5 Hazard Mapping and Risk Assessment

5.1 Hazard Mapping

The derivation of the dune erosion hazard for the present day, 2050 and 2100 planning periods is presented in detail in Appendix A. For each planning period, the erosion hazard has been defined as:

- a line delineating the limit of wave impact and dune slumping (*Zone of Wave Impact and Slope Adjustment*); and
- a line delineating the limit of the area behind the dune face where the capacity of the sand to support building foundations is reduced because of the sloping dune escarpment (*Zone of Reduced Foundation Capacity*).

The limits of the *Zone of Wave Impact and Slope Adjustment* and the *Zone of Reduced Foundation Capacity* have been calculated using the values for design storm erosion demand, with reference to Figure 4.1, for the 2050 and 2100 planning periods. The estimated beach recession allowed for as a result of upper range sea level rise prognoses advocated by the NSW Sea Level Rise Policy and the IPCC Fourth Assessment Report (2007) were added to the storm erosion demand. Measured long term recession effects were found to be negligible as the beach was found to be relatively stable. As required by the NSW Draft Coastal Risk Management Guidelines (DECC&W 2009d), the sensitivity of the 2100 hazard zones without the impact of sea level rise has been examined. From the analysis in this report, the 2100 hazard zones without the impact of sea level rise are equivalent to the present day hazard zones, as the beaches are generally not undergoing long term recession.

To obtain the location of the various zones, averages of the photogrammetric profiles were used as the beaches are relatively stable and showed continuous recovery after each episode of storm erosion.

For the 2050 and 2100 planning periods, sea level rise recession limits were added to the design storm recession for several locations along the beach, to determine the seaward limits of the *Zone of Reduced Foundation Capacity* and *Stable Foundation Zone*.

5.2 Risk Assessment

A risk assessment for the present day, 2050 planning period and 2100 planning period has been carried out for the urban areas of Scotts Head, Nambucca Heads and Valla Beach. This risk assessment was carried out with reference to the hazard mapping done for each of the three planning periods. The results of this risk assessment for each area are summarised below.

5.3 Scotts Head

5.3.1 Present Day

The assessment of coastal hazards has concluded that the only building which could be affected by some storm damage or wave runup is the Scotts Head SLSC. The main building is fronted by a rock armour seawall, and it is likely that the Scotts Head SLSC is

founded on bedrock, which would limit structural damage to the building. However, this seawall would be more effective if constructed to an appropriate coastal engineering standard. Figure 3.6 documents a standard design for a replacement seawall, if the existing seawall were to fail during a future storm. Damage that has been observed in the storms of May 2009 at Little Beach in Scotts Head is shown in Figure 5.1.

All other infrastructure is well protected by the dunes fronting the different beaches, which are high enough to avoid any overtopping all along the Scotts Head coastline. Severe damage to the dune vegetation at Little Beach could also occur (as observed in May 2009), but there is no infrastructure at risk.

There are no private properties currently at risk from coastal inundation due to wave runup.

5.3.2 2050 Planning Period

For the 2050 planning period, the landward limit of the *Zone of Slope Adjustment* line reaches the caravan park infrastructure located next to the SLSC (Figure 5.2). A portion of the caravan park is located within the *Zone of Reduced Foundation capacity.* The roadway of Banksia Crescent lies partially within the *Zone of Reduced Foundation capacity* while the other houses in the area are located on rock and are therefore protected from reduced foundation capacity.

5.3.3 2100 Planning Period

For the 2100 planning period, much of the caravan park, is within the *Zone of Slope Adjustment,* being exposed from the eastern side. One dwelling and three lots at Banksia Crescent as well as the roadway of Banksia Crescent lie partially within the *Zone of Slope Adjustment*. The *Zone of Reduced Foundation capacity* crosses the bowling green and the seaward boundary of the Christian Youth Centre.

5.4 Nambucca Heads

5.4.1 Present Day

The assessment of coastal hazards has concluded that no private dwelling is at immediate risk of direct storm damage. However, the SLSC on Main Beach is at risk and can be flooded by the wave runup. The carpark at Beilbys Beach lies within the *Zone of Reduced Foundation Capacity*.

The existing rock seawalls at Shelly and Main Beaches are at risk from damage in a large storm event, as these seawalls have not been constructed to contemporary coastal engineering standards. Such damage has already been observed in the storms of May 2009 at Main Beach (Figure 5.1). These seawalls require reconstruction to an appropriate coastal engineering standard, to prevent damage to the carparks at these beaches.

The existing picnic area at Bellwood Park within the river entrance is also subject to periodic erosion and loss of amenity when the river entrance is open (allowing ocean swell waves to propagate upstream). Existing rock embankments in this area have previously

suffered damage as a result of this erosion. Figure 3.9 documents a standard design for reconstruction of the damaged embankment.

There are no private properties currently at risk from coastal inundation due to wave runup along the ocean beaches. However, parts of the roadway of Wellington Drive and Riverside Drive would be inundated by wave runup under a combination of scoured estuary entrance conditions and high ocean water levels. The carpark and pedestrian walkway behind the V-wall are subject to wave overtopping from the breakwall during a large storm, with wave overtopping posing an inundation hazard to low-lying areas such as the White Albatross Caravan Park. This area could be isolated with no external access by coastal inundation for several hours as a result of a large storm event.

5.4.2 2050 Planning Period

For the 2050 planning period, Shelly Beach carpark, the toilet block at Shelly Beach, Main Beach carpark and Beilby's Beach carpark extend into the *Zone of Slope Adjustment* in addition to the Main Beach SLSC. The erosion extents are limited by the presence of the rocky escarpment behind Shelly, Beilbys and Main beaches along part of the length of these beaches. The toe of the escarpment slope along the coastline between Shelly Beach and Swimming Creek would be subject to direct wave attack. However, the slope failure mechanisms in this area are different to those for sand dunes and are addressed in the Geotechnical Hazards report. No dwellings are at risk in the 2050 planning period.

Wave overtopping of the breakwall would increase in frequency and severity as a result of sea level rise due to climate change, and inundation events of the carpark, Caravan Park, Wellington Drive and Bellwood Park areas would be expected to increase in frequency.

5.4.3 2100 Planning Period

For the 2100 planning period, the entire sandy portion of the beaches between Shelly Beach and Swimming Creek would be subject to erosion. However, the inland erosion extent would be limited by the presence of the cliffs and bluffs backing the beaches. In addition to the carparks at Shelly, Beilbys, and Main Beach, part of Swimming Creek Road as well as four dwellings along this road and some infrastructure within the caravan park at the northern end of Swimming Creek Road lie within the *Zone of Slope Adjustment.* Three additional dwellings along Swimming Creek are partly within the *Zone of Reduced Foundation Capacity*.

Wave overtopping of the breakwall would further increase in frequency and severity as a result of sea level rise due to climate change, and inundation events of the carpark, Caravan Park, Wellington Drive and Bellwood Park areas would be expected to increase in frequency.

