considerations

While the existing protection works at Bilgola Beach and Basin Beach remain in place, erosion and recession would be constrained from progressing landward of the works. Indeed, the works have successfully provided property protection over the last 40 or so years, albeit that some of the buried works have rarely been exposed in recent decades.

However, the protection works are variable in standard, and they may be undersized and/or founded inadequately. Most of the works are not engineer designed nor approved structures, and were generally implemented by various landowners and authorities and constructed mostly in the 1950's to 1980's during or immediately after erosion events. Also, full details of the protection works are unknown or uncertain at many locations.

Given this, as well as the potential for larger waves attacking the structures under sea level rise[37] (and more frequent wave attack as the beach width narrows due to shoreline recession associated with sea level rise), future effectiveness of the protection works cannot be guaranteed.

That stated, it is considered that some allowance can be made for some protection that would be provided by the revetment works at Allen Avenue, as there is enough known on the works and they are relatively substantial and of a design that would be unlikely to fail catastrophically. It is also considered that some allowance can be made for some protection that would be provided by the two seawalls at 21 Bilgola Avenue, given that there are two walls and with the seaward wall buttressed and counterforted and the landward wall engineer-designed in the 1990's.

However no allowance has been made for the effect of protection works:

- adjacent to Bilgola SLSC (that is, from Bilgola Creek to the southern end of the beach), as these works have an elevated toe level and could fail catastrophically in a severe coastal storm at present; and
- at Basin Beach, as the works are variable in standard and with limited alongshore consistency and cross-shore extent.

See **Appendix A** for further details on the nature of protection works in the study area. It is recognised that there are recent engineer-designed walls at Basin Beach (eg at 27-29, 31 and 33 Surfview Road) and substantial engineered walls at 11 and 15 Surfview Road, but it was not considered to be appropriate from a planning perspective to make particular allowances at these limited lots due to the inconsistency of building alignment that could result.

D7.2 Allowance for Protection Works at Allen Avenue Bilgola

To define acceptable risk to new development in the Allen Avenue area at Bilgola Beach, with known protection works, it is considered that the critical case is complete failure of the works in a storm event, which can occur at any time over the design life. There is no need for recession to be considered in this case, as recession landward of the works cannot occur until failure.

[37] Note that the required rock mass in rock revetment structures is proportional to the wave height cubed, so a small increase in wave height can lead to a large increase in the required mass, meaning that existing structures are more likely to become unstable in the future.

The ("unlikely") acceptable risk with conventional foundations for this scenario can be approximated by the storm event that has a 0.3% probability of occurring during the design life. Following the methodology outlined in Section D6.2, the ARI of this 0.005% AEP (see Table D1) event is 20,000 years, with a storm demand of 500m^3/m at Bilgola Beach based on a linear extrapolation of Figure D1.

Rock revetments can fail if undermined (leading to collapse of the structure), overtopped (leading to sand removed from behind and again potential collapse) and/or the rocks become mobile due to insufficient mass. Examples of failed revetments are provided in Figure D17 and Figure D18.

Figure D17: Erosion landward of revetment at Stockton Beach in July 1999

Figure D18: Erosion landward of revetment at Wamberal Beach in June 1978

However, at Allen Avenue, the rock revetments would most likely limit some of the storm demand due to the significant spatial extent of the works. Even if undermined and/or rocks were dislodged, the revetments would be expected to limit erosion in the lower profile. Therefore, it is considered a reasonable assumption that any failed protection works (rock revetments) would most likely (conservatively) reduce 10% to 20% of the storm demand (that is, 80% to 90% of the theoretical storm demand could be realised) at Allen Avenue. This would essentially shift the "conventional foundations" acceptable risk line at Allen Avenue from the "unlikely" line to the "possible" line[38]. For piled development, this would essentially shift the acceptable risk line at Allen Avenue from the "likely" line to a likelihood line defined by a storm demand of 225m^3/m[39].

D7.3 Allowance for Protection Works at 21 Bilgola Avenue Bilgola

As long as development is constructed landward of the second (landward) seawall (gabion structure) at 21 Bilgola Avenue, this development is considered to be at acceptable risk on conventional foundations. This is because as part of the Conditions of Consent for the most recent Development Application at this property (dated 19 April 2005), it was a requirement that the recommendations of Patterson Britton & Partners (2005) be complied with, including that a positive covenant/restriction on the use of land was to be created prior to the issue of the Occupation Certificate.

In Patterson Britton & Partners (2005), it was recommended that should the vertical seawall seaward of 21 Bilgola Avenue fail in the future, the subject property be inspected by a coastal engineer, with consideration made of restoring beach levels to maintain an adequate sand reserve seaward of the subject property, and/or upgrading the gabion revetment, and/or rebuilding the vertical seawall, and/or founding any new development on piles.

Therefore, with this positive covenant/restriction in place, development landward of the gabion structure at 21 Bilgola Avenue is considered to be at acceptable risk on conventional foundations. On this basis, no acceptable risk lines were delineated at 21 Bilgola Avenue.

[38] The "possible" line was defined by a storm demand of 390m^3/m at Bilgola Beach. This is about 80% of 500m^3/m.
[39] The "likely" line was defined by a storm demand of 280m^3/m, with 80% of this being 225m^3/m. There is no likelihood line corresponding with this storm demand.

D8. PLOTS OF ACCEPTABLE RISK LINES DETERMINED IN STUDY AREA

As described in Section D5, in all areas except areas with private development at Bilgola Beach:

- the “unlikely” likelihood line is the acceptable risk setback for new development on conventional foundations; and
- the “likely” likelihood line is the acceptable risk setback for new development constructed on piled foundations.

These lines were delineated in in Section D6.4.

As noted in Section D7.2, at Allen Avenue at Bilgola Beach (where there are known protection works):

- the “possible” likelihood line is the acceptable risk setback for new development on conventional foundations; and
- a line defined by a storm demand of 225m^3/m is the acceptable risk setback for new development constructed on piled foundations.

As also noted in Section D7.3, at 21 Bilgola Avenue Bilgola no acceptable risk lines have been delineated, as a positive covenant/restriction is in place that recommendations in Patterson Britton & Partners (2005) should be followed if the vertical seawall seaward of this property fails. Development landward of the gabion structure at 21 Bilgola Avenue is considered to be at acceptable risk on conventional foundations.

Plots of the acceptable risk lines to define the setback for new development on conventional foundations and on piled foundations in the study area are provided in Figure D19 for Bilgola Beach and Figure D20 for Basin Beach. Lot boundaries of private development are also shown, as is the Foreshore Building Line as per *Pittwater Local Environmental Plan 2014*.

It is proposed that future development would be landward of the acceptable risk lines as relevant to the foundation type, and potentially further landward based on the Foreshore Building Line and/or amenity and other considerations as discussed in Section D9.2.

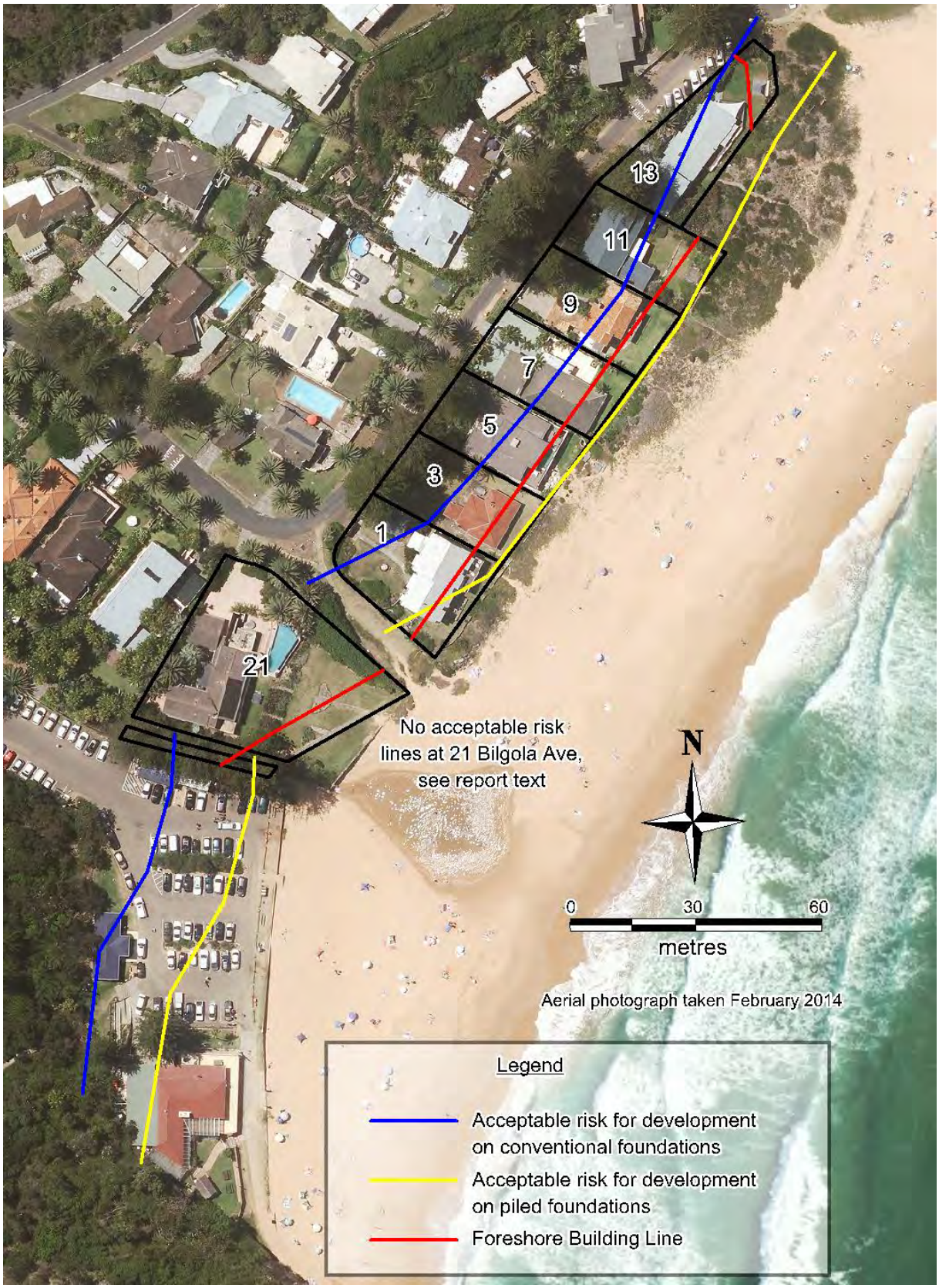

Figure D19: Acceptable risk lines for 60 year design life (at 2075) and current Foreshore Building Line at Bilgola Beach

Figure D20: Acceptable risk lines for 60 year design life (at 2075) and current Foreshore Building Line at Basin Beach

D9. IMPLICATIONS FOR DEVELOPMENT CONTROLS

D9.1 Observations from Figures in Section D8

The following observations can be made for any new private development proposed at Bilgola Beach:

- it is expected that all new development would need to be piled to provide a sufficient development area;
- if new development was constructed at its current position on piled foundations, this would be at acceptable risk at all lots except 1 Allen Avenue;
- there is sufficient development area at 1 Allen Avenue for new piled development (that was relocated slightly further landward than the existing development) to be landward of the acceptable risk line for piled development;
- the acceptable risk line for piled development would not provide any seaward boundary setback at Bilgola Beach, except at 1 Allen Avenue, as it is at or seaward of the seaward property boundaries; and
- on this basis, the Foreshore Building Line would be a suitable setback for development on piled foundations (more appropriate than the acceptable risk line for piled development).

The following observations can be made for any new private development proposed at Basin Beach:

- it is expected that new development from 31 Surfview Road northwards could be constructed on conventional foundations and provide a sufficient development area, while south of this new development would generally need to be piled (unless certified protection works could be relied upon);
- if new development was constructed on piled foundations at the current position of existing development, this would be at acceptable risk at all lots except 3, 5, 7 and 23 Surfview Road (however, at all these lots there would be sufficient development area if the new development was constructed landward of the acceptable risk for piled development line);
- if new development was constructed on conventional foundations at the current position of existing development, this would be at acceptable risk at 37 and 39 Surfview Road;
- the acceptable risk for piled development line would be the appropriate setback for piled development for 3 to 29 Surfview Road inclusive, while the Foreshore Building Line would be the suitable setback for 31 to 39 Surfview Road inclusive; and
- the acceptable risk line for conventional foundations would be the appropriate setback for such development for 3 to 35 Surfview Road inclusive, while the Foreshore Building Line would be the suitable setback for 37 and 39 Surfview Road.

The following observations can be made on public structures:

- Bilgola SLSC is not at acceptable risk even if on piled foundations, so would need to be piled if redeveloped with the same seaward extent as existing, and/or having the adjacent seawall upgraded, to be at acceptable risk.

D9.2 Practical Application with Adopted Setbacks

There can be relatively straightforward application of the two acceptable risk setback lines and in combination with the Foreshore Building Line to define the location of new development (on conventional or piled foundations) in the study area, without any significant negative impacts on

landowners or public beach amenity. As discussed in Section D9.1, seaward private property boundary setbacks for new beach development are to be adopted as follows at all locations except 21 Bilgola Avenue:

- the acceptable risk line for conventional foundations shall apply as the setback for development on conventional foundations at both Bilgola Beach and Basin Beach, except at 37 and 39 Surfview Road, where the Foreshore Building Line shall apply;
- the acceptable risk line for piled development shall apply as the setback for development on piled foundations at 3 to 29 Surfview Road inclusive at Basin Beach, while the Foreshore Building Line shall apply at Bilgola Beach (except at 1 Allen Avenue where the acceptable risk line for piled development is landward) and at 31 to 39 Surfview Road inclusive at Basin Beach.

The adopted setbacks are depicted in Figure D21 (Bilgola Beach) and Figure D22 (Basin Beach). Note that these are minimum setbacks, and there may be other planning considerations such as visual impacts and effects on views that would require an additional setback as each Development Application is assessed on its merits.

At 21 Bilgola Avenue, the setback for development on conventional foundations (note that piled development is not required) shall be 3m landward of the gabion revetment, to allow maintenance access to the revetment if required. The approximate position of this setback is depicted in Figure D21.

The Foreshore Building Line prevailed over the acceptable risk line for piled foundations where the latter would lead to a setback that is too far seaward. The reason why such a setback is necessary is to prevent new piled development moving so far seaward so as to impact on:

- equity (for example, view loss and privacy issues for neighbours relative to existing building lines);
- beach amenity (for example, visual impact of structures near the public beach);
- available space for construction of protection works on private land if required in the future; and
- existing or future protection works maintenance (allowing space for plant and equipment to work seaward of development to undertake maintenance of any protection works if required).

It is recognised that there are limitations to the 'acceptable risk' approach, in that there are other considerations besides coastal processes (such as a consistent building alignment and beach amenity) in defining appropriate setbacks for new development.

Landowners are also entitled to consider the installation or upgrading of protection works under *State Environmental Planning Policy (Infrastructure) 2007*. Where works would be entirely in private property and would not impact on adjacent property, these may be considered to reduce the risk to development and potentially move the acceptable risk line for piled development further seaward (as far seaward as the Foreshore Building Line).

Any such new or upgraded protection works would require current coastal engineering design standards to be adopted for a design life of at least 60 years, and the protection works being certified as having been constructed to these requirements. For any new development relying on protection works to achieve acceptable risk, it is considered to be prudent for Council to consider including a trigger based consent condition such that the consent would lapse if the protection works failed.

