FOGAFALE LAGOON SHORE RECLAMATION, TUVALU

Preliminary Environmental Assessment

TCAP - Tuvalu Coastal Adaptation Project

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Cover page photographs from top left:

1. The reality of central Fogafale's lagoon shore in 2019, WWII machinery and the results of US military engineering continue to dominate large parts of this shoreline.
2. Lack of space leads to buildings being placed too close to the waterline and chronic erosion results in subsequent damage during storms. Reactionary, piece-meal efforts to hold the shoreline position dominate – in this case dumping waste concrete.
3. The seaward edge (volcanic rock revetment) of the recently built Queen Elizabeth Park reclamation.
4. The Fogafale lagoon marine environment is chronically eutrophic and standing thickets of invasive macroalgae now dominate. Kaly and Peacock (2014) refer to the zone up to 1.5km seaward of the shore as "*the zone of dead corals and eutrophication*" and state in their comprehensive EIA for dredging in this area "*Given the damage already done to this area, there is little risk of further damage to reefs during the relatively short duration of dredging (1-2 years)"*.

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EXECUTIVE SUMMARY

The Tuvalu Coastal Adaptation Project (TCAP), funded by the Green Climate Fund (GCF), is being implemented by the United Nations Development Programme (UNDP) in close partnership with the Government of Tuvalu (Department of Climate Change and Disaster).

Funding for TCAP was approved by GCF in June 2016. Implementation of TCAP commenced in August 2017. In the time between project design (2015/16) and the commencement of implementation, conditions at the Fogafale shoreline site significantly changed. This required a reconsideration of the proposed interventions as the originally envisaged seawalls were no longer the optimal solution for the site.

A number of options were considered with a view to continuing to fulfil the TCAP objective of reducing the vulnerability to coastal inundation and erosion. The preferred option identified is to directly replace and protect approximately 780m of lagoon shoreline in the Central Fogafale area through reclamation. However, by integrating TCAP proposed works with the recent government investment (post original TCAP design) in foreshore protection at this location, a combined total of 1,100m will be protected.

The works will involve the construction of a rock revetment wall approximately 100m from the existing shoreline and, using sand dredged from within the lagoon, fill the void behind the revetment. The reclamation, approximately 7.8 ha in area, will be built up to a height that provides both usable land, protection from lagoon-side waves and a refuge for islanders during cyclones.

Almost half of the area within the proposed reclamation footprint has been previously disturbed as a result of engineering works, particularly the major modifications made during WWII that saw dredging, construction and reclamation in this area. Longshore drift, and the supply of sediment to the area, has also been significantly impacted by engineering works that closed of channels to the oceanside.

The sand resource to be dredged has been previously studied and characterised and has successfully been used for other projects. The total volume required for TCAP is approximately 350,000m^3 from a resource that has been estimated to be approximately 24 million m^3.

Current velocities in the project area are very low. Sediment transport is minimal due to lack of supply and low current velocities. Modelling has shown that the proposed reclamation will not have any significant impact on the hydrodynamics of the site. The low velocities will also minimise the spread of any plumes caused by dredging.

The marine ecology of both the dredge area and the proposed reclamation area has also been previously studied. Both the sand resource area and the nearshore zone are depauperate in terms of aquatic ecology. The nearshore zone has been extensively disturbed and continues to be adversely impacted by chronic contamination. Ecological surveys of the area indicated that coral that was once there is now all dead and are now dominated by algae (symptomatic of eutrophication).

This Preliminary Environmental Assessment (PEA) summarises the proposed works, documents the baseline conditions and assesses the likely environmental and social impacts. The PEA considers potential mitigation measures and residual risks. Overall, the PEA has determined that the potential impacts are of a moderate risk and that impacts can be managed to an acceptable level.

TCAP has committed to preparing a full Environmental and Social Impact Assessment (ESIA) for the project. Draft Terms of Reference for the ESIA are provided in the PEA.

1 INTRODUCTION

1.1 BACKGROUND

1. The Tuvalu Coastal Adaptation Project (TCAP), funded by the Green Climate Fund (GCF), is being implemented by the United Nations Development Programme (UNDP) in close partnership with the Government of Tuvalu (Department of Climate Change and Disaster).

2. TCAP is designed to implement substantive coastal infrastructure works on Fogafale in Funafuti Atoll and two outer islands (Nanumea and Nanumaga). About 55% of the total population of Tuvalu live in Fogafale. The two outer islands are small rural communities and have a combined population of less than 800 people and it follows that given TCAP's ambitious national goals in respect to total number of people receiving improved protection, careful consideration must be given to achieving an effective result in Fogafale where such a large proportion of the population reside.

3. The TCAP was approved by GCF in June 2016 and implementation began in August 2017. As described in detail in the TCAP Report *Evaluation of priorities and options to address coastal hazards in Fogafale* (March 2018), significant changes occurred on the Fogafale lagoon shore between the time of project design (2015/16) and the start of project implementation. These changes meant that the original foreshore seawall approaches considered in the TCAP Funding Proposal required review to ensure they continued to be an appropriate response particularly in the central Fogafale area.

4. In 2018, the TCAP Project Management Unit (PMU) reviewed the situation on this shore and held multi-stakeholder meetings to discuss options and conceptual plans for the Fogafale coastal works. TCAP was also made aware of bilateral work between the GoT and the Government of the Republic of Korea to develop a "Foreshore Master Plan" for the same location.

5. The bilateral Foreshore Master Plan was presented to GoT, TCAP PMU and other stakeholders in May 2018. The Plan included offshore breakwaters for foreshore protection. The outcome of these presentations was that there was no local consensus regarding the adoption of the Plan. Local stakeholders requested the incorporation of reclamation into the Master Plan, not just foreshore protection, which aligned with feedback received by the TCAP team during its 2018 scoping work whereby local stakeholders had strong views regarding the applicability of the originally envisaged TCAP seawalls and a large number of stakeholders indicated that TCAP must also consider strategic reclamation as a way to achieve foreshore protection in the central Fogafale area.

6. As a result of the above, the TCAP team investigated the feasibility of implementing limited (within existing TCAP budgets) reclamation and associated foreshore defense work on the central Fogafale lagoon shoreline. In September 2018, the TCAP team took its initial conceptual plans to Funafuti and held multi-stakeholder meetings with Government, Council and Community as well as key individuals. There was unanimous support for TCAP to pursue reclamation as tabled and these same plans were also endorsed by the TCAP Board in November 2018.

7. The revised scope for the Fogafale (reclamation) was assessed using the UNDP Social and Environmental Screening Procedure (UNDP 2016) and it was determined that the proposed reclamation plus foreshore defenses concept would have a moderate (Category B) risk rating, which is in line with the originally approved project.

8. The revised scope and its associated risk rating were discussed with GCF and background information provided. Based on information provided, GCF indicated that they would consider the revised scope of work for approval and requested that a desktop environmental assessment of the Fogafale Reclamation Project be undertaken.

9. This Preliminary Environmental Assessment has been prepared to meet GCF's request for a desktop assessment of the revised proposal for the Fogafale foreshore and as a pre-cursor to a full environmental and social impact assessment that will be undertaken as agreed once final design has been completed.

1.2 CONTEXT

10. Output 2 of TCAP indicates the "*Vulnerability of key coastal infrastructure is reduced against wave induced damages in Funafuti, Nanumea and Nanumaga*" and that approximately 60% of the national population will benefit from the mitigation of exposure to wave overtopping events. About 55% of the national population (about 6,000 people) and the largest build-up of infrastructure are situated on Fogafale Island of Funafuti, the national capital and only port of entry.

11. With a view to faithfully implementing Output 2, the TCAP team has undertaken extensive technical review and stakeholder consultations in Fogafale to develop its intended approach. The outcome of this work is that small scale reclamation combined with foreshore protection is the most appropriate approach to address the key TCAP proposal criteria "*Vulnerability of key coastal infrastructure is reduced against wave induced damages"*, and that specifically, seawalls without associated reclamation were rejected (both on technical merit and by the Funafuti stakeholders) for the main central, heavily populated, area of Fogafale.

12. Stakeholders also requested that TCAP assist to produce a consultative land use plan and strategy for the proposed reclamation to ensure its sustainable use. Local stakeholders expressed the view that the potential new land as public space and may include recreational areas, a community cyclone shelter which would be a dual-purpose facility (e.g. school, community hall) and as appropriate, potentially public housing may also be situated on the proposed reclamation. Plainly, implementing this next stage of development is beyond the remit or budget of TCAP; however, the TCAP team agrees to the strategic importance of developing an agreed, consultations driven, land use plan so that consensus is developed for the use of the area and the subsequent task of attracting funding for development made easier. This will allow the community goals to be realised.

1.2.1 Project Objectives and Need

1.2.1.1 Objective

13. The Project Objective will remain unchanged. In other words, the proposed reclamation would reduce the vulnerability to coastal inundation and erosion. However, it is important to note that the revised design enhances the impact potential of the project as it addresses marine hazard threats from the cyclone coast of Funafuti as well as the protected lagoon shore.

14. The revised proposal will directly replace and protect approximately 780m of lagoon shoreline in the Central Fogafale area. However, by integrating TCAP proposed works with the recent government investment (post original TCAP design) in foreshore protection at this location, a combined total of 1,100m will be protected.

15. The lagoon shore of Funafuti is a protected shallow water shore, and therefore, it is protected from open ocean swell and cyclone waves. The lagoon shore of Funafuti is not subject to life threatening, catastrophic wave overtopping but rather it is subject to regular (annual/seasonal) nuisance wave over topping. In contrast the oceanside shore of Fogafale is subject to catastrophic cyclone driven wave impacts which can be so severe that they cause flooding across the whole island.

16. SPC's (The Pacific Community) Marine Science Team undertook modelling at the request of TCAP to determine the potential return period for catastrophic cyclone landfall at Funafuti. A Cat 3 cyclone, equivalent to the last event (TC Bebe, 1971), which saw a catastrophic level of wave overtopping with water depths up to 1.5m of fast-moving water over the main runway and through much of the settled area of Fogafale, is estimated to be a 1 in 100 year event. However, this return frequency does not account for climate change and thus the frequency is expected to increase.

17. The revised design recognizes the full spectrum of marine hazards in Fogafale and that there is little, if any, "safe" land on Funafuti during catastrophic TC landfall. The revised proposal will provide safe, raised land on the shore furthest from the ocean-side deep water coast. By doing this, TCAP can provide "protection for people and infrastructure from the increasing wave intensity and the effects of future wave overtopping." A detailed technical description of the new infrastructure is contained in Section 2.

1.2.1.2 Need

18. As discussed, TCAP is tasked to protect over 60% of the population from the impacts of wave damage and reduce the vulnerability of key coastal infrastructure. The initial justification to protect this shoreline has already been established in the approved Funding Proposal, thus this work seeks to set out why the deviation and revised design is needed.

19. Because wave hazards in the context of Fogafale's built environment are in fact limited on the lagoon shoreline and are far more dangerous on the oceanside shoreline (see Figure 3), TCAP must consider the whole island's exposure profile. Wave impacts on the lagoon shore are mostly associated with westerly gales (more common during El Nino conditions) and if such gales occur in combination with high spring tides, localised marine flooding can occur on the lagoon shoreline. However, this form of flooding is not life threatening because the lagoon is shallow and surrounded by a continuous shoaling reef rim. Oceanic waves cannot enter the lagoon environment and waves of a life threating size do not occur on the lagoon shore of Fogafale.

Figure 1 Examples of localised flooding.

Left: Office workers in Fogafale (September 2018) pick their way through saltwater flooding. This form of flooding occurs because much of the land elevation in Fogafale is very low lying and already below sea level during routine high spring. Right: High tide mariine flooding alongside the airport runway and to the left of the picture, extensive flooding around the main powerhouse facility.

20. In comparison, cyclone waves which occasionally strike the oceanside coast of Fogafale can have a catastrophic impact to the entire island, and potentially over wash houses and infrastructure across the whole island (Figure 2). Thus, whilst less frequent, cyclone driven waves on the ocean side shore potentially have far more catastrophic implications on people, property and infrastructure in Fogafale. In contrast, the more frequently experienced flooding which occurs on the lagoon shore, is not life threatening and causes only limited damage to nearshore buildings or roads, etc. and any remedial or clean-up effort is of a far smaller scale.

21. The scale of engineering capable of preventing the impacts of cyclone wave attack on the oceanside coast is beyond the scope of TCAP design, budget or focus. TCAP can only directly consider marine hazards on the lagoon shore of Fogafale. However, it is difficult to ignore the potential impact of cyclone waves given the project intends to provide meaningful protection to a large proportion of the population. Seawalls on the lagoon shore as originally envisaged by TCAP do not take this reality into account.

Figure 2 Impact of cyclones.

The metrological office on Fogafale lays some 60m inland from the oceanside shoreline and was completely over washed by waves during Cyclone Bebe in 1972. (**left**) pre-cyclone and (**right**) post cyclone Bebe. Note the level of devastation in the background and wave swept debris scattered over the area source: http://www.janeresture.com/hurribebe/hurricanebebe2.htm.

22. Fongafale also suffers from being extremely low lying. This means large areas of the built environment are already below sea level at high spring tides and they are routinely and increasingly inundated with marine waters. This form of flooding is not usually a direct threat to life but as this phenomenon gets worse due to sea level rise in respect to depth, areal extent and frequency, the damage and inconvenience accrues. Ultimately, this form of flooding renders the land untenable for human use or development and there is no alternative but to seek higher safe ground (of which there is none on Fogafale).

23. Permeable seawalls (as originally conceived by TCAP) can only stabilise shoreline position and if well designed and constructed, reduce wave over wash. But they cannot alleviate flooding from sea level rise. Lagoon shore seawalls therefore would only ever be a partial solution in Fogafale, preventing nuisance storm overtopping to nearshore property. They would not prevent marine flooding caused by increasing sea level rise and importantly would not lessen the impacts of catastrophic cyclone wave over wash from the oceanside coast. Therefore, an alternative solution is required.

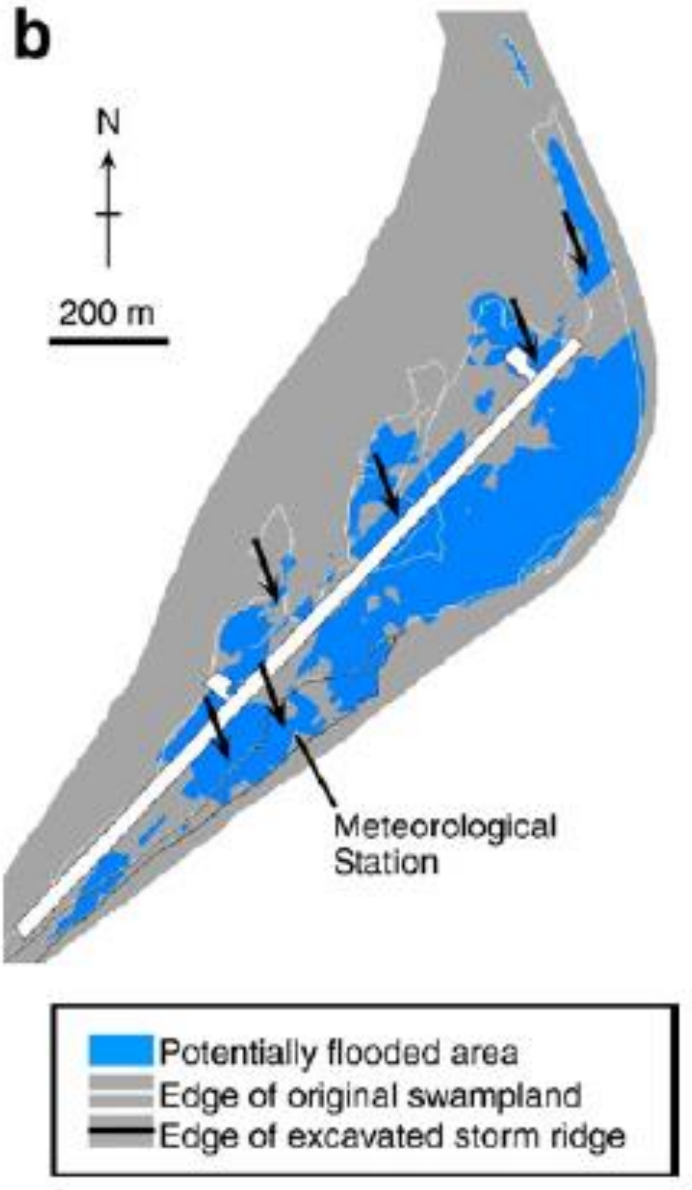

Figure 3 Areas of potential flooding.

Distribution of the original swampland in 1896 based on the area of swamps,mangroves, Pemphis acidula and taro pits; these areas had elevations less than 1.35 m above mean sea level and were overlain by the original swampland in 1896 and the excavated storm ridge in 1942. Arrows indicate areas that experience flooding during extremely high tides, based on interviews with local resident (Yamano et al 2007).

1.3 Options

1.3.1 Do Nothing

24. The issues of chronic instability on the Fogafale shoreline will not improve. Indeed, with increasing settlement pressure and sea level rise impacts, the situation will only get worse. There can be no expectation of "natural recovery" of the former beach processes at this location as the level of damage and disturbance to this system is profound (refer to Section 5 - Existing Environment). Thus, artificial hard measures are the only appropriate option to secure the shoreline position. Given the acceptance of the original TCAP Proposal to do exactly that and the prioritization of this location by Government, no action would be an unacceptable alternative.

1.3.2 Revert to foreshore seawalls

25. Foreshore seawalls at this location can, if well designed, prevent nuisance flooding from lagoon waves and would stabilize the shoreline position for the design life of the infrastructure. However, as already discussed above, seawalls in these settings cannot offer a solution to the increasing incidence of marine flooding which occurs across low lying areas of Fogafale due to sea level rise. This form of marine flooding will continue to occur irrespective of wave conditions and irrespective of any seawall. Likewise, lagoon shore seawalls do nothing about the far greater threat to human life and security posed by cyclone driven waves on the oceanside shore.

26. There are additional drawbacks of seawalls in these conditions. Once a substantive seawall is built it tends to elicit a sense of security (lowered exposure) which in turn can encourage even greater investment and settlement in nearshore areas. Given all lagoon-side nearshore land in Fogafale is very low lying and thus very susceptible to incrementally worsening sea level rise flooding, such engineering may encourage people into areas which are marginal and will soon become untenable due to the frequency of flooding – this would be mal-adaptative.

27. Only if those low-lying areas were filled to a safe height first or building codes were enforced to ensure all buildings were on raised footings, could simple foreshore seawalls be a more acceptable solution. Even so, seawalls and strictly enforced building codes etc still do not overcome the central issue of the threat of cyclone wave overwash from the ocean side shore.

28. Finally, the strong community sentiment in favor of reclamation with foreshore protection instead of just seawalls significantly diminishes the viability of the latter option.

1.3.3 Beach nourishment

29. Beach nourishment (artificially placing sand on the foreshore) was undertaken during the construction of the government-financed reclamation (and the area is now called the Queen Elizabeth Park (QEP)) on shores north and south of the QEP. This approach has been quite successful from the perspective of removing wave stress from the original shoreline and preventing nuisance overtopping etc. However as with all artificial nourishment projects, continued monitoring and maintenance (pumping new sand) is required. Tuvalu lacks the equipment to do this and at this stage has no technical capacity to oversee such an operation. If handled by an international interest, the mobilization / demobilization costs of bringing a dredge to Tuvalu on a routine basis is high (approximately USD $ 1.5 million) and unlikely to be a timely budget priority. Thus, nourishment in this way does not appear to be a sustainable solution in this setting. That said, smaller pontoon mounted sand pumps with far lower running costs may be adequate particularly if regular small nourishment regimes were pursued. Certainly, such an approach has been feasible to maintain on small atoll resort islands in the Maldives for example.

30. Important considerations with nourishment were demonstrated with the JICA funded "Tausoua Beach" project in central Fogafale. The Tausoua beach project was a thoroughly designed and researched undertaking. In many ways, it was also an artificial nourishment program and the premise was to over-fill the beach in question with the expectation that subsequent wave action would redistribute the fill materials and established a new beach profile further seaward from the old stressed shoreline. In this way the new beach profile could provide greater protection and a buffer for the people and assets landward of that shore. The project went to considerable lengths to explain to local stakeholders that this new beach profile was not "new land" and that any apparent land which did accrete was not appropriate for settlement or building because of its inherent instability. Any "new land" associated with this effort was to be considered a buffer or an engineered set back zone. Irrespective, public and private building has already been built immediately behind the Tausoua Beach project area to within a few meters of the former shoreline position. This is very ill advised because there is every chance the Tausoua Beach will continue to erode, and these buildings will be threatened.

31. Any nourishment project on this shore carries the same risk. It is almost assured that if areas of a nourished beach appear stable, even if only for a matter of 12 months or so, the adjoining landowners will almost certainly move to build on this "new land". This results because of the immense pressure for more land on Fogafale and the traditional connotation that "naturally accreted land" adjoining one's property becomes part of your property. Whilst nourishment is not natural, once the sand is reworked and

redistributed by natural processes (waves) it appears natural. This ambiguity is almost sure to lead to problems. If artificially nourished sand is redistributed to a neighboring beach, in all likelihood the landowner will see this as new accreted personally owned land. Reclamation on the other hand is not considered "accreted land" either in the Tuvalu Foreshore Act 2008 or traditionally, thus it does not suffer this same risk.

32. In this way, soft nourishment can easily lead to a situation of ever greater numbers of people living in ever greater situations of hazard since soft sandy accreted areas, maintained and nourished or not, can quickly shift or erode.

1.3.4 Breakwaters ("Foreshore Master Plan" approach)

33. The bilateral agreement between the Government of Korea and Tuvalu to develop a Master Plan for the Fogafale foreshore did not result in a consensus regarding the adoption of the plan. Indeed, there were significant local concerns and associated requests that the plan must include reclamation not breakwaters and nourishment alone. Already this highlights a risk of community resistance to pursuing this option.

34. Nonetheless, considerable effort was expended by the Korean Authorities in gathering baseline data, modelling and in the design of the approaches in the Master Plan. Their approach included construction of detached, off-shore breakwaters. These would act as a barrier to wave energy and provide protection to the shoreline within. This approach was to be combined with several strategically placed groins (placed perpendicular to the existing shore) and subsequent beach nourishment with dredged sand.

35. This approach would likely result in greater longevity and a degree more stability of any beach nourishment effort but would likely ultimately suffer the same problems as discussed above. Local landowners would almost certainly perceive this "newly accreted land" as an opportunity and building would likely soon follow. Even with the provision of breakwaters, any unconsolidated nourished beach or accreted sand on this shore will never be an appropriate site for development. The Master Plan's approach was that such areas would remain as undeveloped buffer zones which provide protection to the old shoreline and a more pleasant foreshore environment. However, because of the likelihood they will shift and erode over time, they will always require monitoring and maintenance.

36. As such, this approach is not considered optimum either and given the already witnessed community dissatisfaction with the Master Plan and the fact this approach still does not address the fundamental issue of the need for safe raised land in Fogafale to reduce exposure to marine flood risk, it is not recommended.