5.5 Valla Beach

5.5.1 Present Day

The assessment of coastal hazards has concluded that no private dwelling is at immediate risk of direct storm damage. Most of the coastline is protected by rocky cliffs

and bluffs. Erosion of the car park area caused by Deep Creek entrance dynamics is possible, as is wave inundation of the carpark area.

There are no private properties at risk from coastal inundation due to wave runup.

5.5.2 2050 Planning Period

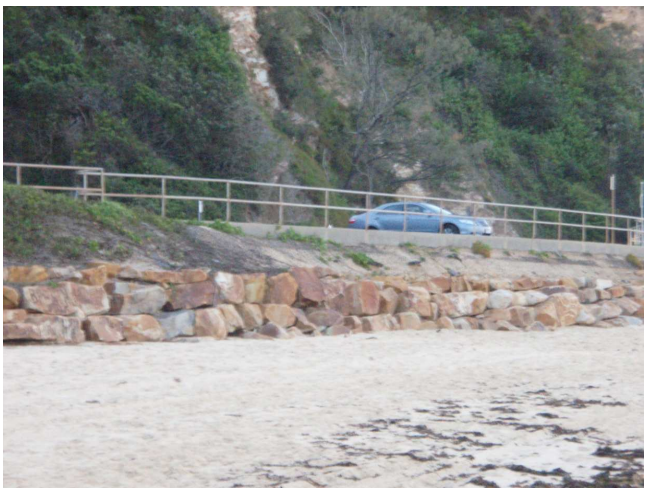
For the 2050 planning period, no additional properties or infrastructure would be at risk. However, overwash of the dune south of the entrance to Deep Creek may be possible, if the volume of sand store is reduced due to future sea level rise. This could cause breakthrough of Deep Creek south of its present location and threaten the footbridge.

5.5.3 2100 Planning Period

For the 2100 planning period, no private dwelling would be at risk. However, the morphology of the entrance to Deep Creek could change, as the dune separating the river from the ocean could be completely eroded under the action of the sea level rise. This would expose the current foreshore of Deep Creek to an open coast wave climate. Infrastructure which is at risk includes the carpark and toilet block at South Valla Beach.

Little Beach, Scotts Head December 2008

Little Beach, Scotts Head May 28 2009



Carpark seawall, Main Beach October 2008

Carpark seawall, Main Beach May 28 2009

Figure 5.1 – Storm erosion and damage caused by East Coast Low, May 2009

6 Summary, Conclusions and Recommendations

6.1 Summary and Conclusions

Detailed technical studies using an updated empirical database have allowed for the quantification of the coastal hazards at the beaches of Nambucca Shire. The assessment has been made on the basis of detailed photogrammetric survey data.

Several storm events occurred over the period of the photogrammetric data record and in particular, the following storm signatures could be identified at various locations:

- Cyclone Violet (which had a marked impact on the mid-north coast) occurred in 1995 and was visible within the photogrammetric record at Scotts Head. The signature of the storm could be clearly seen in the photogrammetric data, and the maximum measured erosion between 1988 and 1996,
- The May-June 1974 storm event which impacted most of the NSW coastline which was adopted for analysis at Nambucca Heads. The signature of this storm could not be clearly seen in the photogrammetric data, so the maximum measured erosion between 1973 and 1980, which encompasses the large storm events of the 1970's, was adopted as the design storm erosion for Nambucca Heads;
- Cyclone Nancy in February 1990 which caused severe erosion along Valla Beach and had a peak significant wave height of 6.7 m. The effects of this storm were able to be isolated by analysing photogrammetry data between 1988 and 1991 (Appendix A). At its closest point, Cyclone Nancy tracked to within 80 km of Valla Beach.

6.1.1 Long Term Recession

The available photogrammetric data has indicated that the beach at Scotts Head have not been undergoing long term recession between 1973 and 2004. This, in conjunction with geomorphological studies conducted by others, have led to the conclusion that the beaches at Scotts Head have been relatively stable in the long term and no allowance has been made for observed long term recession.

At Nambucca Heads, the photogrammetric data indicates that long term recession along the northern end of Forster Beach is occurring at an estimated rate of around 0.4 m/year while the other beaches were relatively stable. Consequently, an allowance has been made for historic long term recession of 0.4 m/year for the northern end of Forster Beach and the long term recession rate has been neglected for the other beaches.

At Valla Beach, the available photogrammetric data has indicated that the beach is not noticeably undergoing long term recession. Consequently, the long term recession rate has been neglected.

6.1.2 Sea Level Rise Recession

The prognosis for a future sea level rise, as a result of global warming, could increase the rate of long term recession. Estimated sea level rise scenarios in line with the NSW Sea Level Rise Policy Statement, indicate a potential sea level rise of 0.40 m by 2050, and 0.90 m by 2100. This led to an "upper range" assessment of beach recession of 23.3 –

28.7 m by 2050 at Scotts Head, 34.2 - 38.7 m by 2050 at Nambucca Heads and 40.0 – 42.7 m by 2050 at Valla Beach. By 2100, beach recession could reach 52.5 – 64.6 m at Scotts Head, 77.0 - 87.0 m at Nambucca Heads and 90 – 96 m at Valla Beach. These values differ from beach to beach as a result of the range of active beach profile slopes. It is possible that these estimates are conservative, as the assumptions inherent in the Bruun analysis do not take account of the presence of underlying rock strata within the dune areas.

6.1.3 Risk Assessment

At Scotts Head, for the 2050 planning period, it was found that, based on the hazard parameters adopted, parts of the caravan park and the SLSC are at risk from beach erosion. For the 2100 planning period, the roadway of Banksia Crescent, one dwelling and three lots may be affected by future storm erosion. The *Zone of Reduced Foundation capacity* crosses the bowling green and the seaward boundary of the Christian Youth Centre.

At Nambucca Heads, for the 2050 planning period, it was found that, based on the hazard parameters adopted, no private properties are at risk. Main Beach SLSC and Beilbys Beach carpark lie within the *Zone of Slope Adjustment* and the roadway of Swimming Creek Road lies within the *Zone of Reduced Foundation Capacity*. The seawalls at Shelly and Main Beaches are at risk of damage or failure in a large storm due to their construction not meeting contemporary coastal engineering standards, which could lead to damage at the carparks. For the 2100 planning period, in addition to Main Beach SLSC and Beilbys carpark, four dwellings and Swimming Creek Road lie partially within the *Zone of Slope Adjustment* and three more dwellings are partially within the *Zone of Reduced Foundation Capacity.*

At Valla Beach, for both the 2050 and 2100 planning periods, no dwelling is at risk and the only infrastructure which may suffer damage due to coastal hazards is the carpark and amenities block at South Valla Beach. However, overwash of the dune south of the entrance to Deep Creek may be possible by 2050, if the volume of sand store is reduced due to future sea level rise. This could cause breakthrough of Deep Creek south of its present location and threaten the footbridge. By 2100, the morphology of the entrance to Deep Creek could change, as the dune separating the river from the ocean could be completely eroded under the action of the sea level rise. This would expose the current foreshore of Deep Creek to an open coast wave climate, putting existing infrastructure such as the Valla Park Resort at risk from erosion and wave inundation.