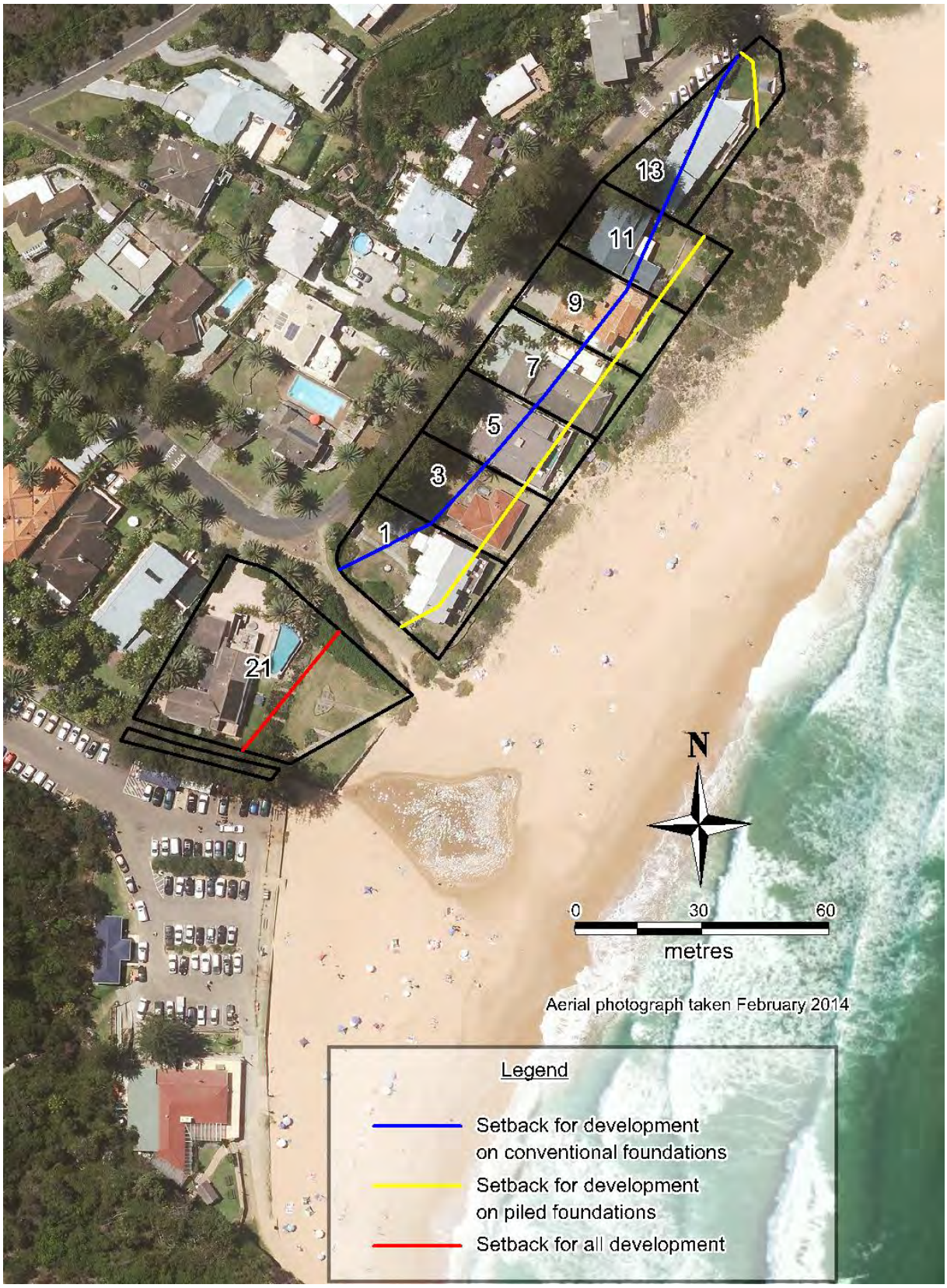

Figure D21: Adopted minimum beachfront setback lines for development on conventional and piled foundations at Bilgola Beach

Figure D22: Adopted minimum beachfront setback lines for development on conventional and piled foundations at Basin Beach

D10. OTHER APPROACHES TO RISK DETERMINATION

The approach to defining acceptable risk herein was developed by the authors as an extension to WorleyParsons (2012e, f), in which they (in previous employment) completed a relative risk assessment of Warringah's coastal structures. This risk assessment work has also been described in Horton et al (2011) and Roberts and Horton (2011).

Familiarity with and further review of the AGS (2007a, b) procedures, recognition of the limitations of the traditional hazard lines approach, review of Australian Standards on risk[40], and support in *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010a; OEH, 2013) for a risk management approach led to development of the approach herein. This approach was seen as rational and robust.

Although others have defined likelihood hazard lines (for example, in the *Coffs Harbour Coastal Processes and Hazards Definition Study*), these have been defined qualitatively without reference to defined probabilities, and are not considered to be consistent with AGS (2007a, b) probabilities.

Jongejan et al (2011) considered the use of setback lines as a form of risk mitigation at Collaroy-Narrabeen Beach. They noted that defining appropriate setback lines for land-use planning purposes was a balancing act, but found that it was unclear what level of protection was facilitated by current setback lines, and whether this was sufficient from an economic perspective.

Jongejan et al (2011) presented an economic model to determine what setback lines would be optimal from an economic perspective. They concluded that:

- it is useful to define setback lines on the basis of their exceedance probabilities (as has been undertaken herein)[41];
- the approach required probabilistic estimates of coastal erosion volumes (as has been undertaken herein);
- an order of magnitude 1% AEP event produced an "economically efficient" setback line without sea level rise; and
- long term uncertainties (for example due to climate change) influenced the exceedance probability of "economically efficient" setback lines but only to a limited extent.

Jongejan et al (2011) used the Callaghan et al (2008) and Ranasinghe et al (2009) procedures in their analysis, to obtain probabilistic hazard lines.

Woodroffe et al (2012) further applied the Jongejan et al (2011) procedure to develop "economically efficient" setback lines for Collaroy-Narrabeen Beach. They found that these setbacks lines were located near to Ocean Street and Pittwater Road, that is relatively landward. It is considered that the approach adopted herein is more appropriate for defining acceptable risk to development from a Council perspective at this point in time.

Some of the potential limitations of Woodroffe et al (2012) included that:

[40] Namely AS/NZS ISO 31000:2009, "Risk management - Principles and guidelines", AS 5334-2013, "Climate change adaptation for settlements and infrastructure - A risk based approach", the draft "Risk management guidelines, Companion to AS/NZS ISO 31000:2009 (Revision of HB 436:2004)" (DR HB 436) and the document HB 327:2010, "Communicating and consulting about risk".
[41] Also supported by Kinsela and Hanslow (2013).

- setbacks were defined based on economic criteria only, as opposed to the approach herein of defining acceptable risk on the basis of probabilities and consequences (which embody an economic consideration) over an appropriate design life compared to a standard developed rigorously by AGS (2007a, b);
- they assumed that those that suffer damage from storm erosion would be compensated by a third party (government, charity or other) that is unable to collect a premium for its explicit or implicit guarantee, whereas it is expected that in practice landowners would bear entirely the financial consequences of any damage to their properties;
- the economic model utilised a number of “doubtful constants” which were noted as imprecise and subject to debate, such as the discount rate and rate of return, and it was assumed that there were no market imperfections;
- there was no consideration of an appropriate design life; and
- there was no consideration of the effect of measures to reduce risk (such as piling and protection works) in the economic model.

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Appendix E: Private Property Risk and Response Categories as per OEH (2013)

CONTENTS

E1. INTRODUCTION

Based on "Guidelines for Preparing Coastal Zone Management Plans" OEH (2013), there is a requirement to define "property risk" and "property response" categories for private property in the study area. This categorisation is tabulated in Section E2.

A description of the "property risk" categories is provided in Table E1.

Table E1: Property risk categories from OEH (2013)

Risk Category	Description
1	Immediate Hazard Area (land seaward of the Immediate Hazard Line) covers at least 25% of lot
2	2050 Hazard Area (land seaward of the 2050 Hazard Line) covers at least 25% of lot
3	2100 Hazard Area (land seaward of the 2100 Hazard Line) covers at least 25% of lot
4[1]	2100 Hazard Area (land seaward of the 2100 Hazard Line) covers part of lot but less than 25%

Where multiple risk categories applied at a particular lot, the numerically lower (that is, shorter planning period) risk category was adopted. The risk categories were determined for hazard lines defined using the landward edge of the Zone of Slope Adjustment (ZSA), ignoring existing protection works and non-sandy subsurfaces, with hazard lines derived from WorleyParsons (2012).

OEH (2013) defined hazard lines including the Zone of Reduced Foundation Capacity (ZRFC). An opinion was obtained from the Department of Planning as to whether it was mandatory to include the ZRFC in hazard definition, and the advice received was:

> "a council can use its own judgement based on local circumstances to decide whether to include an allowance for reduced foundation capacity".

Therefore, it is considered to more appropriate and acceptable to define property risk categories using hazard lines defined at the landward edge of the ZSA (and not the ZRFC) since:

- the ZRFC is not an area that gets eroded or is necessarily attacked by waves; it is delineated to take account of the reduced bearing capacity of the sand adjacent to a slumped storm erosion escarpment;
- a structure located within the ZRFC (suitably founded) is not expected to impacted by erosion/recession coastal processes, either directly or indirectly, for a particular design event;
- it is not unusual for foundation conditions to be influenced by certain geotechnical conditions or proximity to natural hazards;
- inclusion of the ZRFC would trigger inclusion of additional properties into the study area, including some that are landward of Allen Avenue at Bilgola Beach, which was considered to be overly conservative given realisation of hazards at these locations is barely credible over the next 50 to 100 years; and
- delineation of hazard lines at the landward edge of the ZSA has been traditional accepted coastal engineering practice for over 25 years.

A description of the "property response" categories is provided in Table E2.

[1] Additional category adopted herein and not included in OEH (2013), to capture additional lots with a small proportion of land seaward of the 2100 Hazard Line.

Table E2: Property response categories from OEH (2013)

Response Category	Description
A	Coastal protection works considered technically feasible and cost effective - funding is being sought for implementation
B	Coastal protection works considered technically feasible but not cost-effective for public funding
C	Coastal protection works not considered technically feasible – no intended public authority works[2]

Given that Council has stated that it does not intend to fund any protection works at or seaward of private property, no lots in the study area could be given a Response Category of "A".

The term "technically feasible" was not defined in OEH (2013), but has been defined herein that protection works are only considered to be appropriate in the part of the study area where 'end effects' would not be expected, due to there already being protection works at adjacent properties. Accordingly, the lots in the study area at Bilgola Beach and most of the lots at Basin Beach were defined as Response Category "B". At 35, 37 and 39 Surfview Road , the Response Category was defined as "C". That stated, if the three property owners collaborated to construct protection works over the 3 lots that also tied into the works at 33 Surfview Road then it may be technically feasible to construct protection works at these properties.

[2] This category can appropriately be redefined adding the clause "and private works not generally recommended due to potential end effects on neighbouring properties".

E2. TABULATED CATEGORIES

The property risk and response categories for all lot addresses in the study area are listed in Table E3 (Bilgola Beach, 8 addresses) and Table E4 (Basin Beach, 16 addresses), moving south to north in each case. Note that strata properties have additional individual addresses within the lot address listed.

Table E3: Property risk and response categories for all properties in study area at Bilgola Beach

Address	Risk Category	Response Category
21 Bilgola Avenue Bilgola 2107	3	B
1 Allen Avenue Bilgola 2107	2	B
3 Allen Avenue Bilgola 2107	2	B
5 Allen Avenue Bilgola 2107	2	B
7 Allen Avenue Bilgola 2107	2	B
9 Allen Avenue Bilgola 2107	2	B
11 Allen Avenue Bilgola 2107	2	B
13 Allen Avenue Bilgola 2107	2	B

Table E4: Property risk and response categories for all properties in study area at Basin Beach

Address	Risk Category	Response Category
3 Surfview Road Mona Vale 2103	2	B
5 Surfview Road Mona Vale 2103	2	B
7 Surfview Road Mona Vale 2103	2	B
9 Surfview Road Mona Vale 2103	2	B
11 Surfview Road Mona Vale 2103	2	B
13 Surfview Road Mona Vale 2103	2	B
15 Surfview Road Mona Vale 2103	2	B
17 Surfview Road Mona Vale 2103	2	B
19 Surfview Road Mona Vale 2103	2	B
23 Surfview Road Mona Vale 2103	2	B
29 Surfview Road Mona Vale 2103	2	B
31 Surfview Road Mona Vale 2103	3	B
33 Surfview Road Mona Vale 2103	3	B
35 Surfview Road Mona Vale 2103	4	C
37 Surfview Road Mona Vale 2103	4	C
39 Surfview Road Mona Vale 2103	4	C

E3. REFERENCES

Office of Environment and Heritage [OEH] (2013), *Guidelines for Preparing Coastal Zone Management Plans*, OEH 2013/0224, July, ISBN 978-1-74359-054-6

WorleyParsons (2012), *Pittwater Shire Council Coastline Hazard Definition and Climate Change Vulnerability Study*, Revision A, 3 July, Draft

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Appendix F: Coastal Erosion Emergency Action Subplan for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)

CONTENTS

F1. INTRODUCTION

A "Coastal Erosion Emergency Action Subplan for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)" is set out in this Appendix. An "emergency action subplan" is defined in Section 55C(1)(b) of the NSW *Coastal Protection Act 1979* as follows:

> "A coastal zone management plan must make provision for emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event."

It is required that the Emergency Action Subplan includes information on Council's intended response to a coastal erosion emergency, as well as explanation being provided on ways in which beachfront property owners can undertake placement of "temporary coastal protection works" (Office of Environment and Heritage [OEH], 2011). OEH (2011) noted that the following are considered to be key elements of an Emergency Action Subplan:

- a clear and concise description of the emergency response actions Council would take when coastal erosion is imminent, occurring or has occurred;
- determination of the criteria or thresholds that would be used to initiate actions under the Emergency Action Subplan;
- identifying actions that would be undertaken before, during and after an erosion emergency; and,
- identifying any site-specific issues that might limit landowners placing "temporary coastal protection works" at authorised locations.

"Temporary coastal protection works" (TCPW)[1] has a specific meaning based on Part 4c of the *Coastal Protection Act 1979*, generally being "sand, or fabric bags filled with sand" (also known as sand-filled geotextile containers), which are temporarily placed on a beach "to mitigate the effects of wave erosion on land" (that is, to reduce the landward extent of erosion).

An Emergency Action Subplan must not include matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* (such as a State Emergency Service Local Flood Sub Plan), and no such duplication of material (or change in defined roles and responsibilities) has been included herein.

The investigation herein is set out as follows in relation to the study area of Bilgola Beach and Basin Beach (the same study area as the overall CZMP):

- approvals required for implementation of TCPW and other emergency or long-term protection works of any form are described in Section F2, both for landowners and Council;
- evaluation of potential emergency protection measures is undertaken in Section F3;
- roles and responsibilities of various authorities in coastal emergency management are outlined in Section F4;
- a description of proposed Council actions before, during and after coastal storms is provided in Section F5 (also including discussion on criteria or thresholds to initiate actions);
- details on consultation that has and is proposed to be undertaken are outlined in Section F6; and

[1] Formerly known as "emergency coastal protection works".

- key contact details are provided in Section F7.

The document herein is intended to inform and define Council actions, inform landowners, and meet State Government requirements. This Emergency Action Subplan should be reviewed and amended (if necessary) if any of the following events occur:

- if there is any review of local State Emergency Service (SES) sub plans;
- if Coastal Zone Management Plans are updated for Bilgola Beach or Basin Beach; or,
- following a coastal erosion emergency event affecting the study area.

