

# Environmental Impact Assessment of proposed seawall construction at Pukusrik

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## Introduction

This brief Environmental Impact Assessment (EIA) has been prepared for the Development Review Commission Board (DRC) to assist their consideration of an application for a Development Permit to reclaim part of the beach and reef flat, and associated seawall construction at Pukusrik.

The applicant proposes to reclaim an approximate 20 ft width of beach over the entire length (170 ft) of land plot Lot 033 K28, with flanking walls extending onto the land plots to the north and south (see Figure 1 below). The reclamation is bounded on its seaward flanks by a 3 ft high rock revetment with a 1 in 1 seaward slope. The plans submitted to the DRC show the elevation of the reclamation surface (and crest of the revetment) to be lower than that of the natural beach crest, with the toe of the revetment founded in the sand beach and not down to the solid reef flat substrate.

## Overview of the Pukusrik coastline

The eastern facing Pukusrik coastline is one of the most exposed sections of coast on Kosrae being exposed to dominant north-east wave conditions all year round. The coastline is concave in shape and is characterised by an outer coral reef, a fringing reef flat, a narrow storm berm that runs parallel with the outer reef, and, between the storm berm and the volcanic part of the island, an extensive area of intertidal mangroves which drains in to Lelu Harbour to the south. The circumferential road and a number of residential properties are located on the narrow coastal berm.

The fringing reef is relatively narrow being around 190m in width at the promontory in front of the Pheonix Resort, reducing to around 110m further south. The reef flat is covered by a large volume of superficial coral rubble, which is an important component in reducing wave energy translating over the reef flat and reaching the beach.

The present day coastal berm is a relic feature attributable to the climatic conditions experienced on Kosrae over the last 3000 – 4000 years. However, under present day conditions the narrow width of reef along much of the eastern coast is less effective at dissipating wave energy than wider reef flat areas, and also produces little sediment to replenish the existing beach. As such the eastern coastline of Kosrae is experiencing a long-term retreat as it attempts to reach a balance between the present day reef morphology, sediment budget (the gains and losses of beach sediment on a coastline), and hydraulic processes. The rate of this erosion is being exacerbated by the removal of sand from the beach for construction projects, which is an ongoing problem along much of the eastern coast, and the ongoing impacts caused by previous removal (1950's – 1980's) of coral rubble from sections of the reef flat on the east coast.

With the exception of the concrete seawall protecting the Pheonix Resort to the north, the coast is free of coastal defences or other human structures. The lack of such structures has been an important factor in limiting the overall rate of erosion along this coast as, with the exception of sand mining and coral rubble removal, the entire coastline has been allowed to evolve in a relatively natural manner along its entire length without any localised exacerbation.

The dominance of wave conditions from the north-east quadrant would be expected to result in a net southerly longshore movement of beach sediment along the eastern coast. However, the promontory, and shallow sloping reef terrace to the immediate north of Pukusrik (in front of the Pheonix Resort) shelters this coast somewhat from waves from the north-east which are focussed by the promontory.

As a result wave conditions at Pukusrik tend to be heavily refracted and translate over the reef approximately parallel to the beach with it being debatable whether there is any significant net longshore transport to the south.