Infrastructure at Valla Beach which is currently at risk includes the carpark and toilet block at South Valla Beach. Estuary entrance instability hazard is relevant only for the berm zone within the 500m south of Valla Headland, this zone being outside the existing urban developed area.

6.1.4 Inundation

Wave runup analysis at Valla Beach for the design storm has indicated that runup levels would not pose an inundation hazard to any properties as the embankment height is above the maximum runup value of 6.0m AHD. However, overwash of the berm area into the 500m where the river entrance is oscillating over the year, would occur on a relatively frequent basis. This could lead to damage to the existing carpark and seawall due to wave attack.

At Nambucca Heads, estuary entrance instability hazard is relevant only for the berm zone around the existing river entrance, this zone being outside the existing urban developed area. Wave penetration into the estuary entrance is possible when the entrance is open, causing erosion of areas within the lower estuary (such as at Bellwood Park picnic area). Under the right conditions, ocean waves up to 0.9 m in height could penetrate into the lower estuary (through the “hole” in the breakwall) at Wellington Drive, and waves up to 0.5 m in height could reach Bellwood Park, if the entrance is open and the ocean water level is high enough. Wave heights at Bellwood Park and Wellington Drive are independent of the offshore wave height – the above wave heights could occur even under average ocean wave conditions if the ocean water level is high enough and the entrance scoured deeply enough. Wave runup under these conditions would inundate parts of Wellington Drive and Riverside Drive.

Wave overtopping of the breakwater between the V-wall and Wellington Rocks is a coastal hazard in large storms. This wave overtopping has the potential to cause a hazard to pedestrians using the walkway behind the wall, as well as cause flooding of low-lying parts of the Caravan Park and carpark near the V-wall.

At Scotts Head, wave runup analysis for the design storm has indicated that the only area that would most likely experience inundation due to wave runup would be the SLSC. Wave inundation may also impact the carpark adjacent to the surf club, which may also affect the adjacent caravan park. Wave runup levels would not pose an inundation hazard to any other properties as the embankment height is higher than the predicted maximum runup level.

At the open coast beaches of Nambucca Heads, wave runup analysis for the design storm has indicated that runup levels would not pose an inundation hazard to any private properties as the embankment height is higher than the runup level. However, overwash of the berm area south of the river entrance would occur on a relatively frequent basis, and coastal inundation of low-lying areas around Wellington Drive may be possible due to penetration of storm surge and storm waves into the lower Nambucca River. Wave runup would also impact Main Beach SLSC, and the carparks of Shelly, Beilbys and Main Beaches.

Parts of the roadway of Wellington Drive and Riverside Drive would be inundated by wave runup under a combination of scoured estuary entrance conditions and high ocean water levels. The carpark and pedestrian walkway behind the V-wall are subject to wave overtopping from the breakwall during a large storm, with wave overtopping posing an inundation hazard to low-lying areas such as the White Albatross Caravan Park. This area could be isolated with no external access by coastal inundation for several hours as a result of a large storm event.

Wave overtopping of the breakwall at Wellington Rocks would increase in frequency and severity as a result of sea level rise due to climate change, and inundation events of the carpark, Caravan Park, Wellington Drive and Bellwood Park areas would be expected to increase in frequency.

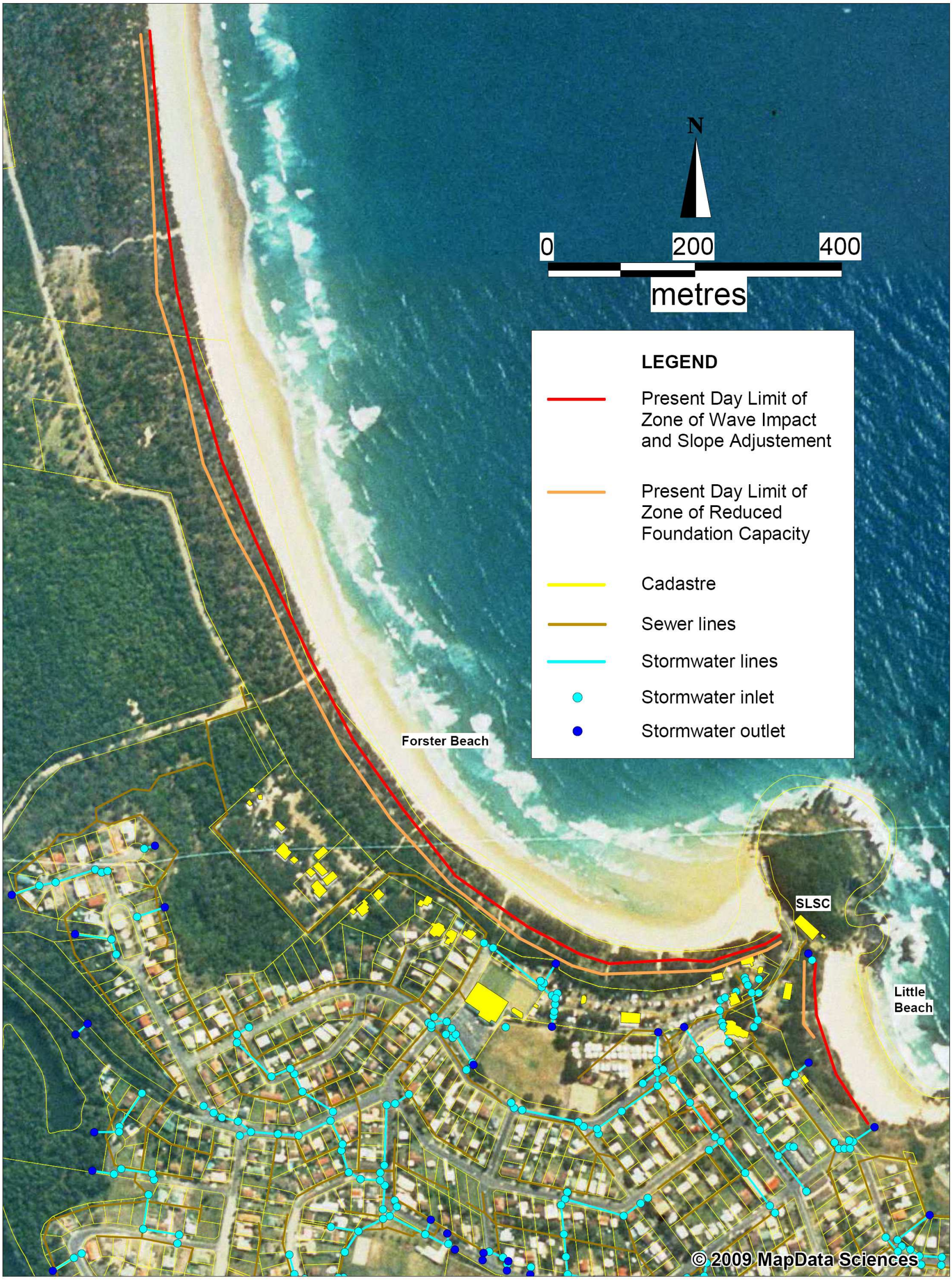


Figure 6.1 – Immediate Hazard Zones, Scotts Head (2100 hazard zones with no sea level rise)