1.3.5 Foreshore Reclamation

37. As discussed above, direct replacement and protection of approximately 780m of lagoon shoreline in the Central Fogafale area and reclamation using sediment dredged from nearby in the lagoon to create elevated land would offer a solution that addresses multiple challenges presented above. Most importantly, this is the only option that offers safe raised land in Fogafale in response to catastrophic cyclone events and their associated wave overwash from the ocean side shore. In addition, as reclamation would not be perceived as "naturally accreted land," and it would be under the management of the Government (i.e. crown land as stipulated by the Tuvalu Foreshore Act), an unintended consequence of landowners building new assets can be avoided. Total area would be approximately 7.8ha. The reclaimed land would be protected from wave action on the lagoon side by a rock revetment wall. The reclaimed area would be integrated with recent government investments to provide a combined protected shoreline length of approximately 1,100m.

1.4 Summary of Status and Alternatives – Identification of Preferred Solution

38. There must be no expectation that the Fogfale lagoon shore can ever recover a natural protective beach if left undisturbed (see following section). That opportunity has essentially been unavailable since 1943 when the US Military so comprehensively destroyed the natural shoreline processes at this location. Thus, in line with the original TCAP concept, hard engineering of some kind is an appropriate urgent response.

39. Foreshore seawalls can stabilize the foreshore position and prevent nuisance wave overtopping if well designed. However, lagoon foreshore seawalls do not address the greater threat posed by oceanside cyclone wave overtopping exposure (essentially the entire Funafuti community is exposed to this risk) and cannot address the increasing issue of marine flooding of low-lying land caused by sea level rise.

40. There has been reasonable success with beach nourishment on the Fogafale lagoon foreshore; however, there is no evidence that monitoring, or regimes of subsequent nourishment can be implemented. This exacerbates the additional risks regarding use of any perceived “new land” accreting via nourishment efforts and the subsequent loss and damage that will occur.

41. Foreshore reclamation has been identified as the preferred solution as it is the only engineering alternative that provides a complete suite of potential benefits: shoreline stabilization, wave overtopping protection, provision of higher safer land. Reclamation interacts positively with the situation of exposure to cyclone waves on the oceanside coast of Fogafale because it provides safe land which lessens the pressure to build in ever more exposed locations near the ocean side berm. Likewise, in the case of land fall of another catastrophic event such as cyclone Bebe (1972), a community shelter built on raised lagoon shore land would be the only safe, flood free infrastructure on island. Finally, on low-lying atoll islands with such scant land resources, well planned and implemented reclamation is the only pragmatic, viable solution to flooding associated with long-term sea-level rise.

1.4.1 Summary of preferred option

Investment criteria / other parameters	
Length of shoreline protected	780 m (1,100m when integrated with recent GoT work on this shoreline)
Type of protective infrastructure	Reclamation foreshore
Surface area/footprint	78,000m^2
Rock revetment materials estimate	16,000m^3
Fill volume required	350,000m^3
Relevant elements in the Results Framework	Input 2.2.1 Construction of coastal protection infrastructure in Funafuti, Nanumea and Nanumaga covering 2,210 m of vulnerable coastlines
Budget	$14,520,000
Direct beneficiaries	2,174
Indirect beneficiaries	3,262
Environmental and social risks	Moderate

2 Description of the Project

42. As noted above, foreshore reclamation has been identified as the preferred revised solution. The revised TCAP proposal seeks to build new properly designed raised land on the lagoon shore and will protect this new land with appropriate foreshore measures. This offers significant protection to wave impacts from either ocean or lagoon shore and provides raised land which is not exposed to incremental sea level rise flooding (within the design life of that land). The development of new higher land is the only appropriate adaptation response to long-term sea-level rise in such low laying atoll environments.

43. This section describes the key elements of the proposed TCAP foreshore reclamation at Fogafale, which are:

- Dredging
- Reclamation
- Post-work land use.

2.1 Dredging

2.1.1 Location

44. The proposed TCAP reclamation will require an estimated 350,000 m³ of suitable fill material. In 1995, Smith (SOPAC) confirmed and characterised a potential 24 million m³ lagoon basin sand resource immediately off-shore from Fogafale. The TCAP dredging will take place within this resource area (Figure 4). As per Smith (1995) and Kaly and Peacock (2014), there is also a degree of variability in the quality of sediments across the resource area and it may be advantageous to select specific areas based of grain size, material composition, etc. (Refer Section Marine sediments5.6)

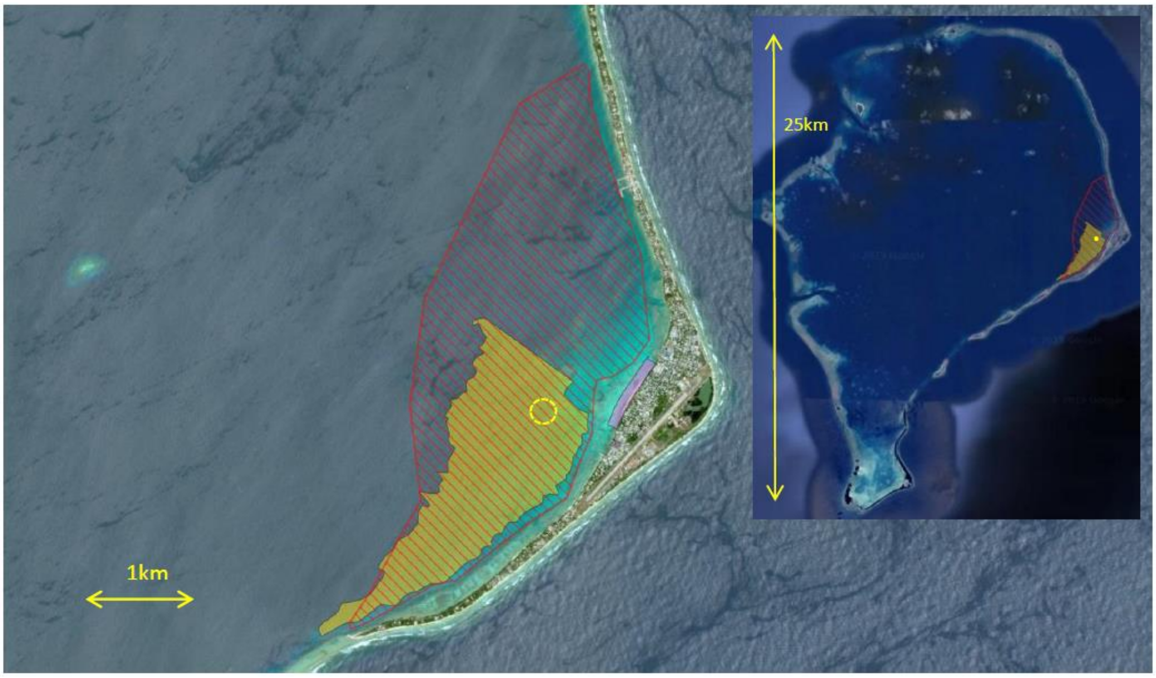

Figure 4 proposed location for dredging (yellow circle).

The olive orange area is the sediment resource identified by Smith (1995) and the red hatched area "the zone of dead coral and eutrophication" described by Kaly and Peacock (2014).

45. The exact location within the boundary of the designated sand resource area will be the subject of site-specific consideration informed by the planned TCAP full ESIA, discussions with Tuvalu stakeholders and

taking into consideration the operational limits of the dredge vessel involved, however Figure 4 provides an indicative location for the proposed dredging.

2.1.2 Dredge Equipment

46. Dredging is most likely to be done using a suction dredge. Several such dredges are available in Tuvalu or alternatively a dredge could be brought in from elsewhere.

47. Suction dredges suck material by means of dredge pumps and discharge through a floating pipeline and pipes on shore to the deposit area. These dredgers are stationary dredgers i.e. they do not 'sail' while dredging. During dredging the vessel remains in the same location, secured by a spud lowered into the seabed; by means of winches and anchors, the dredger swings sideways and the suction head removes the sand. Figure 5 shows an example of a typical suction dredge, note the dredge pipe trailing from the stern. Figure 6 shows a pipeline coming ashore from the dredger, due to the weight of such pipelines heavy machinery is often required to reposition them on land.

Figure 5 Example of a suction dredge - the AMITY, which has previously done dredging at Funafuti

Figure 6 Dredge pipeline on shore for the Tuvalu Borrow Pit Reclamation Project (Source Hall Contracting)

2.2 RECLAMATION

2.2.1 Area to be reclaimed

48. The revised proposal considers modest reclamation in the central Fogafale lagoon nearshore area (approximately 7.8Ha, adjoining some 780m of shoreline), which over lays previously heavily disturbed substratum. Likewise, it is located between and adjoins to the south the recently built "Queen Elizabeth Park – Reclamation" (QEP) and to the north the WWII Catalina Ramp / reclamation. The proposed TCAP works will only extend seaward as far as these pre-existing features (approximately 100m). The proposal also includes associated hard foreshore protection measures to stabilise the seaward edge of the reclamation (this is expected to be an imported rock riprap revetment).

Figure 7 Footprint of proposed reclamation (purple zone).

49. Lagoon basin dredging is required to provide material for the reclamation. As indicated in Table 1, approximately 350,000 m^3 is required. All materials required can be sourced safely in the already characterized lagoon sediment resource area (refer Section 5.6). Smith (1995) confirmed a potential sediment resource of 24 million m^3 within the basin area immediately offshore from Fogafale. This work was recently re-confirmed with additional sampling during the New Zealand funded Borrow Pit Filling Project.

Table 1 Estimated Materials

Length of lagoon shoreline protected	780 m (1,100m when integrated with recent Govt. work on this shore)
Surface area / foot print	78,000 m^2
Rock revetment materials estimate*	16,000 m^3
Fill volume required	350,000 m^3

*volcanic rock sourced out of Fiji

50. The total footprint of the proposed reclamation area accounts for 0.03% of Funafuti's lagoon area and over 55% of the footprint lays over already heavily physically disturbed substratum.

2.2.2 Reclamation design

51. The design of the proposed reclamation would have a finished surface elevation which on average will be some 1.5 to 2 m above ambient land heights in Funafuti. Given the situation of exposure on the island of Fogafale, this approach is the only proposal that can provide safe, flood free land now and beyond the year 2100. Importantly, such engineering would also remain above the reach of wave over wash during cyclone events which otherwise have been shown to inundate the greater proportion of Fongafale's built environment.

52. The surface of the reclamation will also be designed to provide natural increased elevation towards the lagoon shore (long term lagoon shore protection) and will otherwise be graded to ensure efficient surface water drainage during heavy rainfall.

53. Figure 8 provides a conceptual diagram of Fogafale island and the proposed reclamation (green zone). The lagoon shore is left and oceanside shore is right and the horizontal red broken line represents sea level. This simplified schematic shows the close proximity of high tide water levels and the surface of land in Fogafale. Large areas of Fogafale's built environment are increasingly subject to routine tidal seawater flooding (orange low-lying zone) and this will only increase as sea levels continue to rise. The higher land associated with the ocean side foreshore (red zone) is not subject to tidal inundation but it is critically unsafe for development because of the threat of catastrophic wave overtopping during cyclone land fall on the deep-water oceanside shore. Only reclamation (the green zone) can provide safe areas for sustainable development in the Fogafale environment. If such reclamation is well designed, it will be beyond the reach of cyclone waves and tidal flooding.

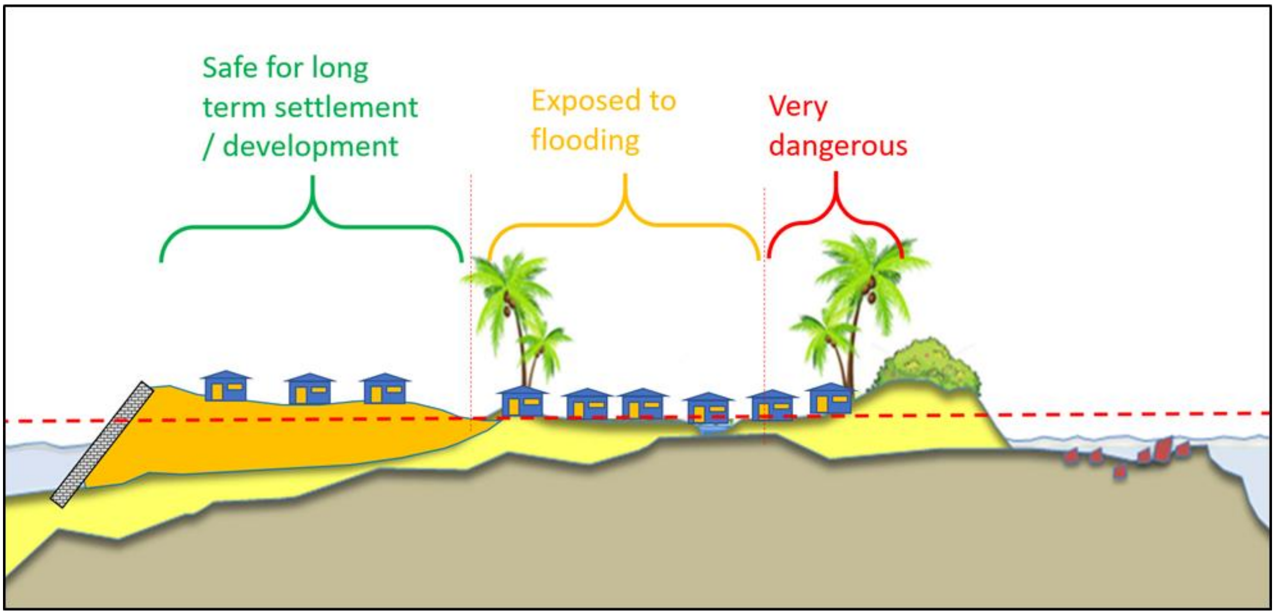

Figure 8 Conceptual diagram of Fogafale Island and the proposed reclamation zone (green zone), the lagoon shore is left and oceanside shore is right and the horizontal red broken line represents sea level.

54. The average surface elevation will be 2.5 m above contemporary Highest Astronomical Tide or HAT (about 2.0 m above the highest measured SL). Global average sea level rise between 1993 – 2010 has been around 3.2mm/year, compared to an average rate of about 1.7mm/year between 1900 and 2010 (IPCC, 2014). This indicates acceleration in the rates of sea level rise which is consistent with increasing trends of global warming. However, sea level does not change at the same rate in every location and at this time no highly confident, long-term trend which departs significantly from the global rate has been specifically identified for Funafuti. This is because of the shortness of the available data set. The IPCC (2014) indicates the mid-range RCP 8.5 (Representative Concentration Pathway) global sea level rise is projected to be approximately 73cm above 2010 levels by 2100. Short-term rates of sea level change are

reported by the Bureau of Meteorology Australia for the Tuvalu gauge. As of September 2018 the continuously measured 25 year Funafuti record indicates 4.2 mm/year. Whilst this record is too short to derive long-term sea level rise rates and the data requires analysis to remove seasonal effects, etc., they are nonetheless consistent with recent studies such as (Royston et al, 2018; Becker et al, 2011), which confirm about 5 mm/year for this location. This is significantly higher than the global average. Thus, a precautionary approach is warranted by observing the largest vertical margin of error possible if reclamation for adaptation purposes is to be considered.

55. The transects a/b (upper and lower) are constructed using accurate spot height data (Figure 9) corrected to the Funafuti Tide Gauge (Tide Gauge Zero = 0 vertical elevation on the profile).

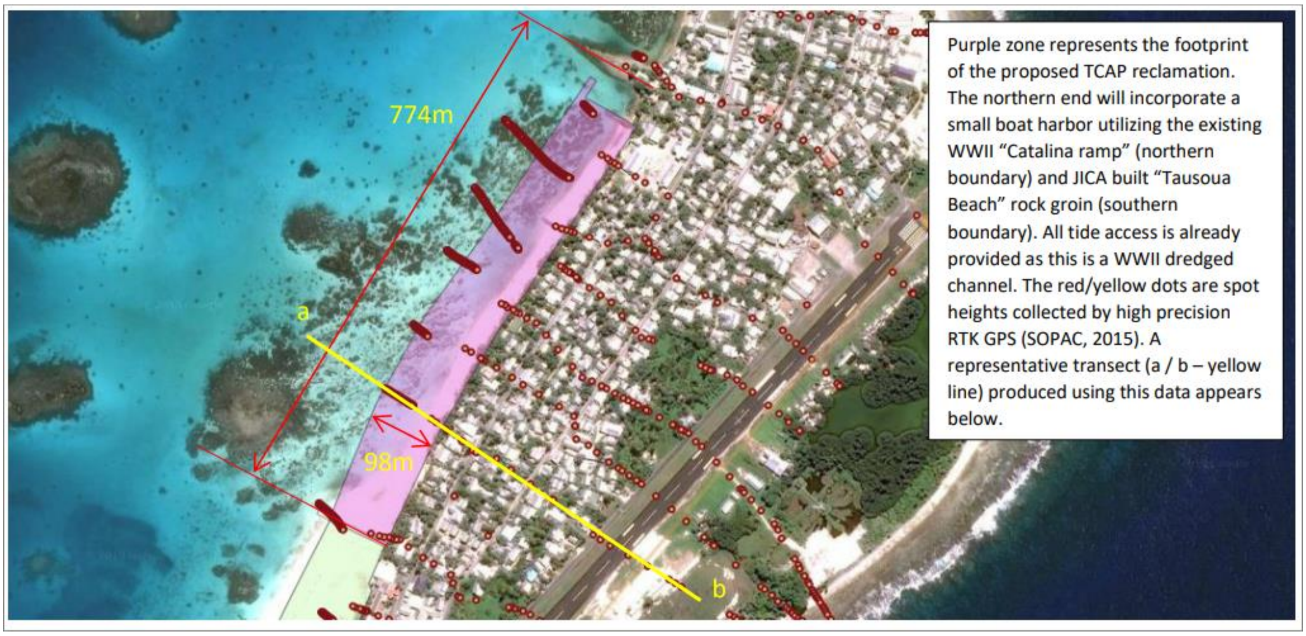

Figure 9 Footprint of reclamation and location of spot heights and transect a-b

56. Figure 10 shows profile across the island along transect a-b. The red line in the upper profile of shows the highest predicted sea level (HAT = 3.303 m). Note its relationship to ground elevation. The green line is LAT or the Lowest Astronomical Tide (0.888 m).

57. The upper profile has a vertical exaggeration x 10, meaning 1 m in elevation is equal to 10 m in horizontal distance. Vertical exaggeration is routinely used to describe atoll relief as they are otherwise too flat to show meaningful elevation in standard paper representations. The lower profile is identical but has no vertical exaggeration. In other words, 1 m in elevation is equal to 1 m in horizontal distance. This emphasizes the extraordinarily low-lying nature of these islands and the urgent need for raised safe land.

58. The image in the center shows the section where this profile dissects the island (transect a-b in Figure 9). Note the correlation of the spot height locations between this image and the upper profile. Half the village, the main roadway (250 m mark), the runway and many other features are at or below HAT. Measured sea level is routinely different to predicted sea level, since well controlled records began in 1993, measured SL has exceeded HAT (predicted highest sea level) by 112 mm (on the 28.02.2006; 5pm).

Figure 10 Profile across island (a-b) showing proposed reclamation

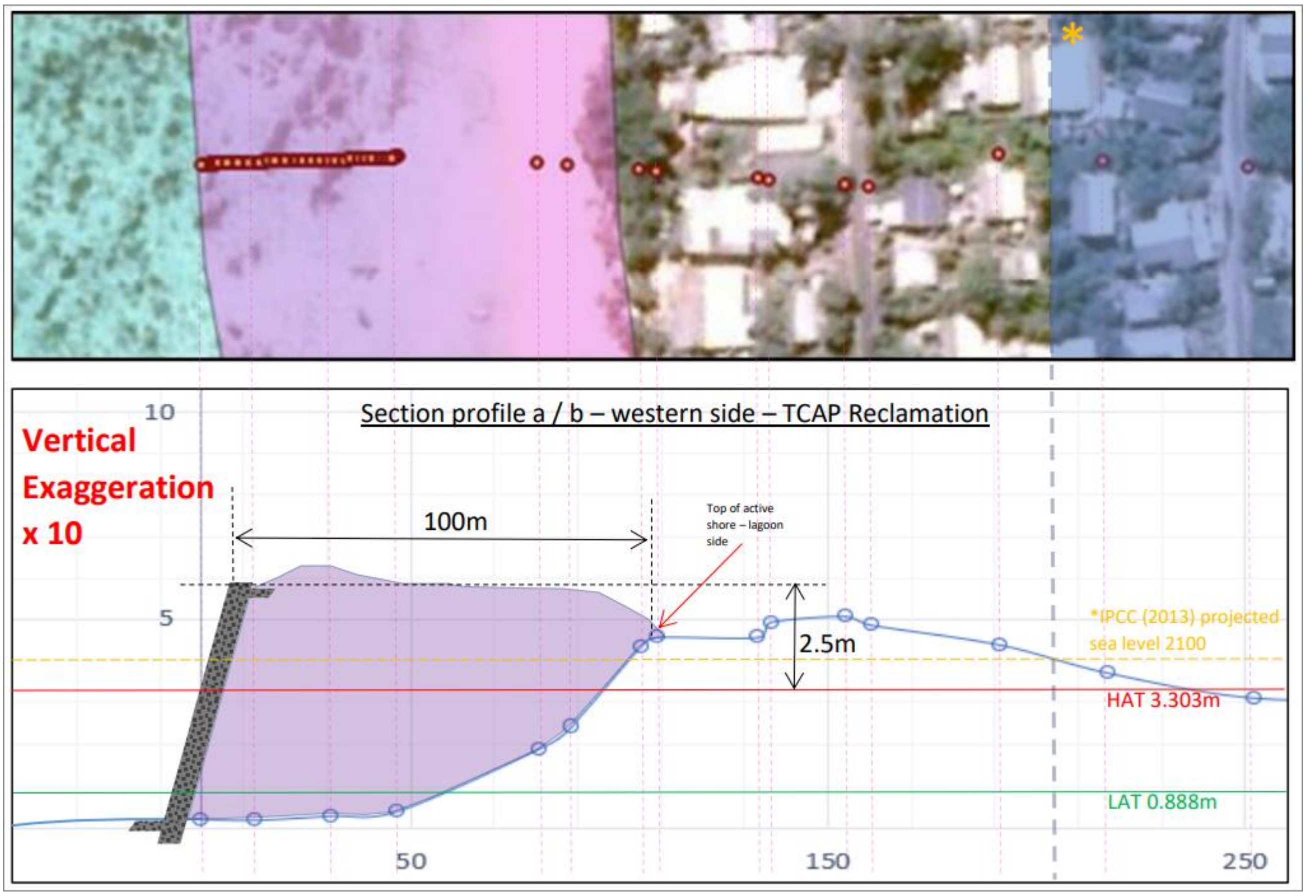

Figure 11 Section profile - western side TCAP reclaimation.

59. The substratum profile shown in Figure 11 is representative of shoreline profiles of the entire length of the target shoreline prior to 2017. In places, sand over spill / beach nourishment from the Queen Elizbeth

Park (QEP) reclamation (200m south of this transect position) has adjusted the profile. This artificially-added sand remains highly mobile so it is not considered in this profile. Instead a more conservative approach has been taken using the pre-2017 substratum.

60. The surface of the proposed reclamation will be designed with a foreshore raised berm that will act as a “no-build” buffer zone. Otherwise, a gentle slope will be incorporated to facilitate drainage and avoid standing surface water “ponding” (a common feature in wet tropics atolls) and can be a health hazard.