F2. APPROVALS REQUIRED FOR IMPLEMENTATION OF EMERGENCY PROTECTION WORKS

F2.1 Approvals Required by Landowners

F2.1.1 Preamble

There are two options available for landowners considering construction of emergency coastal protection works at their property, namely either:

- undertaking temporary sand/sandbags TCPW (as defined under Part 4c of the *Coastal Protection Act 1979*) at limited "authorised locations"; or,
- installation of emergency or long term[2] coastal protection works of any form as allowable based on *State Environmental Planning Policy (Infrastructure) 2007* (denoted as *SEPP Infrastructure* herein)[3].

The approvals required for installing these works are described in Section F2.1.2 and Section F2.1.3 respectively.

It is emphasised that landowners must act well (generally months) in advance of a storm to consider implementing either of these works. It should also be noted that landowners are not permitted to install coastal protection works without following these procedures, and severe penalties may apply if they are not followed.

F2.1.2 Temporary Coastal Protection Works (TCPW)

TCPW comprise either (OEH 2013a, b):

- sand-filled geotextile containers of 0.75m^3 filled volume stacked up to 1.5m high at a slope flatter than 34° from the horizontal (that is flatter than 1:1.5 vertical:horizontal) against the seaward side of an erosion escarpment, and within 4m of the escarpment; or,
- clean sand placed up to the crest on the seaward side of an eroding escarpment at a slope flatter than 34° from the horizontal.

Additional requirements are also listed in OEH (2013a, b), such as that sand cannot be taken from the adjacent beach or dune for TCPW.

TCPW can only be installed at "authorised locations" in NSW. Both Bilgola Beach and Basin Beach are "authorised locations" (OEH 2013a, b), and are the only such locations in the former Pittwater Council area. However, TCPW can also only be installed "where buildings are known to be currently vulnerable to erosion" (OEH, 2013a). This is an imprecise definition, and on this basis and in

[2] "Long term" works are defined herein as works that would be installed prior to an emergency, generally based on a detailed engineering design and with the intention of eliminating or reducing the risk of damage to an asset from a coastal storm over the long term (although note that long term works such as beach nourishment may require ongoing implementation).
[3] The terminology used for such works is "coastal protection works" in *SEPP Infrastructure*.

consultation with OEH it was determined that TCPW could be installed at all locations at Bilgola Beach and Basin Beach where undertaken in conformity with OEH (2013a, b)[4].

Based on OEH (2013a, b), if a landowner chooses to install TCPW, access is permitted for plant and equipment at:

- the northern end of Allen Avenue or at Bilgola Avenue at Bilgola Beach, and
- via the beach access track at the corner of Surfview Road and Bassett Street (at the northern end of Basin Beach) or adjacent to Mona Vale SLSC.

However, TCPW are not recommended for use by landowners in the study area due to various limitations, in particular that they are likely to be ineffective and difficult to install in an emergency as:

- the designated sand-filled geotextile container size of 0.75m^3 is not stable under severe open coast wave action, with design wave heights of only about 1m to 1.5m likely to cause damage of bag structures at a slope of 1:1.5 vertical:horizontal (Coghlan et al, 2009);
- only limited beach excavation can be undertaken, meaning that the structure toe level would most likely be inadequate;
- the maximum allowable structure height of 1.5m would not be expected to provide adequate protection of eroded escarpments in the order of 3m to 5m high, as may occur at Bilgola Beach and Basin Beach in severe storms; and,
- the bags would be difficult to install in an emergency as they require adequate foundation and careful placement.

TCPW must be placed in accordance with the requirements of:

- Part 4c of the *Coastal Protection Act 1979*;
- *Guide to the Statutory Requirements for Temporary Coastal Protection Works* (OEH, 2013a)
- *Code of Practice under the Coastal Protection Act 1979* (OEH, 2013b); and
- the document herein (that stated, no specific requirements for TCPW have been listed herein).

F2.1.3 Other Works (of any Form)

Based on *SEPP Infrastructure*, landowners can consider the installation of emergency or long term coastal protection works of any form. As consent is required for such works, Part 4 of the *Environmental Planning and Assessment Act 1979* applies. Therefore, before installing these general protection works it would be necessary for landowners to:

- undertake an environmental assessment , that is either a Statement of Environmental Effects or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- lodge a Development Application (DA) with a consent authority.

If a certified CZMP is in place on the land, Northern Beaches Council is the consent authority, or otherwise the consent authority is the NSW Coastal Panel. Note that it is the general expectation of

[4] In the previous Emergency Action Subplan prepared for the study area (WorleyParsons, 2012a, b), it was noted that at that time TCPW were only permitted in areas that did not have existing protection works. However, that requirement no longer applies.

Council that any emergency or long term protection works implemented by landowners would be entirely on private land (that is, within their property boundaries)[5].

F2.2 Approvals Required by Northern Beaches Council

Based on *SEPP Infrastructure*, coastal protection works (of any form) can be carried out by Council without consent on any land. Given this, Part 5 of the *Environmental Planning and Assessment Act 1979* applies to coastal protection works (emergency or long term) undertaken by Council, unless the works can be considered to be exempt development. Council would generally be the determining authority for these works.

If the works are not exempt development, before installing protection works it would be necessary for Council to:

- undertake an environmental assessment, that is either a Review of Environmental Factors or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- (only if a certified CZMP is not in force on the land) notify the NSW Coastal Panel before carrying out the works and take into consideration any response received from the Coastal Panel within 21 days of the notification (unless the proposed works only comprise the placement of sand or sandbags, or only replacement, repair or maintenance of works is proposed).

A number of emergency works may be considered to be exempt development under *SEPP Infrastructure*, including emergency works undertaken by Council to protect roads and stormwater management systems, as long as the works are of minimal environmental impact and structurally adequate.

[5] Under the *Local Government Act 1993*, Council is not authorised to allow (or undertake) protection works on community land (which is the classification of the Council land immediately seaward of private property at Basin Beach and Bilgola Beach, both being categorised as "natural area – foreshore"), as protection works are not explicitly allowed for as permissible uses in the Plans of Management that apply at each of these beaches.

F3. EVALUATION OF EMERGENCY PROTECTION MEASURES

As noted in Section F2.1 and Section F2.2 respectively, landowners and Council can consider the implementation of any form of emergency works based on *SEPP Infrastructure*. These works could be implemented if environmental impacts were found to be acceptable (through completion of an environmental assessment), and:

- (for private landowners) a Development Application had been approved or,
- (for Council, only if a certified CZMP is not in force on the land) the NSW Coastal Panel had been notified and any response within 21 days had been considered (unless the works were exempt development, or unless the proposed works only comprised the placement of sand or sandbags, or only replacement, repair or maintenance of works was proposed).

Therefore, assuming that environmental impacts had been assessed to be acceptable and appropriate approvals/notifications were in place, landowners and Council could consider the implementation of emergency measures (protection works) in the study area such as (for example):

- sand-filled geotextile containers (0.75m^3 and 2.5m^3 bags have been evaluated herein);
- rock (basalt or sandstone); and,
- concrete blocks (either "standard" concrete or high-density concrete).

Densities of these materials vary from 1.7 tonnes/m^3 for the bags, 2.2 tonnes/m^3 for sandstone, 2.4 tonnes/m^3 for standard concrete, 2.6 tonnes/m^3 for basalt and 3.0 tonnes/m^3 for high density concrete.

Both 0.75m^3 and 2.5m^3 sand-filled geotextile containers (bags) are unlikely to be stable as protection works in severe storms, and thus cannot be expected to provide adequate protection. There is also a risk in using bags along beaches such as Bilgola Beach and Basin Beach that the bottom layer of bags could be damaged if placed on existing rock works. Accordingly, use of these bags as emergency protection works in the study area is not recommended.

Rock and concrete blocks can be dropped in place (random placement), achieved by specification of a minimum rock strength and other requirements such as maximum rock aspect ratio for rock, and by specifying a minimum concrete strength for concrete.

The cheapest protection option out of the works evaluated is sandstone rock, costing about $1,000/m for toe protection and $1,800/m for escarpment protection, with basalt rock costing about 20% to 30% more.

Concrete blocks are significantly more expensive, costing about $2,500/m (standard mix) and $3,700/m (high-density mix) for toe protection.

Using a commercial sand source, 0.75m^3 sand-filled geotextile containers would cost about $1,200/m for toe protection and $3,900/m for escarpment protection.

Using a commercial sand source, 2.5m^3 sand-filled geotextile containers are more expensive still, and would cost about $2,700/m for toe protection and $5,900/m for escarpment protection (if a "free" local source of sand was used, these costs would reduce by about 25%). Vandal deterrent fabric sand-filled geotextile containers would cost more still.

Rock and concrete blocks have well established and accepted design guidelines, and can be sized to provide adequate protection. Rock and concrete blocks also have much faster placement rates than sand-filled geotextile containers, and can generally be placed at times of storms. For more severe events than the design event, rock and concrete blocks would be more likely to interlock (since these materials are randomly placed) after any movement and suffer damage more progressively than bags.

However, exposed rock and concrete blocks remaining in the long term after a storm may be unacceptable, and may require removal except when they would be covered with sand during natural beach recovery.

In summary (of the types of works evaluated), it is likely that only rock or concrete blocks would achieve effective protection and be able to be implemented during an emergency, with rock also being the cheapest option. That stated, such works could only be implemented if environmental impacts were acceptable. Implementation of the emergency works evaluated herein (sand-filled geotextile containers , rock and concrete) may not be acceptable in the longer term and may require removal or modification after the storm event.

As discussed in Section F2.1 and F2.2 respectively, landowners and Council can consider the implementation of any form of emergency or long term works, and are not limited to only considering the options evaluated above. It should also be noted that the approvals process is generally identical for emergency and long term works proposed under *SEPP Infrastructure* (that is, for all works that are not TCPW[6]). Therefore, landowners and Council may consider the installation of long term works prior to an emergency occurring (with the advantage of construction under more controlled conditions if approval was granted for such works), to avoid the requirement for any emergency works to be undertaken in a storm. Other non-works measures could also be considered to reduce the risk of damage to assets from coastal storms, such as relocation.

It is reiterated that TCPW are not recommended for use by landowners due to various limitations, in particular that they are likely to be ineffective and difficult to install in an emergency.

[6] Except that some emergency works of Council may be considered to be exempt development.

F4. ROLES AND RESPONSIBILITIES IN COASTAL EMERGENCY MANAGEMENT

F4.1 Preamble

The roles and responsibilities of the State Emergency Service (SES), Northern Beaches Council, Office of Environment and Heritage, Bureau of Meteorology and NSW Police in coastal emergency management are described below briefly in turn. Further discussion on these matters is provided in the *NSW State Storm Sub Plan* (currently dated September 2013).

Landowners also have responsibilities if they want to install protection works (refer to Section F2.1 for a description of the approvals process).

F4.2 State Emergency Service

The role of the SES in coastal erosion and inundation emergencies is essentially warning and evacuation of residents at risk. If time and available resources permit, the SES may also assist with lifting and/or relocating readily moveable household goods and commercial stock and equipment. These activities would be carried out in accordance with a Coastal Erosion Annex to the SES Local Flood Sub Plan (in preparation).

SES is not authorised to undertake coastal emergency protection works (such as placement of rocks or sand-filled geotextile containers) of any form.

SES use the release of a Severe Weather Warning from the Bureau of Meteorology (see Section F4.5) as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. If required (that is if an emergency developed) when neither of these warnings had been issued, it is expected that Council would call on SES for assistance in matters that SES deal with.

F4.3 Northern Beaches Council

The carrying out (or authorising and coordinating) of coastal emergency protection works is Northern Beaches Council's role, if it chooses to undertake such measures to protect public assets from coastal erosion and inundation (assuming adequate environmental assessment had been carried out, and the NSW Coastal Panel had been notified if a certified CZMP was not in force on the land). Council does not consider it has a responsibility to protect private property.

If a Severe Weather Warning as per Section F4.5 had been released or SES was mobilised in some other manner, Council would assist SES as required and where resources permit.

If SES was not mobilised (eg if a Severe Weather Warning had not been released by the Bureau of Meteorology), Council may undertake some of the activities that would otherwise be conducted by SES (where resources allow, although under no obligation to do so), but note that Council cannot order evacuation. If required, Council could request SES taking on a Combat Agency role if an actual emergency was occurring.

In practice, typical tasks that Council may undertake (where required) before, during and after a coastal erosion/inundation event (besides considering the need for and potentially implementing protection works on public land) would be as discussed in Section F5.

F4.4 Office of Environment and Heritage

The Office of Environment and Heritage (OEH) is the NSW government authority responsible for advising on coastal zone management.

F4.5 Bureau of Meteorology

The release of severe weather warnings for “unusually large surf waves expected to cause dangerous conditions on the coast” or “abnormally high tides (or storm tides) expected to exceed highest astronomical tide” by the Bureau of Meteorology are the official triggers adopted by SES for involvement in a coastal erosion/inundation episode.

F4.6 NSW Police

The NSW Police Force is the agency responsible for:

- law enforcement and search and rescue;
- controlling and coordinating the evacuation of victims from the area affected by the emergency in conjunction with the combat agency; and,
- being the combat agency for terrorist acts.

Some members of the NSW Police may also be appointed as Emergency Operations Controllers.

Police would typically become involved in a coastal erosion event as follows:

- assisting SES where required (for example controlling and coordinating evacuation) when SES was acting in its Combat Agency role; or,
- if SES was not mobilised, police may undertake or coordinate activities such as evacuation, barricading, removal of the contents of buildings and the like.

F4.7 Private Landowners

In essence, landowners must act well in advance of a coastal emergency, and prior to placement of any works must have:

- **a certificate if TCPW are proposed on public land, or**
- **development consent for other types of works.**

Landowners are not permitted to install coastal protection works without following these procedures, and penalties may apply if they are not followed.

F5. COUNCIL ACTIONS

F5.1 Preamble

Northern Beaches Council seeks to manage the ocean beaches in the former Pittwater LGA to be as near as possible to the natural condition of each beach compartment within the constraints imposed by adjacent land uses and development. In this regard, the restoration and stabilisation of beach foredunes and littoral areas (often with the assistance of community volunteer organisations) is a major feature of Council's beach management strategy.

Conservation of the natural beach systems together with the protection of beach amenity and public access are the priority management objectives for Council and are critical considerations in the determination of appropriate emergency management actions, particularly the protection of assets affected or likely to be affected by coastline hazards.

Lists of potential actions that Council may undertake before, during and after a coastal erosion emergency are provided in Section F5.3, F5.4 and F5.5 respectively. Prior to this, a brief discussion on potential criteria/thresholds for action is provided in Section F5.2.

The key public asset at risk in the study area is Bilgola SLSC and its adjacent car park and promenade. Until further investigations of all coastal assets and facilities at risk are completed, Council's asset management approach for public assets such as Bilgola SLSC is not to undertake emergency protection works. This framework governs the actions that have been listed.

Bilgola ocean rock pool is also at potential risk from wave action, but it is not considered to be appropriate or practical to attempt to protect the pool in any emergency. The pool would be repaired or replaced as required, where appropriate. Similarly, it is not considered to be appropriate or practical to attempt to protect the three stormwater outlets discharging on to Bilgola Beach (these would be repaired or replaced as required, where appropriate).

There are no significant public building assets at Basin Beach. There is a stormwater outlet at the northern end of the beach, but it is not considered to be appropriate or practical to attempt to protect this infrastructure in any emergency. This asset would be repaired or replaced as required.

There is also a fenced and vegetated dune area and beach accessways at the northern end of Basin Beach. Again, it is not considered to be appropriate or practical to attempt to protect these areas in any emergency. Fencing and accessways would be repaired or replaced as required.