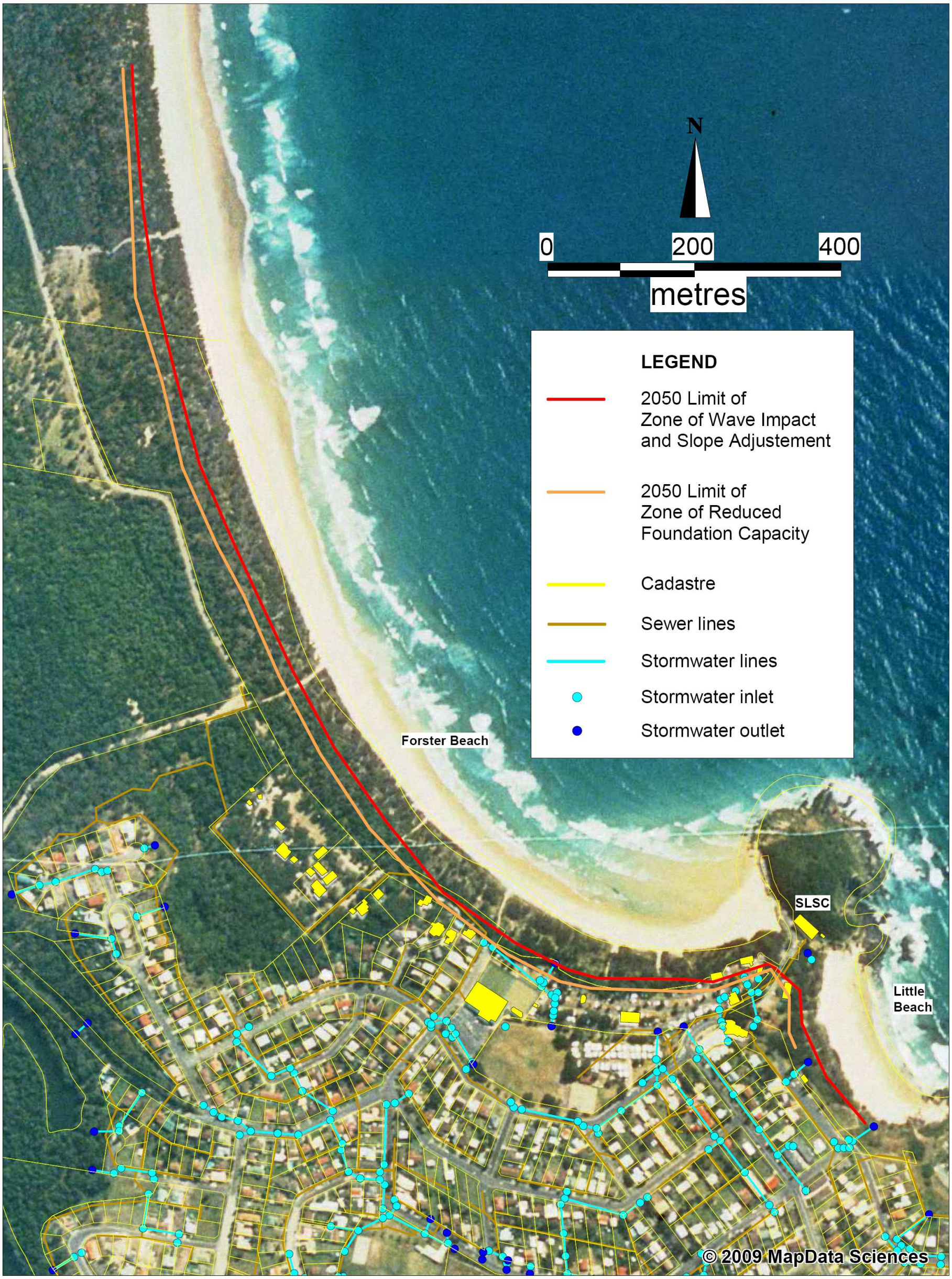


Figure 6.2 – 2050 Hazard Zones, Scotts Head

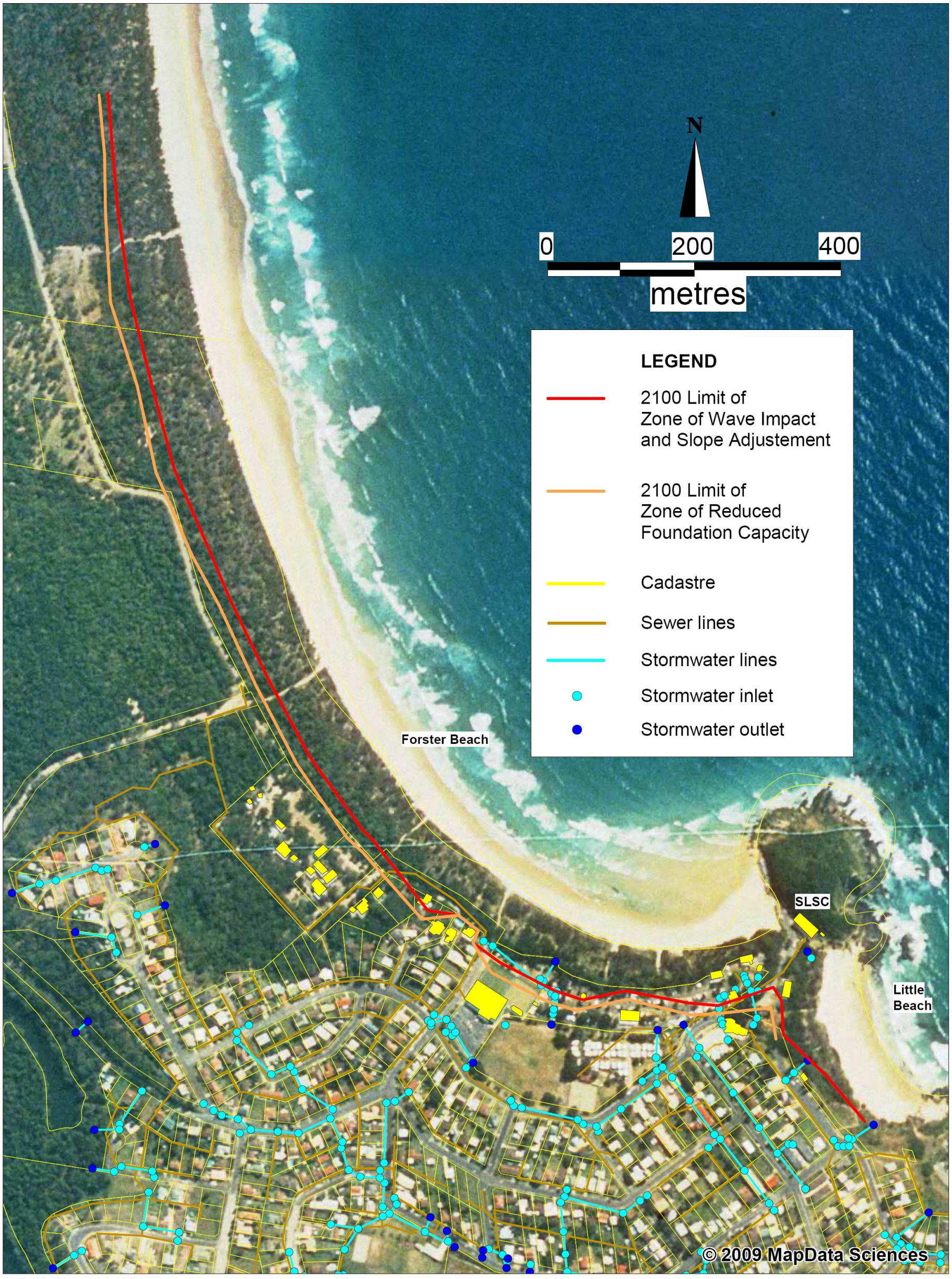


Figure 6.3 – 2100 Hazard Zones, Scotts