61. Overall, the upper surface of the reclamation is designed to be at least 1m higher than natural land elevation on the island on this shore so that it can act as a refuge during catastrophic cyclone land fall. The area under transparent blue (aerial image in Figure 11) represents the extent of daily tidal inundation under conservative (IPCC, 2013) projections out to 2100. Funafuti will be little more than a 100 m wide strip incapable of supporting the population unless new safe land is secured

2.2.3 Reclamation Technique

62. A perimeter barrier over the footprint of the reclamation area (bunding) will first be established. Then sand for the reclamation will be pumped as the slurry extracted by the dredge by pipeline into an isolated inner basin of the reclamation. This allows slow and controlled de-watering and eliminates the return of turbid, sediment laden water to the broader lagoon environment.

63. Most sediment will be pumped into its in situ position. However, heavy machinery e.g. a bulldozer / front end loader / dump truck will be required to push sediments around and create final levels.

2.2.4 Revetment

64. The foreshore wall shown in Figure 11 is not intended to represent a final design or materials choice. It is simply a “placeholder” to indicate hard defenses will be applied to the foreshore of the reclamation. The final design and choice of materials will be the subject of specific engineering assessment, economics and interaction with the community and Government stakeholders.

65. At present, a natural volcanic rock (imported material most likely from Fiji) revetment is the preference and the costs associated with such a wall have been incorporated into estimates. Volcanic rock revetments are relatively simple, have excellent durability and the costs are reasonable in comparison to other approaches. Volcanic rock has also been used across the face of the existing QEP Government reclamation and the JICA funded Tausoua Beach development.

66. These existing revetments will form part of the northern and southern boundaries of the proposed TCAP reclamation and thus a continuation of this locally preferred approach is appropriate. A further advantage of rock revetments is their comparative ease of removal and reuse as well as retrofitting in any future development. In other words, the investment would not be buried and lost.

2.3 Equipment and Workforce

67. Equipment required for this project will include a dredger and its tenders; earthmoving equipment (bulldozer / excavator), dump truck; light vehicles, survey equipment.

68. A limited workforce will be required for the project, it is likely to be approximately 10-15 people. Most of the workforce is likely to be local, with the exception of the dredge crew.

2.4 Land Use Plans

69. There is no firm land use plan for the proposed reclamation area, but it is recognised that it will represent the highest and safest location on the islet in the event of overtopping by events such as cyclones. The proposed reclamation is intended for public space and public / community buildings, a possible community cyclone shelter and potentially public housing. Work to develop a consultative, land use plan for the area will be explored once full approval to proceed has been acquired.

3 LEGAL AND INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL AND SOCIAL MATTERS

3.1 LEGISLATION, POLICIES AND REGULATIONS

70. The legislative and policy basis for the provision of the coastal protection infrastructure projects comes under a number of piece of legislation (in alphabetical order only rather than by importance) including but not limited to the:

- **Closed Districts Act 1936** - provides for the declaration of 'closed districts'. The Minister may, by notice, declare any islands, island or part of an island to be a closed district.
- **Conservation Areas Act 1999** - declaration and management of conservation areas;
- **Constitution of Tuvalu 1986** - provides the basis for law-making in Tuvalu, sets the limits of Tuvalu's jurisdiction;
- **Crown Acquisition of Land Act 1954** - regulates acquisition of land by the crown for public purposes;
- **Environmental Protection Act 2008** – comprehensive law that makes express provision concerning the responsibility for managing the environment. Some of the areas that the Act regulates are:
    - the conduct of environment impact assessments;
    - the regulation and control of pollution and wastes;
    - all matters concerning the implementation of international environment related conventions;
    - the protection of the biodiversity; and
    - responses to climate change.
- **Falekaupule Act 1997** - makes provision for the establishment of Falekaupule and Kaupule, composition, meetings, by-laws, financial provisions and audit ;
- **Foreshore and Land Reclamation Act 1969** - to declare ownership of the foreshore and to regulate reclamation projects, defined as the "construction of causeways, bridges, viaducts, piers, docks, quays, wharves, embankments, sea-walls, landing-places and other structures". Qwnership of the foreshore and sea-bed is vested in the Crown, "any land reclaimed otherwise than under section 11 (1) shall be vested in the Crown" (9 Vesting of reclaimed land);
- **Harbours Act 1957** - provides that it is an offence to throw anything into a harbour or to allow it to fall in, whether it comes from land or from a vessel. The Act also outlines that it is an offence to let something fall onto land from where it may enter a harbour. This Act provides for the control and safety of shipping on the lagoons and inland waters of Tuvalu.
- **Lagoon Shipping Act 1957** - concerns the inspection, certification and licensing of vessels intended for navigation in lagoons. The Act also requires the licensing of vessels registered outside Tuvalu and employed in trade;
- **Marine Pollution Act 1992** - for preventing and dealing with pollution of the sea, and to give effect to international conventions for the prevention of marine pollution and the protection of the marine environment;
- **Marine Resources Act 2006** - seeks to ensure the long term conservation and sustainable use of the living marine resources for the benefit of the people of Tuvalu;
- **Maritime Zones Act 2012** – and Act to provide for the interal waters, the archipelagic waters, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of Tuvalu;
- **Mineral Development Licensing Act 1977** - the main objective of this Act is to provide for the grant of licences to search for and win minerals in Tuvalu;
- **Native Lands Act 2008** - Titles, Lands Court, Leases, Survey, Penalties;
- **Quarantine Act 1929** - comprehensive provisions in relation to quarantining vessels, persons and goods through the effective imposition of quarantine arrangements and requirements.

- **Waste Operations & Services Act 2009** - define the roles and responsibilities for waste management in Tuvalu, and makes provision for the collection and disposal of solid wastes and other wastes related operations and services in designated areas of Tuvalu;
- **Wildlife Conservation Act 2008** - declaration and management of conservation areas.

3.2 Environmental Impact Assessment in Tuvalu

71. Environmental management and the requirement for an environmental impact assessment are controlled by the *Environment Protection Act 2008*. Specifically, Part 5 of the Act (sections 17 and 18) sets out the process and procedures for the undertaking of an Environmental Impact Assessment (EIA).

72. The *Environmental Protection Regulations 2014* provides the regulatory management of EIA in Tuvalu. It provides for the undertaking of preliminary environmental assessment report (PEAR) or EIA. All projects must comply with the legislation and regulations.

73. The Department of Environment (DoE) administers the Act and Regulations.

74. Under Regulation 4, the Minister determines what projects should have either a PEAR or EIA. Pursuant to Schedule 1 (9), public works that require either a PEAR or EIA include (d) soil erosion, beach erosion and siltation control; and (k), seawalls/land reclamation. Regulation 5 exempts *routine maintenance* of for example, seawalls; however, this project involves land reclamation which is not routine maintenance, therefore will be required to undertake environmental assessment. As part of discussions with GCF, TCAP has committed to undertaking a full EIA.

75. The process for impact assessment, described in the Regulations are further described and elaborated upon by IPA (2017), which provides a flow chart of the process (Figure 12).

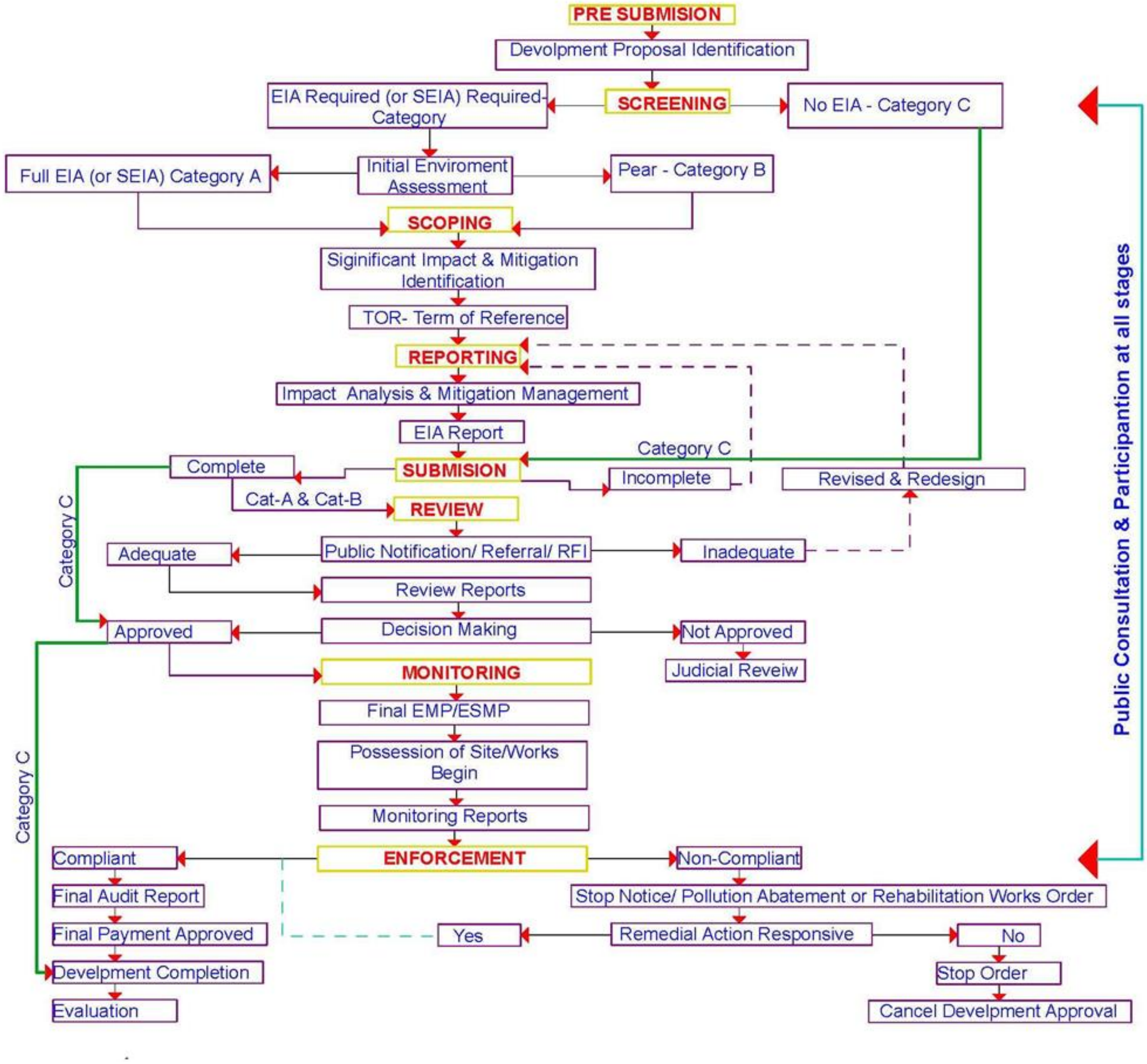

Figure 12 Tuvalu draft ESSS process flow for EIA (IPA 2017)

3.3 MULTILATERAL AGREEMENTS AND BIODIVERSITY PROTOCOLS

76. Tuvalu is a signatory to a number of international and regional agreements and conventions, which are related to the environment. They include:

- 1972 Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)
- 1973 All IMO conventions and protocols relating to the prevention of pollution from ships
- 1982 United Nations Convention on the Law of the Sea (UNCLOS)
- 1982 Cooperation in the Management of Fisheries of Common Interest (Nauru Agreement)
- 1985 South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty)
- 1985 Vienna Convention for the Protection of the Ozone Layer
- 1986 Protection of Natural Resources and Environment of the South Pacific Region and Related Protocols
- 1987 United States Multilateral Fisheries Treaty (as amended)
- 1987 Montreal Protocol for the Vienna Convention
- 1989 Basel Convention - Control of Transboundary Movements of Hazardous Wastes and Their Disposal
- 1989 Convention on the Prohibition of Fishing with Long Drift Nets in the South Pacific

- 1990 London Amendment to the Vienna Convention
- 1992 Rio Declaration on Environment and Development
- 1992 United Nations Framework Convention on Climate Change (UNFCCC)
- 1992 United Nations Convention on Biological Diversity (CBD)
- 1992 Copenhagen Amendment to the Vienna Convention
- 1993 Niue Treaty in Fisheries Surveillance and Law Enforcement
- 1993 United Nations Chemical Weapons Convention
- 1994 United Nations Convention to Combat Desertification
- 1995 Ban the Importation into Forum Island Countries of Hazardous and Radioactive Waste and to Control the Transboundary Movement and Management of Hazardous Waste within the South Pacific Region (Waigani Convention)
- 1995 Amendment to the Basel Convention
- 1997 Kyoto Protocol to the UNFCCC
- 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments
- 2007 Nairobi International Convention on the Removal of Wrecks
- 2010 Nagoya Protocol on Access to Genetic Resources and their Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity
- 2010 Memorandum of Understanding on the Conservation of Migratory Sharks
- 2015 Paris Agreement

4 CONSULTATION

77. Stakeholders have been engaged on the project from its initial inception through to implementation. As has already been indicated, as a result of changed conditions at Fogafale, TCAP revisited the design and undertook a series of consultation activities to determine and confirm support for the preferred revised design option.

78. The following demonstrates that that the project stakeholders and project board have been consulted on the proposed changes.

- **January 20th – Feb 3rd 2018** – the TCAP team undertook a site-specific scoping mission to Funafuti to consider the original approved TCAP FP (Output 2.2) in light of changes which have occurred on this same shoreline since TCAP was designed. One of the team members, the Chief Technical Advisor, is a qualified and published atoll coastal geomorphologist and it became rapidly apparent that TCAP's original design would struggle to fulfil its stated aim to protect people and property from the effects of wave overtopping.

  During this visit, a number of one on one meetings where undertaken with senior government officials, Kaupule members and others to discuss their aspirations for the target shoreline. It was at this time that the weight of public support for reclamation became apparent.

- **May 26th – 30th 2018** – Second TCAP Board Meeting. During this meeting, the TCAP team also discussed the potential interest in reclamation and attended the Funafuti Foreshore Master Plan project completion meeting (an independent bilateral arrangement between the Government of Korea and the Government of Tuvalu). The resultant "Master Plan" focused on the same area of lagoon shore TCAP was designed to work on and hence the need for close attention. During this multi-stakeholder meeting, the "Master Plan" was not adopted by the Tuvalu Government and reclamation was again highlighted as a priority for the Funafuti community.

- **August 21st 2018** – GCF was informally advised that design changes are being proposed.

- **September 13th – 27th 2018** – On the weight of community feedback to date and interest by the TCAP Board, the TCAP team produced an initial reclamation proposal to understand the feasibility within current TCAP Output 2.2 budgets. These plans were shared at specific Funafuti Community, Kaupule, Senior Government officials (one on one) meetings. The plans were shared in an open consultative approach designed to glean feedback. It used practically identical maps and design concepts as shown in this document.

  There was unanimous support for TCAP to revise its plans and to implement well designed and planned reclamation instead of foreshore revetments. The only substantive additions which were repeated across the stakeholder groups was that there was a preference for a greater area than that proposed by TCAP and that a small boat harbor be incorporated into the northern end of the reclamation. TCAP does not have the necessary budget to consider more complex or larger reclamation than that outlined here. Furthermore, TCAP is confident that the environmental risks of the proposed modest reclamation are moderate. As such this concept plan can appropriately be recommended as an alternative to the original design.

- **October 6th – 15th 2018** – The TCAP Board approved TCAP's revised concept for Funafuti Output 2.2 – reclamation.

- **February 22nd 2018** – An unscheduled meeting with the Prime Minister of Tuvalu at the Suva High Commission also resulted in the Prime Minister reiterating his Government's support for the TCAP proposed reclamation concept in Funafuti.

- **March 11th 2019** – GCF formally advised of proposed changes to project. Following this, there has been a series of information requests and responses between UNDP/TCAP and GCF regarding details of the revised design.

5 DESCRIPTION OF EXISTING ENVIRONMENT

79. This section of the PEA provides a description of the baseline conditions that are relevant to the project. It is based on desktop information, that is, existing reports, papers, maps and data.

5.1 GEOGRAPHY

80. Tuvalu is a volcanic archipelago, and consists of three reef islands (Nanumanga, Niutao and Niulakita) and six true atolls (Funafuti, Nanumea, Nui, Nukufetau, Nukulaelae and Vaitupu) located in the Pacific Ocean, situated in Oceania, about midway between Hawaii and Australia (Figure 13). Its small, scattered group of atolls have poor soil and a total land area of only about 26 km^2.

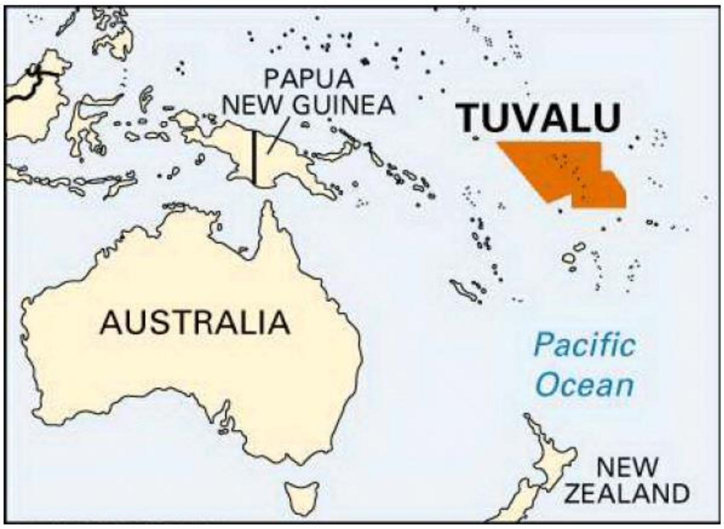

Figure 13 Location of Tuvalu in Pacific Ocean (Yamano et al 2007)

81. Funafuti is the capital atoll of Tuvalu and is located in the southern group, 130 km SE of Vaitupu and 470 km from Nanumea in the north. Funafuti is the largest atoll and comprises numerous islets around a central lagoon aligned approximately north-south that is roughly 25 km long by 18 km across the centre at its widest part (Figure 14).

82. The lagoon is up to 55 m deep and the surrounding atoll rim is cut by several deep passages on the western side and a single deep passage to the southeast. These passages permit ship access to the lagoon and to the only deep water wharf in the country. The distance between the atoll's eastern and western sides narrows in the south where the lagoon is 2-3 km wide and shallow with large areas of sand and reef exposed at low tide. Mean tidal range is about 1.2 m. The lagoon is by far the largest in Tuvalu and occupies an area of about 205 km^2 (McLean and Hosking, 1992).

83. The land of Funafuti Atoll covers around 270 ha (2.7 km^2) and although it is the largest atoll in the country, its land area is small relative to the total reef top and exceeds only Niulakita, Niutao and Nukulaelae in area, making it the fourth smallest island. Thirty-three separate islets (*motus*) make up the total land area and these are unevenly distributed around the atoll. Of the 33 islets only four have areas greater than 1 ha and five greater than 5 ha. Most of the land extends as a chain of islets around the eastern side and in the extreme south. The islets are very narrow, typically about 100m wide and elongate in shape, the greatest width (650 m) being achieved in the extreme east in the centre of Fongafale where the capital buildings, main town and international airport are located (Figure 14c). Fongafale is the largest islet by far and it together with Tegako accounts for 60% of the total land area of the atoll.

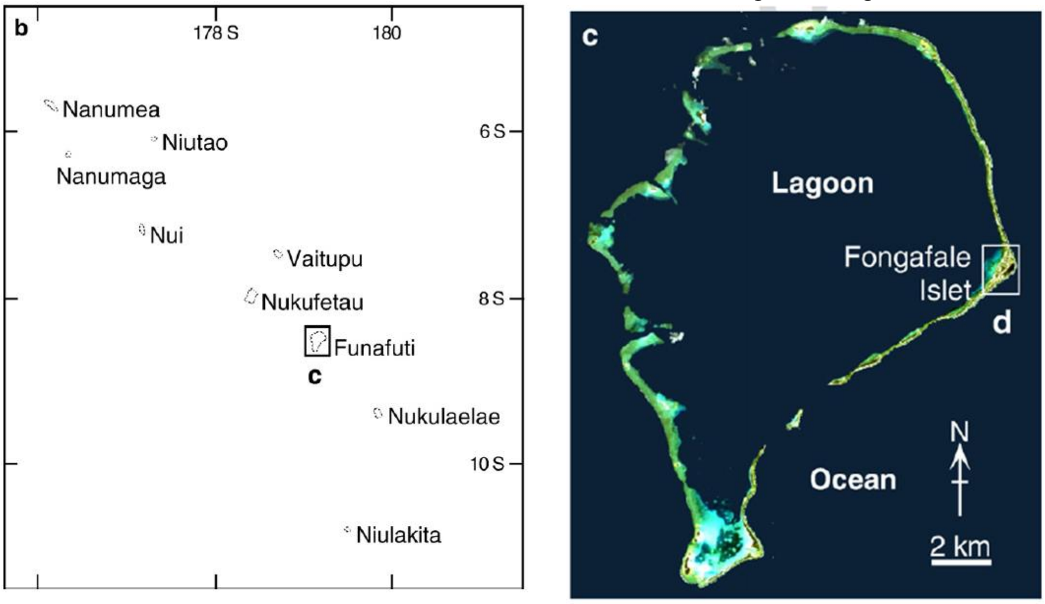

Figure 14 Location of Funafuti Atoll in Tuvalu (b) and Fogafale Islet of Funafuti Atoll (c)(Yamano et al 2007)

5.2 CLIMATE

84. The climate of Tuvalu is tropical and marine. Air temperatures in Tuvalu are relatively constant throughout the year and are closely related to sea-surface temperatures. The mean air temperature is 28^{o} C, with a mean maximum of 31^{o}C and a mean minimum of 25^{o} C.[1] Climate variability and extremes, in particular, the El Niño-Southern Oscillation and tropical cyclones, are important features of the Tuvaluan climate. Tuvalu has two distinct seasons; a wet season from November to April and a dry season from May to October; however, rainfall averages more than 200 mm each month of the year in Funafuti. Funafuti has the highest and most consistent annual rainfall of the nine islands in Tuvalu. Its mean annual fall is 3,469 mm (1941-1980).

85. Tuvalu lies within the trade wind zone. Persistent easterly trade winds blow throughout the year; however, they are generally stronger in the dry season. Wind data from Funafuti shows surface winds are predominantly from the east (32%), SE (18%) and NE (14%). Winds from the north, NW and west are more common in the summer months and account for 42% of wind in the December, January and February period (westerly season). Mean monthly wind speeds range from 7 to 12 knots, the annual average being 9.4 knots, and there is a distinct maximum from June to September. Strong westerly and northwest winds occur at times during the westerly season and these sometimes reach gale force, however tropical cyclones are rare in Tuvalu.

5.3 GEOLOGY AND SOILS

86. The geology of Funafuti, including its lagoonal sediments, reefs, submarine topography, stratigraphy and deep structure and composition were described in some detail following three coral reef boring expeditions mounted by the Royal Society in 1896, 1897 and 1898, and a fourth visit by Professor Agassiz of Harvard in 1899.

87. Described by Coates (1970), Funafuti is an almost circular and conical submarine volcanic mountain 3.6 km high and approximately 45 km wide at its base. It rises in a gentle slope which gradually steepens to a point 730 m below water level, after which it rises at an angle of 80 degrees to 256 m below water level. From this point, it rises vertically, like an enormous pillar, till reaches the surface in the form of a reef enclosing a lagoon.