Council would undertake actions to warn the public of and/or reduce the risks associated with storm damage and severe beach erosion hazards. All Council units would have a responsibility to document records of decisions made and the reasoning in making those decisions (before, during and after coastal erosion emergencies).

As stated previously, Council does not consider that it has a responsibility to protect private property from coastal erosion and inundation hazards, and does not intend to do so.

F5.2 Criteria/Thresholds for Action

It is considered that a prescriptive set of trigger conditions that could be used to initiate Council actions in relation to coastal erosion emergencies are impractical to stipulate. This is because such conditions would be exceedingly complex to devise, and would still be unlikely to cover every situation[7]. Examples of complexities include variability in storm conditions (wave height and period, wave direction, water level), state of the tide, antecedent conditions, forecasts, existing protection works, and existing structure types (in particular foundations). In the case of protection works and foundations, there may also be unknowns regarding the nature of the works.

A more practical approach is considered to be to apply expert engineering judgement at times of storms to assess when to initiate particular actions as required. That stated, this approach relies on regular monitoring of environmental conditions and beach behaviour, and seeking appropriate advice when required.

F5.3 Before a Storm

The following actions have already been undertaken by Council:

- informing the community of the council's intended erosion emergency responses under its Emergency Action Subplan, as per the document herein and previously in WorleyParsons (2012a, b);
- identifying areas where landowners may install TCPW (that is, the entire study area) and any applicable site-specific requirements for those works[8]; and,
- preparing up-to-date contact details for key personnel (see Section F7);

These actions would be updated where required if circumstances change.

The following actions would be undertaken (as necessary and as resources permit) by Council before a storm:

- monitoring beach erosion and weather/wave conditions and forecasts;
- ensuring sufficient warning signage and barricades are available for use if required (eg to close off damaged and potentially dangerous beach access points);
- provision of information and advice to affected beachfront landowners and the wider community; and,
- consulting with SES and other relevant agencies such as OEH.

Monitoring is the key to maximising warning time, preparedness and predictive capability in regard to emergency coastal erosion events.

Monitoring of physical environmental conditions would include weather conditions (measurements, warnings and forecasts), wave forecasts (height and direction), water level (tidal) predictions, real time wave data (height, period and direction), real time water level data (including consideration of elevated

[7] There is also no single quantitative parameter, such as an offshore significant wave height of a certain magnitude, minimum beach width of a certain value, or distance from an erosion escarpment which can be adopted as the trigger for imminent damage to an asset since there are a combination of many factors involved.
[8] Council has not resolved to apply any additional site-specific requirements to these works.

water levels due to storm surge), and beach behaviour (extent of erosion, beach width, understanding of historical beach behaviour at times of storms).

In a potential emergency event, it would be expected that beach areas would be inspected at least daily, particularly at high tide, where resources permit.

As noted previously, until further investigations are completed, Council's intended protection strategy for public assets such as Bilgola SLSC is not to undertake emergency protection works. However, Council is intending to undertake these further investigations to assess whether implementation of protection works may be appropriate if required in an emergency. This would include a cost:benefit analysis of implementing emergency protection works to reduce the risk of damage to Bilgola SLSC and its adjacent promenade and car park if required, including assessment of insurance implications.

If it is found that it is appropriate to protect this area, it would then be necessary for an environmental assessment of the works to be undertaken. If environmental impacts were found to be acceptable, it would then be necessary to develop specific designs and methods of works for protective actions that it is intended to undertake, obtain and stockpile required materials, and identify appropriate plant and equipment and personnel to carry out the works if required. Notifying the Crown Lands Division of any works may also be required.

Council is also intending to consider the need to develop a communications strategy to keep affected communities informed during an erosion emergency, and developing the strategy if required.

F5.4 During a Storm

Actions undertaken during an erosion emergency should be managed by Council officers who clearly understand the Subplan and know the roles and responsibilities of key personnel, with the principles that:

- no actions undertaken should impede, conflict or overlap with those of response agencies such as the SES;
- actions should focus on the safety of personnel who might be working under the extreme adverse weather conditions that gave rise to the emergency;
- a communication strategy needs to be in place during an erosion emergency, keeping affected communities informed of the Council's intended responses (this should include giving regular warnings where erosion is likely to sever public access and result in relatively high, unstable, near-vertical erosion escarpments along beaches; in this case, it is vital to advise the public of the dangers these conditions may present); and
- the communications strategy may need to be complemented by erection of temporary safety fencing and associated warning signage..

Council actions during a storm would include (as necessary and as resources permit):

- regular monitoring of environmental conditions and beach behaviour;
- assessing the need for barriers and safety signage to be erected at damaged and potentially dangerous beach access points, to minimise risk to public safety;
- erecting barricades and safety signage;
- seeking coastal and geotechnical engineering advice;
- seeking advice from OEH staff;

- supporting SES;
- releasing information to the media; and,
- provision of information and advice to beachfront landowners and the wider community.

F5.5 After a Storm

Council actions after a storm would include (as necessary and as resources permit):

- continuing temporary safety fencing and associated warning signage;
- continuing to maintain a communication strategy warning of the dangers of any persisting high, unstable or near-vertical erosion escarpments drying out and collapsing without notice (in high-use public areas, Council may consider collapsing these escarpments with machinery);
- cleansing the beach of debris and other inappropriate materials;
- remedial works to restore safe beach access;
- assessing the structural integrity of any exposed infrastructure, buildings and other assets and taking appropriate action;
- repairing or replacing damaged infrastructure, such as stormwater pipes, dune fencing and beach accessways;
- rehabilitation of damaged dune vegetation;
- beach scraping and/or sand nourishment to restore beach amenity;
- monitoring the performance and impact of any coastal protection works;
- maintaining photographic and written records of events (including an inventory of any damage) and decision making processes;
- monitoring unauthorised coastal protection works and enforcement of penalties under the *Coastal Protection Act 1979* (this may also be undertaken before and during a storm);
- replenishing any emergency materials and supplies for use in any future erosion events;
- seeking financial assistance from the NSW (and Federal) government to restore damaged infrastructure; and,
- critically reviewing the Subplan to ensure it achieved its performance objectives and revising it to address any identified shortcomings.

F6. CONSULTATION

The following consultation was involved in the preparation of WorleyParsons (2012a, b), which the document herein was based on:

- internal Council consultation was undertaken on 18 October 2011;
- a briefing of Councillors was held on 14 November 2011;
- a draft Emergency Action Subplan was placed on public exhibition for 21 days (from 22 November to 12 December 2011);
- a community information meeting was held on 29 November 2011,
- telephone enquiries were received from the public during the exhibition period, as well as written submissions and meetings;
- staff from OEH were consulted; and,
- due consideration of the public and OEH submissions received was made in revisions of WorleyParsons (2012a, b).

The document herein was placed on public exhibition for 21 days in June/July 2015.

F7. KEY CONTACT DETAILS

Key coastal emergency contacts are listed below:

- State Emergency Service (SES), telephone 132 500
  Local Controller: Mr Wayne Lyne (mobile 0412 656 484)

- Local Emergency Operations Controller (LEOCON)
  - Police Service Local Area Commander, telephone 9971 3399 (Dee Why Police Station)
  - alternate LEOCON: Manly Police, telephone 9977 9499

- Local Emergency Management Officer (LEMO) at former Pittwater Council, telephone 9970 1175 or mobile 0407 221 820

- Former Pittwater Council general switch telephone 9970 1111, and website http://www.pittwater.nsw.gov.au/

- Key former Pittwater Council units:
  - Catchment Management and Climate Change Unit[9]
    (Principal Officer – Coast and Estuary, telephone 9970 1375);
  - Reserves and Recreation Unit[10]
    (Principal Officer – Reserves and Recreation, telephone 9970 1359);
  - Urban Infrastructure Unit[11]
    (Principal Engineer –Strategy, Investigations and Design , telephone 9970 1177);
  - Administration and Governance Unit[12]
    (Risk Officer, telephone 9970 1147)
  - Community Engagement and Corporate Strategy Unit[13]
    (Senior Communications Officer, telephone 9970 1119)

- Office of Environment and Heritage (Coastal Management Unit) local representative: Mark Moratti, telephone 9895 6489

If SES was mobilised, Council has a Local Emergency Management Officer (LEMO). A LEMO is appointed under Section 32 of the *State Emergency and Rescue Management Act 1989*, in which it is stated that "A council is to provide executive support facilities for the Local Emergency Management Committee and the Local Emergency Operations Controller in its area. The principal executive officer is to be known as the Local Emergency Management Officer".

In the Northern Beaches Local Government Area, the Local Emergency Operations Controller (also known as LEOCON) is a Senior Member of the Police Service stationed in the area. The functions of the LEOCON are described in Section 31 of the *State Emergency and Rescue Management Act 1989*.

[9] Responsible for coastline hazard risk management and education, amongst other matters.
[10] Responsible for coastal reserves and beaches maintenance (including assets within the coastal reserve such as car parks) and dune management, amongst other matters.
[11] Responsible for roads, drainage and footpaths, and geotechnical issues.
[12] Responsible for Council's risk register and insurance amongst other matters.
[13] Responsible for community relations and corporate communications.

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Appendix G: Notes from Consultation Meetings and Responses to Public Submissions

CONTENTS

G1. INTRODUCTION

Notes from various public meetings and responses to public submissions are provided in this Appendix.

The meetings and consultations held have comprised:

- an initial mailout to all landowners in the study area (see Section G2);
- a community workshop held on 29 April 2015 (see Section G3);
- presentation to and answering questions from the Natural Environment Reference Group of Council on 13 May 2015 (see Section G4);
- a public workshop held on 29 July 2015 (see Section G5); and
- public exhibition of the draft CZMP in July-August 2015, with review of submissions as discussed in Section G6.

NORTHERN BEACHES COUNCIL

Royal HaskoningDHV
Enhancing Society Together

G2. MAILOUT TO LANDOWNERS IN MARCH 2015

On 27 March 2015, a letter was sent to all landowners in the study area, along with a two page "Information Sheet". Landowners were given information about the CZMP and given the opportunity to provide feedback on options to manage risks to development and maintain beach amenity, and what they thought the study area beaches should look like in 50 years.

The letter is shown within the box below, with the information sheet reproduced on the next 2 pages.

Dear Sir/Madam

Re: COASTAL ZONE MANAGEMENT PLAN FOR BILGOLA BEACH AND BASIN BEACH (MONA VALE)

Pittwater Council is preparing a Coastal Zone Management Plan (CZMP) for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale) with financial assistance from the NSW Government. CZMPs support the goals and objectives of the *Coastal Protection Act 1979* and the *NSW Coastal Policy 1997*.

The CZMP considers priority environmental management and land use issues, in order to develop appropriate management actions to be implemented by Council and other public and private stakeholders in relation to:

- managing risks to public safety and built assets,
- reducing pressures on coastal ecosystems, and
- community uses of the coastal zone.

Council has engaged consultants Royal HaskoningDHV to prepare the CZMP and assist in consulting with the community. We are seeking the community's help in collecting information and photos on any coastal problems that you may have experienced in the past at Bilgola Beach and/or Basin Beach. We are also seeking your feedback on:

- What are your preferred options to manage the risks to development and maintain beach amenity at Bilgola Beach and Basin Beach? and
- What you think Bilgola Beach and/or Basin Beach should look like in 50 years?

Please take a minute or two to read over the enclosed information sheet. Any feedback on the above questions can be emailed to catchment@pittwater.nsw.gov.au.

We are also seeking community representatives to be part of a stakeholder forum, that will take place on the 29 April 2015. Should you wish to participate in the forum please email your interest to catchment@pittwater.nsw.gov.au.

Your help is most appreciated. For further enquiries please contact Paul Hardie at catchment@pittwater.nsw.gov.au or phone 02 9970 1111.

Yours sincerely

JPang

Jennifer Pang
Manager, Catchment Management and Climate Change

INFORMATION SHEET

PITTWATER COUNCIL

Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)

Coastal Zone Management Plan

Pittwater Council is preparing a Coastal Zone Management Plan (CZMP) for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale) under Ministerial Direction from the NSW Minister for the Environment.

What is a CZMP?

The CZMP will look at issues such as managing risks to public and private built assets, pressures on coastal ecosystems as well as community access, use and enjoyment of Bilgola Beach and Basin Beach. In essence, the CZMP for these beaches will guide the development of beachfront properties in the future and help to protect the environmental qualities and recreational opportunities that are so highly valued by the Pittwater community.

Coastal erosion and recession are the key coastline hazards at these beaches, with coastal inundation from wave runup also a potential hazard. Erosion is the short term beach cut that occurs over hours/days due to large waves and elevated water levels, with sand then moving back from offshore to onshore to build up the beach again over a period of months. Recession is a progressive landward movement of the average long term position of the shoreline over a period of years. Over the last 50 years or so there has been no evidence of long term recession at either Bilgola Beach or Basin Beach, although of course significant short term erosion events have occurred from time to time during this period.

Study area

The CZMP will cover the sandy beach areas of Bilgola Beach and Basin Beach as well as adjoining beachfront residential development and public reserves and assets.

Who is preparing the CZMP?

Haskoning Australia Pty Ltd, a company of Royal HaskoningDHV, has been engaged to assist Council in the preparation of the CZMP.

How will the CZMP affect me?

Landowners at Bilgola Beach and Basin Beach would be familiar with the different measures that may be in place to protect beachfront properties and provide access to the public facilities and open spaces at these beaches. Council would like to ensure that future development of beachfront property has an acceptably low risk of damage from coastal erosion and recession whilst enabling the public to continue to access and enjoy the public beach areas.

The CZMP will investigate existing coastal protection works and will evaluate different management options in order to define achievable measures to enable new development to meet acceptable risk standards. In order to responsibly address the potential long term impacts of sea level rise, the CZMP will also inform Council's land use planning provisions.

What has happened in the past?

Beachfront property at Bilgola has been damaged by coastal erosion and storm processes in the past, most notably in 1974. Indeed, the rock revetment that was constructed during the 1974 storms was constructed as an emergency response to coastal erosion threatening private properties.

In recent years, the risk of damage to residential development at Bilgola Beach from coastal erosion has been generally managed by residents constructing new development on deep pile foundations.

At Basin Beach there are no known reports of significant damage to development from coastal storms, although emergency rock protective works have been carried out in the past when property has been threatened by coastal erosion, for example in 1974 and 1978.

The risk of damage to residential development at Basin Beach has largely been managed by residents constructing buried seawalls and/or constructing new development on deep pile foundations.

What is likely to happen in the future?

Credible scientific opinion projects that global mean sea level will continue to rise during the 21st century and that the rate of sea level rise will very likely accelerate due to increased ocean warming and loss of mass from glaciers and ice sheets. This is likely to cause beaches to recede (move landward), placing development at greater risk and reducing the width of sandy beaches.

Council has a legal obligation and duty of care to make adequate provisions to plan for the likely impacts of climate change, so that new development is not placed at unacceptable risk of damage from coastal hazards during its design life.

Providing feedback

A public workshop/forum on the CZMP is intended to be held on 29 April 2015 (details to be confirmed).

Once the draft CZMP report is completed it will be placed on public exhibition in June 2015 for your review and feedback.

For further information on the CZMP please contact Paul Hardie at Pittwater Council on 9970 1111 or email:
catchment@pittwater.nsw.gov.au

Some useful reference resources:

- Coastal Erosion Emergency Action Sub-plan for Bilgola Beach & Basin Beach -
http://www.pittwater.nsw.gov.au/environment/natural_hazards/coastal_emergency_information
- Coastal Management -
http://www.environment.nsw.gov.au/coasts/coastreforms.htm
http://www.environment.nsw.gov.au/coasts/coastalerosionmgmt.htm

Bilgola Beach Study Area

Basin Beach Study Area

In response to the mailout and partly in response to the workshop on 29 April 2015 discussed in Section G3, one submission (in three parts sent from 28 to 30 April 2015) was received from a beachfront Bilgola Beach resident. This submission contained copies of literature reviewed as part of the CZMP herein, namely Patterson Britton & Partners (2005), WorleyParsons (2012b) and WRL (2013). These references were considered in Appendix A, with the former two references also considered in Appendix D, and WorleyParsons (2012b) also considered in Appendix F.