Head (with sea level rise)

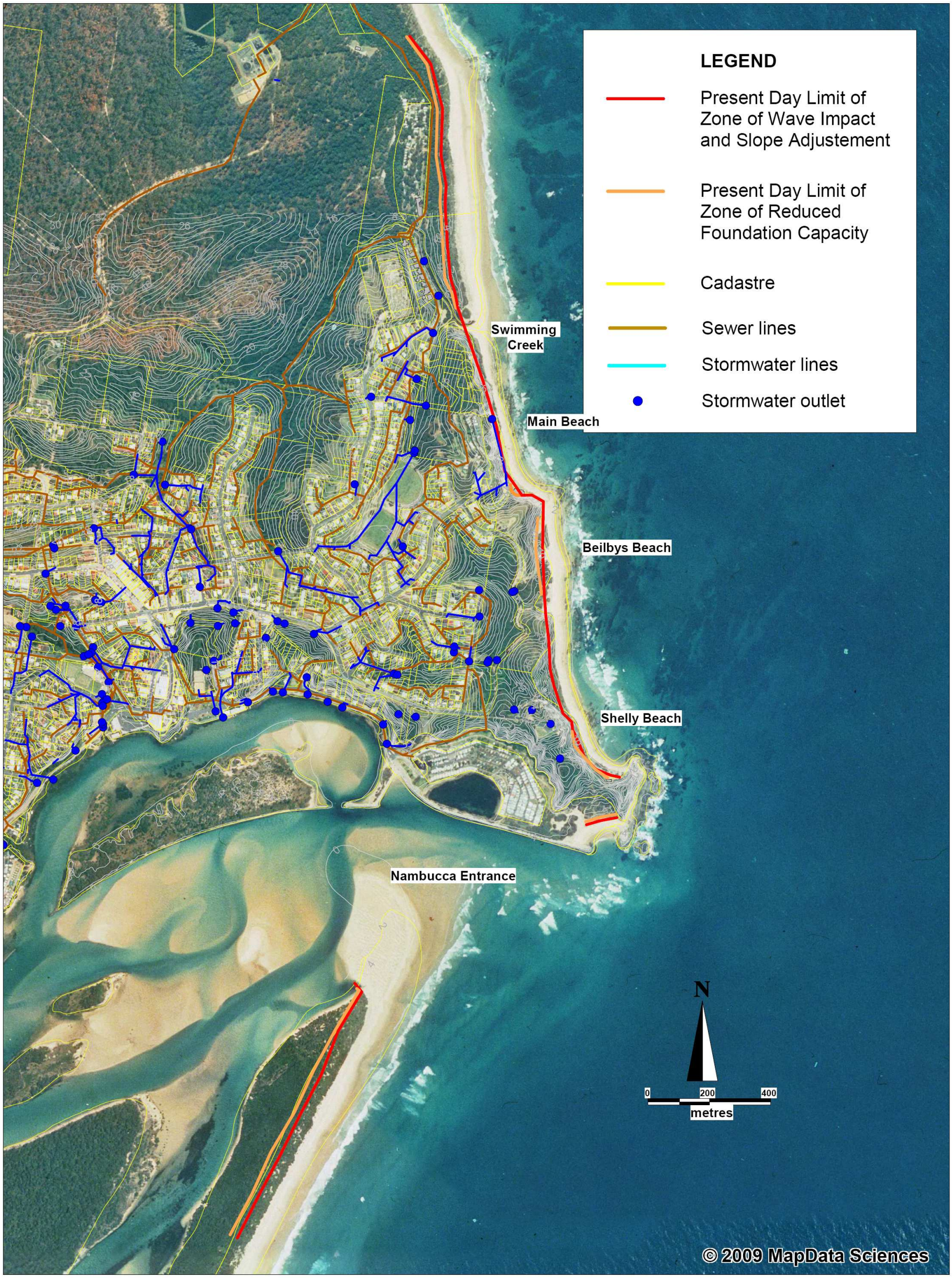


Figure 6.4 – Present Day Hazard Zones, Nambucca Heads (2100 hazard zones with no sea level rise)