[1] Tuvalu Meteorological Society

88. Additional studies on the deep structure of Funafuti comprised a magnetic survey (Creak, 1904) and a single seismic refraction survey inside the lagoon (Gaskell & Swallow, 1953). These two data sets are interpreted to show a minimum of 500 m of limestone below the lagoon floor, with presumed underlying volcanic (Locke, 1991).

89. No volcanic basement was reached during the drilling campaign in Funafuti in the late 19th century, and the boundary depth was estimated at approximately 1,000 m from data provided by seismic experiments. (JICA 2011b).

90. The atoll soils of Tuvalu are young, shallow, alkaline, course textured and of a carbonate mineralogy. Due to their age, they are poorly developed and similar to the original coral limestone parent material. They range from 250 mm to 1 m in depth and consist of a variable layer of organic material, coral sand and rock fragments overlaying a limestone platform. The chemical structure of the soils makes the scarce trace elements of iron, manganese, copper and zinc unavailable to plants. Activity of soil micro-organisms is limited, soil water-holding capacity is low, and the groundwater is often saline (Lane 1993).

5.4 Topography and Coastal Geomorphology

91. Fongafale islet is a long and narrow strip of extremely low elevation with a broad “V” shaped outline. On the ocean-side fringe of the islet there are coral rubble berms up to 3 m above mean sea level, making the highest points of the islet. Other areas are below 2 m above mean sea level over a large portion of the islet.

92. On the ocean side, both the active beach and ridge are made up of coarse coral rubble that often includes slab fragments and large blocks up to 1 m in diameter. The ocean side ridge crest is commonly quite narrow and is frequently located right at the vegetation-beach edge. The ridge form is asymmetrical with a steep seaward slope and more gentle backslope inclining toward a central depression, interior flat or to the lagoon. This kind of simple single ridge with steep crest is associated with the elongate islets of the eastern side of Funafuti.

93. The ridge is constructed of reef materials initially emplaced during exceptional storms and reworked during quiet periods. Incremental build-up of a single high ridge may result from wash-over during several storm-fair weather episodes. Alternatively, each episode may result in the formation of a new ridge to seaward thus enlarging the islet. The ocean side ridge mapped on Funafuti coincides with what is called the 'outer hurricane bank'.

94. The centre of the Fogafale Islet is comprised of a landform termed the ‘central depression’. This forms an almost continuous trough which varies from an open v-shape at the inland meeting of the opposing ocean and lagoon ridge backslopes to a wider trough with concave profile. Typically, the central depression has the lowest land elevation on the island and is the area most likely to be inundated by a rise in water level.

95. The lagoon side ridges of Fogafale and Tegako are less pronounced than the older ocean side coastal ridges which protect them from ocean swell and storm waves. The ridges are lower, typically extending 1-2 m above lagoon reef flat level, the absolute elevation varying dependent on exposure and lagoon fetch length. Whether bank-like or mound-like, the ridges are typically built of foraminifera or algal sand and mollusks derived from the adjacent lagoon, together with some coral fragments and gravel. On Fogafale and Tegako the ridges are very linear and may include cemented beachrock outcrops in the intertidal zone. At the northern end of Tegako, it was assessed that the lagoon shoreline was undergoing erosion (McLean and Hosking, 1992).

96. The topography of Fongafale Islet is closely related with its history. Fongafale Islet was used as a military base by the United States during WWII. An airfield and a naval base and other related facilities were constructed in emergency in 1942 (Figure 15). Senior residents remember that there was a long, low-gradient, sandy beach prior to the WWII. Modifications of the lagoon side of Fongafale islet during WWII include a 2.3 km long piece of reclamation with wood and coral rock seawall, a long borrow pit (ship passage) beside the seawall was made by excavating reefs, and other channels normal or parallel to the seashore. Note that the area proposed for reclamation by this project includes the area previously dredged for ship passage.

97. These developments changed the shoreline and sedimentation patterns. The seawall was placed at about the former low tide line and suffered erosion after it was built. The borrow pits (or channels) have been filled with sand transported by wave and long-shore currents and with sand and/or gravel eroded from the reclaimed land (JICA 2011b)

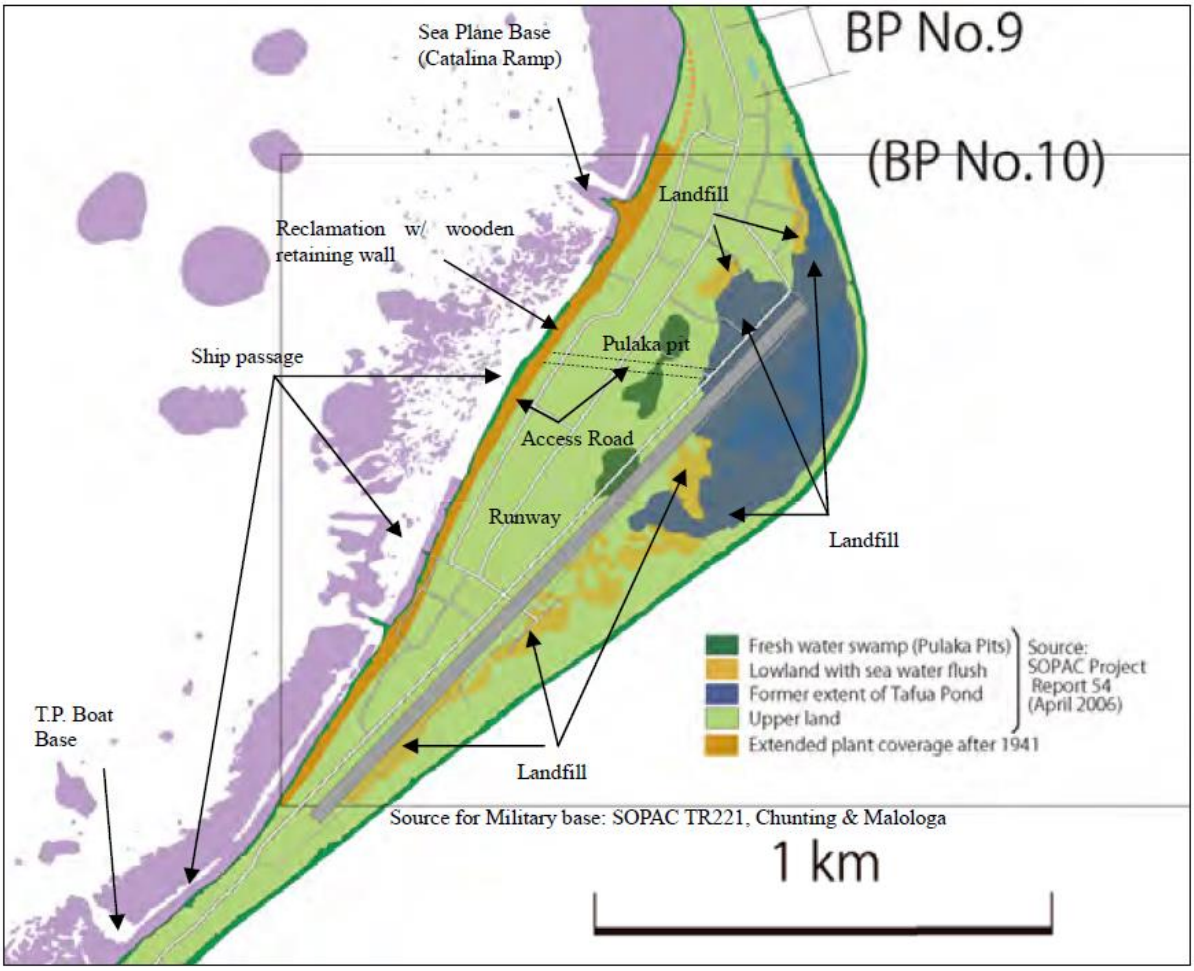

Figure 15 Impacts of the naval base on the previous landform (JICA 2011b)

98. Yamano et al (2007) reconstructed the changes in topography, land use/cover and distribution of buildings at Fogagale Islet over 108 years (1896 to 2004) (Figure 16). Profiles along three transects show how the topography of the islet has changed, largely as a result of excavation and reclamation during WWII (Figure 17).

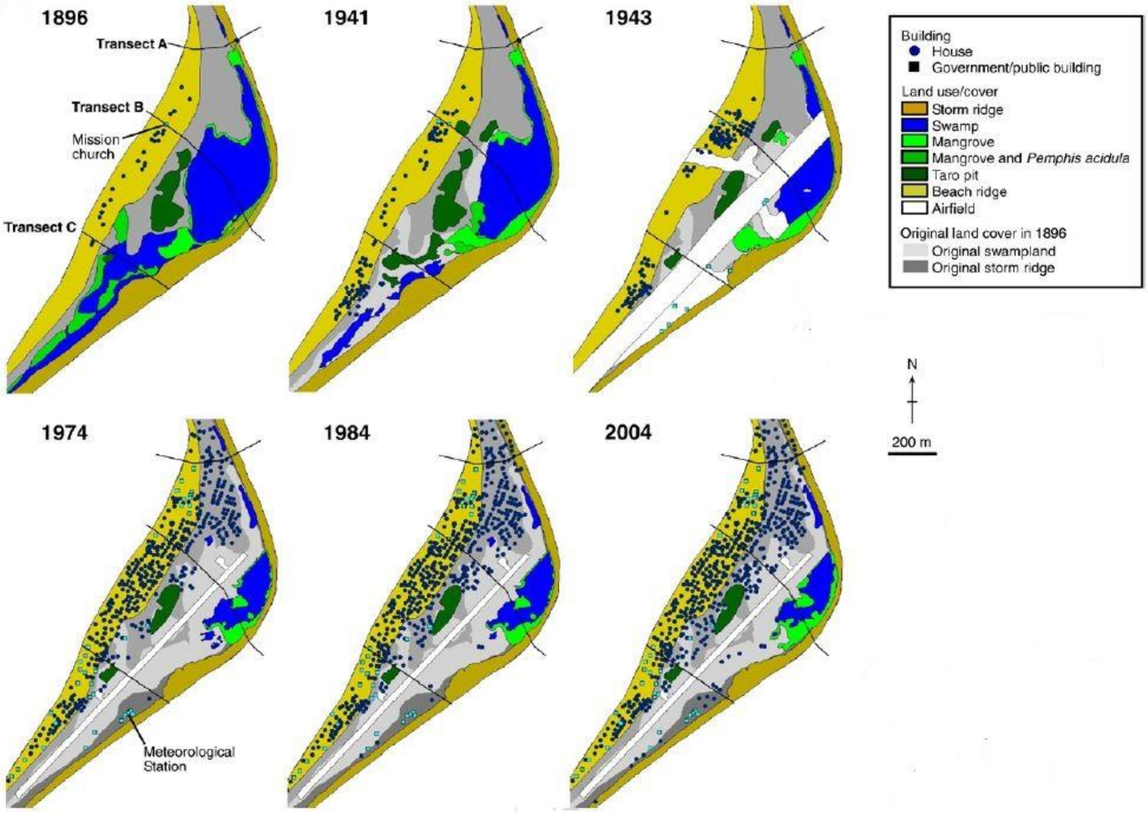

Figure 16 Changes in land use/cover in Central Fogafale from 1896 to 2004 (Yamano et al 2007).

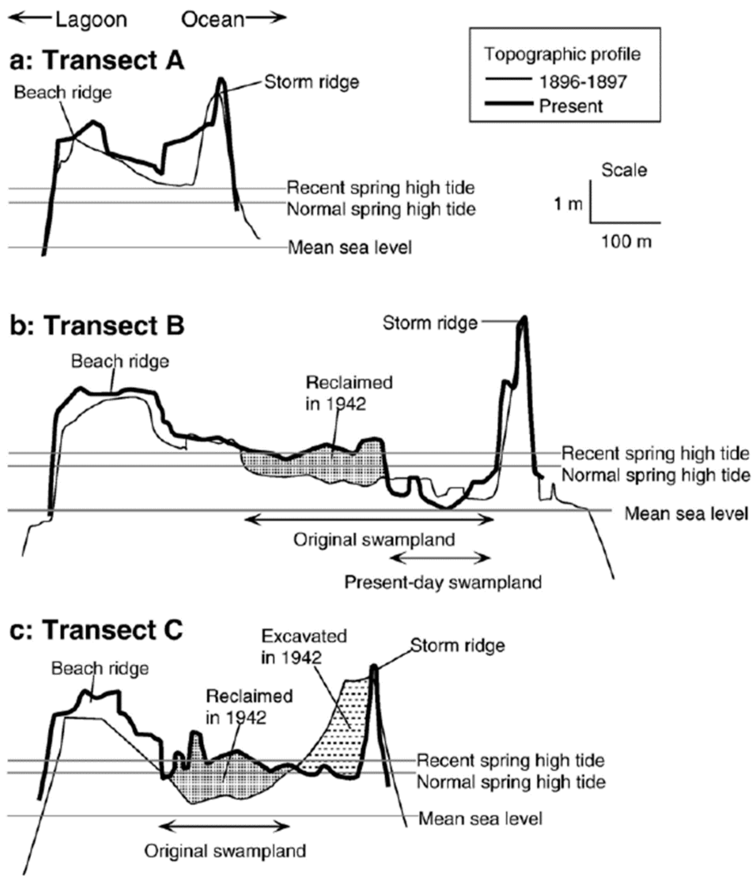

Figure 17 Topographic profiles along transects in 1896/1897 and 2004 ('present') (Yamano et al 2007)

These changes can also be seen in the series of aerial photographs in Figure 18, which focus on central Fogafale (the project area). In 1941 (**top left**) Fogafale had little development and no airstrip. At that time, the Fogafale shore is a broad sandy beach some 40 m wide from its seaward edge to the vegetation line. By 1943 (**top right**), immense disturbance has occurred with the filling of low-lying inland areas to build the airstrip and most of the Fogafale lagoon shore has been subject to dredging and reclamation. The magnified inset image in 1943 shows the darker material being filled over the top of the original white Fogafale sandy beach behind a makeshift seawall. This seawall is the dark line which can be traced along the lower edge of the beach all the way down the shore. The 1971 image (**bottom left**) shows the still moderate rate of development on Fogafale as there is little development on the eastern side of the runway and large areas of coconut woodland still exist between the lagoonside village and the runway. By 2017 (**bottom right**), huge changes can be seen and these characterise much of the island to day. Housing and development cover practically all available land. Likewise, the level of development on the eastern side of the runway has been dramatic.

Figure 18 Central Fogafale, these images trace the change on Fogafale over time from 1941 to 2017

99. Figure 16 and Figure 17 and work such as (Chunting, 2005; Webb, 2006, 2007 and 2018, JICA 2011, etc) tell a very detailed story of the massive changes wrought on Fogafale Island and lagoon foreshore in the early 1940's by the WWII US Military build-up. Today, there is no part of Fogafale's lagoon margin which remains undisturbed and the central part of Fogafale's lagoon shore (the project area) was comprehensively destroyed through reclamation, dredging and other engineering in the 1940's. The legacy of instability and erosion on the Fogafale lagoon shore today is a direct result of those early engineering efforts which were implemented without any thought for their longevity or impacts beyond a few months use.

100. Today, there are essentially no natural sedimentary processes or even a residual regenerative capacity left on the central Fogafale foreshore as ocean-side sediment supply sources have been cut through the closure of channels and the lagoon side now consists of dead coral and excessive algal growth (refer 5.9.2).

5.5 BATHYMETRY

101. Funafuti lagoon is characterised by a wide (18 km) and deep (maximum 54.7m depth) basin in its northern part, and a very narrow shallow basin in its southern part. Figure 19 shows the bathymetry in the Funafuti atoll.

102. The reef flat on the ocean side is about 100 m wide in front of storm ridge. Outside of reef edge increases rapidly depth and is over 1,000 m deep. The lagoon side reef flat is 55-350 m wide including a 15-25 m wide beach.

103. JICA (2011b) undertook detail bathymetric surveys of the lagoon area near Fogafale, which includes the project area.

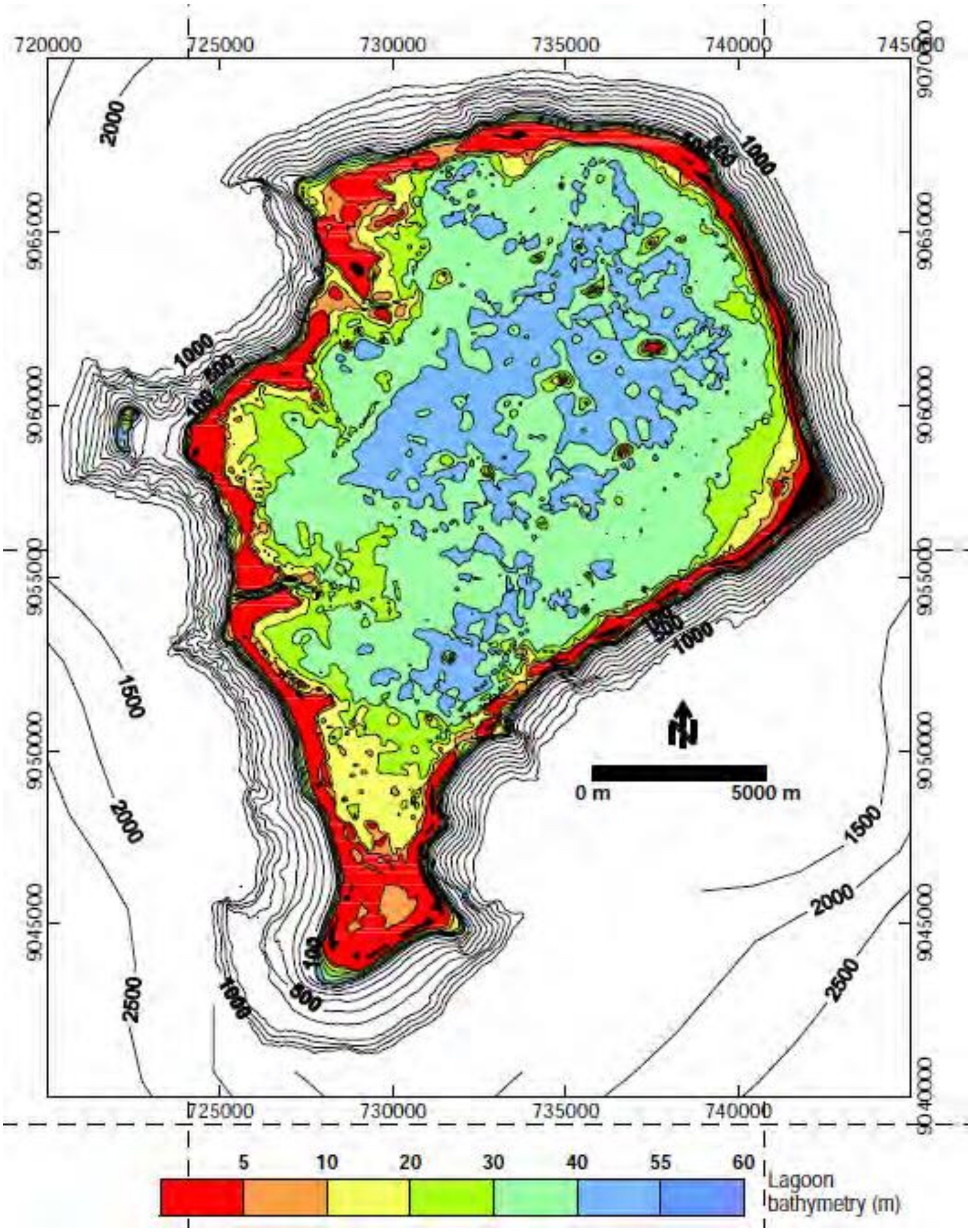

Figure 19 Composite bathymetry of Funafuti (JICA 2011)

5.6 MARINE SEDIMENTS

104. Two major studies have been undertaken to locate and describe sediments of the nearshore parts of Funafuti Lagoon (Gibb, 1985; Smith, 1995a). Gibb (1985) estimated the thickness of unconsolidated sediments using seismic surveys. Figure 20 is an isopach map, which shows the thickness of unconsolidated sediments above the inferred coral basement surface. The maximum sediment thickness is around 25 m.

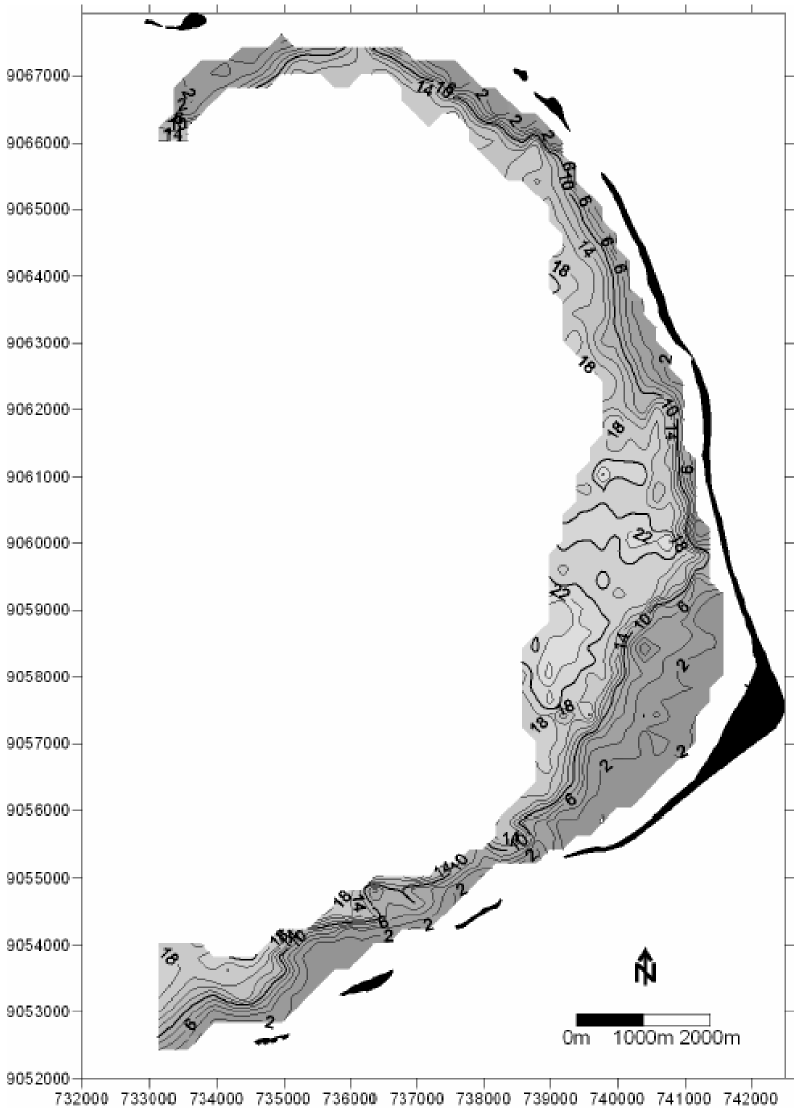

Figure 20 Isopach map showing thickness of unconsolidated sediments in the lagoon area off Fogafale (JICA 2011b)

105. Both of these studies identified large resources of *Halimeda* sands and muds between the 10 m and 25 m depth contours and deeper. Both studies also identified smaller patches of foraminifera, or foraminifera plus coral sand shallower than 10 m depth. The foraminifera/coral sands are close to the fringing reef (lagoon margin of the atoll rim), while the *Halimeda* sand is located in an area with many patch reefs (Kaly & Peacock 2014). Figure 21 shows the distribution of sands available near the project area.