In response to the mailout, a submission was also received from a beachfront Basin Beach landowner on 26 April 2015. In essence, it was stated in this submission that to the extent that coastal erosion planning may be factoring in projected rises in sea levels it should be noted that the Intergovernmental Panel on Climate Change (IPCC) models for global warming and sea level rises are now discredited. Various pieces of information were included to support that position. In response, it is acknowledged that there are some dissenting viewpoints on the IPCC in the general and scientific community. However, the authors of the report herein and Council consider that the IPCC work is still widely accepted by competent scientific opinion (in particular peer reviewed scientific literature), despite these viewpoints, and hence is appropriate to rely upon for estimating sea level rise projections for the CZMP (as had been applied in Appendix D).

G3. COMMUNITY WORKSHOP ON 29 APRIL 2015

A public notice for this workshop was placed in the *Manly Daily* newspaper on 25 April 2015, as reproduced below. On 20 April 2015, a letter was also sent to all landowners as well as community groups and surf clubs (within or in the vicinity of the study areas) inviting them to attend the community workshop or to provide feedback, information and local photographs to the project team.

PITTWATER COUNCIL

Public Notices

Bilgola Beach and Basin Beach Coastal Zone Management Plan – Community Workshop

Pittwater Council is preparing a Coastal Zone Management Plan (CZMP) for Bilgola Beach and Basin Beach, Mona Vale under direction from the NSW Minister for the Environment. The CZMP will look at issues such as managing risks to public and private beachfront development, pressures on coastal ecosystems as well as community use and enjoyment of Bilgola and Basin beaches.

If you would like to find out more, Council is conducting a community workshop on **29 April 2015**, from 6–7pm in the Conference Room at Mona Vale Customer Service Centre, 1 Park Street, Mona Vale.

Enquiries: Paul Hardie on 9970 1375 or email: catchment@pittwater.nsw.gov.au

The workshop was attended by about 13 community members (almost all beachfront landowners) and 5 Councillors. At the workshop, Peter Horton of Haskoning Australia gave a presentation on the purpose and content of a CZMP and direction of likely management actions in the CZMP. Attendees were then given the opportunity to ask questions for about 1 hour. Questions asked (or comments made) and responses given are listed in Table G1.

Table G1: Questions asked and responses given at Community Workshop on 29 April 2015

Question or Comment	Response
1. Why wasn't Newport Beach included in the study area?	Council suggested to OEH that Newport Beach should also be included as one of the hotspot/authorised locations, but this was declined by OEH as they considered that it did not meet the necessary criteria.
2. There used to be a stormwater outlet between 9 and 11 Surfview Road Mona Vale that was closed off around 1973-1974. Should stormwater outlets be extended further into the surf zone?	There can be negative impacts with extending stormwater outlets as they can start acting as a groyne, be hazardous to swimmers, or get blocked by sand. However, this is a valid option to consider where appropriate. Stormwater outlets in back beach areas can have negative impacts as well, eg from sand scouring and scattering of gross pollutants on the beach.
3. Details on rock wall at 3 Surfview Road Mona Vale in Emergency Action Subplan are not correct	If documentation can be provided then this information will be updated[1] A useful function of this Workshop is to seek information from long-term residents and to seek more history and local knowledge from the community.

[1] This has now been undertaken in Appendix A.

Question or Comment	Response
4. Bilgola Creek is a natural watercourse and should be left that way	There is no intention to modify the Bilgola Creek open channel, except that improved scour protection at the outlet may be appropriate.
5. Stormwater outlets near the SLSC and Bilgola Avenue cause scour, could they be relocated?	Improved scour protection at the outlets would be appropriate. Relocation would be hydraulically difficult to achieve and costly.
6. There has been build-up of dunes at the northern end of Bilgola Beach and the sand seems to naturally recycle back on to the beach.	This is correct, both Bilgola Beach and Basin Beach have been stable over the long term.
7. Will the CZMP consider the use of man-made structures such as artificial reef structures?	Artificial reefs can be used for improving surf or property protection but both functions cannot be achieved at the same time. The other issues are that effective property protection would require the structure to stick out of the water and they are expensive and largely unproven. One example is the artificial reef at Narrowneck on the Gold Coast using large sand-filled geotextile bags. The structure has not particularly improved surfing conditions for most of the time and there is not clear evidence that it has created a salient on the shoreline. The use of breakwaters would be costly and have too many secondary (negative) impacts to consider.
8. Why has Council asked what we would like to see in 50 years? Is that timeframe what we are trying to achieve with the CZMP?	With sea level rise, beaches will get narrower with time. To maintain the beach, there will have to be sand nourishment. However, sand nourishment is not an action that can be currently implemented due to lack of funding and NSW Government restrictions on getting access to offshore sand sources. An achievable action for council is to lobby the NSW Government on this issue. The CZMP should be updated every 10 years.
9. What is the opinion on sea level rise to date on the beaches?	The historical impacts would have been small and undetectable in the context of natural variability in beach volumes with erosion/accretion cycles. However, future sea level rise is projected to be larger than has been experienced over the last 100 years.
10. Will Council wait until the completion of the CZMP to determine a current DA?	No, it would be assessed under the present framework. If further information is made available through the CZMP, then this could considered in future DA's.
11. What if properties don't currently have seawalls or other coastal protection? What can Council make us do?	The CZMP has no effect on existing development. Council can't compel a landowner to protect an existing development. If a landowner submits a DA, they will need to satisfy Council's development controls. Council could encourage property owners to get together and consider property protection, but again cannot make property owners undertake coastal protection works.
12. What type of work is permissible in an emergency situation?	This relates to the Emergency Action Subplan. If rock work is proposed, then this would be subject to a DA process. If sandbags are proposed then coastal reforms allows for some emergency works in certain areas, however this would still be subject to an approvals process. Key message is that landowners must act well in advance of an emergency.
13. Can residents place rocks on the beach in front of existing seawalls to protect their properties?	This would be difficult if on public beach as this is owned and managed under multiple tenures. It would require negotiation and consent from the various landowners including the Crown and would not be supported by Council. On private land, an application would be considered on its merits.
14. Does Council have records of coastal protection works?	In some cases. There is limited historical information available, but better information has been provided in support of more recent DA's[2].

[2] Available information has been compiled in Appendix A.

Question or Comment	Response
15. Seeing that the Royal Haskoning is a Dutch company, how would the Dutch deal with this coastal issue?	As a large proportion of the country is at risk in the Netherlands (large areas of land below mean sea level), coastal protection works are mandated to deal with the 10,000 year ARI event, typically involving dikes and beach nourishment by dredging. The Dutch have more funding due to the national significance of maintaining protection.
16. What is the impact on the environment as a result of dredging for sand nourishment?	Studies offshore of Sydney have shown that dredging of sand at about 30m depth offshore would not cause impacts on beaches.
17. What is the impact of climate change on adverse storm events?	There is no consensus at this time on the direct impacts of climate change on the frequency and magnitude of future extreme storm events.
18. Does the rock wall constructed on bedrock after the 1974 storm at Bilgola provide sufficient protection?	No, investigations indicate that the rocks are undersized at 2 tonnes and not the preferred 5 tonnes. The wall cannot be certified. If the wall is actually constructed on bedrock, then this would help its stability.
19. The rock pool and rock platform at Basin Beach protects the beach from wave action and erosion.	Agreed.
20. Why is so much seaweed deposited on the beaches?	Due to the extent of offshore rock reefs.
21. Has there been more seaweed after Warriewood STP?	No expertise to answer.
22. Dune vegetation should be encouraged to stabilise dunes. At Bilgola Beach the dune vegetation is really doing a great job of trapping the sand and that the volume of sand is important to protect the properties.	Agreed, vegetation helps in trapping windblown sand and maintaining a healthy sand volume in a dune.
23. Are the individual private access pathways to the beach impacting on the vegetation? Should there be a rationalisation of pathways or shared use of fewer paths connected to public pathways?	Combining of access points could be considered where appropriate but in general access for beachfront private landowners to the beach is considered to be reasonable.
24. What other management measures should be considered?	Need clear building setback guidelines based on acceptable risks, consistent building alignments, potentially deep piled foundations and possibly seawall upgrades funded by landowners.
25. There seems to be a preference for the use of piled foundations instead of seawalls.	With seawalls there needs to be continuity and a consistent alignment to avoid end effects. A seawall DA would be assessed on its merits.
26. Would setbacks prevent the owner from retaining existing buildings unless they were protected?	Landowners have existing use rights and it is only when there is a DA trigger that coastal risk management measures are required.
27. What is the likely impact on property prices from the CZMP?	Property prices are subject to market forces but significant impacts would not be expected unless the land is considered not developable[3]. If anything, having the option of incorporating coastal protection in the development of properties provides greater certainty and may improve value.

[3] No land has been considered as undevelopable in the study area.

Subsequent to the workshop, on 17 May 2015, a beachfront Bilgola Beach resident provided photographs of stormwater scouring Bilgola Beach in the vicinity of the car park adjacent to the SLSC and near Bilgola Avenue. This resident also made a submission regarding management of the Bilgola Beach coastal zone and requested that Pittwater Council and Royal HaskoningDHV consider some solutions in the proposed CZMP to two problems, namely that:

1. some of the existing stormwater outlets located along the Bilgola Beach carpark cause localised scour to the beach berm and/or dune area creating erosion zones and localised flooding when outlets are blocked with sand. It was noted that potential upgrade works could include diversion of stormwater discharges away from the beach where possible and away from the carpark with relocation to the southern end of the beach (Bilgola Creek was not considered be to covered by this submission);
2. some sewer mains are located within coastline hazard areas. It was asked whether Council could work with Sydney Water to assess the level of the sewer mains and to assess the risk to sewerage infrastructure from coastal erosion/recession. It was noted that this would enable Sydney Water to manage this risk consistently with the CZMP, and that Sydney Water may need to consider either protection or relocation of some sewer mains, particularly as long term hazards are realised.

With regard to Item 1 above, stormwater issues have been discussed in Section 4.3 and 5.2 of the CZMP, and numerous related actions included in Section 8. It is not considered to be appropriate to relocate stormwater outlets to the southern end of the beach, as other less costly actions can be implemented to manage stormwater issues at this point in time.

With regard to Item 2 above, sewage mains are located landward of the beachfront development at Bilgola Beach (except at 21 Bilgola Avenue, but located landward of two seawalls at this property), and landward of the beachfront development at Basin Beach. Risk to sewage infrastructure is therefore not considered to be a significant issue at this point in time. That stated, an action has been included in the CZMP that Council would work collaboratively with asset owners as required to encourage them to assess the location and elevation of their assets in relation to coastline hazards so that the risk of damage can be determined and managed by these owners consistently with the CZMP.

G4. NATURAL ENVIRONMENT REFERENCE GROUP MEETING ON 13 MAY 2015

This meeting was attended by 13 community representatives, 6 Council staff and 2 Councillors. At the meeting, Peter Horton of Haskoning Australia gave a presentation on the purpose and content of a CZMP and direction of likely management actions in the CZMP. Attendees were then given the opportunity to ask questions for about 30 minutes.

Questions asked (or comments made) and responses given are listed in Table G2.

Table G2: Questions asked and responses given at Natural Environment Reference Group meeting on 13 May 2015

Question or Comment	Response
1. The 1974 photo of Bilgola Beach shows no sand left on the beach and only rubble protecting the houses on the beachfront. Surely the rock protection needs to be built up substantially for any future construction to be sustainable on the beachfront?	The 1974 photo was taken prior to additional rock being placed at Bilgola, and there is now up to about 2 tonne rocks extending to a higher elevation than in the photo. That said, the existing rock cannot be relied upon for protection. Any future beachfront residential development at Bilgola Beach will probably require piles.
2. Are the seawalls on public or private land? Who owns them and who is responsible for their maintenance?	Some of these seawalls are quite old and some were constructed without approval. Also, they were constructed by a mixture of Council or other public authorities and landowners. As a result it is complex to determine responsibility in some cases, although Council would generally argue that they are not responsible for maintaining protection for private landowners. The sloping rock seawalls (revetments) at Bilgola are currently partially on private and partially on public land (probably mostly on public land). If any landowners choose to upgrade seawalls, it would generally be preferred that these are constructed on private land, but that would be very difficult to achieve and to tie in with the adjacent revetment at Bilgola Beach.
3. Is Council responsible if the seaward building line control is subsequently found to be insufficient?	Development consents are (by default) forever, but they cannot be expected to guarantee the property forever, although Councils are of course required to exercise an appropriate duty of care. Any new development in affected areas would require a Coastal Engineering report which projects into the next 100 years. Also, all properties have Section 149 notations warning landowners of issues such as tidal inundation, coastal erosion, flooding hazards or bluff instability.

Question or Comment	Response
4. Surely the preservation of the beach (rather than beachfront properties) would be Council's primary objective?	Ideally a healthy beach is one with no development at all, but beachfront residential development is a reality. Historical subdivisions were undertaken before any serious consideration of environmental concerns such as coastal erosion. Even though many protection works were constructed without approval, they cannot be ordered to be removed by Council. Therefore, even if Council somehow sterilised development (which is very difficult to achieve given existing use rights), private land would remain in private ownership and protection works would remain, thus preventing the public beach from extending further landward. Projections of sea level rise indicate that eventually we will lose the sand from the beaches and it will not be returned over the long term. It would require private property becoming public land for the beach to be able to extend landward and at present the cost of property buyback would preclude Council from considering it. To maintain beach amenity into the future the only solution is to undertake beach nourishment which is the importation of sand to widen the beach. This may also be beyond the financial resources of Council and in any case the nearby offshore sand sources cannot be accessed at this time under NSW Government legislation. It is therefore important that Council lobbies the State Government to remove these impediments so that beach nourishment can be undertaken in the future. Apart from the application of development controls, Council is also working very hard on other mitigation strategies such as dunes restoration
5. I thought a shortage of washed building sand coming from the Nepean area had led to a proposal to dredge sand from the Broken Bay basin. Could we access this sand supply?	There have been numerous investigations, mainly by commercial entities due to the major shortfall in sand for the building industry. Most building sand is currently coming from the Penrith Lakes but this is running out. As noted above, offshore sand sources cannot be accessed at this time under NSW Government legislation. The alternative source is crushed friable sandstone from the Blue Mountains area although there are environmental concerns. If commercially viable it might be possible to find companies prepared to invest in extraction from offshore reserves in return for providing beach nourishment, but at present there is no strategy in place for sustainable offshore dredging on a commercial scale and it may be currently not permissible.
6. Has any consideration been given to mitigation measures such as an artificial reef structure offshore?	Reefs can be designed to assist with property protection or improved surfing, but not both. Furthermore, they are expensive and they can be difficult to design and construct to work as intended. For instance, a reef may influence wave action which results in the protection of beachfront properties but the loss of surf or other recreational amenities. It is difficult to design an effective surfing reef and this would not necessarily provide property protection. Therefore, it is difficult to see why construction of such a reef would be a priority for Council or how they could justify the costs to ratepayers.

G5. PUBLIC WORKSHOP ON 29 JULY 2015

A public notice for this workshop (and notification of public exhibition of the CZMP) was placed in the *Manly Daily* newspaper on 18 July 2015, as reproduced below. As per the Community Workshop described in Section G3, all previously notified landowners, local community groups and surf clubs received a written invitation to attend the public workshop.