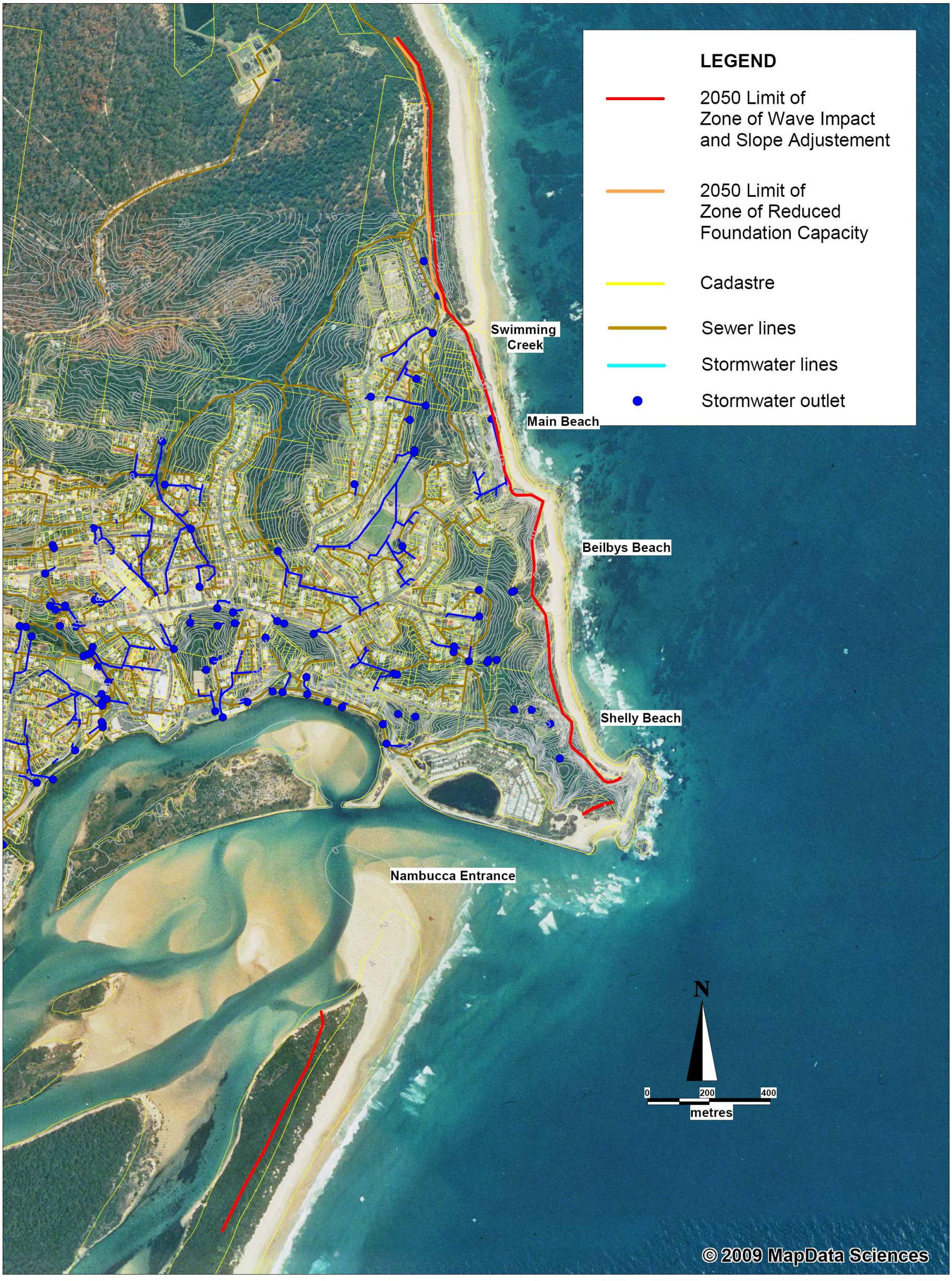


Figure 6.5 – 2050 Hazard Zones, Nambucca Heads

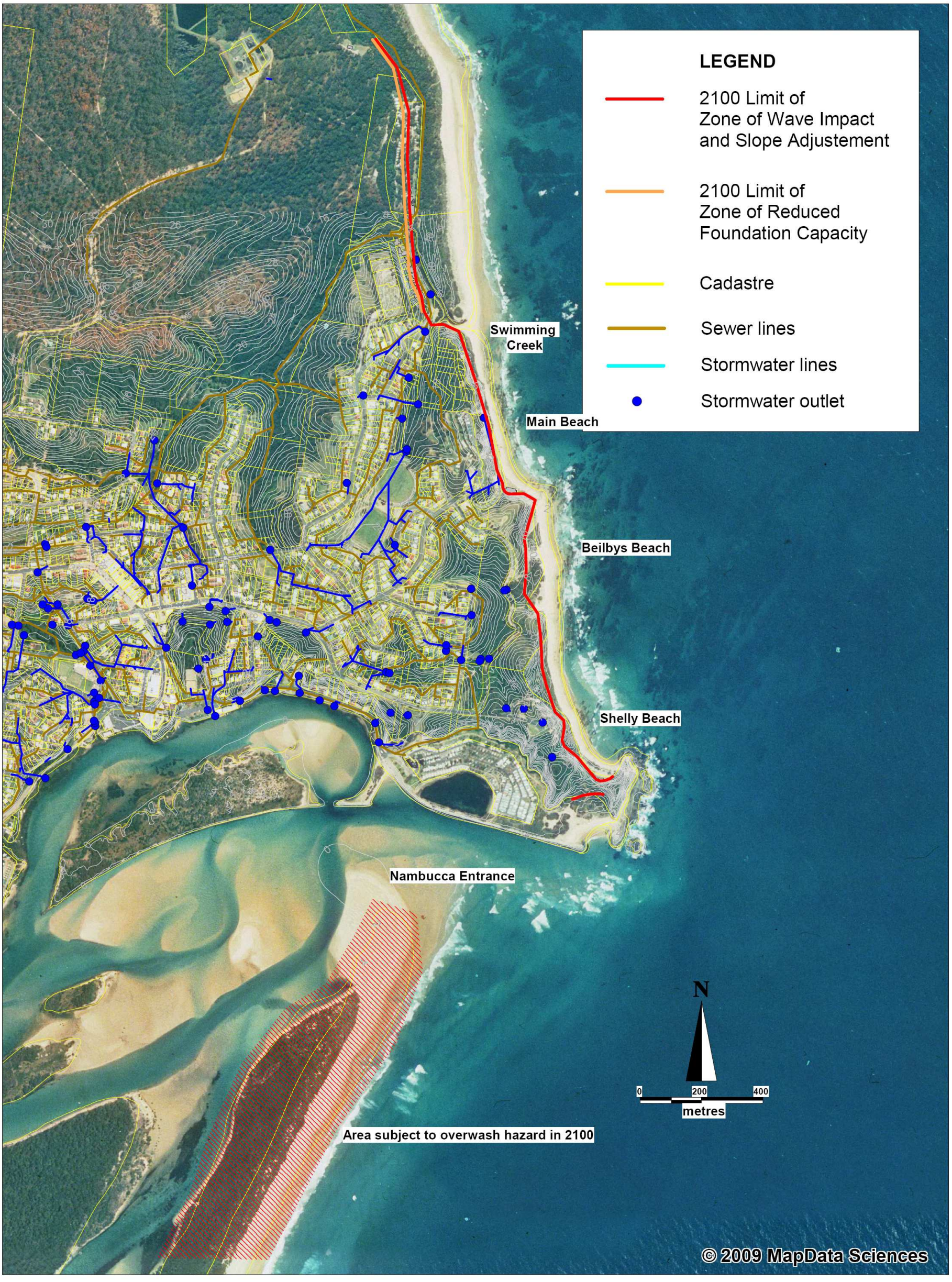


Figure 6.6 – 2100 Hazard Zones, Nambucca Heads (with sea level rise)