106. Over timeframes meaningful to human development, within the sediment resource area, there is no connectivity in these basin sedimentary processes and neighbouring island shoreline process. In essence, the basin collects sediments, and it does not act as a source to the shoreline of the island.

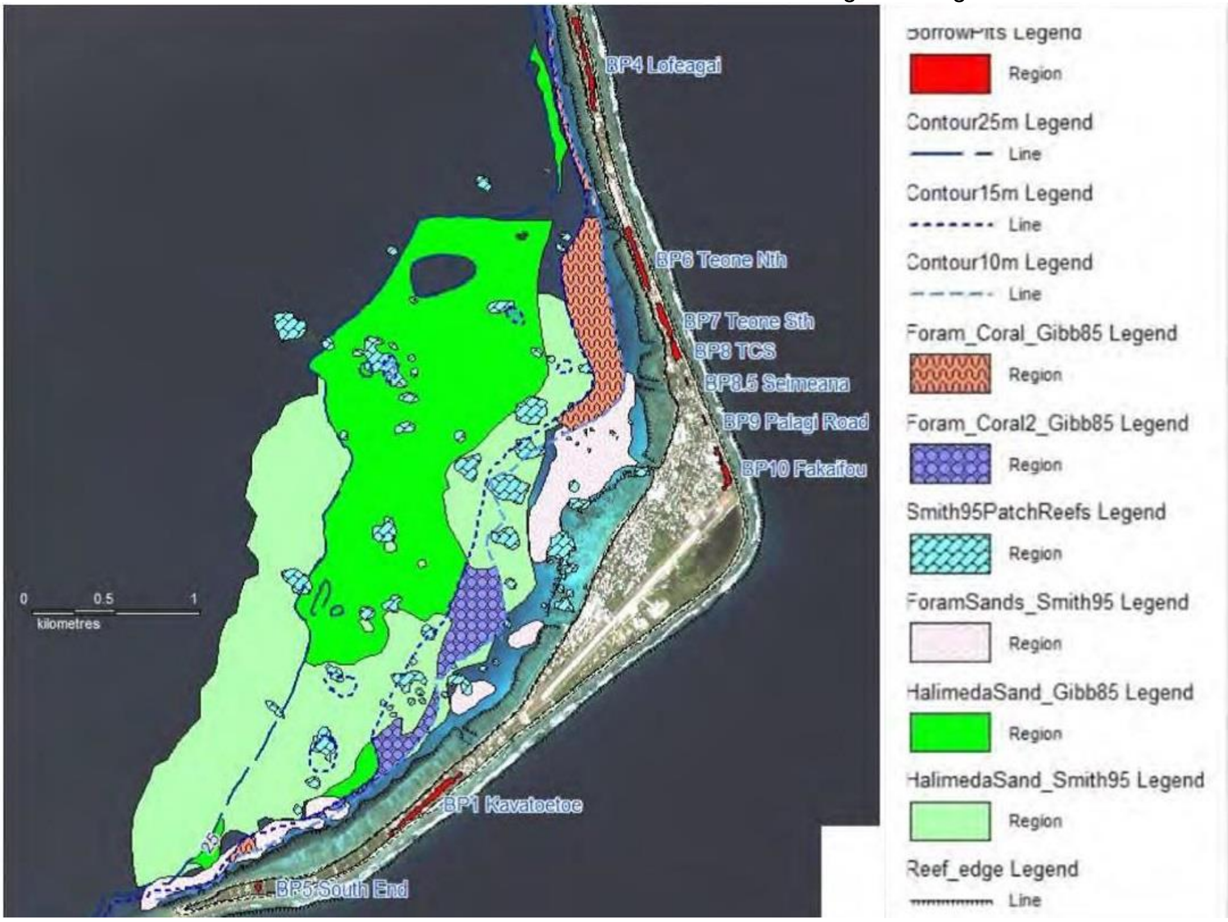

Figure 21 Lagoon sands available near Fogafale Islet as described by Gibb 1985 and Smith 1995 (source Kaly and Peacock 2014)

5.6.1 Source material characteristic

107. Table 2 shows a typical grain size analysis of sediments cored in the lagoon substratum within the sand resource area (Figure 4 and Figure 21). The samples display mostly coarse sand to fine gravel, with minor amounts of medium sand, fine sand and silt. Note the absence of clay (atoll's have no volcanic substrate so clays are not developed).

Table 2 Typical lagoon substratum grain size analysis (Smith 2015)

JP#	Easting m	Northing m	% Clay	% Silt (0.02-0.006 mm)	% Fine sand (0.06-0.2 mm)	%Medium Sand (0.2-0.6 mm)	% Coarse sand (0.6-2.0 mm	% Fine Gravel (2-6 mm)	%Coarse Gravel
12	739871.6	9055833	0	1.2	6	3.4	43.1	21	0
13	739843.3	9055793	0	1.2	28.7	37.1	29.2	3.4	0
14	739868	9055898	0	0.7	9.3	27.1	34.1	26.4	0
15	739913.7	9055866	0	2.2	13.7	26.4	31.4	21.8	0
16	739939.7	9055835	0	0.7	5	26.1	47.1	19.7	0

108. It is silt size particles that can be mobilized and remain suspended for longer periods. This analysis of the actual sediments in the resource area show these risks are minimal. Furthermore, the existing comprehensive sampling work across the resources area allows for site selection during dredging to retain operations in coarser grained (low risk) materials. Coarser grained fill is also a better-quality option as a reclamation material as it ultimately has greater potential for the establishment of vegetation and water infiltration characteristics.

109. The lagoon bottom in the area proposed for dredging is generally featureless, consisting of open areas of sand (Figure 22)

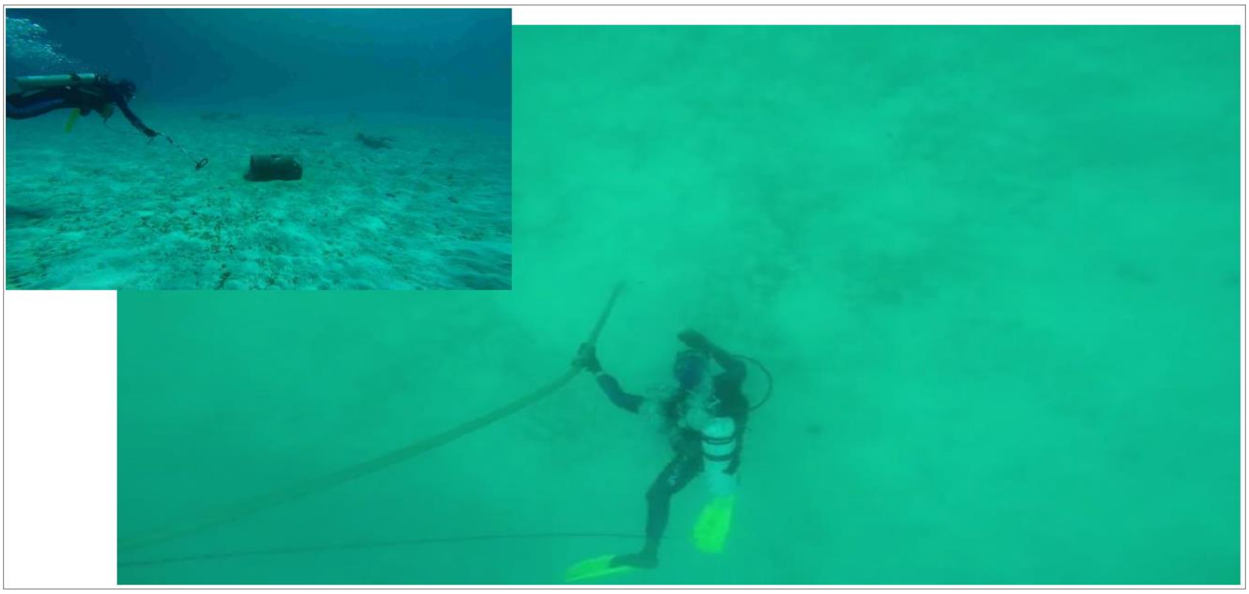

Figure 22 Divers sampling sediments within the Fanuti sand resource area in 2015 (source: SPC)

5.7 Oceanographic Phenomena

5.7.1 Waves

5.7.1.1 Ocean side

110. Wave measurements with a Waverider Buoy were carried out off the eastern coast of Funafuti Atoll between May 8th, 1990 and April 7th, 1992 as part of the Wave Measurement Program funded by the Norwegian Government Agency. The significant wave heights (H1/3) is remarkably constant throughout the year with an average of 1.8 m. The average wave period is 9.2 sec, in the main dominated by local wind seas. The highest measured sea state occurred in November 1990 when the H1/3 reached 3.4 m with a peak period (Tp) of 16.7 sec, partly as a result of swell arriving from Tropical Cyclone Sina. Although average wave heights are remarkably steady in Tuvalu, the directional character of the waves is extremely variable through the year (JICA 2011b).

111. The oceanside shore of Fogafale is subject to catastrophic cyclone driven wave impacts which can be so severe that they cause flooding across the whole island. SPC's (The Pacific Community) Marine Science Team undertook modelling at the request of TCAP to determine the potential return period for catastrophic cyclone landfall at Funafuti. A Cat 3 cyclone, equivalent to the last event (TC Bebe, 1971), which saw a catastrophic level of wave overtopping with water depths up to 1.5m of fast-moving water over the main runway and through much of the settled area of Fogafale, is estimated to be a 1 in 100 year event. However, this return frequency does not account for climate change and thus the frequency is expected to increase. The revised design recognizes the full spectrum of marine hazards in Fogafale and that there is little, if any, "safe" land on Funafuti during catastrophic TC landfall. The revised proposal will provide safe, raised land on the shore furthest from the ocean-side deep water coast. By doing this, TCAP can provide "protection for people and infrastructure from the increasing wave intensity and the effects of future wave overtopping."

5.7.1.2 Funafuti Lagoon

112. JICA (2011b) recorded wave characteristics in the lagoon over three periods (Nov 2009, Feb 2010 and Feb-Mar. One of the sampling sites was immediately offshore from the proposed reclamation.

113. The range of significant wave height, wave period and wave direction (traveling direction) obtained from the first observation were respectively 0.2 to 0.3 m (average: 0.2 m), 2 to 4 seconds (average: 2.5 sec)

and 49 to 83 degrees with hydrographical convention (average: 70.7°). The range of wave height, wave period and wave direction obtained from the second and third observations were respectively 0.2 to 1.4 meters (average: 0.4 m), 2.1 to 4.5 seconds (average: 3.1-3.6 sec) and 51 to 99 degrees (average: 76-80°).

114. The lagoon shore of Funafuti is a protected shallow water shore, and therefore, it is protected from open ocean swell and cyclone waves. The lagoon shore of Funafuti is not subject to life threatening, catastrophic wave overtopping, but rather it is subject to regular (annual/seasonal) nuisance wave over topping.

5.7.2 Tides and Currents

115. Tuvalu has a diurnal tidal cycle consistent with other island nations in the Pacific. Of importance, King Tides (properly defined as Perigean spring tide) which is a term used in the Pacific for the highest spring tide can have a significant impact on the local infrastructure through overtopping and flooding. The height of a king tide is affected by the combined factors of spring tide, storm surge, climate variability, and, significantly, by the warm-water effect. Tuvalu can be severely affected by king tides. The tides of February 2011 reached within about a metre of the level of the national government building, on the central lagoon. Recent surveys measured the lagoon ridge at about 4.12 m above the lowest astronomical tide.[2]

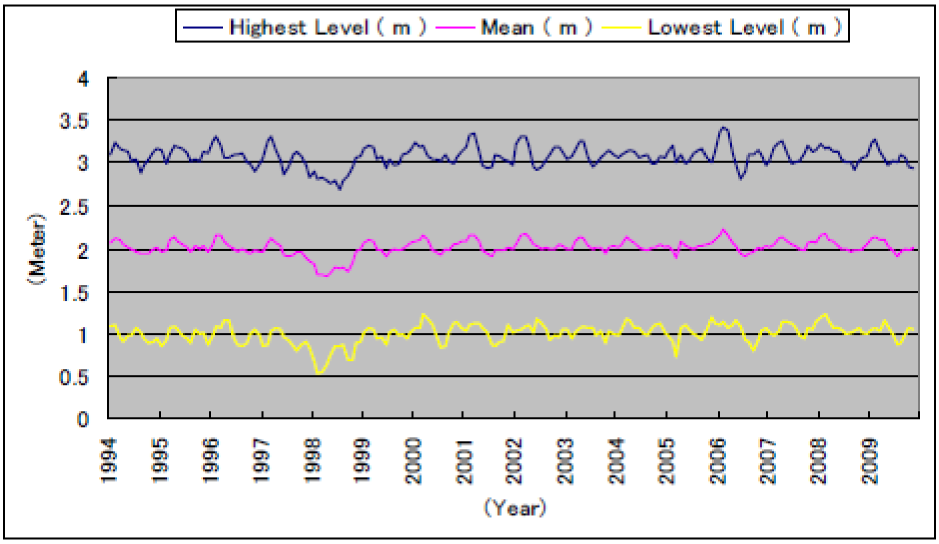

Figure 23 Monthly sea level at Funafuti, 1994-2009 (JICA 2011b)

116. Hydrodynamic modelling of tidal flows around Funafuti show that the currents on the lagoon side of Fogafale have very low velocities (Figure 24). Tidal cycles produce the bulk of ongoing water exchange in this location and water current data associated with this site (Damlamian, 2008) shows tidal signals are the dominant variable changing water direction and speed. The peak tidal flows, incoming and outgoing, both result in very low velocities in the Fogafale lagoon nearshore area – generally below 0.053 m/s (<0.2km/hr). Generally, sediment particle size of 1mm (sand) requires velocities of 0.3-0.4m/s to be mobilised.

[2] Lin, C. C., Ho, R., and Cheng, Y, H (2014) "Interpreting and analysing King Tide in Tuvalu", *Natural Hazards Earth System Science*, 14, 209–217

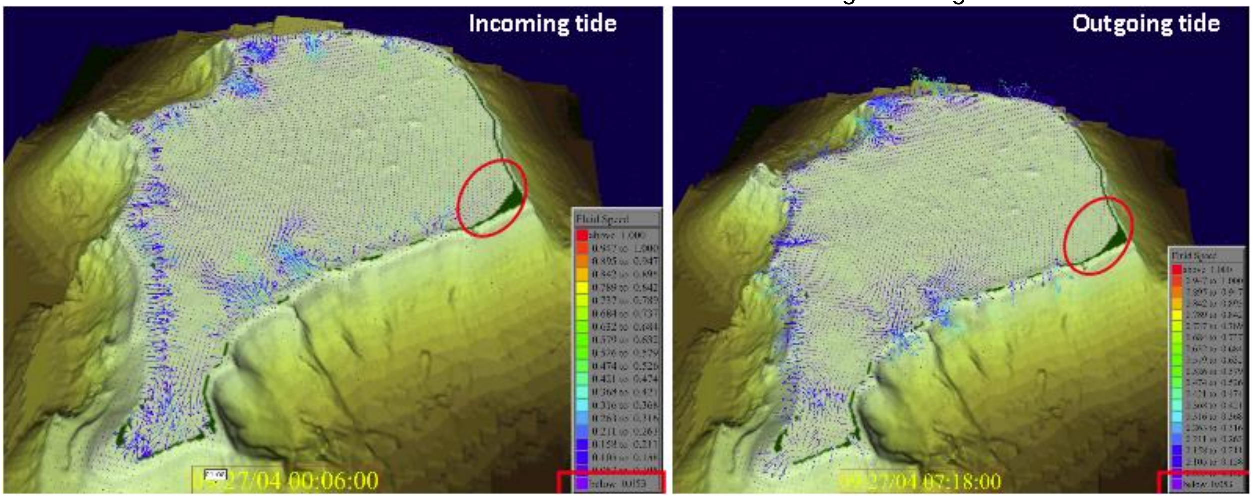

Figure 24 Outputs of hydrodynamic models showing water velocities for both incoming and outgoing tides (Damlamian 2008)

5.8 Seismic Activity

117. The tectonic setting of the South Pacific (SOPAC) region is very complicated. Seismicity in the SOPAC region can be attributed to crustal earthquakes on known faults, large subduction interface earthquakes, large subduction earthquakes, such as normal faulting intraplate and outer rise events, and shallow background and deep seismicity.

118. The earthquakes, volcanoes, ground deformation and tsunamis that can cause destruction in the region all result from the interaction of four major plates (Figure 25): The Pacific (PA), Australia (AU), Philippine Sea (PS) and Sunda (SU) plates. In Figure 25, the red arrows in the inserted map show the plate motions relative to Sunda (SU) plate. Colored dots in the main map are historical earthquakes (M≥6.0) from 1900 to 2008. Colors represent epicenter depth ranges and circle size shows the magnitude ranges.

119. Tuvalu has experienced only one significant event in the past 100 years (Rong et al 2010).

120. A regional seismicity model has been developed for the SOPAC region (Rong et al. 2010). Tuvalu earthquake hazard is classified as very low[3]. This means that there is less than a 2% chance of potentially-damaging earthquake shaking in the project area in the next 50 years. Impact of earthquake therefore is not a significant consideration in the design of the project infrastructure.

[3] http://thinkhazard.org/en/report/252-tuvalu/EQ

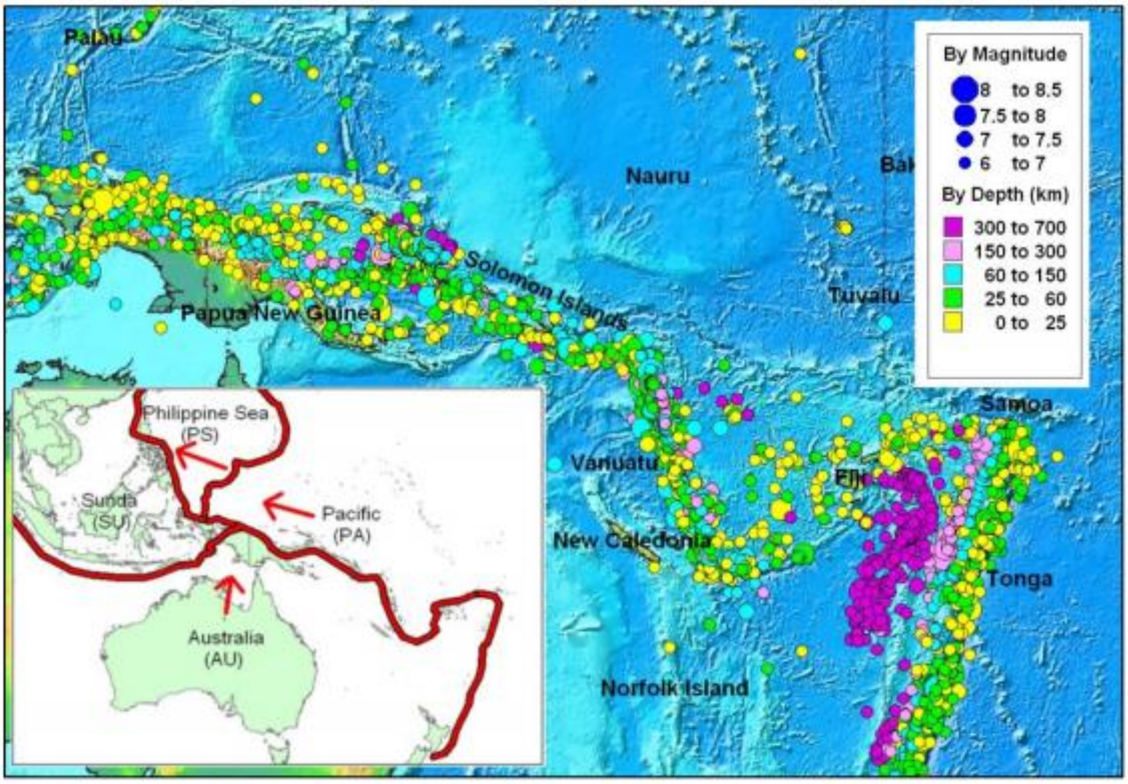

Figure 25 Regional Tectonic Setting and seismicity in the SOPAC region. (Rong et al 2010).

5.9 Ecology

5.9.1 Terrestrial Ecology

121. The indigenous vegetation of Funafuti is highly disturbed and now dominated by introduced exotic species (Thaman et al., 2012). The total recorded flora of Funafuti is about 349 species, only 16% of which are indigenous. The construction of the borrow pits in WWII was a significant period in the history of Funafuti which resulted in extensive destruction of habitat.

122. There are no endemic plants species unique to Tuvalu and almost all of the indigenous plants are widespread, easily dispersed pantropical, Indo-Pacific or pan-Pacific coastal species that are adaptable to environments with loose shifting sands, high salinity, strong sunlight, periods of drought and poor soil development. The most common trees found on all islands are coconut (*Cocos nucifera*) stands, casuarinas (*Casuarina equisetifolia*), breadfruit (*Artocarpus sp*), hibiscus (*Hibiscus sp*), papaya (*Carica papaya*) pandanus (*Pandanus tectorius*), flame tree (*Delonix regia*) salt bush (*Scaevola sericea*) and terminalia (*Terminalia sp*). Indigenous broad leaf species, including *Calophyllum inophyllum*, make up single trees or small stands around the coastal margin.

123. No birds or terrestrial species found on Tuvalu are considered endangered or critically endangered.

5.9.2 Marine Ecology

124. Of the 442 marine species found in Tuvalu, 83 are listed to be threatened (one of which is endangered and 79 listed as vulnerable species). There are 379 species of Cnidarians of which there are 366 species of hard coral. Seventy of the species are considered vulnerable (facing a high risk of extinction in the wild). Some 70 species of Cnidaria, which include hard, soft and blue corals, are considered as 'vulnerable' (facing a high risk of extinction in the wild) (MCT 2016).

125. Only four marine species found in the waters of Tuvalu and recorded on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species are considered endangered (facing a very high risk of extinction in the wild). These include the green turtle (*Chelonia mydas*), fin whale

(*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*) and the Maori wrasse (*Cheilinus undulates*). None of these species is likely to be found in the project area due to its highly disturbed nature.

126. There are 59 species of marine algae recorded with the dominant ones being green (*Halimeda* species) and red algae making up 76% of the total number of species, followed by blue and brown algae which make up the balance.

127. Cover by corals in Funafuti Lagoon is highly site-specific, with very low cover adjacent to Fogafale. The dominant corals are *Pocillopora* sp., *Acropora* sp. and *Porites* sp. Adjacent to Fogafale 96% of the area has coral cover of <1% and 3.7% has 1-5% cover. There are no areas with >20% cover (Figure 26) (JICA 2011c).