### **Assessment of potential environmental impacts**

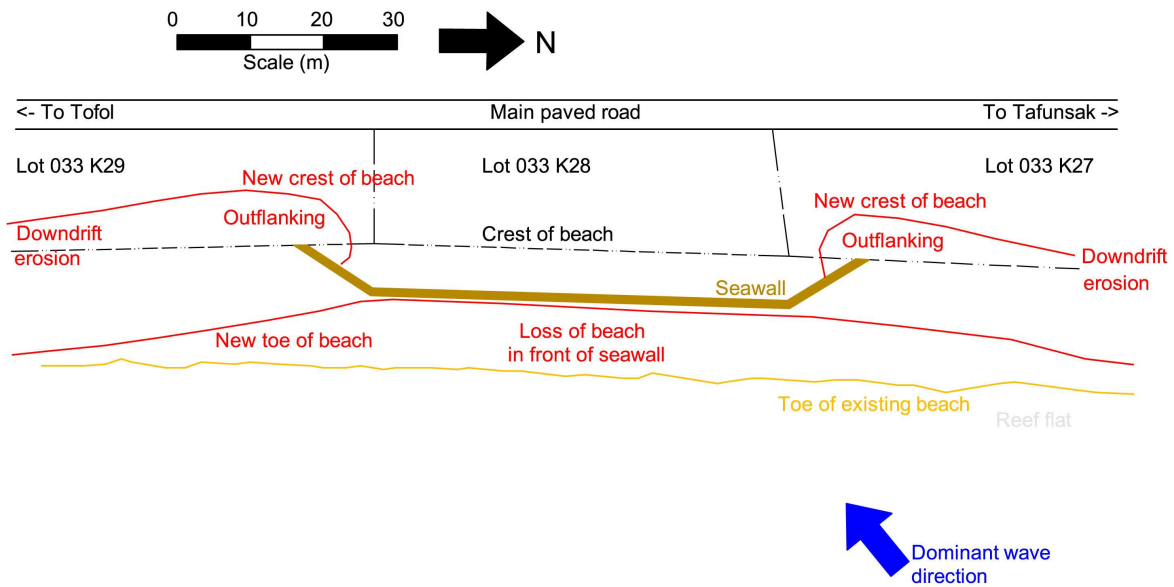
Any construction activities on the coastline have the potential for considerable environmental impacts. This is even more of an issue on a coastline such as that at Pukusrik, where the coastal berm is narrow and could potentially breach if localised erosion effects were exacerbated.

The environmental impacts of constructing seawalls, reclamations and other structures over the beach are well known. The main effects are summarised in the schematic plan shown in Figure 1 and the proposed reclamation profile shown in Figure 2 (the beach profile has been taken from the latest DRC beach profile survey of November 2003 for the closest beach profile to the site). These effects include:

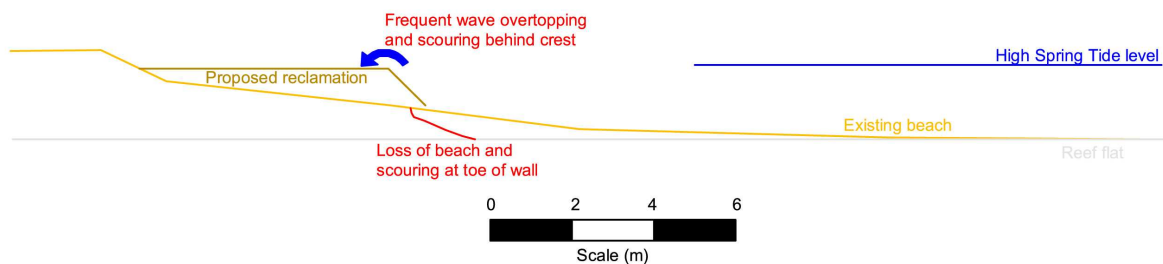
1. Where hard structures such as seawalls are constructed on a beach, it can result in a loss of beach in front of the defence. This is due to waves during high tides being reflected back off the seawall resulting in the beach sand being transported seaward, increasing the potential for it to be lost over the seaward edge of the reef. Whilst a sloping rock revetment does not reflect waves as much as a vertical concrete wall, it will still have an impact. The loss of beach in front of seawalls can be seen at many places on Kosrae including Malem village, Lelu Island and in front of the seawall at the Pheonix Resort.
2. Associated with this loss of beach in front of the defence is outflanking or exacerbated erosion at the ends of the defence. Where there is a strong transport of sand along beach due to wave action, this can cause a build up of sand on one side (the updrift side) and exacerbated erosion on the downdrift side (downdrift erosion). The net movement of sand is likely to be to the south along this section of the Pukusrik coast, hence the coastline to the south would likely experience the most severe erosion. However, as any longshore sand movements are likely to be minimal, there may also be exacerbated erosion to the north. Downdrift erosion effects are also seen at many places on Kosrae, the most apparent being the previous erosion problem at Sandy Beach Hotel

It is difficult to say how far either side of the defence erosion is likely to be exacerbated or how much erosion will occur. However, given the proximity of the circumferential road, and the narrow nature of the coastal berm, there is no scope for accommodating this erosion without significantly increasing the risk to the circumferential road and land to the north and south of the proposed seawall.