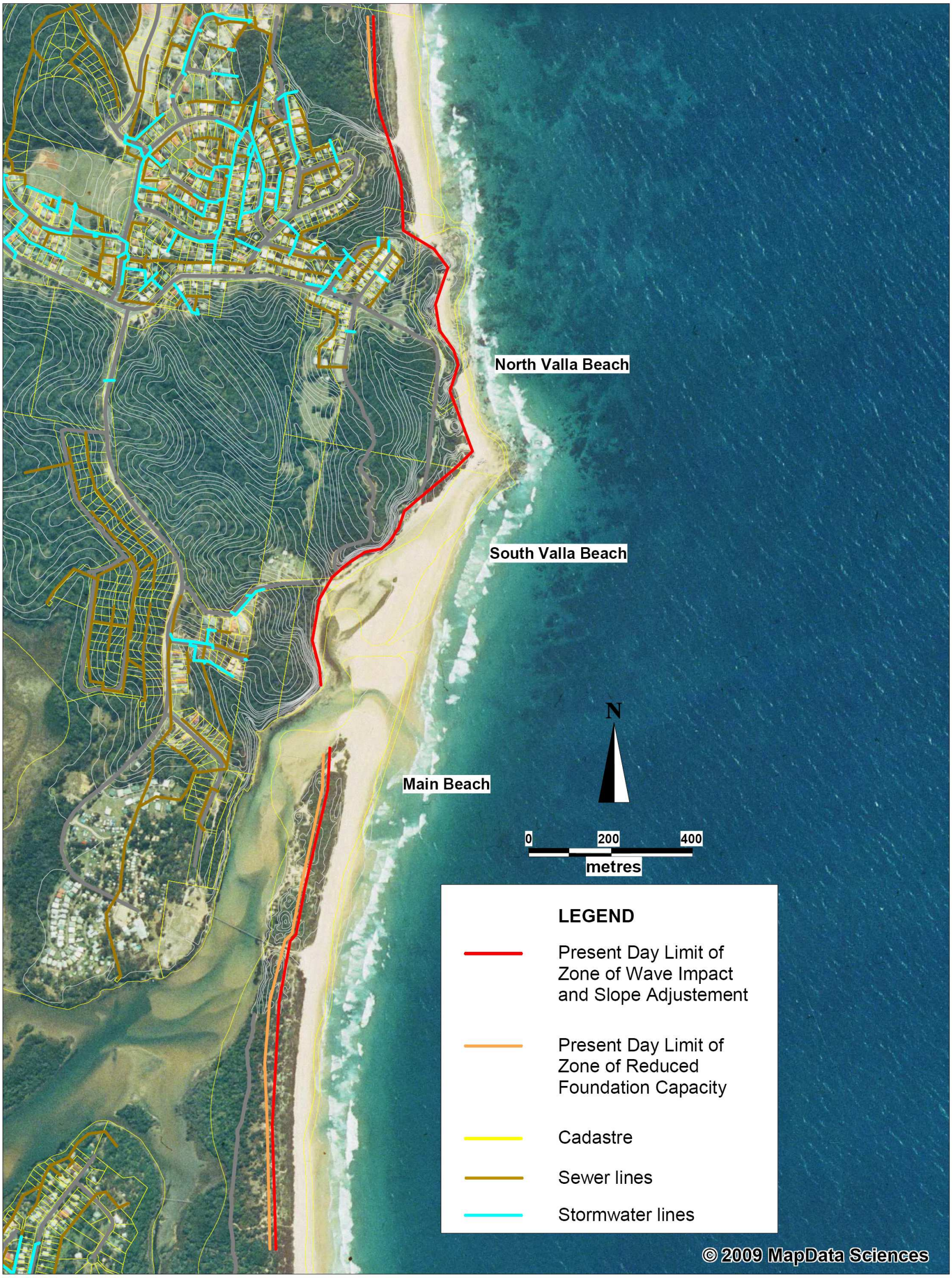


Figure 6.7 – Present Day Hazard Zones, Valla Beach (2100 hazard zones with no sea level rise)

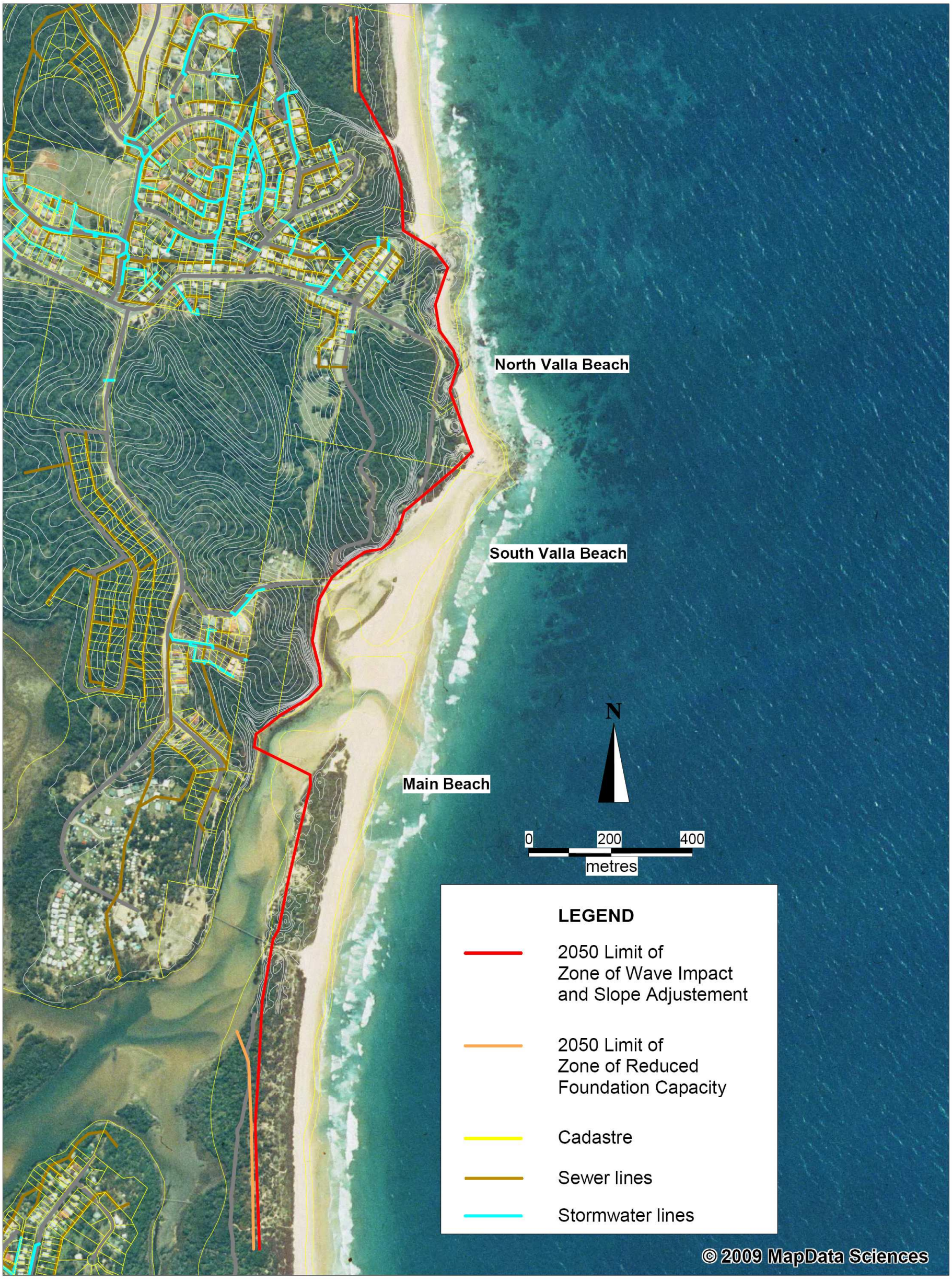


Figure 6.8 – 2050 Hazard Zones, Valla Beach

Figure 6.9 - 2100 Hazard Zones, Valla Beach (with sea level rise)

6.2 Preliminary Recommendations

The recommendations provided herein are preliminary only, and subject to detailed study in the Management Study phase of the project.