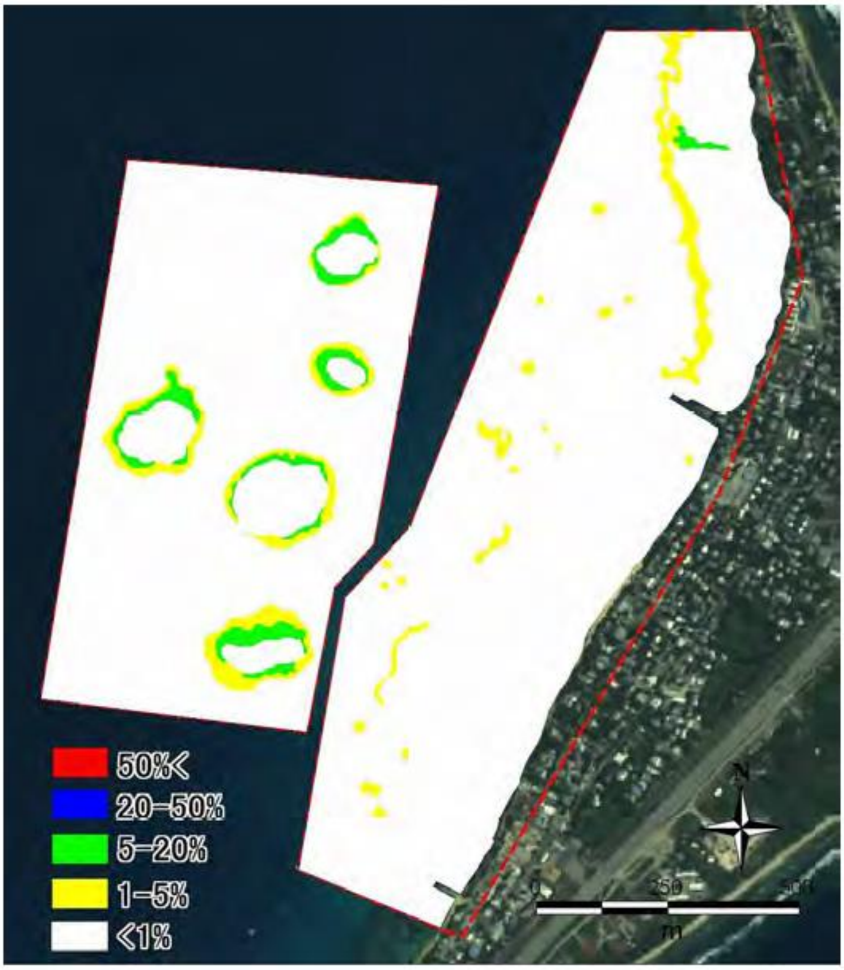

Figure 26 Coral distribution and degree of cover at Fogafale (JICA 2011c)

128. Figure 27 shows the distribution of algal in the project area. Note that almost all areas of rock or coral are covered by algae. Algal cover, in particular *Sargassum polycystum,* now dominates the nearshore reefs and occupies approximately 70+% of the reef top and slope on the lagoon side (Kaly & Peackock 2014). Work by Andrefouet et al (2017) and De Ramon et al (2014) documents the extent and proliferation of now persistent eutrophication associated macroalgae outcrops in the nearshore Fogafale area. This highlights how chronic water pollution, resulting from domestic wastewater, is affecting the ecology of the lagoon close to the densely populated areas of Fogafale. This underlines the more contemporary level of human impact over water quality and ecological shift at this location. As Kaly and Peacock (2014) indicate, corals simply do not occur in this zone anymore.

129. In an ecological assessment of the impacts of a smaller scale dredging operation in Funafuti lagoon undertaken between 1991 and 1994, (Kaly and Jones, 1994) found that the area of reef close to Vaiaku, the main settlement were already heavily impacted with higher levels of algal cover and more

invertebrates and fish that are associated with algae or sediments than in other areas of the lagoon which were more dominated by live corals. Further, fish diversity and abundance were found to be generally low in the Fogafale area compared with other areas (JICA 2011c). This can largely be explained by the poor habitat as a result of pollution and the loss of coral.

Figure 27 Distribution of algae (JICA 2011c)

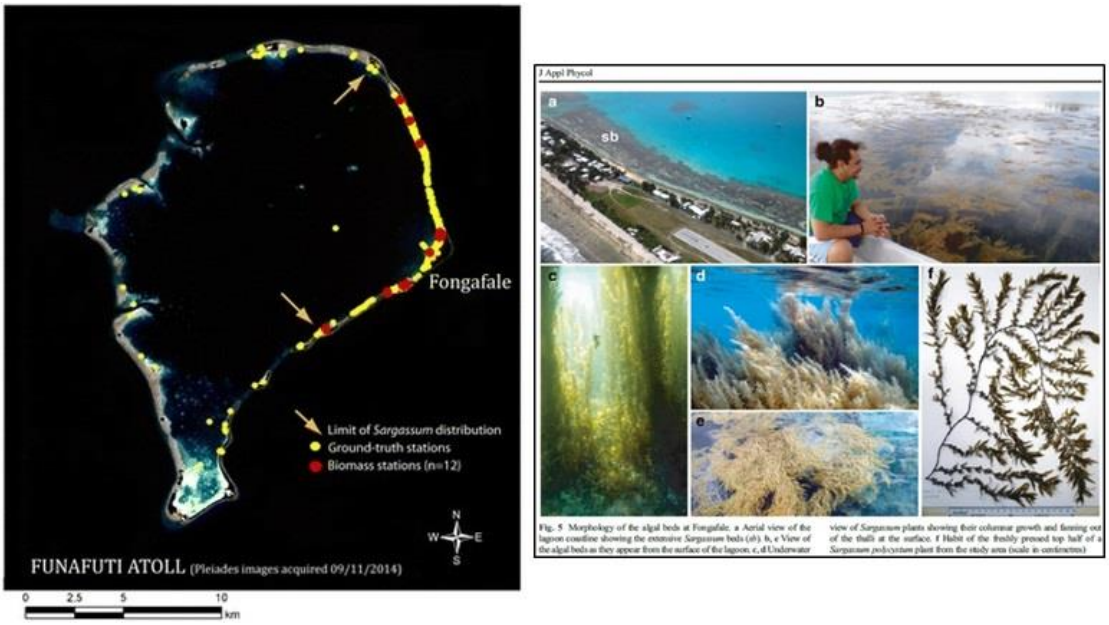

Figure 28 Sargasum dominates the nearshore area of the project (Andrefouet et al (2017) and De Ramon et al (2014)).

130. As described by Smith (1995) and as explained in recent similar EIA documents (e.g. JICA, 2011 and Kaly and Peacock, 2014), the sea floor in the sand resource area is predominantly simple sandy

substratum with patches of *Halimeda* algae (Figure 29). These habitat types are very well represented throughout the broader Funafuti lagoon and they, along with simple bioturbating organisms and epifauna (e.g. sea cucumbers), typically recover very quickly following physical disturbance.

Figure 29 Lagoon substratum and common benthos

(left) photo shared by Hall Contracting of the lagoon sand resource substratum taken during dredging project in 2016. (right) photos of the common bioturbating marine worm Arenicola and Halimeda algae.

5.10 GROUNDWATER

131. The demise of the Fogafale freshwater lens began in the early 1940's when the US Military essentially land-formed the surface of the island, filled taro gardens and swamp areas, reclaimed the lagoon foreshore, dredged deep navigation channels and built the runway. The viability of the fresh water lens has been very limited ever since (Webb, 2007). Otherwise, with the prevalence of flush toilets and septic tanks across the densely populated island, any freshwater formation on Fogafale is today very contaminated and essentially no potable groundwater resource exists (JICA, 2011).

132. On Funafuti, the domestic sewage (fecal and non-fecal wastewater) is currently seeping into the groundwater, either untreated or only after simple treatment or being moved into coastal waters. The JICA study found that nitrogen and phosphorous concentrations are higher than water quality criteria and threshold values of eutrophication near the coast on lagoon side, raising concerns about the influence of eutrophication, although the chlorophyll-a concentration was ≤0.05μg/l or 0.1 to 0.2μg/l in the overall for the area, suggesting that eutrophication has not reached a level where it influences the growth of coral.

5.11 UNEXPLODED ORDINANCES

133. Tuvalu was used as an important staging base for US aerial attacks in the Battle of Tarawa in Kiribati during WWII. Bomber bases were established on Funafuti, Nanumea, and Nukufetau, being the only islands big enough to accommodate them, with the latter two being considerably closer to Tarawa. Funafuti, Nanumea and Nui were the only islands to be bombed during this operation.

5.12 AIR QUALITY

134. Air pollution is not a significant issue in general sense in Tuvalu, but there are situations where some individuals may be affected. Generally, such cases will simply be nuisance rather than significant health risk.

135. Common emission sources include motor vehicles, cooking fires and stoves. Odour nuisance can occur from waste, sewage, and animal feedlots.

5.13 Ambient Noise

136. Noise pollution sources in Tuvalu are limited and noise levels are low compared to most other places with similar or even lower population densities. However, the high urban and village population densities mean that noise could become an issue in some circumstances. Noise from industrial processes (e.g. the powerhouse), vehicles and aircraft are the biggest potential problem.

5.14 Social Environment

5.14.1 Population

137. No countries in the Pacific region have experienced more recent or more rapid population migration and urbanization than Tuvalu. At the end of the 19th century, Funafuti Atoll was one of the least populated atolls in Tuvalu with a population of only 251, representing 7% of Tuvalu's total population. In the 1970s, the populations of both Funafuti and Tuvalu increased markedly (Yamano et al 2007). The most recent census in 2017 puts the population of Tuvalu at 11,192, while the latest estimates from the UN's World Population Prospects estimates the population to now be 11,393[4]. Funafuti is the most populated atoll in Tuvalu, with over half of Tuvalu's population living there. The population density is now very high at 2,500 people per square kilometre, most of whom are concentrated on Fongafale which has a total land area of 142 ha.

138. The population of Tuvalu is primarily of Polynesian ethnicity, with approximately 5.6% of the population being Micronesian. Funafuti's people originated from Samoa. The ancestors, after one of which the atoll is named, first settled on Funafala islet before shifting to Fongafale. During that time people from Kiribati and Tonga raided Funafuti and a number of people of mixed ancestry were born. There were also later arrivals from Samoa, Uvea and Futuna bringing with them pulaka roots which they planted in swamps to increase the food supply. Feuding among the people led to the formation of two groups, one on the islet of Mulitefala and another on Fongafale. Disputes over land boundaries and redistribution occurred until the coming of the Samoan pastors who brought the chiefly (aliki) system to an end (McLean and Hosking, 1992).

139. The Tuvaluan language and English are the national languages of Tuvalu. Tuvaluan is of the Ellicean group of Polynesian languages, distantly related to all other Polynesian languages. Tuvaluan is spoken by almost everyone, while English is not spoken in daily use.

5.14.2 Gender

140. Women make up just over half the population of Tuvalu (51.13%)[5].

141. Tuvalu government is party to the Convention on the Rights of the Child (September 1995) and the Convention on the Elimination of all forms of Discrimination Against Women (October 1999). According to most of the MDG indicators for gender equity, the status of women in Tuvalu is high and rising. Also, Tuvalu is rated first among 15 Pacific Island countries based on UNDP's gender development ratio (Te Kakeega II 2005-2015). (JICA 2011 VII)

142. Historically, Tuvalu is a patriarchal society where women's roles are confined to the homes, and decisions of matters outside the family are left to the men. Despite the relative gender balance within the public service, men still dominate senior positions.

143. The laws of Tuvalu allow equal eligibility to men and women to enter parliament, although representation remains low. Since independence, only three women have been elected to the National Parliament.

[4] Tuvalu Population. (2019-05-12). Retrieved 2019-05-17, from http://worldpopulationreview.com/countries/tuvalu/
[5] Tuvalu Population. (2019-05-12). Retrieved 2019-05-17, from http://worldpopulationreview.com/countries/tuvalu/

5.14.3 Governance

144. Tuvalu is a unitary constitutional monarchy with two spheres of government: national and local. The legal basis for Tuvalu local government is the Falekaupule Act 1997 and there is only one level, which is the kaupule (island council).

145. Each island has a traditional assembly of elders called a falekaupule or 'te sina o fenua' (literally, 'grey-hairs of the land'), and the Falekaupule Act 1997 brings together the traditional responsibilities of the falekaupule and the elected kaupule.

146. The governance system, as it applies in Funafuti, is shown in Figure 30

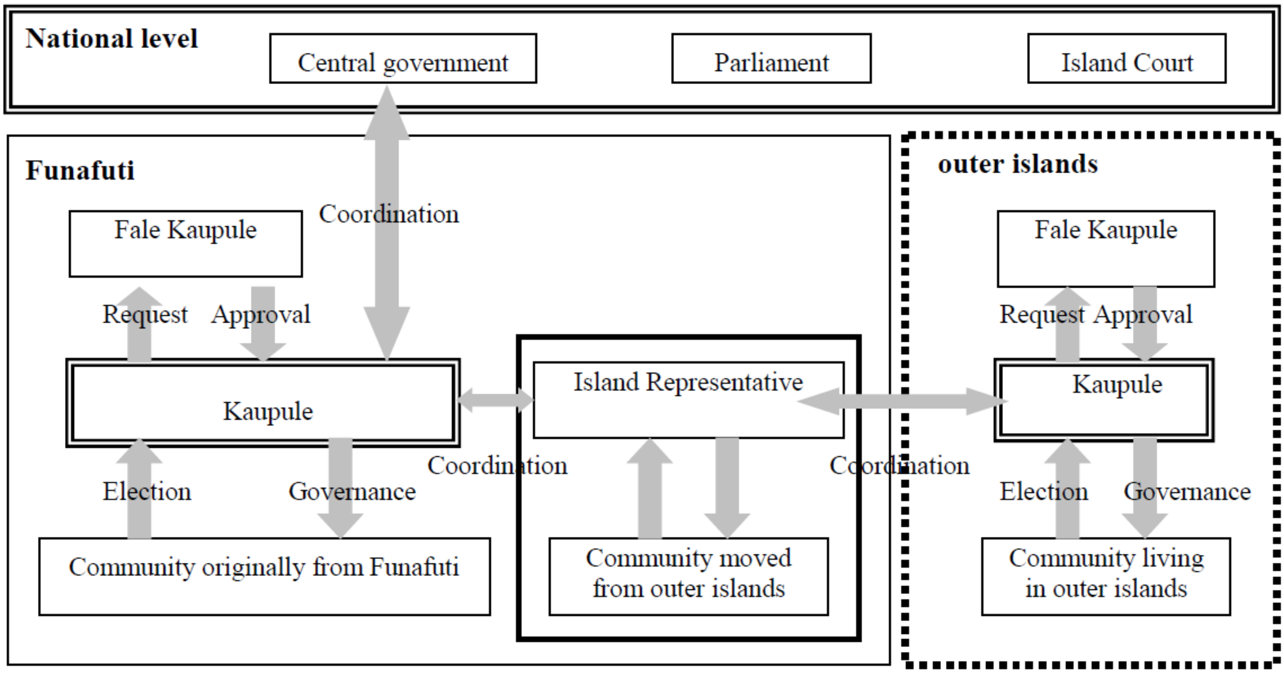

Figure 30 Governance system in Tuvalu (source: JICA 2011b)

5.14.4 Land Tenure and Land Use

147. There are several land tenure arrangements in Tuvalu: private land, government acquired land, leased land, crown land, public land, communal land, village land, and Tuvalu Church land. Tuvalu has retained its traditional land tenure system by merging its traditional setting into the Land Codes that govern the use of land today. The traditional land tenure system is primarily based on kinship. Tuvalu is a patriarchal society where men inherit land. Land will only be passed to a daughter if there are no sons, she is the only child, or the only surviving child.

148. Most of the land in Funafuti is privately owned and there is a significant area of leased land associated with its function as the country's capital. Land use of Fongafale Islet is either residential area or governmental land (leased from private land owners). All areas of Alapi Village, the oldest village on the islet, are residential; Fongafale's main institutions are located in Senala Village, such as the Funafuti Council (Kaupule), Conference Hall of the supreme decision making body (Fale Kaupule), a church, a hospital, and a primary school. Buildings of the Tuvalu Government are concentrated in Vaiaku Village, and also the Prime Minister's house. The south-eastern side of the airstrip is designated as government land. There are no residential houses, but a power plant, a prison, public works department, and meteorological bureau buildings. Figure 31 shows the location of residential and government buildings.

149. There are many small fishing boats moored in the ship passages made by U.S. troops on the lagoon side of Alapi and Senala villages (Figure 31). The boats are easily landed on the shore by fishermen who live nearby. Many boat ramps are found along the shore.

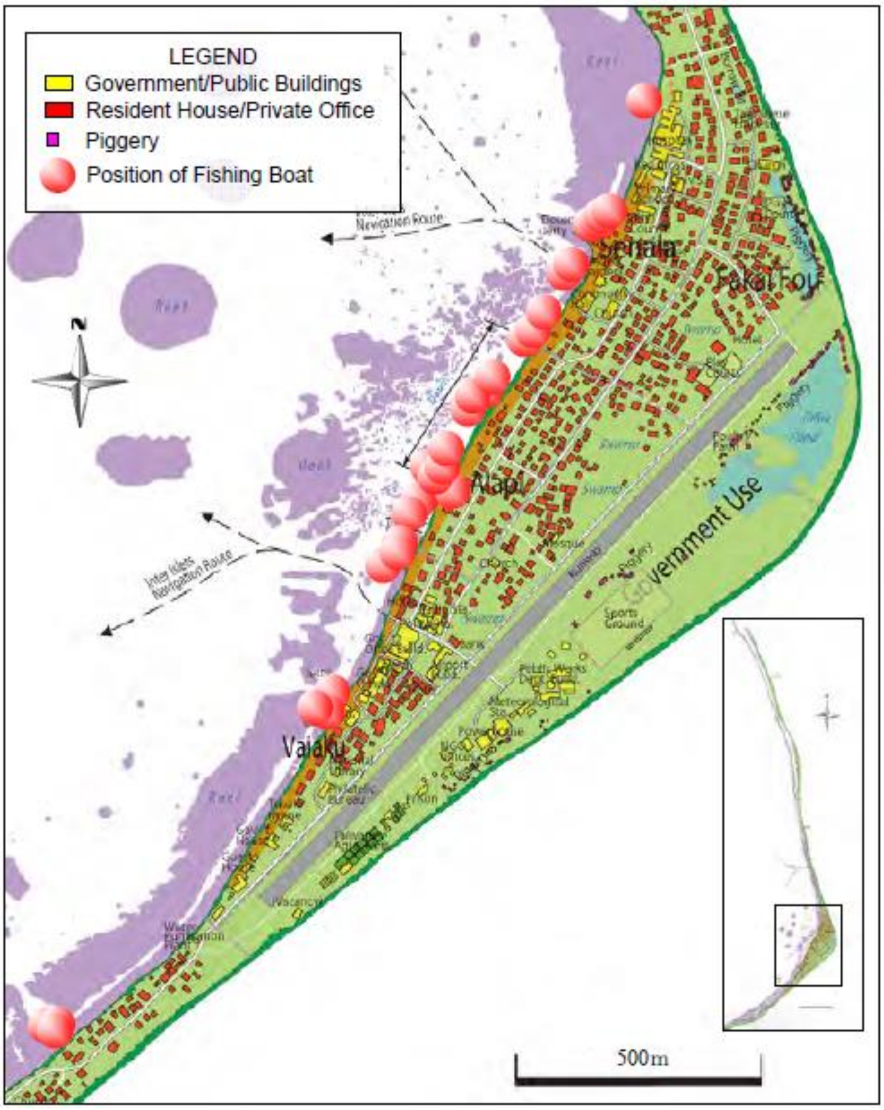

Figure 31 Land use (JICA 2011b)

5.14.5 Economic Aspects and Livelihoods

150. Tuvalu is predominantly a subsistence economy. Due to scarcity of domestic resources, the population relies heavily on imports in terms of foodstuffs and other daily necessities, and as a result, trade deficits are significant.

151. The public sector dominates economic activity. Tuvalu has few natural resources, except for its fisheries. Earnings from fish exports and fishing licenses for Tuvalu's territorial waters are a significant source of government revenue.

152. Tuvalu's main industries are fishing and tourism, and the country also exports small quantities of copra (dried coconut meat from which oil may be extracted). Manufacturing sub-sectors include small-scale timber processing and various handicrafts. Beach tourism is more associated with the uninhabited pristine island shores and reefs within the Funafuti Conservation Area (FCA), a protected area established in 1997, located some 13 km away on the western reef of the Atoll, rather than the densely populated Funafuti (Figure 32).

153. Women struggle economically as the cultural norm is to undertake domestic responsibilities only. The main sources of income for women are: handicraft and small business (including selling ice cubes, catering for school, selling homemade cakes and sewing).

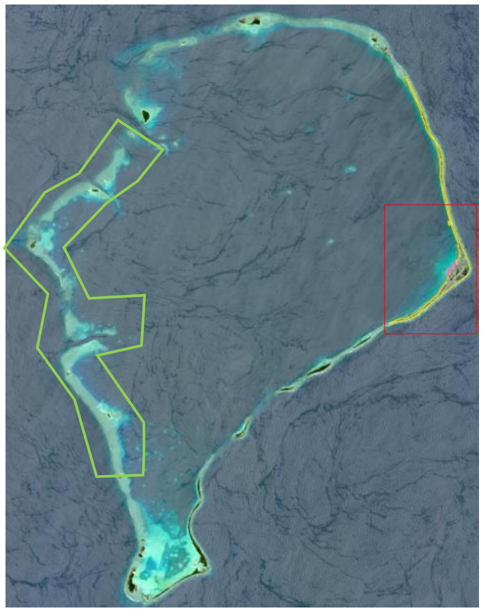

Figure 32 Funafuti Conservation Area (green polygon)

5.14.6 Archaeological and Cultural Heritage

154. Adjoining the proposed reclamation area (Tausoua Beach), there is an important community church compound. This location was already the site of significant earthworks during the recent JICA shoreline renovation project. Although an older church building, which may have greater sensitivities, is present in this area, it is located well back (60 m) from the foreshore.

155. There are no known archaeological or cultural heritage sites within the project area.

6 DESCRIPTION OF POTENTIAL IMPACTS AND MITIGATION MEASURES

6.1 IMPACTS DURING WORKS (CONSTRUCTION)

6.1.1 Terrestrial ecology

156. The proposed reclamation has limited direct interaction with the terrestrial environment or resources of Fogafale Island beyond the immediate shoreline. The reclamation would overlap with the existing lagoon shore over a length of some 750 m. It is likely that along this “overlap” zone a small amount of sand may spill over (perhaps 2 or 3 m landward) over the existing shoreline environments. As most of the reclamation material will be pumped directly into place, “sand spills” should be minimal, temporary and easy to clean up if do occur. Vegetation along the upper shoreline should not be significantly impacted by the works. Any sensitive areas (vegetation or cultural items identified during the ESIA process) would be identified and marked for special care and avoidance.

157. Importation of materials, particularly rock, can represent a potential vector for the importation of unwanted plant or animal pests. Rock supply will be selected such that risk is minimised, furthermore, inspection and handling protocols will be developed for pest detection and control. It is likely that rock will be dumped directly into position i.e. deposited directly into the marine environment, which will further reduce the chance of any pest terrestrial organisms surviving.

158. The existing ESMP will be updated based on the findings of the planned ESIA. It will detail any specific requirements for the protection and management of terrestrial ecology issues.

159. Otherwise, there are no terrestrial negative impacts expected from this proposal given the existing shoreline is already entirely artificial and has been dysfunctional and erosive for decades. Ultimately the provision of new land for safe development can only improve the state of affairs on Fogafale Island where increasingly dangerous and marginal areas are being developed because there is simply no other option.

6.1.2 Marine ecology

160. Today, live corals are practically absent and dense thickets of macro algal (otherwise unheard of in such atoll environments) dominate and choke the nearshore shallows (Figure 28). Anecdotal reports (Kaly, 2017) of fish kill events in the nearshore have also been recorded and appear to be related to quiet weather conditions and the large biomass of macro algae now present. These standing crops can cause significant draw down of dissolved oxygen concentrations at night and stress or kill slow moving epifauna (in this case sea-cucumber were killed).