Public exhibition and meeting

Coastal Zone Management Plan for Bilgola Beach (Bilgola) and Basin Beach (Mona Vale)

Pittwater Council has commissioned a draft Coastal Zone Management Plan (CZMP) for Bilgola Beach and Basin Beach under direction from the NSW Minister for the Environment. The draft CZMP deals with issues such as managing risks to public and private beachfront development, conserving the natural beach environment and enhancing the ongoing use and community enjoyment of Bilgola Beach and Basin Beach.

An information presentation will be held to provide an opportunity for the community to find out more about the draft CZMP and to speak with Council staff and the consultant. Details of the meeting are:

Where: Mona Vale Customer Service Centre

When: Wednesday 29 July 2015, 6–7pm

Enquiries: Paul Hardie on 9970 1111

The document will be on public exhibition until Friday 7 August 2015 and may be viewed at the customer service centres and libraries at Mona Vale and Avalon during normal business hours and at pittwater.nsw.gov.au/yoursay

Any person may make a written submission to Pittwater Council, PO Box 882, Mona Vale NSW 1660 or via email: catchment@pittwater.nsw.gov.au Submissions close 5pm, Friday 7 August 2015.

There was also a notice in the *Manly Daily* newspaper on 25 July 2015, as reproduced below:

COMMUNITY MEETING

There is a community meeting regarding the draft of Bilgola Beach and Basin Beach (Mona Vale), as part of the Coastal Zone Management Plan. It's from 6pm to 7pm. Meeting to provide the community with an opportunity to find out more about the Plan. Located Mona Vale Customer Service Centre, Village Park, 1 Park St, Mona Vale.

The workshop was attended by 2 community members (Bilgola beachfront landowners) and 5 Councillors. At the workshop, Peter Horton of Haskoning Australia gave a presentation on the content of the draft CZMP. Attendees were then given the opportunity to ask questions for about 45 minutes. Questions asked (or comments made) and responses given are listed in Table G3. There were also questions in relation to matters discussed in Section G6.2.

Table G3: Questions asked and responses given at Public Workshop on 29 April 2015

Question or Comment	Response
1. Are the seawalls at 29-33 Surfview Rd Mona Vale engineered structures that were undertaken by private property owners?	Yes
2. If a seawall is approved, would this negate the use of piles?	This would need to be considered on a case by case basis. There may be outflanking issues associated with isolated seawalls which would require piling to be considered.
3. Would seawalls be considered in isolation (ie. per lot)?	It would be difficult to demonstrate acceptable environmental impacts for an isolated seawall. Where a proposed seawall is not surrounded by existing protection works, seawall proposals would generally need to be developed in conjunction with neighbouring properties.
4. There are some seawalls (or portions of seawalls) on public property, eg the rock revetment seaward of Allen Ave at Bilgola. Would Council consider allowing works by private landowners on these seawalls on public land?	This situation is complex because the seawalls span across private property, Council reserve and Crown Land. It would be a complicated approvals process with no expectation of consent. To upgrade the revetment at Allen Ave to current coastal engineering standards this would require work on the toe (on Crown Land) and larger rocks to be placed on Council land.
5. If there were no regulations could there be building forward of the foreshore building line from a coastal engineering perspective?	The foreshore building line deals with aesthetics and other issues, so this is an important consideration. Technically it would be possible to build forward of this line from a coastal engineering perspective, relying on piled foundations for support, but the foreshore building line is valid to invoke to keep structures a suitable distance landward of the public beach and enabling sharing of views etc.
6. At what level of risk would a council consider not having any coastal development?	This varies between councils. Some councils have been known to be more conservative and not apply the probabilistic lines as used in the CZMP. The methodology used in the draft CZMP is a transparent process and relies on considered research as to a suitable design life and probability to adopt to obtain acceptable risk.

Question or Comment	Response
7. Will the CZMP start overriding individual DA applicant requirements?	The draft CZMP is currently a valid consideration in development assessment in Pittwater, and once certified and implemented will become a statutory part of the DA process.
8. What is the process following exhibition of the CZMP?	Public submissions on the exhibited CZMP will be considered and the draft CZMP will be modified as required. The modified draft CZMP will then go to the Minister of Planning for review, who may suggest amendments or certify the document unaltered.

G6. PUBLIC SUBMISSIONS IN RESPONSE TO PUBLIC EXHIBITION OF CZMP IN JULY/AUGUST 2015

G6.1 Preamble

In compliance with Section 55E of the *Coastal Protection Act 1979*, notification of public exhibition of the draft CZMP (Issue B at that time) was made in the *Manly Daily* on 11 July 2015, as reproduced below:

Draft Coastal Zone Management Plan for Bilgola Beach and Basin Beach – Public Consultation

Pittwater Council has commissioned a draft Coastal Zone Management Plan (CZMP) for Bilgola Beach and Basin Beach, Mona Vale, under direction from the NSW Minister for the Environment.

The draft CZMP deals with issues such as managing risks to public and private beachfront development, conserving coastal ecosystems as well as the community use and enjoyment of Bilgola and Basin Beaches.

The document will be on exhibition from **Friday, 17 July until Friday, 7 August 2015** and may be viewed at Customer Service Centres and libraries at Mona Vale and Avalon during normal business hours and online at *pittwater.nsw.gov.au/exhibition*

During the public exhibition period, any person may make a submission in writing to Pittwater Council, PO Box 882, Mona Vale NSW 1660 or via email: catchment@pittwater.nsw.gov.au

For further information please contact Paul Hardie at catchment@pittwater.nsw.gov.au

Enquiries: Paul Hardie on 9970 1111.

pittwater.nsw.gov.au

A total of three public submissions were made in response to the public exhibition of the CZMP from July to August 2015. These submissions are discussed in turn below.

G6.2 Submission 1: from Bilgola Beach Resident

The first submission, from a beachfront Bilgola resident and dated 2 August 2015, noted concern that the calculation of setback lines was incorrect. Haskoning Australia agreed to recheck the calculations, and prepared a letter dated 21 August 2015 in response. In the letter it was concluded that the setback lines were calculated correctly based on the methodology described in Appendix D of the CZMP. It was also noted that the reason that the setback line for development on conventional foundations moved relatively landward in the vicinity of the resident's property was that there was less volume in the beach profile seaward of the property compared to adjacent areas.

The beachfront resident involved engaged a coastal engineering consultant to review the setback lines defined for his property and this consultant contacted Haskoning Australia on 28 August 2015 to obtain some data to assist in the review. Following queries from Council staff regarding the progress of the technical review, an additional submission was made by the resident on 1 November 2015, but no professional report was provided in support of the submission.

In his submission the resident questioned the relevance of the risk assessment for residential development and magnitude of the adopted storm demand. He also noted that he believed there was a lack of the support from other Councils (including Warringah) for the adopted risk assessment methodology, and further noted that his property had not been damaged in the May 1974 storms and was landward of the Immediate ZSA Hazard Line.

In a letter response from Council dated 3 November 2015, it was noted that:

- the acceptable risk methodology was specifically applied for residential development;
- storm demand was reduced by 20% in the CZMP to take account of existing protection works, and was not reduced further given that the buried rock revetment has limitations, which was considered to be reasonable;
- a very similar approach was applied in the CZMP for Collaroy-Narrabeen Beach and Fishermans Beach, which has been certified by the NSW Minister for Planning, and Warringah Council strongly supported the acceptable risk approach adopted;
- development at the resident's property was less affected by coastal erosion in May-June 1974 as it was further landward than adjacent development;
- the positions of the hazard lines were determined volumetrically, and any seeming variability in hazard line positions between properties depends on the measured sand volume seawards; and
- Council does not propose to amend the beachfront development setback lines shown for this property in the CZMP.

G6.3 Submission 2: from Member of Mona Vale SLSC

The second submission, from a member of Mona Vale SLSC (and Mona Vale resident, not beachfront) and dated 7 August 2015, had comments on Basin Beach in relation to:

- the potential future location of Mona Vale SLSC;
- sand needing to remain on Basin Beach as there is a heavy dumping shore break during high swell (and for this to be a consideration in seawall proposals);
- access to Mona Vale rock pool being dangerous (across the rock platform) when the formed concrete path is not used (it was suggested that these slippery access areas be covered with sand when conditions permit);
- the rock platform adjacent to Mona Vale rock pool, for which Council should consider making a submission to the NSW Department of Primary Industries (Fisheries) in terms of making this a no collection intertidal protected area due to high usage (with fishing and collection of bait still permitted, but not general harvesting of the rock platform);
- Council considering the position of the stormwater outlet at the northern end of Basin Beach as overflow after heavy rain is often evident on the rock platform and in the water (as the water tends to circulate in the basin);
- the reserve at the northern part of the Basin beach being the main access from the Headland track and Bassett Street, and whether any improvements are planned in this reserve or for access to the beach.

In the submission it was also noted that it may be worthwhile having an area at Bilgola Beach where lifesaving patrols can be elevated on a platform at the back of the beach/dune area in the vicinity of the normal designated (flagged) swimming area.

In response, it can be noted that:

- in collaboration with Mona Vale Surf Life Saving Club Incorporated, Council is investigating the potential for a redevelopment (demolish and rebuild) of the Mona Vale SLSC building at its current location;
- it is stated in the CZMP that it is expected that any protection works such as seawalls proposed by private landowners would be entirely on private land. It is also stated in the CZMP that Council would seek to maintain beach amenity in the future, within its financial capacity, with the most feasible option for this being campaigns of beach nourishment undertaken in partnership with the NSW Government and other similarly affected Sydney metropolitan coastal councils;
- comments regarding access to Mona Vale Rock Pool, across the rock platform, have been referred to the relevant operational area of Council for further consideration in managing ongoing public access to the pool;
- Council is supportive of additional protection for current aquatic reserves (Barrenjoey Head and Narrabeen Head) and intertidal protected areas (Bungan Head and Mona Vale Headland) in Pittwater and would support the addition of new areas if scientifically justified. Council has made and will continue to make submissions to the NSW Marine Estate Management Authority to this end. A CZMP action has been included to continue to liaise with the NSW Marine Estate Management Authority on these matters;
- the location of the northern stormwater outlet is considered to be reasonable and the cost of relocating the outlet is not considered to be justified in terms of improved water quality. In accordance with Beachwatch general warnings it is recommended that swimming is avoided during and at least one day after heavy rain at ocean beaches, due to the possibility of pollution from stormwater drains;
- the adopted Plan of Management for Mona Vale and Basin Beach includes recommendations to investigate opportunities to improve existing access pathways connecting the northern reserve, Mona Vale Headland and Basin Beach. A general recommendation for the northern reserve requires that existing access points, steps and dune protective fencing are upgraded as required having regard for the existing character of Basin Beach as well as public safety issues; and
- the need for elevated observation platforms and outpost towers for surf lifesavers is determined in close consultation with the individual surf clubs on the basis of existing beach sight lines and to best match available surf patrol resources.

G6.4 Submission 3: from Mona Vale resident

The third submission, from a Mona Vale resident (not beachfront) and dated 25 July 2015, had discussion on a number of matters peripheral to the CZMP and questions and commentary on matters already addressed in the CZMP. A response to the most relevant of these comments/questions is set out below in Table G4.

Table G4: Questions and responses for Submission 3

Question	Response
Has been any evidence of permanent/ongoing recession at Basin Beach?	As discussed in Appendix D this beach has been prograding over the photogrammetric data record from 1961 to 2008

Question	Response
Why were Bilgola Beach and Beach designated as coastal erosion hotspots?	As stated online[4] "these locations have been defined as areas where five or more houses and/or a public road are located in a current (or immediate) coastal hazard area, as identified in a coastal hazard study"
Why are full details of the protection works at Bilgola Beach and Basin Beach generally unknown or uncertain?	This is because most of the works were constructed many decades ago and records have not always been kept of the toe levels, crest levels and other details of the works (what is known about the works is outlined in Appendix A)
Why were the beaches in the study area designated as hotspots if they have been relatively stable over the last 50 or so years?	The relative stability refers to long term behaviour. As stated in Section 4.2 of the CZMP, the beaches are subject to short term beach erosion (storm demand) from coastal storms, but natural recovery after storms has meant that sand has returned to the beaches such that although beach volumes fluctuate over time, the long term average beach volumes have been relatively stable. The beaches have been designated as hotpots as development is at risk from (short term) beach erosion in a severe coastal storm or series of storms at present. This short term severe erosion still occurs on beaches stable in the long term.
Why is the Mona Vale rock pool not a heritage item?	It is a heritage item, and the text in Section 2.6 of the CZMP has been updated to state this
Has there been drilling of the beach or nearshore at Basin Beach?	This has been undertaken as part of some Development Applications. The upper dunal areas are generally composed of sand, and it was considered reasonable to assume an entirely sandy subsurface for hazard definition calculations.
Has lobbying of the State Government commenced with regard to funding beach nourishment and allowing access to offshore sand sources?	Council continues to support the Sydney Coastal Councils Group in its efforts to open dialogue with the NSW Government and scope the feasibility of utilising offshore sand deposits for beach nourishment purposes along the NSW coastline
What legislation does not allow access to offshore sand sources?	In Aecom (2010), cited in Appendix H, it was stated that an amendment to Schedule 2 of the *Offshore Minerals Act 1999* and the introduction of companion regulations would be required to enable a mining licence to be issued over an area within NSW State Coastal Waters (the first 3 nautical miles of the territorial sea from the baseline) before sand may be recovered for beach nourishment purposes. Given the uncertainty in this statement it has now been noted in the CZMP that the NSW Government has not stated a policy position on this matter.

[4] At http://www.environment.nsw.gov.au/coasts/coasthotspots.htm, accessed 5 November 2015 (page last updated 26 February 2011)

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Appendix H: Identification and Evaluation of CZMP Management Options

CONTENTS

H1. INTRODUCTION

In *Guidelines for Preparing CZMPs* (OEH, 2013), it is noted that CZMPs are to be prepared using a process that includes evaluating potential management options by considering social, economic and environmental factors, to identify realistic and affordable actions. OEH (2013) also noted that CZMPs are to achieve a reasonable balance between any potentially conflicting uses of the coastal zone.

The identification and evaluation of management options herein was mostly based on a framework in the *Coastline Management Manual* (NSW Government, 1990) and is presented under the generic categories of:

- structural works (Section H2);
- sand transport (Section H3);
- dune management (Section H4;
- environmental planning (Section H5); and
- development control provisions (Section H6).

It is noted that the Intergovernmental Panel on Climate Change uses an alternative categorisation of options (first introduced in 1990), namely:

- protect - continue the use of vulnerable areas by using defensive measures (eg seawalls, beach nourishment);
- accommodate - continue living in vulnerable areas by adjusting living and working habits (eg piled development, insurance, early warning and evacuation); and
- retreat – withdrawal from vulnerable areas (land use restrictions, setbacks).

H2. STRUCTURAL WORKS

H2.1 Seawalls/Revetments

Seawalls/revetments are structures built on an alongshore alignment to provide a landward limit to coastal erosion during storm events, usually to protect assets located landward. Seawalls/revetments may be vertical or stepped (for example, constructed from reinforced concrete or sandstone blocks) or sloping (for example, constructed in layers from randomly placed interlocking rock or concrete units, or pattern placed using sand-filled geotextile containers). For convenience herein, vertical/stepped structures are denoted as "seawalls" and sloping structures are denoted as "revetments".

If appropriately designed and constructed (including being founded at levels below the scour depth of the beach, that is typically below at least -1m AHD), seawalls/revetments can be effective in limiting the landward extent of storm erosion. However, there is the potential for 'end effects' (additional erosion) adjacent to seawalls/revetments which makes construction of these works at isolated lots problematic.