It is recommended that Council proceed with the Coastal Management Study and Plan for the Nambucca LGA in accordance with the procedure in the NSW Government's Coastline Management Manual (1990), NSW Coastal Policy 1997 and requirements of the Coastal Protection Act 1979 with the following objectives:

- Council not approve applications for new development or redevelopment of existing allotments forward of the 2050 limit of the *Zone of Slope Adjustment*.

- Council require that new development, located within the 2100 *Zone of Reduced Foundation Capacity*, be on pier foundations designed to transfer the building loads into the *Stable Foundation Zone* for the 2100 planning period, and that Council develop an appropriate standard pier specification as a Consent Condition for new development. An example pier specification is provided in Figure 6.10.

- Council include the 2050 and 2100 limits of the *Stable Foundation Zone* on the Section 149 Certificates where relevant to inform residents of the potential coastal hazard risk at each site.

- Council monitor and maintain the seawall fronting the Surf Club at Scotts Head and should it be damaged in future storms, reconstruct it to an appropriate engineering standard, to prevent damage to the surf club and carpark.

- Council undertake a study of the regional drainage catchment leading to the stormwater outlet at the southern end of Forster Beach adjacent to the Surf Club at Scotts Head, to define volumes and peak discharges for the stormwater drain. This would allow various management options to be investigated (such as energy dissipation, stormwater detention, diversion to adjacent catchments) which would reduce the stormwater erosion hazard at this outlet and allow the stormwater system to function more effectively.

- Council reconstruct the seawalls at Shelly and Main beaches to an appropriate engineering standard (as presented in Figure 3.6), to prevent erosion damage to the carparks of these areas

- Council conduct maintenance of the existing reserve at Bellwood Park following wave erosion when the river entrance is open, and Council consider improving the existing embankment protection to better withstand a large wave event.

- Council consider the implications of wave penetration in the lower Nambucca estuary as presented in Section 4 when developing the Nambucca River Masterplan for the lower estuary

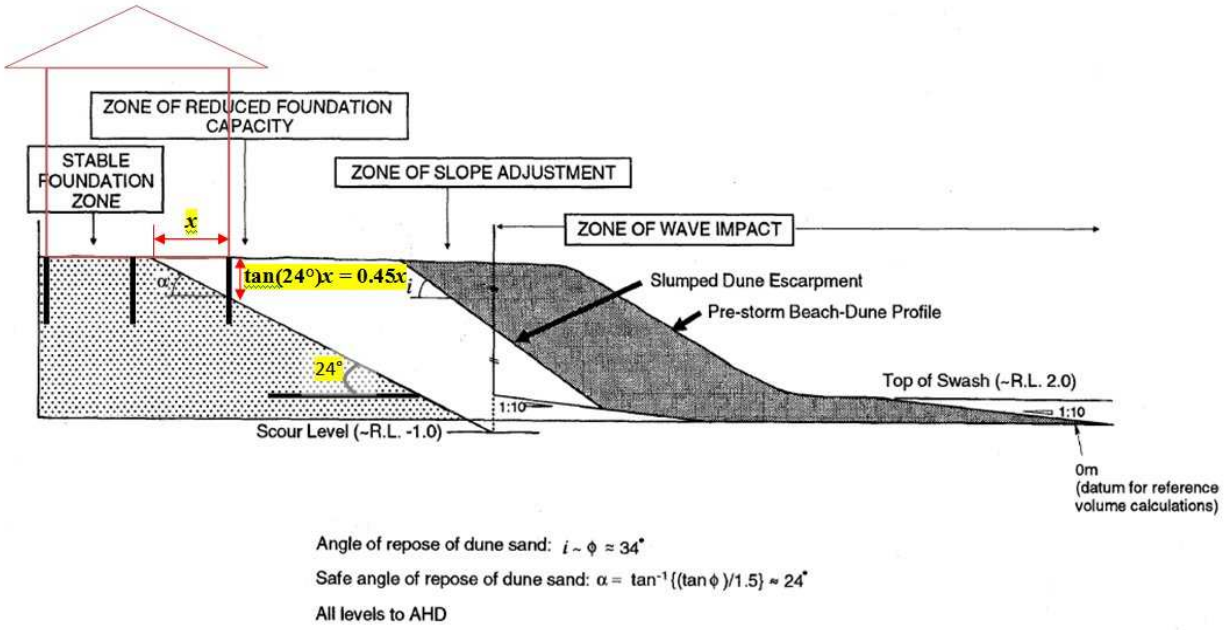
- Council reconstruct the seawall at South Valla Beach to provide effective protection against future realignment of the creek entrance and wave attack. The rock wall should be underlain by a geotextile layer to prevent failure due to erosion of fine material through the wall

- Council maintain dune management for the dune south of Deep Creek entrance to prevent the dune destabilising due to wind erosion. Council should monitor the level of this dune to reduce the risk of breakthrough of a new entrance of Deep Creek. It is considered that a dune level of 7m AHD would be sufficient to prevent breakthrough.

- Council monitor the existing footbridge at Deep Creek, particularly scour around the piers, to ensure bridge stability. If the bridge becomes unstable, new piles should be driven to sufficient depth to protect against scour.

- The quantification of the erosion hazard be re-assessed every 10 years, based on the continuing collection of empirical data and on the more advanced analysis techniques that will become available in the future. This would include incorporating the results of recent mapping of offshore reefs by DECC&W to improve estimates the long term recession due to sea level rise.

- Where sewer or water infrastructure is under direct threat from coastal erosion within the 2050 planning period, consideration be given to relocating that infrastructure.



Draft Coastal Engineering Planning Controls

Within 2100 Stable Foundation Zone (SFZ) –

- no coastal engineering constraints

Within 2100 Zone of Reduced Foundation Capacity (ZRFC) –

- Refer to above diagram
- New development to be on piles extending into the Stable Foundation Zone. Depth of piles is given by **0.45 *x*** where ***x*** is the horizontal distance seaward of the landward boundary of the Zone of Reduced Foundation Capacity
- For additions or alterations no building footprints to extend seaward of existing footprint
- Minor development allowed under Exempt & Complying Development (SEPP) (i.e. interior renovations, sheds, decking etc.)

Within 2050 Zone of Wave Impact and Slope Adjustment (ZWISA) -

- No development allowed within Zone of Wave Impact and Slope Adjustment except for development covered under Exempt & Complying Development (SEPP) (ie. interior renovations, outdoor sheds, decking etc.)

Figure 6.10 – Potential Coastal Engineering Development Controls for inclusion into draft Nambucca Shire DCP

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