161. Beyond the footprint of the proposed reclamation and indeed substantially further out from this shore, the substratum is reported by Smith (1995) to be uncharismatic, soft sedimentary environment dominated by *Halimede* algae and lightly bioturbated. These habitats are very well represented across the broader lagoon system, are not ecologically sensitive or rare and recover rapidly from disturbance. Similarly, Kaly and Peacock (2014) indicated the surrounding marine area is heavily impacted and over fished and of little contemporary value as a fishing ground.

162. Thus, any impacts associated with this reclamation would simply be the physical burial of the already disturbed and low ecological value substratum (namely bear sand and invasive macroalgae thickets) within the footprint of the reclamation, of which over 50% of that footprint is already subject to a litany of pre-existing physical disturbance impacts (dredging, reclamation, groins, seawalls, etc). In these circumstances, there are significant benefits of implementing an overarching action which will address, in one well planned activity, the entire range of pre-existing physical disturbance problems. Furthermore, if undertaken using best practice methods and well managed operation, there are no significant coastal processes risks or impacts associated with this action.

163. The dredging contractor will be required to prepare an ESMP for the dredge operations. In particular, the management of plumes and dewatering will require detailed documentation. Although unlikely to be a

significant issue given the nature of the sand resource and the low current velocities in the Fogafale part of the lagoon, physical barriers such as silt curtains may be required if sediment plumes are found to be problematic.

6.1.3 Dredging impacts

6.1.3.1 Turbid water

164. In respect to impacts, the reclamation proposal presents an opportunity to contain dredge sediment laden water associated with pumping sand. Increased turbidity from sand pumping is generally the main aspect of concern in such operations. Under the revised design (reclamation), there is a means to control the release of any such sediment laden water as the proposal is to pump the sand directly into a containment area behind a new revetment wall, thus providing an area separate from the lagoon for dewatering.

165. During dredging, there may be plumes generated that affect significant areas of the nearshore lagoon. However, nearshore consists of pre-existing disturbance regimes that are a combination of WWII dredging and reclamation efforts, extensive reactionary seawall building, recent foreshore engineering by the Government of Tuvalu (Queen Elizabeth Park reclamation - QEP), recent beach nourishment, groin building, and the foreshore protection works by JICA (Tausoua Beach Project). Beyond these areas that have been physically disturbed, the nearshore has been described by Kaly and Peacock (2014) as a "zone of dead corals and eutrophication". The nearest sensitive area (Funafuti Conservation Area) is approximately 13 km away (Figure 32).

166. Past dredging efforts in the Fogafale sediment resource area have graphically shown these sediments are deficient in labile carbon and lack any visible horizontal zoning where greater interstitial concentrations of nutrients or harmful compounds (e.g. hydrogen sulphide) associated with anoxic layers persist. As is commonly found in oceanic atolls, shallow open lagoon systems are naturally oligotrophic (nutrient poor) with low productivity (compared to continental shallows with terrestrial runoff). As a result, no significant water quality risk is expected from dredging these sediments beyond the potential for increased sediment resuspension and turbidity. Even this risk is, however, mitigated by the relatively uncharismatic substratum and absence of, for example, living coral, seagrass, etc. Kaly and Peacock's EIA study completed for the Tuvalu Borrow Pits Project (2014) called this area "the zone of dead coral and eutrophication" and noted "benthic communities have changed from coral-rich to algae-dominated. Given the damage already done to this area, there is little risk of further damage to reefs during the relatively short duration of dredging (1-2 years)". Note in this study the authors considered ongoing dredging over a possible 2 year period. This proposal will complete dredge operations within an estimated 2 to 3 week period because of the relatively modest size and simplicity of the task.

167. Damlamian (2005) undertook HD modelling of resuspension and sedimentation impacts associated with dredging in this specific lagoon resource area. These models were calibrated using in-situ sediment analysis data (samples collected from the resource area) and water current direction, velocity and elevation data collected over several weeks. It is also important to understand that Damlamian (2005) modelled the impacts of sediment pumping to a floating barge, meaning de-watering occurred at sea with direct release of waste water 2m above the substratum. On average sediment pump slurry is around a 75:25 ratio of water to solids (so 1 T of sand results in around 3,000 L of sediment laden water). Under these adverse dewatering conditions, sediment desperation did occur in an area of some 4,000m^2, an area well within the sediment resource zone. Outside the resources area, rates of modelled sedimentation were so low as to not present any threat; suspended particles did not exceed 1mg / L whereas normal ambient levels were expected to range up to at least 10mg / L. Likewise, sedimentation rates outside the resources area (0.1mg / cm^2 / day) were far lower than for example tolerance levels of common corals such as Acropora sp.

168. Ultimately, even modelling the sub-optimum method of dredging considered by Damlamian (2005) did not find significant impacts. TCAP proposes to pump the sand/water slurry directly to the containment area within the footprint of the reclamation. This will contain the sediment laden water and allow all solids to settle and for only clarified water to eventually move back to the lagoon. In this way, dredge impacts in respect to sedimentation and turbidity can be more or less eliminated. This method was used by the

recent NZ funded Borrow Pit Filling Project which pumped some 0.6 million m^3 of sand from the same resource area onto the island, which resulted in no significant environmental impact.

169. If TCAP emulates those approaches to ensure any turbidity or sedimentation risks are minimised and managed, no significant negative impacts are expected. This is especially so given the absence of sensitive benthic habitat such as corals in the area.

6.1.3.2 Habitat loss

170. The sand resource proposed has been utilised on three occasions since 1995 for similar dredging projects. In all cases, no significant environmental impacts were observed or reported - most recently in 2016, the New Zealand Government dredged 0.6 million m^3 for the Funafuti “Borrow Pit Filling Project”. Extensive and contemporary New Zealand Government Safeguards processes were used during the Project and these found no significant impacts (Kaly and Peacock, 2014). The proposed reclamation accounts for approximately 0.0314% of the total lagoon area of the atoll system.

171. Thus, although dredging will cause a direct loss of habitat and some loss of organisms (such as polycheates and crustaceans), the impacts will be far less than it would be for an undisturbed environment. If plumes develop in areas outside of the designated ‘dead coral zone’, the Contractor will reactively monitor them for stress using the techniques employed on the previously successful Borrow Pit Filling Project. If necessary, sediment curtains or similar devices will be deployed to ensure harm to corals is minimised.

6.1.3.3 Access, public safety

172. The operation of the dredge could disrupt the movements of fishing boats and other vessels in the lagoon. To mitigate these, the Contractor will clearly communicate the dates and locations of dredging to all. Also, it is expected that dredging operations will be of limited duration (2-4 weeks) due to the relatively small scale of the project.

6.1.4 Contamination and Waste

173. With the operation of any machinery that utilises engines, fuel, and hydraulics, there is the potential for spills of hydrocarbons. These can occur through refueling, storage of fuels, hydraulic fluid and greases, hose bursts or during maintenance.

174. Through the application of good industry practices, spills can be kept to a minimum. Contractors will be required to have spill response plans and kits to deal with any spills. Operators are to be trained in dealing with spills.

175. Other than the excess water that will decant from the dredged material once implaced into the reclamation area, the project will not generate significant volumes of waste. The discharge water has the potential to be turbid. The reclamation will be designed such that turbidity beyond the reclamation area is minimised. If required, additional barriers, such as silt curtains, can be utilised to further restrict the movement of turbid water.

176. Minor amounts of solid waste, including domestic rubbish and waste from maintenance activities, will be generated. These will be collected and disposed of as part of the usual island waste management system.

6.1.5 Hours and days of operation and noise

177. Operating the dredge and other equipment as part of the project could result in disruption to the community through noise and hours worked by local labourers. To reduce impacts the noise generated by machinery should be minimised and machinery well-maintained. The days of the week worked and hours on each day need to be negotiated with the Kaupule, and an agreed work schedule communicated to the community. The project grievance mechanism will receive and address all complaints.

6.1.6 Access

178. Access impacts will be limited as the dredge pipeline will not be required to cross any roads.

179. If machinery or other equipment has the potential to cause traffic hazard or reduced access, then appropriate signage and traffic controls will be put in place. Residents will be notified prior to works of any anticipated restrictions.

180. There is potential for access impacts to boat users, particularly those that currently use the beach. Navigation disruptions could also occur as a result of dredging operations. Impacts will be minimised through ongoing consultation with stakeholders and clear communication about dredging locations and times.

6.2 Impacts Post-Construction (Completed Project)

6.2.1 Loss of Resources

6.2.1.1 Sand Resource

181. As has been previously described, the available sand resource has been estimated at 24 million m^3, whereas the volume required for the project is only 350,000 m^3, so the project will in no way exhaust the available sand resource.

6.2.1.2 Nearshore Fisheries

182. The footprint of the proposed reclamation and the marine resources within are not high value because of their degraded nature and have little residual fishery value (Kale and Peacock, 2014). Furthermore, 55% of the reclamation footprint has previously been heavily disturbed through engineering activities (Figure 33 Overlay of various reclamation and engineering that has occurred since 1940s at the project site.Figure 33) and the proposed reclamation accounts for only about 0.0314% of the total lagoon area of the atoll system.

183. The proposed rock revetment wall will create some artificial reef habitat that could, overtime, become populated by reef species currently not found in the area.

184. There may be some impact on fishers who use the current shoreline for boat access. However, a small boat harbour will be provided at the northern end of the reclamation area.

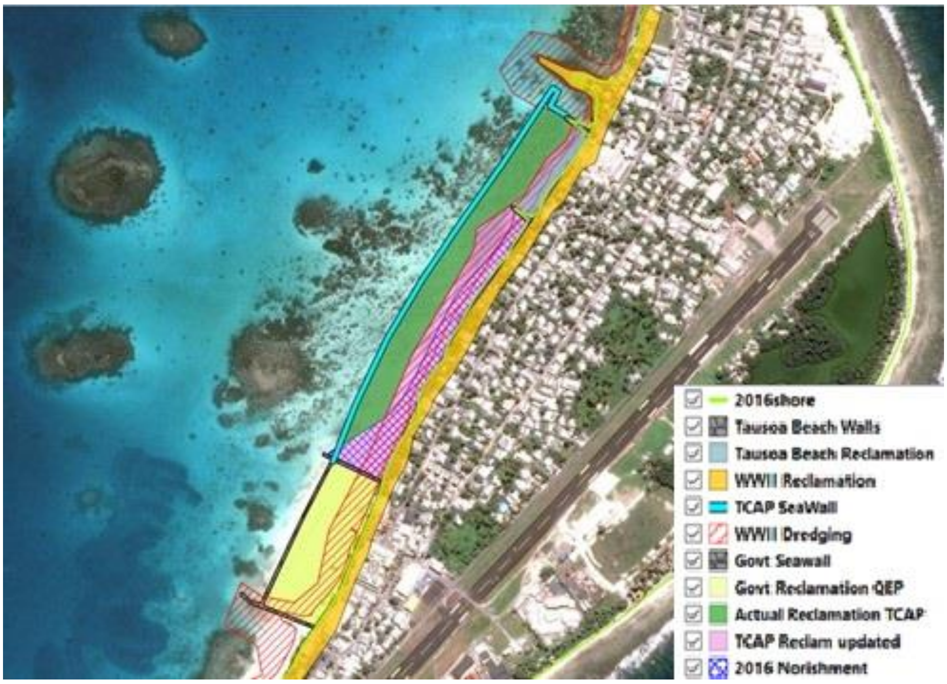

Figure 33 Overlay of various reclamation and engineering that has occurred since 1940s at the project site.

185. Figure 33 illustrates the various activities that have impacted the site since the 1940s. This figure highlights the previous level of disturbance and shows that the actual 'new' footprint of the proposed

reclamation is significantly less than the total 7.8 ha. The green zone shown in Figure 33, which is the TCAP reclamation footprint that lies outside of previously disturbed areas, accounts for about 3.2 ha or 45% of the total TCAP reclamation area.

186. The footprint of the proposed reclamation lays over what has become the most impacted area of lagoon shallows on this atoll, indeed in the entire country. Combined with the legacy of past engineering and physical damage which has occurred and the ongoing issues of eutrophication, this area is now essentially a pocket of water “trapped” between the WWII Catalina ramp and the recent QEP reclamation. Because of the now complete isolation from any residual longshore movement on this coast, it is likely this pocket of water will suffer even lower exchange rates and problems with anoxia, eutrophication, etc. The unplanned nature of the neighboring engineering and uncontrolled contaminated groundwater inputs makes this very difficult to remedy in terms of improving the water quality.

187. Whilst the proposed reclamation cannot “correct” this issue either, it does in fact remove it. This isolated pocket of water, which otherwise is leading to fish kills, will become land. The relatively continuous shoreline which would be reinstated will extend from the QEP reclamation, across the proposed TCAP reclamation and over the WWII Catalina ramp. From the perspective of longshore currents and processes, this continuous shoreline will better promote water exchange than the present artificially indented shoreline which traps pockets of water.

6.2.2 Land Disputes

188. The basic law for the coastal zone in Tuvalu is the Foreshore and Land Reclamation Ordinance. The ordinance provides that, “Subject to the public rights of (a) navigation and fishing, and (b) of passing over the foreshore, and to any private fights that may exist in or over the foreshore or the sea-bed, the ownership of the foreshore and sea-bed is vested in the Crown” ((1), 3 Declaration of ownership of foreshore and sea-bed), in which “foreshore” means the shore of the sea or of channels or creeks that is alternately covered and uncovered by the sea at the highest and lowest tides, and “sea-bed” means the bed of all territorial and inland tidal waters.

189. As the ownership of the foreshore and sea-bed is vested in the Crown, “any land reclaimed otherwise than under section 11 (1) shall be vested in the Crown” (9 Vesting of reclaimed land), subject to subsection (2). Subsection (2) provides that “Causeways and landing-places constructed by a local government council shall, subject to the right of the Minister to call for their surrender to the Crown at any time, vest in that council.” And “Subject to section 11 (1) the Minister may, in accordance with this section, authorise the reclamation of land over and upon the foreshore or the sea-bed irrespective of the ownership of land bordering on or of whether any land borders on such foreshore or sea-bed” (4 Minister may authorise undertaking).

190. However, “Without prejudice to any public or private rights that may be affected thereby, this Ordinance shall not apply to the filling by a landowner of the whole or any portion of the foreshore that borders on his land” (11 Landowner's liberty to fill foreshore not to constitute a right).

191. Thus, no disputes over ownership of the new land created by the reclamation is anticipated.

6.2.3 Hydrodynamics

192. Prior to the 1940’s, longshore sediment transport was once the predominant mechanism which delivered sand to the Fogafale lagoon shore. As discussed above, engineering in the 1940’s comprehensively destroyed this natural system and closure of an ocean / lagoon passage in the northern part of Fogafale (also in the 1940’s) also reduced sediment supply onto this shoreline. Otherwise, wave energy is the main mechanism by which sediments are redistributed on this shore. However, until the recent nourishment projects, “sediment redistribution” was simply perceived as loss and erosion.

193. The reclamation will remove the stress of wave action from the current dysfunctional shoreline and transfer that point of contact to the seaward margin of the reclamation. Water depth is around 1.5 m at this location, meaning slightly larger waves can be expected to break on the reclamation foreshore. The proposed design will include an appropriately designed sloping revetment of volcanic rock (likely imported from Fiji) to armor the seaward margin of the reclamation. This will be designed to prevent overtopping

and marine flooding during stormy conditions and the rough porous nature of natural rock minimizes wave reflection.

194. Otherwise, tidal cycles produce the bulk of ongoing water exchange in this location and water current data associated with this site (Damlamian, 2008) shows tidal signals are the dominant variable changing water direction and speed. That said, the velocities recorded over that month-long campaign are very small. The highest recorded peak velocity was under 0.2 m/sec and otherwise the majority of the time, over all states of tide, velocities remained lower than 0.05 m/sec. Generally, sand sized sediment particle size (~1mm Ø) requires velocities 0.3 – 0.4 m/sec to even begin mobilization.

195. In summary, tides are the dominant influence over water movement in this area of the lagoon, but this is too slow to contribute to sediment transport. Additionally, this very sluggish rate of movement goes some way to explaining the damage that eutrophication has at this site. Water exchange rates are naturally low at this location and thus the site is more sensitive to heating, nutrient inputs and contemporary issues like night time anoxia. The reclamation will not influence these dynamics negatively.

196. The regional geoscience agency (Geoscience, Energy and Marine Division of SPC) was requested to rerun their existing hydrodynamic model (see Damlamian, 2005) of Funafuti. This was undertaken to investigate the question of possible changes to water movement (exchange) with and without the proposed reclamation. This model is informed by *in situ* current, wave data and the only complete bathymetric model of Funafuti lagoon in existence.

197. Six locations were considered in the models, two of the locations were immediately offshore from the proposed reclamation area (Figure 34). The model conclusively shows no significant difference in hydrodynamic conditions could be detected in neighbouring areas off-shore from the proposed reclamation (the outputs shown in Figure 34 demonstrate this quite clearly where the blue (without reclamation) and red (with reclamation) plots are almost identical). This is unsurprising given the naturally protected, low energy nature of this environment.

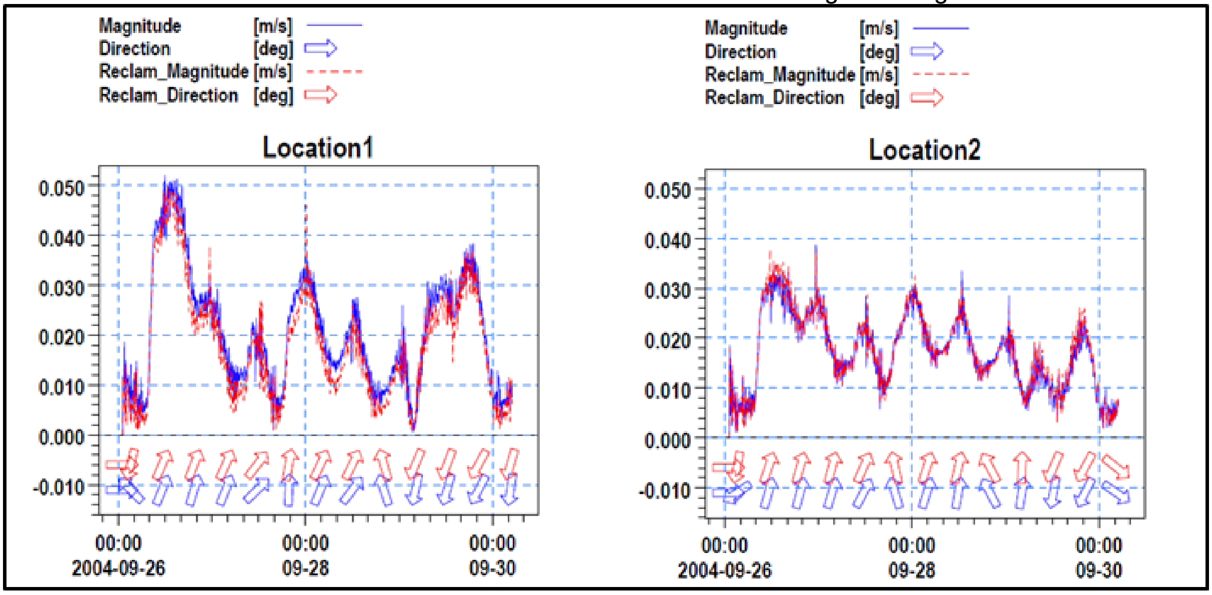

Figure 34 Results of hydrodynamic modelling undertaken by SPC's GEM Division in 2018).

Upper - The location map showing the 6 "sample" locations, and the superimposed reclamation (yellow zone). Lower - Modelled water flow velocity and direction at 2 locations immediately neighbouring the proposed reclamation. The blue data shows dynamics without the reclamation and the red data shows dynamic with the reclamation in place.

6.2.4 Groundwater

198. The project does not require the use of groundwater, nor is it likely to contribute to the already chronic contamination of the groundwater lens at Fogafale.

199. Early observations from the neighboring QEP reclamation and subsequent excavation at this site since its completion has found the water table to be quite fresh, suggesting that, within the finer grade sands dredged to build the QEP reclamation, conditions for the formation of a freshwater lens may be favorable. The design will seek to capitalise on the freshwater lens formation potential.

200. However, as the project site adjoins the main island and there are already such high levels of contamination in that groundwater, it is unlikely any newly formed freshwater lens would be potable, but it could be used for "second-class" purposes such as toilet flushing, watering gardens, washing down vehicles, etc.

201. Furthermore, the feature that provides groundwater lens development potential (essentially a body of supratidal lower porosity fine sands) may also, via the same properties, assist to reduce the free movement of contaminated groundwater from Fogafale Islet into the nearshore marine environment. In other words, it is likely that the proposed reclamation may buffer or restrict the free movement of contaminated ground water from the island to the nearshore lagoon environment. In this way, it may reduce the impacts of ongoing eutrophication in the Fogafale nearshore marine environment.

202. Therefore, the proposed reclamation potentially has net beneficial effects in respect to groundwater.

6.3 Socio-Economic Impacts

6.3.1 Cultural Resources

203. It has already been explained that the entire shore and much of the nearshore substratum in the project area has been profoundly disturbed by earlier engineering efforts. It is possible that locations of cultural significance may once have been located on this shore and it is also possible that more contemporary graves or perhaps trees of value may be located just landward of the current shore. However, discussions with stakeholders have not so far identified any such features and as a result it is unlikely that

the project will ultimately impact any significant cultural items. Nonetheless, during the full impact assessment, the project area will be surveyed and any cultural resources identified and mapped so that such features can be avoided. Chance find procedures would need to be included in all reclamation contracting.

204. Adjoining the proposed reclamation area (Tausoua Beach), there is an important community church compound. This location was already the site of significant earthworks during the recent JICA shoreline renovation project. Although an older church building, which may have greater sensitivities, is present in this area, it is located well back (60 m) from the foreshore; and thus, no negative impacts are envisaged. Indeed, early discussion with stakeholders at this site suggests the reclamation is a welcome development at this location as it will mean improved resilience of the shoreline during storms, etc.

205. During Funafuti Community meetings, some concerns were raised (from the perspective of cultural practices) that an existing all tide small boat anchorage area (southern side of the Catalina Ramp) is an important feature to local fishermen. This small “harbour” is a relic of WWII nearshore dredging, but stakeholders requested that TCAP seek to preserve this feature to allow artisanal fishermen to continue to moor, launch and land their catch at this site. TCAP has adjusted its proposed reclamation plan to preserve this feature.

206. There are important issues regarding the change or loss of amenity which can occur due to reclamation. Currently there are a number of nearshore properties along this coast which will lose their direct access to the lagoon foreshore as a result of this reclamation proposal. In effect, the shoreline will be moved approximately 100m seaward and what was a water side property will become part of the island interior. However, perspectives in the Pacific atoll communities are different. This is particularly so in this environment where this shore has been known for its chronic instability and inability to provide protection from storm waves for decades. In many ways, local residents view this shoreline as a liability that has required inter-generational effort to “hold the line” and clean up after overtopping events etc. This is demonstrated by example of community attitudes at the Tausoua Beach (main Funafuti Community Church Compound) site and part of the TCAP area of proposed works. This area was part of the earlier JICA Project and local stakeholders were dissatisfied that this project only sought to reinstate a functional foreshore instead of an option which would have secured the shore and provided additional land. As it happened, reclamation was never the intention or design of the JICA efforts and a lengthy delay (12 months) occurred midway through that project whilst this disparity in priorities was negotiated between the Project and the Community. Eventually, the JICA Project engineered a new beach crest some 10 m seaward of the original shoreline (small scale reclamation). However, JICA was always of the view this was not “new land”, and this was a necessary buffer zone to allow the reinstated beach profile to adjust.