3. The soil used on Kosrae for landfilling and reclamation is typically a fine silty loam. The introduction of terrestrial material to the marine environment can cause detrimental environmental impacts due to an increase in suspended sediment concentrations within the water column. This can impact on corals and seagrass and other reef organisms, particularly if the suspended sediment concentrations persist over a long period of time, or the sediment settles out and covers the coral or seagrass beds. Whilst the reclamation is not large, the measures taken are inadequate (see below) to prevent the soil being winnowed out and entering the nearshore region and may well cause some localised impacts.



**Figure 1:** Plan showing proposed reclamation and likely environmental impacts



**Figure 2:** Profile of reclamation showing likely environmental impacts

The proposed seawall construction also gives great cause for concern. Based on the design submitted the seawall is unlikely to be sufficient to withstand the wave conditions experienced along this section of coast and will likely experience significant damage with a short space of time following construction. Specifically:

1. The design suggests that the toe of the rock wall will be founded on the lower part of the sand beach. With loss of sand in front of the defence, it is likely that the sand underneath the rock will scour out within a few months of construction causing the defence to subside or collapse. This will reduce the protection afforded to the reclamation result in damage and loss of terrestrial soils used for the reclamation to the marine environment.
2. The design also suggests that the elevation of the crest of the wall to be lower than the elevation of the existing natural beach crest. This suggests that the crest of the sea wall will be barely above the level of a Mean High Spring Tide. Wave overtopping of the defence will be significant and likely to occur frequently. This will result in erosion / damage to the reclamation surface (even if it is concreted) and potential wave damage and inundation to any structure located on it. The lack of a properly designed crest for the rock revetment will also contribute to the potential for damage both to the rock revetment structure and reclamation behind it.

3. The design does not suggest that the rock armour size or placement would be sufficient to withstand storm wave conditions likely to be experienced on this coastline. The design would also require a much more detailed filter layer for such an environment. Filter cloth behind the proposed rock armour layer would not be expected to last long resulting in loss of a significant amount of the reclamation material through the voids in the rock armour

The rock revetment that protects Tafunsak village is an example of a properly designed rock revetment (in terms of engineering performance) appropriate to the wave and water level conditions experienced on Kosrae. This proposed defence is a much less substantial structure than that at Tafunsak and one that is certainly far from adequate for the conditions likely to be experienced.

### **Conclusions and recommendations**

A common response to the threats of coastal hazards such as coastal erosion is to build sea walls or other form of coastal defense. On Kosrae this approach has failed to resolve many of the erosion problems and in a number of places made the problem worse. Economic constraints have resulted in many inadequate sea walls (such as around Lelu island, Malem, Utwe and parts of Walung), which provide a very low standard of protection to the land behind from the effects of coastal hazards such as storm damage.

The construction of piecemeal coastal defense structures or land reclamation over the beach region is a key threat to the beach and the shoreline areas of Kosrae, which will limit their effectiveness as a part of the natural coastal defense and lead to further, exacerbated long term coastal erosion. This is particularly the case along the Pukusrik coast where the natural resilience of the coastal system is in part due to the lack of engineered structures and limited other human impacts along this section of coast.

Developing land so close to the beach on one of the most exposed sections of the coastline on Kosrae will result in a very high level of risk to the reclamation and any property located on it from storm damage. Development such as this only increases the magnitude of the overall risks of coastal hazards to the people, property and infrastructure on Kosrae. In the long term a fundamental approach to reduce such risks is to discourage development so close to the coastline, and to slowly encourage landward retreat from the coast through the construction on new property and infrastructure away from the immediate shoreline.

If the proposed defence were to proceed, this would set a very dangerous precedence for other landowners along this section of coast to construct coastal defences. If further such seawalls were allowed to be constructed this would seriously destabilise this narrow and sensitive stretch of coast.

In summary the proposed reclamation and construction of a coastal defence has considerable potential to cause detrimental impacts to the adjacent coastline at Pukushrik, and is inadequately designed to withstand the wave conditions experienced on this coastline leading to a very high risk of damage to the reclamation and any property built on, or immediately landward, of the reclamation.

The DRC has spent much time and effort trying to raise awareness that developing land so close to the coastline exposed sections of the coastline on Kosrae will result in a very high level of risk to the property from storm damage or coastal flooding. This emphasis needs to continue through appropriate consideration of such development permit applications by the DRC Board, continued public education activities by the DRC staff, and the continued implementation of improved land use planning practices and policies, such as the land use plan.

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