Details on known existing seawall/revetment protection works in the study area have been provided in **Appendix A**. Where full details of the protection works are unknown or uncertain or may be inadequate (such as crest and toe levels and rock size), future effectiveness of these protection works cannot be guaranteed. There are recent engineer-designed walls at Basin Beach (eg at 27-29, 31 and 33 Surfview Road) and substantial engineered walls at 11 and 15 Surfview Road, and landowners may be able to obtain certification from a coastal engineer that the works are adequate in providing sufficient protection to give acceptable risk over a suitable design life. The only properties in the study area not known to have some form of protection works are at 35, 37, and 39 Surfview Road.

Landowners are entitled to consider the installation or upgrading of protection works under *State Environmental Planning Policy (Infrastructure) 2007*. Where works would be entirely in private property and would not impact adversely on adjacent property, these may be considered as part of a Development Application.

Any such new or upgraded protection works would require current coastal engineering design standards to be adopted for a design life of at least 60 years, and the protection works being certified as having been constructed to this design.

H2.2 Groynes

Groynes are typically constructed perpendicular to the shoreline from materials similar to seawalls/revetments (that is, rock or concrete units). These structures act to trap sand moving along a beach, and may be effective where there is a dominant direction to longshore sediment transport, promoting accretion/progradation on the updrift side. However, the downdrift side becomes starved of sand, and would be expected to recede (until such time that sand bypassed the groyne). Groynes are often used in conjunction with beach nourishment.

Groynes are not considered to be appropriate in the study area as Bilgola Beach and Basin Beach are relatively compartmentalised already and have relatively low rates of longshore sediment transport. Furthermore, groynes have potential effects on visual amenity, cause recession of downdrift areas and would cause potential impacts on swimming and surfing amenity (given that groynes would be

expected to extend offshore to around -4m AHD to be potentially effective). They are also relatively expensive.

Groynes do not significantly affect onshore/offshore movement of sediment and are thus an ineffective means of managing storm erosion in the study area unless they have been used to create an additional buffer of sand updrift to meet the storm demand.

H2.3 Artificial Headlands

Artificial headlands are similar to groynes but are larger scale structures that extend into deeper water. These types of structures are not effective in managing onshore/offshore sediment transport and would impact on beach amenity and are hence not applicable for the study area.

H2.4 Offshore Breakwaters and Artificial Reefs

Offshore breakwaters are flexible structures that are typically constructed parallel to the shoreline from materials similar to revetments (such as rock or concrete units) and have also been built from sand-filled geotextile containers (such as the Narrowneck Artificial Reef, Gold Coast, Queensland). These structures can either have their crest level above the water (emergent breakwater) or be submerged, and act to modify the wave climate and thereby longshore sediment transport at the shoreline landward of them.

Emergent breakwaters modify the wave climate by blocking the passage of waves to the shoreline and limiting wave action to that resulting from diffraction around the extents of the structure. Submerged breakwaters (such as artificial reefs) may limit waves under calmer wave conditions and during lower tides, but are less effective in limiting the erosive action of larger waves at times of storms when there are associated elevated water levels and the structure is more submerged.

An offshore breakwater or artificial reef that was designed to guarantee protection to the study area from the action of storm swell waves and elevated water levels would likely have to be an emergent structure. This would severely impact on surfing conditions along the beach, create public safety issues, alter natural swimming conditions and change the natural aesthetics of the beach compartment. The length of breakwaters that would be required to protect both of the beaches in the study area would be expensive to construct, in the order of millions of dollars and not feasible for Council to fund. Therefore, offshore breakwaters or artificial reefs are not considered to be an appropriate management measure for the study area.

An artificial reef that was designed to improve surfing conditions would also be expensive to construct, and it is difficult to design and construct such a structure to be effective. It is not feasible (nor considered warranted) for Council to fund such a structure.

H2.5 Configuration Dredging

Configuration dredging involves the nearshore removal (and placement) of sand from the seabed in a manner that changes the way that storm waves act on the coastline. This is achieved by seabed level modifications that redirect the orientation of wave attack away from erosion prone areas.

The effectiveness of configuration dredging for the study area is limited by the number of wave directions that are possible in an open coast situation. Changes in seabed levels would also have the potential to adversely impact on surfing and swimming conditions. The existence of rock reef would also limit its viability, particularly at Basin Beach. Therefore, configuration dredging was not considered to be an appropriate management measure for the study area.

H3. SAND TRANSPORT

Sand transport management measures include beach nourishment, beach sediment recycling, and beach scraping, as discussed below:

- Beach nourishment involves adding sand to a beach, with the sand obtained from another location (from outside the sediment budget system for the beach). Beach nourishment can be used to maintain and enhance the recreational amenity of a beach, provide some additional protection for beachfront development at threat, and to improve public safety. Aecom (2010) completed a scoping study investigating the feasibility of undertaking beach nourishment in Sydney using offshore sand sources. They considered that an amendment to the *Offshore Minerals Act 1999* and the introduction of companion regulations would be required before sand may be recovered for beach nourishment purposes from offshore of NSW. Consultation with NSW Department of Industry (Resources and Energy) staff suggests that the longstanding belief that a moratorium on offshore sand extraction exists may be questionable. Until the NSW Government states a policy position on the extraction of sand from offshore of NSW, or makes legislative amendments (if required), this will not be resolved. Beach nourishment can also be undertaken using sand from terrestrial and estuarine/river sand supply sources.

- Beach sediment recycling involves redistributing sand within a particular embayment, typically by the mechanical movement of beach sediment from downdrift to updrift (CIRIA, 2010), that is taking sand from where it is not needed to where it is. Beach sediment recycling is different to beach nourishment as the operations only redistribute sediment within the sediment budget system, as opposed to being an external source adding to the sediment store in the system.

- Beach scraping is another form of mechanical sand redistribution on beaches. Beach scraping is defined as the movement of relatively small to medium quantities of sand from the lower part of the beach profile in order to assist in rebuilding the dune system and upper beach profile, by mechanical means (typically using earthmoving equipment such as bulldozers). It is usually undertaken after storm events to accelerate beach recovery, such as to bury exposed areas of protection works that may present a public safety risk.

An appropriate beach nourishment option (if funding and sand sources become available) can be described as “moderate” beach nourishment in order to maintain beach amenity. If moderate beach nourishment was undertaken, the initial volume of sand placed would need to be sufficient to restore beach amenity at that time and to accommodate losses from natural processes and future sea level rise over say a 10 year renourishment cycle. The nourishment volume required to accommodate sea level rise is dependent on the implementation time as the projected rate of sea level rise varies with time (IPCC, 2013a, b).

Aecom (2010) estimated that if beach nourishment was undertaken as a collaborative exercise between Councils responsible for 31 beaches in the greater metropolitan region of Sydney, this would cost around $25/m^3 on average[1] if a central source of sand at Cape Banks (offshore of the entrance to Botany Bay) was utilised with sand extracted by specialised dredging equipment[2] mobilised from overseas. This would equate to costs for an initial beach nourishment campaign in the order of $30

[1] This includes direct costs of dredging and nourishment and project costs, including survey, sediment sampling and analysis, geotechnical investigation, environmental assessment and design and tender documentation.
[2] A large Trailer Suction Hopper Dredger (TSHD).

million to $35 million and costs for renourishment campaigns undertaken every 10 years being in the order of $1.5 million to $2.0 million[3]. It is evident that significant funding outside Council resources would be required for moderate beach nourishment to be implemented (particularly for the initial beach nourishment campaign) and collaboration between multiple Councils would be required.

Furthermore, it is reiterated that ongoing episodic renourishment campaigns would be required to maintain beach amenity, that is funding would need to be ongoing.

[3] That is, an initial beach nourishment cost in the order of $1 million per beach and costs for renourishment campaigns undertaken every 10 years being in the order of $60,000 per beach.

H4. DUNE MANAGEMENT

Dune management involves the maintenance of dunes and their vegetative cover. Well maintained dunes hold a reserve of sand on the beach to cater for storm erosion and provide a barrier to oceanic inundation. The establishment and maintenance of dune vegetation also minimises loss of windblown sand from the beach compartment.

Management of coastal dune areas in developed areas typically involves:

- control of public access (pedestrian and vehicular) to dune areas by the use of fencing and formalised beach access tracks;
- rehabilitation of degraded dune areas involving weeding and planting of native plant species;
- controlling land use in dune areas by applying development controls; and
- prevention or minimisation of scour caused by stormwater outlets by:
    - siting these structures away from beach areas where possible (for example, by discharging over rock platforms, subject to environmental assessment);
    - provision of energy dissipating structures (such as rock blankets) at beach outlets; or
    - discharge of stormwater flows into drainage swales located in back beach areas.

Along Bilgola Beach, established vegetated dune areas exist seaward of the Allen Avenue beachfront properties. These areas should be maintained. South of Bilgola Avenue there is little opportunity for dune vegetation to be established seaward of existing protection works.

Due to the proximity of existing protection works to the beach along the southern portion of Basin Beach, dune vegetation is limited. However, existing areas of dune vegetation should be maintained and opportunities taken to increase the coverage of dune vegetation in other areas where possible. The established vegetated dune areas at the northern end of the beach should be maintained.

All dune management works should be undertaken in accordance with the principles of the *Coastal Dune Management Manual* (Department of Land and Water Conservation, 2001).

H5. ENVIRONMENTAL PLANNING

H5.1 Land Use Zones

The definition of land use zones is a basic method available to Councils for controlling the nature of land use and development. Land use zones are implemented through a Local Environment Plan (LEP) and its associated land zone mapping. The document structure and available land use zones and their descriptions within an LEP are prescribed by the NSW Department of Planning in their *Standard Instrument—Principal Local Environmental Plan* (Standard Instrument LEP) and associated LEP practice notes.

The current land use zones applied to beachfront properties in the study area have been discussed in Section 2.2 of the main report. The private beachfront development is zoned as "E4 - Environmental Living" in the study area. Zone E4 has the following objective:

> "to provide for low-impact residential development in areas with special ecological, scientific or aesthetic values and to ensure that residential development does not have an adverse effect on those values".

For Zone E4, based on the Standard Instrument LEP, home occupations are permitted without consent and dwelling houses are permitted with consent. The following types of development are prohibited: industries; service stations; warehouse or distribution centres; any other development not specified in item 2 or 3 [that is, the items listed above as permitted without and with consent]".

Based on the Standard Instrument LEP, "environmental protection works" must be included as either "permitted without consent" or "permitted with consent" for Zone E4 (they are "permitted with consent" in the *Pittwater Local Environmental Plan 2014*). "Environmental protection works" means:

> "works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works[4], dune restoration works and the like, but does not include coastal protection works[5]".

Therefore, the environmental protection zoning within the Standard Instrument LEP appears to prohibit the construction of protection works and beach nourishment, which conflicts with the adoption of these two measures as allowable CZMP actions herein. An action is included in the CZMP herein for Council to investigate how this anomaly may be resolved, so that coastal protection works are a permitted use[6].

An action is also included in the CZMP herein that alterations to the *Pittwater LEP 2014* (to include acceptable risk setbacks, for example) and specification of associated controls within the *Pittwater 21 Development Control Plan* be undertaken.

[4] "Erosion protection works" is not defined in the Standard Instrument LEP, making it potentially somewhat ambiguous with "coastal protection works".
[5] Where "coastal protection works" has the same meaning as in the *Coastal Protection Act 1979*, that is "activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters and includes seawalls, revetments, groynes and beach nourishment".
[6] Note that there is no zoning in the current LEP that allows coastal protection works.

H5.2 Buffer Zones

The main function of a buffer zone is to provide a width of beach that can be stabilised with vegetation to accommodate short-term shoreline fluctuations caused by storm erosion and subsequent beach recovery. This is typically achieved on undeveloped coastlines through appropriate zoning in LEP's (such as for public recreation). However, in areas with high levels of existing development this is difficult to implement as current legislation protects the "existing use" rights of existing development, which can continue to exist and be subject to renovations and additions despite rezoning of land by Councils. The only other option available for Council to create buffer zones is to acquire private land, which is currently considered to be cost-prohibitive in the study area (refer Section H5.3).

Nevertheless, opportunities to enhance and complement existing dune vegetation as a part of the landscape requirements for development on private properties should not be overlooked by Council when setting conditions of development consent.

H5.3 Property Purchase

Acquisition of private property by Councils can be achieved by 'voluntary purchase' (when a landowner voluntarily offers their property for sale to the government) or by purchase on the open market. These types of schemes aim to return property that is considered to be at-risk back into the control of Councils, who can rezone the land and/or establish a coastal buffer zone (refer Section H5.2).

However, in practice voluntary purchase is unlikely to be realised in the study area as the market for beachfront property is typically strong and owners have no incentive to arrange for sale of their property off the open market. The end result is that Councils need to compete with other private buyers as properties are sporadically offered on the open market, which requires significant capital investment and may take decades before an at-risk length of coastline is completely acquired. Council cannot afford to purchase at-risk beachfront properties.

H5.4 Planned Retreat

Planned retreat is a strategy that can be used to allow development to exist on a receding coastline for a period of time until the risk to property becomes unacceptable. The trigger for actioning planned retreat can be either time-based (occupation of an area is allowed until a certain date) or trigger-based (based on physical realisation of coastal hazards, such as when an erosion escarpment encroaches within a specified buffer distance from a dwelling). If implemented on an existing undeveloped coastline, planned retreat can be facilitated by construction of relocatable buildings, which can be readily moved when development consent lapses and landowners are required to cease occupation and retreat further landward.

In the case of a highly developed coastline such as the study area, this approach becomes problematic to implement as private landowners would be required to demolish their existing dwellings and completely rebuild at significant cost. There a number of issues with the broad-scale implementation of planned retreat in the study area, including:

- current legislation protects the "existing use" rights of existing development, which can continue to exist and be subject to renovations and additions despite adoption of a planned retreat strategy for new development;

- in many cases retreat of dwellings is limited by the size of the lots;
- the likely financial impacts on landowners;
- existing protection works would remain if such a policy was applied, and land ownership would not change, so beach amenity would not necessarily improve.

That stated, event-based triggers may be considered in new development consents by Council, and should be retained as a planning control that could occasionally be used under specific circumstances that require merit-based assessment of development applications. Examples of event-based triggers requiring future actions by landowners would include:

- proximity of an erosion scarp to property, requiring underpinning with piles, seawall upgrading or new seawall construction or landward setback of the development (where practicable); and
- failure of protection works, requiring restoration of the works to an appropriate engineering standard.

It would be important that where event-based triggers are applied the event is defined unambiguously. Furthermore, it would be necessary for Council to periodically monitor conditions in the study area to determine if any event triggers had occurred, which would create an administrative burden on Council. It can be difficult to both define a trigger and determine when the trigger conditions have been met, as well as then applying and enforcing the relevant conditions of consent.

When Council has applied trigger or time limited conditions of consent on coastal properties in the past (and this has only occasionally occurred) a Section 88B instrument (as per the *Conveyancing Act 1919*) on title has also usually been applied to alert future owners to such requirements. This option is also an administrative burden on Council under existing environmental planning and legislative provisions.

H6. DEVELOPMENT CONTROL PROVISIONS

H6.1 Preamble

Development control provisions, in addition to normal building industry standards, can be enforced to incorporate the management of coastal hazards into new development applications. These controls can be implemented through planning instruments including Local Environment Plans (LEPs) as statutory provisions, and Development Control Plans (DCPs) as non-statutory performance guides. Development control provisions can include:

- definition of setback lines, seaward of which development is restricted or prohibited[7];
- requirements to provide coastal protection works if development is proposed in an area particularly prone to current or future coastal hazards (particularly where there are existing protection works in the study area);
- requirements to provide appropriate foundations (such as deep piling) beneath structures to accommodate storm erosion;
- measures to minimise damage from coastal inundation, such as minimum floor levels and use of water resistant materials;
- dune management measures, to establish vegetated dunes in order to protect the development or to prevent damage to existing dune areas from construction or land use;
- requirements to return any sand excavated as part of construction activities to the active beach system;
- maintenance of an access route to facilitate emergency protection;
- design of structures such that they are relocatable; and
- requirements to cease occupation and relocate landward when an erosion scarp is within a certain buffer distance from a dwelling or after a certain time period.

H6.2 Setback Lines

As discussed in **Appendix D**, it is recommended that setbacks for future development in the study area be defined based on consideration of acceptable risk and the position of the Foreshore Building Line. This would require modification of the *Coastline Risk Management Policy for Development in Pittwater* and where possible changes to the *Pittwater Local Environmental Plan 2014*.

H6.3 Coastal Protection Works

Beachfront landowners have a legal right to submit a Development Application to protect their property with protection works. Such applications would need to be assessed by Council on their merits. To provide a basis for merits assessment and define a standard for the design and construction of protection works, it is considered that a protection works policy document should be prepared to supplement any existing development control provisions in the *Coastline Risk Management Policy for Development in Pittwater*.

H6.4 Foundation Design

It is considered that development controls for design of foundations are an appropriate measure for management of future new development or redevelopment of existing dwellings in coastal risk areas.

[7] Note that prohibition can only be applied in an LEP, not a DCP.

Foundation design is currently mentioned in the *Coastline Risk Management Policy for Development in Pittwater* but further specifics on requirements could be added.

H6.5 Floor Levels

Requirement for minimum floor levels are currently specified in the *Coastline Risk Management Policy for Development in Pittwater*. For new development, all floor levels shall be at or above a so-called Coastline Planning Level. However, due to the ambiguity in the meaning of a Coastline Planning Level in situations where wave overtopping occurs, it is recommended that modifications are made to the policy.

H6.6 Dune Management Measures

There are current controls relating to dune management in the *Coastline Risk Management Policy for Development in Pittwater*, namely:

- wherever present, remnant foredune systems shall be appropriately rehabilitated and maintained for the life of the development to stabilise an adequate supply of sand (as determined by a coastal engineer) that is available to buffer erosion processes and/or minimise the likelihood of oceanic inundation; and
- all vegetated dunes, whether existing or created as part of coastal protection measures shall be managed and maintained so as to protect the dune system from damage both during construction of the development and as a result of subsequent use during the life of the development.

These controls could be retained.

H6.7 Sand Preservation

Given the position of beachfront lots along Bilgola Beach and Basin Beach in relation to what may have been a natural dune area, any excavation for development is likely to encounter sandy subsurface material that is compatible with the native sand in the active beach system. It is considered that a requirement to return any surplus clean sand to the beach as part of construction activity is an appropriate condition to build up reserves of beach sand for storm erosion. This is currently specified in the *Coastline Risk Management Policy for Development in Pittwater* as “all uncontaminated dune sand excavated during construction operations shall be returned to the active beach zone as approved and as directed by Council”.

H6.8 Emergency Access Routes

The maintenance of an access route for installation of emergency coastal protection works is a relevant consideration where approval has been obtained for placement of such works, and can be placed as a consent condition for such works if required.

The establishment of a foreshore access corridor for the purposes of long term protection works maintenance (for example to repair damage following major storms) is considered to be an appropriate measure for any works constructed . This would be most effectively implemented over time by incorporating an access width provision into building setback lines (refer Section H6.2).

H6.9 Relocatable Buildings and Planned Retreat

As discussed above in Section H5.4, the adoption of a planned retreat strategy is not considered to be appropriate for the study area, which contains high levels of existing development.

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Appendix I: Sources of Funding for CZMP Actions

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Page I

I1. INTRODUCTION

Various potential Federal, NSW and Council funding sources for funding of CZMP actions are outlined in Section I2, I3 and I4 respectively.

Funding programs are regularly changing and Council should maintain an awareness of other funding opportunities (as required) as they arise.

I2. FEDERAL GOVERNMENT

Information in this Section was derived from Attorney-General's Department (2014).

During 2009, various Commonwealth programs for disaster mitigation works were replaced by the National Partnership Agreement on Natural Disaster Resilience (NPA). The NPA has provided approximately $27 million per year to states and territories to enhance the resilience of communities against the impact of natural disasters. The NPA consolidates the former Bushfire Mitigation Program (BMP), the Natural Disaster Mitigation Program (NDMP) and the National Emergency Volunteer Support Fund (NEVSF).

As noted at Attorney-General's Department (2015), a two year National Partnership Agreement on Natural Disaster Resilience was agreed in 2013-14 by the Australian, state and territory governments. It establishes the mechanism through which the Australian Government provides the states with $26.1 million per annum to invest in disaster resilience projects which are prioritised by the states in accordance with their respective state-wide natural disaster risk assessments. States are responsible for securing matched funding, which may include third party and in-kind contributions.

A key aim of the NPA is to enhance Australia's resilience to natural disasters through mitigation works, measures and related activities that contribute to safer, sustainable communities better able to withstand the effects of disasters, particularly those arising from the impact of climate change.

The NPA is a partnership with states and territories where jurisdictions provide direct administration of the funding and submit an annual implementation plan to the Attorney-General.

Funding for projects is prioritised by states and territories in the context of their natural disaster risk priorities. This recognises that different jurisdictions have different priorities and that these may change over time. Each state and territory will ascertain eligibility for funding against their risk priorities when applications are called for.

NSW aspects of the program are described in I3.3.4.

I3. NSW GOVERNMENT

I3.1 NSW Coastal Management Program

Grants under the NSW Coastal Management Program are administered by the Office of Environment and Heritage (OEH) to support Councils in their management of coastal hazards. Up to 50% of project costs that can be funded include (OEH, 2014):

- preparation (or updating) of coastal zone management plans and associated technical studies (including coastal hazard assessments);
- action to manage the risks from coastal hazards;
- action to implement environmental repairs, including habitat restoration and conservation projects;
- pre-construction activities for projects that are eligible and are likely to proceed to construction; and
- development of management tools (such as education projects).

OEH typically provides about $2 million per annum in the program. However, this funding level has stayed approximately the same in dollar terms for decades, so in real terms has been dropping. Note also that in the most recent (2014-2015) grant funding announced in November 2014, the total program funding was only $0.8 million.

I3.2 NSW Floodplain Management Program

Grants under the NSW Floodplain Management Program are also administered by OEH to support councils in their management of flood risk. Grants provided under the program typically comprise payment of $2 from OEH for every $1 provided by councils.

I3.3 NSW Natural Disaster Assistance Schemes

I3.3.1 General

In the event of a severe natural disaster, Councils are able to apply for financial assistance from the NSW Government for emergency work and restoration of damaged public assets provided that certain criteria are met. Natural disasters can be caused by coastal hazards including storm, storm surge, cyclone and tsunami. This funding is only made available if a Natural Disaster Declaration has been issued by the NSW Premier, Treasurer or their delegate. A Natural Disaster Declaration is only considered if the damage to an affected community (including damage to public assets, and other eligible costs incurred by the local community) exceeds $240,000.

Separate grants can be issued by NSW Roads and Maritime Services (RMS) for damage to roads (Section I3.3.2) and NSW Public Works (Section I3.3.3) for restoration works other than those involving roads. In addition, grants are also available from the Natural Disaster Resilience Program (Section I3.3.4).

I3.3.2 NSW Roads and Maritime Services – Natural Disaster Arrangements

In the event of a declared natural disaster, the funding available from RMS for restoration of road infrastructure comprises:

- Emergency Works – 100% of the approved actual cost;
- State and Regional roads – 100% of the approved actual costs; and
- Local Roads – 75% of the assessed cost up to $116,000 and 100% thereafter.

For non-declared events, the responsibility for funding of restoration works is as follows:

- State Roads – RMS responsibility;
- Regional Roads – Council responsibility; and
- Local Roads – Council responsibility.

I3.3.3 NSW Public Works – Natural Disaster Relief and Recovery Arrangements

In the event of a declared natural disaster, there are two broad categories of works for which NSW Public Works can provide financial assistance. These comprise:

- Emergency Works, for which 100% of costs can be subsidised; and
- Restoration Works, for which 75% of costs can be subsidised up to a maximum of $116,000, and 100% thereafter (the maximum amount payable by Councils for Restoration Works under this program is thus capped at $29,000 for any disaster event[1]).

Eligible items of work that are relevant for the study area under each of the above categories include:

- Emergency Works:
  - clean-up of debris from Council maintained areas; and
  - clearance of blockage and debris from public drainage.
- Restoration Works for:
  - stormwater assets;
  - tree replacement;
  - retaining walls and rock protection;
  - recreational facilities and play equipment; and
  - fencing.

Non-eligible items include the “restoration of damage that can be wholly or partly attributed to inadequate design, inadequate maintenance or faulty construction”. This is of interest for future restoration works that may be proposed for existing protection works that have not been certified nor maintained on a regular basis.

Restoration of damage to beaches and dunes (such as by beach nourishment and/or revegetation of dunes) would not be funded. However, damage to Council beach access and dune protection infrastructure (such as fencing) is eligible for restoration funding.

I3.3.4 Natural Disaster Resilience Program

The Natural Disaster Resilience Program (NDRP) is the joint Commonwealth/State program funded under the two year National Partnership Agreement on Natural Disaster Resilience (NPA, see Section I2).

[1] Being 25% of $116,000.

The funding available from the Natural Disaster Resilience Program (NDRP) supports a wide range of activities including research and development, disaster risk assessments, physical works and engineering measures, community education and engagement programs and projects that support emergency management volunteers. In NSW it is administered by the Ministry for Police and Emergency Services and has been used in the past to partly fund coastal management studies and plans for local government areas.

I4. COUNCIL REVENUE

I4.1.1 General

In addition to external grant funding, Council could fund coastal management actions from their own revenue generated by ordinary rate income, special rate variations or a coastal protection service charge. The potential use of revenue generated outside of ordinary rate income is discussed below.

I4.1.2 Council Wide Special Rate Variations

Councils are able to apply for increases in ordinary rate income beyond the annual rate peg amount (a 'special rate variation'). Councils may apply for a single year increase under Section 508(2) of the *Local Government Act 1993*, or a multi-year increase (of between 2 and 7 years) under Section 508A.

The Independent Pricing and Regulatory Tribunal (IPART) has the responsibility for assessing and determining special rate variation applications. Councils may seek a special rate variation in order to undertake environmental works, fund town improvements, redevelop community and civic facilities, address maintenance backlogs and maintain or improve existing service provision. Beach nourishment could be considered as an environmental work that benefits all beach users, with the main aim of providing a wider beach (or maintaining beach width under sea level rise) to enhance or maintain beach amenity.

Councils that are seeking special rate variations are required to submit applications to IPART for review and assessment. The Council must include details of its intention to apply for a special variation in its draft delivery program and operational plan and must consider any submissions received from the public. If a Council's application is approved, IPART will specify the percentage by which the council may increase its ordinary rate income. IPART must assess special variation applications against the following criteria: demonstrated need for the rate increase, demonstrated community support for the special variation, reasonable impact on ratepayers, sustainable financial strategy consistent with the principles of intergenerational equity, productivity improvements achieved and planned, and implementation of the Integrated Planning and Reporting framework.

I4.1.3 Special Rate on Particular Properties

Based on Section 495(1) of the *Local Government Act 1993*, a "council may make a special rate for or towards meeting the cost of any works, services, facilities or activities provided or undertaken, or proposed to be provided or undertaken, by the council within the whole or any part of the council's area, other than domestic waste management services".

Based on Section 495(2) of the *Local Government Act 1993*, "the special rate is to be levied on such rateable land in the council's area as, in the council's opinion: (a) benefits or will benefit from the works, services, facilities or activities, or (b) contributes or will contribute to the need for the works, services, facilities or activities, or (c) has or will have access to the works, services, facilities or activities"[2].

[2] There is also Section 529 of the *Local Government Act 1993* that says a Council may determine a sub-category or sub-categories for one or more categories of rateable land in its area, but this would not seemingly be for the case of rating coastal landowners differently.

Therefore, if Council changed its current position and chose to financially contribute to upgrading or providing new protection works adjacent to private property then a special rate on beachfront landowners (who would be the main beneficiaries of these works) could be considered to assist in funding these works.

I4.1.4 Coastal Protection Service Charge

It is also possible to levy particular coastal landowners by applying annual charges for coastal protection services. This is set out in Section 496B of the *Local Government Act 1993*, entitled "making and levying of annual charges for coastal protection services". Guidance on the application of the coastal protection service charge is also provided in the *Coastal Protection Service Charge Guidelines* (DECCW, 2010).

There are three situations when the coastal protection service charge (CPSC) could apply, namely:

1. when landowners construct protection works and Council maintains them; or
2. Council constructs protection works to protect private property and maintains them; or
3. Council maintains existing protection works on behalf of a landowner.

In all cases, Council could levy the landowner for maintaining and repairing the works and mitigating any impacts (such as replacement of eroded beach sand). In Item 2, the CPSC cannot be used to fund the initial new or upgrading works

However, Council has stated that it does not intend to protect private property from coastal erosion (so Item 2 above is not relevant). Furthermore, Council does not intend to maintain existing or any new/upgraded protection works adjacent to private property, considering that this is the landowners responsibility (so Item 1 and 3 above are not relevant).

Based on Section 553B(1) of the *Local Government Act 1993* "an annual charge for coastal protection services may not be levied on a parcel of rateable land in relation to existing coastal protection works unless the owner (or any previous owner) of that land has consented in writing to the land being subject to such charges". That is, the CPSC can only be applied if a landowner agrees to it.

To reiterate, the CPSC cannot be used to fund construction of new works or upgrade works, only maintenance and repair of existing protection works that have been voluntarily constructed or financially contributed to by a benefiting landowner (or landowners) or where a landowner has agreed to pay a CPSC for maintenance and repair of existing protection works that they did not financially contribute to.

A coastal protection service charge may have potential application in situations where consent for future development has been granted subject to upgrade and maintenance of an existing seawall or construction and maintenance of a new seawall. If agreed with the landowner, conditions of this consent could include payment to Council of a CPSC associated with Council's maintenance of the seawall on behalf of the landowner to provide greater certainty that satisfactory arrangements have been made for ongoing maintenance of the seawall works in accordance with Section 55M of the *Coastal Protection Act 1979*.

However, Council does not have to provide this maintenance service and does not intend to enter into these types of arrangements. Council's position is that it is the landowner's responsibility to maintain and repair any protection works that the landowner has constructed or upgraded to protect private

property (or that were pre-existing prior to their purchase) and that Council's resources should only be used for protection of public assets.

I5. REFERENCES

Attorney-General's Department (2014), "National Partnership Agreement on Natural Disaster Resilience", online at http://www.em.gov.au/npa, accessed 1 February 2014, date last updated 14 October 2011

Attorney-General's Department (2015), "National Partnership Agreement on Natural Disaster Resilience", online at http://www.em.gov.au/npa, accessed 28 May 2014, date last updated unknown

Department of Environment, Climate Change and Water [DECCW] (2010), *Coastal Protection Service Charge Guidelines*, DECCW 2010/1020, December, ISBN 978-1-74293-052-7

Office of Environment and Heritage [OEH] (2015), "Coastal management grants", online at http://www.environment.nsw.gov.au/coasts/coastalgrants.htm, accessed 28 May 2015, date last updated 1 May 2015