207. The priority in Fogafale is for this shoreline to be secured from current and future storm wave attack and that such effort should incorporate well planned and implemented reclamation to provide safe higher ground. These messages have been the consistent central message from the Government, Funafuti Council and Funafuti community. As such, while the risk of objections from neighboring properties can not be ruled out, it is considered an unlikely in view of consultations and experience to date.

208. Community consultation meetings to date as well as advice from local Project staff indicate that there is no contemporary sensitivity regarding the nearshore marine environment. Since nearby coral outcrops have long ago died (JICA 2012, Kaly and Peacock, 2014) and the area is no longer a useful fishing area and, there are no known cultural obstacles to the proposed reclamation of the nearshore marine area.

6.3.2 Land Use

209. The proposed reclamation is intended for public space and public / community buildings, a possible community cyclone shelter and potentially public housing. Work to develop a consultative, land use plan for the area will be explored once full approval to proceed has been acquired but it is important to broadly outline the wishes of Government and Community at this juncture. The proposed reclamation is a pragmatic proposal to provide much needed security on this chronically dysfunctional shoreline and new safe public space which is not subject to marine flooding. As a result, there are no simple economic analysis to be explored here regarding socio-economic impacts, positive or negative, of a new single purpose facility such as a commercial wharf. But rather, there is a far more complex and urgent story of

the socio-economic cost of failing to implement real coastal adaptation in a densely populated, low lying, cyclone prone atoll environment.

210. The footprint of the proposed reclamation and the marine resources within are not high value from a marine resource or ecological perspective. As discussed, this area is a deeply degraded environment and there is little, if any, economic or ecological cost to implementing the proposal. Beach tourism is not really relevant in Tuvalu (as it is for example in Fiji or Palau) and there is no beach or charismatic foreshore environment in Fogafale itself. Any beach tourism which does occur is far more associated with the uninhabited pristine island shores and reefs within the Funafuti Conservation Area (FCA) located some 13 km away on the western reef of the Atoll.

211. Otherwise, and as discussed in “cultural impacts” above, there will be a loss of amenity or direct lagoon foreshore access for an estimated 24 households that adjoin the effected shoreline. A number of these are thought to be subject to Government lease (i.e. Government Housing) and a number are occupied by the traditional owners – surveys during the full ESIA will determine exact ownership details. To date, the Funafuti community outreach meetings have not elicited any negative comment regarding this proposal and the Funafuti Kaupule (Funafuti Council) and Funafuti Traditional Chiefs are fully briefed and fully supportive of the proposal which has been presented to them in detail in 2018 (See item 13.a in Annex II).

212. It is perhaps important to briefly outline the socio-economic implications / impact of not implementing this proposal. As the national capital and the only port of entry (sea and air), Fogafale’s population will presumably continue to grow. Even without sea level rise and other climate change impacts, the capacity of the island to provide for this population safely and provide an environment where local development aspirations can be fulfilled is a challenge. However, if sea level rise and the possibility of more intense tropical storms is superimposed over this scenario, life within the foreseeable future will become untenable on this island. Vertical adaptation is the only viable solution in these environments and in the case of well-planned and implemented reclamation, this has the added benefit of affordability, minimal environmental risk and crucially the provision of substantial new areas of safe land to accommodate sustainable development. There is no other practical and affordable solution to sea level rise in these environments. It follows that the socio-economic cost of not implementing such work is difficult to constrain or even contemplate.

Figure 35 Foreshore at site of recent QEP Government reclamation

213. The proposed reclamation will not be privately owned land but rather it will become crown land as stipulated by the Tuvalu Foreshore Act. No detailed land use plan has to date been sketched regarding

the use; however, there is strong consensus that the land is intended for communal uses and to house community facilities.

6.3.3 Resilience against tidal inundation and overtopping

214. There are additional ongoing social / development issues which also directly interact with the dynamic of increasing levels of exposure of people and property to wave impacts in Fogafale. Development on Fogafale has occurred very rapidly since independence in 1974. Population growth and associated demand for space to accommodate development for Government and Community infrastructure as well as private dwellings is very high (See Figure 18). Almost all available land on Fogafale is now already built on or used and the only remaining space for development is associated with the oceanside berm (berm - highest part of the foreshore which protects from large waves). The ocean side berm is being increasingly encroached upon by Government and the community for buildings and homes. This occurs because there simply is no alternative land left.

215. On Fogafale, the opportunity to manage the exposure of people and property to the impacts of catastrophic wave impacts can only be achieved via the provision of new safe land. If safe land were available, it would become feasible to offer a safe alternative for building and infrastructure. However, in the current Fogafale environment, no such options are available, so the situation of exposure becomes significantly worse and urgent year by year. The interaction between increasing urban population on Fogafale, the demand for accommodation space to allow safe development to proceed and the reality that there is no available safe land is the most pressing coastal management / hazards management issue in Tuvalu.

216. There is otherwise no Government coastal management authority in Tuvalu and as outlined briefly here, and the management of exposure to marine hazard risk must become a priority if TCAP is to achieve its objectives. The TCAP Board has already endorsed these approaches recognising reducing coastal hazard exposure is about more than simply building infrastructure.

217. Aligned to the revised proposal for reclamation are approved plans from the TCAP Board and Government of Tuvalu to gradually transition the existing TCAP Project Unit (based in Funafuti) into the local Tuvalu Coastal Management Authority at the end of the TCAP final year of implementation

6.3.4 Scale

218. Reclamation is frequently associated with “industrial uses” such as wharf and port facilities, aircraft runways, etc., and may involve significant scale. TCAP’s proposed reclamation is not for industrial purposes and at approximately 7.8 ha, by international standards, is small scale. Indeed, once mobilized, a mid-sized dredge could easily pump the sediment required within 2 working weeks. It is also instructive to consider past reclamation efforts on this same shoreline in Fogafale. Given that 55% of the total proposed TCAP reclamation area is already very physically disturbed through ad hoc reclamation and navigation channel dredging, beach nourishment and/or hard engineering, the TCAP proposal will in fact only disturb an additional 3.2 Ha of substratum.

219. As noted earlier, TCAP’s proposed reclamation in Fogafale, Tuvalu’s capital accounts for 0.0314 % of Funafuti’s lagoon area.

6.4 Cumulative Impacts

220. Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. The concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus, the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource.

221. “Cumulative impacts” must be viewed with a clear understanding of the present state of the environment and conditions of human exposure which exist at this location. Whilst there can be no doubt this reclamation proposal will further, permanently change this shore, this proposal will permanently

remedy the litany of physical damage which has occurred at this site over the last 80 years and is continuing to have ongoing impacts to the physical, biological and socio-economic value of the site.

222. Cumulative impacts from the perspective of broader hydrodynamic processes including net water movement and exchange and surface wave conditions are not expected either.

6.5 Impact and Risk Assessment

223. An impact risk assessment was undertaken using a 5 x 5 risk matrix (

Table 3), which provides an overall risk rating (high, medium or low) based on the probability or likelihood of the risk occurring (

224. Table 4) and the consequence of the risk (critical, severe, moderate, minor, negligible) (Table 5).

225. Risks have been assessed before and after mitigation and are summarised in Table 6.

Table 3 Impact risk rating matrix

Impact						
	5	High	High	High	High	High
	4	Medium	Medium	High	High	High
	3	Low	Medium	Medium	Medium	Medium
	2	Low	Low	Medium	Medium	Medium
	1	Low	Low	Low	Low	Low
		1	2	3	4	5
	Probability					

Table 4 Rating of probability of risk occurring

Score	Rating
5	Expected
4	Highly Likely
3	Moderately likely
2	Not Likely
1	Slight

Table 5 Rating of consequence of risk

Score	Rating	Definition
5	Critical	Significant adverse impacts on human populations and/or environment. Adverse impacts high in magnitude and/or spatial extent (e.g. large geographic area, large number of people, transboundary impacts, cumulative impacts) and duration (e.g. long-term, permanent and/or irreversible); areas impacted include areas of high value and sensitivity (e.g. valuable ecosystems, critical habitats); adverse impacts to rights, lands, resources and territories of indigenous peoples; involve significant displacement or resettlement; generates significant quantities of greenhouse gas emissions; impacts may give rise to significant social conflict
4	Severe	Adverse impacts on people and/or environment of medium to large magnitude, spatial extent and duration more limited than critical (e.g. predictable, mostly temporary, reversible). The potential risk impacts of projects that may affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples are to be considered at a minimum potentially severe.
3	Moderate	Impacts of low magnitude, limited in scale (site-specific) and duration (temporary), can be avoided, managed and/or mitigated with relatively uncomplicated accepted measures
2	Minor	Very limited impacts in terms of magnitude (e.g. small affected area, very low number of people affected) and duration (short), may be easily avoided, managed, mitigated
1	Negligible	Negligible or no adverse impacts on communities, individuals, and/or environment

Table 6 Impact assessment, before and after mitigation measures

Phase/Type of activity	Un-mitigated Impacts	Pre-mitigation Impact: • Probability • Consequence • Risk rating	Avoidance and Mitigation Measures	Post-mitigation Impact: • Probability • Consequence • Risk rating
During Construction				
Mobilisation	Unsafe transportation / unsuitable equipment. Unclear requirements before hand lead to conflict or poor performance	P = 2 C = 3 R = Medium	Dredgers are already available in Tuvalu, alternatively vessel would sail in. Normal rules of the sea and custom requirements would apply. Vessels required to be in survey Extraction / procurement plan with source locations and volumes identified The Project Environmental and Social Management Plan will be instrumental in ensuring only best practices are used and any environmental risk kept to a minimum. Furthermore, UNDP tender procurement processes are stringent and only dredge operators which meet full accreditation and environmental safety standards will be considered for such work.	P = 1 C = 3 R = Low
Marine-based works: Dredging	Increased turbidity of water bodies eg dredge plumes, dewatering runoff Turbid waters spread widely in the lagoon damaging corals and fish communities	P = 4 C = 3 R = Medium	Dredging method will prefer pipeline for conveying slurry to fill sites and minimise losses to lagoon waters Only sand (not muds) dredged and used as fill Pipeline does not damage reefs or leak excessively Reclamation design incorporates use of revetment wall to enclose area to allow filtering and control of waste water HD modelling has confirmed that currents in the project area are very low, therefore any turbid waters	P = 3 C = 2 R = Low

			are not likely to move far or fast. Monitoring of plume to be undertaken and dredging halted if plume excessive.	
	Loss of habitat	P = 3 C = 2 R = Low	No ecologically significant areas included in design Dredging concentrates on damaged parts of the lagoon No sensitive species in the design area Habitats impacted are common and widespread Area of lagoon bed impacted represents approximately 0.0314 %of lagoon Dredging will not remove all the sand in the area that is dredged, therefore there is not a loss of habitat. The disturbed areas will be rapidly recolonised from nearby undisturbed areas.	P = 2 C = 2 R = Low
	Loss of marine flora/fauna	P = 4 C = 3 R = medium	No sensitive areas included in the project. Prevention of loss of coral cover in areas outside the Dead corals and Eutrophication Zone - dredging within 100m of live corals will be reactively monitored for stress and works suspended if necessary.	P = 4 C = 2 R = medium
	Noise from dredge operations causes nuisance	P = 3 C = 2 R = medium	Hours of operation restricted to daytime (7am-7pm) unless otherwise agreed Residents notified of any operations likely to cause excess noise. Machinery to be well maintained and fitted with appropriate noise abatement equipment Any noisy static equipment, e.g. generators to be located such that impacts to sensitive receptors minimised. Acoustic shielding will be utilised if required. Grievance redress mechanism put in place	P = 2 C = 2 R = low
Access	Public use of the lagoon is affected	P = 4	Dredge locations will be relatively static for periods of time, therefore hazard easily marked and recognised.	P = 2

	Pipeline disrupts sea traffic / fishers	C = 2 R = medium	International signals to be displayed during dredging operation. Continue ongoing stakeholder engagement Communication between PUI, Contractor, Kaupule, Falekaupule, shoreline residents and wider community. Locations and dates of dredging and filling posted in public places and announced over the radio Grievance procedures established and disclosed prior to works	C = 2 R = Low
Emergencies	Accidental spills (hydrocarbons or other fluids utilised on vessels) Fire	P = 2 C = 3 R = medium	Equipment to be well maintained Fuels and other hazardous substances to be appropriately stored in a defined area. Spill/Emergency response plan in place, including suitable equipment to contain/clean up spills. No fires permitted on site	P = 2 C = 2 R = low
Land-based works: Reclamation	Impacts to items/areas of cultural significance.	P = C = R =	No items or areas of cultural significance are known to be in the project area. However detailed survey of nearshore area to identify any graves or features of importance. These will be flagged to ensure disturbance is avoided.	P = C = R =
	Disturbance or destruction of terrestrial flora / fauna	P = 3 C = 2 R = medium	Reclamation design stops short of existing terrestrial vegetation line. Detailed survey of vegetation along shoreline to identify vegetation of significance (if any). Any significant vegetation along shoreline will be identified and flagged to minimise potential for inadvertent sand 'spill' or dozer strikes. Any sand spills that do occur are likely to be minor and will be readily cleaned up by hand or with light machinery. Areas accidentally damaged during works are restored by clean up, re-contouring and planting	P = 2 C = 2 R = Low

	Disturbance or destruction of marine flora / fauna	P = 5 C = 2 R = medium	Some epifauna and infauna species such as burrowing polychaete worms, sea-cucumber, as well as; residual patches of halimede algae, but mostly standing thickets of brown algae will be permanently buried by the reclamation. The epifauna and infauna involved are extraordinarily well represented across the broader lagoon and sea cucumber, in particular, are no longer found in these shallow nearshore waters in great numbers. The removal and transfer to safer ground of epifauna species such as sea cucumber can be easily achieved and should be carried out to avoid burial.	P = 5 C = 2 R =medium
	Turbid water as a result of dewatering operations	P = 3 C = 3 R = medium	Design of works makes filtering of decant fluid possible. Sequence of construction (building containing seawall first) will greatly mitigate any risk. Strict control on de-watering release by pumping to an impounded area, using sediment curtains and routine monitoring of turbidity as required will be implemented. Because the proposed surface height will be significantly higher than existing land on Fogafale, care will be taken to ensure de-watering does not occur towards the island (nuisance pooling of waters in built areas).	P = 2 C = 3 R = medium
	Access to reclamation area restrictions causes stakeholder grief Heavy machinery in public areas Unauthorized entry to site could present a safety hazard	P = 3 C = 2 R = medium	Public will be advised well before commencement of works that access will be restricted and alternative arrangements will be made. Transport machinery limited to access ways for cartage and minimised. Further, there should be no need for heavy machinery to operate outside of the project area. Adequate fencing of the works area will be implemented to ensure a separation (physical barrier) of the general public from the works site and controlled entry points will be established.	P = 2 C = 2 R = low

	Spread of STIs and HIV/AIDS	P = 2 C = 2 R = Low	Worker awareness training Workshops with community	P = 1 C = 2 R =
Worker and public safety	Operation of equipment	P = 2 C = 3 R = medium	Workers to be appropriately trained and skilled Workers to be issued with appropriate PPE Spotters to be used around heavy machinery Public to be kept clear of operational works areas	P = 1 C = 3 R = Low
	Safety information in adequate	P = 2 C = 3 R = medium	Signs in vicinity of works Contractor's personnel trained in safety and first aid Workers trained in safety procedures Safety equipment	P = 1 C = 2 R = Low
	Poor management of garbage and effluent	P = 2 C = 2 R = Low	Project areas free of rubbish Project team household wastes disposed of in approved Landfill Use existing toilet systems on island or build temporary latrines / composting toilets at construction site (consult Kaupule, landowners). No beaches or other sensitive ecosystems to be used as toilets	P = 1 C = 2 R = Low
	Risk to public from heavy machinery	P = 3 C = 2 R = medium	There should not be any need for heavy equipment of any type to broach the existing built, terrestrial environment during the construction phase. Access to reclamation (work) area will be restricted. Operators of machinery will be suitably trained and qualified. Where vision is restricted or potential risk to others exists, spotters will be used around heavy machinery.	P = 2 C = 2 R = Low
Sewage / general waste	Soil contamination by oils or chemicals	P = 3 C = 3 R = Medium	Machinery well maintained Oil and chemical wastes collected in approved containers and recycled / disposal of in Funafuti or	P = 2 C = 2 R = Low

			overseas Oil and chemicals stored in secure containers away from public and sensitive ecosystems Develop spill response plan	
	Noise from land operations causes nuisance Nusiance emissions impact stakeholders	P = 2 C = 3 R = Low	Contractor's Code of Conduct for team and workers Vehicles and machinery well maintained to reduce noise / pollution Project sites kept clean, tidy and safe Work schedule agreed with Kaupules and Church leaders and publicly announced Times of day for noise, days of week and public holidays for work cleared with Kaupule and Church Kaupule and Falekaupule consulted in all matters that interface with community Grievance mechanism to be put in place	P = 1 C = 2 R = Low
Social disruption and conflicts	Inequitable distribution of project benefits	P = 2 C = 2 R = Low	Contractor works with Kaupules to arrange teams and food supplies Pay in accordance with Kaupule or Government published rates Equal opportunity and pay for men and women Youth are provided work opportunities	P = 1 C = 2 R = Low
	Poor public disclosure	P = 2 C = 3 R = medium	Continue ongoing stakeholder engagement Communication between PUI, Contractor, Kaupule, Falekaupule, shoreline residents and wider community. Locations and dates of dredging and filling posted in public places and announced over the radio Grievance procedures established and disclosed prior to works	P = 1 C = 2 R = low

	Lack of skilled local labour.	P = C = R =	Where possible local labour will be involved with the works however given there is limited domestic OHS awareness and training particularly with earthworks of this type potential safe hazards exist. All local labour will be fully inducted and trained and briefed regarding occupational safety procedures on site to ensure a safe work environment.	P = C = R =
Post-Construction				
Dredge area	Reduction in sand resource	P = 1 C = 2 R = Low	The total sand resource size is significant compared to the volume required for the project.	P = 1 C = 2 R = Low
	Loss of habitat	P = 3 C = 2 R = Low	The amount of sand removed and the area impacted is very small compared to the total resource and lagoon area. Dredging design will seek to minimise the disturbance area. Dredging will not remove all the sand in the area that is dredged, therefore there is not a loss of habitat. The disturbed areas will be rapidly recolonised from nearby undisturbed areas.	P = 2 C = 2 R = Low
	Alteration of lagoon bed topography has negative impacts	P = 3 C = 2 R = medium	The dredging will have some impact on the bed topography, but its extent will be limited. Final dredge design will consider optimal dredge pattern. The lack of fine material in the sand resource means that under high wave or current conditions mobilisation will occur and the topography will eventually return to something similar to the pre-dredge condition.	P = 2 C = 2 R = Low

Reclamation	Negative impacts on groundwater / freshwater lens	P = 1 C = 3 R =low	No negative impacts expected, in fact it is entirely feasible that the proposed reclamation may provide greater freshwater lens potential. Possible formulation of a water lens should be monitored. Drainage (from rainfall) dynamics on the surface of the proposed reclamation should be designed to drain to avoid flooding but can also be designed to promote maximum infiltration and storage.	P = 1 C = 1 R = Low
	Permanent alteration to existing shoreline and nearshore substratum causes negative impacts.	P = 2 C = 2 R = Low	Shoreline already heavily modified – 55% of project footprint. Project area already dysfunctional and erosive. Natural sedimentary process on this shore are absent Hydrodynamic modelling indicates minimal impact of proposed reclamation.	P = 1 C = 2 R = low
	Disruption/modification to hydrodynamics. The proposed reclamation will move the shoreline approximately 100m seawards. No downstream impacts are expected from this given shores both north and south are also predominantly very disturbed or engineered. Wave energy regime altered	P = C = R =	Tidally driven longshore processes on this shoreline have long been disrupted through earlier engineering. Recent HD modelling confirms water exchange regimes (direction and velocity over time) show no significant difference between the presence or absence of the proposed reclamation. In respect to wave action the project will design an appropriate foreshore seawall which will absorb and reduce wave energy, prevent overtopping and minimize any wave reflection issues. Because stress will be removed from the existing dysfunctional shoreline, the existing situation of wave hazard exposure will improve significantly	P = C = R =
	Reclamation results in loss of area currently used for mooring small boats	P = 5 C = 2 R = medium	Consultation with stakeholders – no significant objections have been received to date. Consultation will be ongoing. Provision of small boat harbour at northern end of	P = 5 C = 1 R = low

			project incorporated into design. Explore opportunities to include some boat ramps into revetment wall design	
	Loss of fishing resource impacts fishers	P = 2 C = 2 R = low	Project being undertaken in area that is not considered of high ecological, cultural or socio-economic value. Area currently subject to eutrophication and dominated by associated thickets of macroalgae and has been subject to anoxic “fish-kill” events. Due to past activities / disturbance, fishing value of reclamation area already very low. Rock revetment wall will create habitat diversity which may enhance ecological diversity. Boat harbour at northern end of reclamation will continue to allow ready access to lagoon waters via small boat.	P = 1 C = 2 R = low
	Negative impacts on cultural items.	P = 2 C = 2 low	No known cultural items in the project area Chance find procedures will be included in reclamation contracts. A local Safeguards Officer will be engaged and will maintain regular contact with community members Routine monitoring of works will ensure any concerns are documented and addressed. A redress mechanism will also be established and ongoing public outreach and awareness effort will keep the community updated on Project progress and any issues which arise.	P = 1 C = 2 R = low
	Negative socio-economic impacts	P = 2 C = 3 R = medium	No negative socio-economic issues have been raised to date following community meetings in Funafuti through 2018. Rather there is specific interest and agreement for TCAP to not simply implement foreshore seawalls but rather to undertake well designed and implemented reclamation in the central Fogafale area. Broadly speaking, feedback to date	P = 2 C = 2 R = low

			from all stakeholders is that reclamation as envisaged by TCAP offers socio-economic benefits not risks. It has been reiterated many times to the Project that the "risk" lays in not taking sea level rise seriously and not implementing appropriately designed reclamation plans in a timely manner. As with "Cultural risks" above, socio-economic risk will continue to be monitored and recorded via Project outreach and redress mechanisms. Any unforeseen issues will be documented and addressed. Key to the long-term socio-economic benefits of the Project being realized will be the careful development of a consensus orientated plan for the main uses of the proposed reclamation. These have already been framed at a conceptual level by stakeholders (community or public use); however, a more detailed plan will be instrumental in assisting to attract additional funding for services and facilities to be constructed and to ensure the new safe land becomes a model for sustainable safe living and development.	

7 NEXT STEPS – UNDERTAKE FULL ESIA

226. TCAP has committed to undertake a full ESIA[6] which will be shared with the GCF Secretariat upon completion. Not only did UNDP feel it advisable to ensure that all risks are identified and managed but there is also a need to collect some primary field data (both bio-physical and social) to confirm the information that has been gathered through the desktop assessment (this document) and ensure all aspects of this proposal are thoroughly considered and any risks managed.

227. Furthermore, TCAP understands that the Tuvalu Government's development application process will also likely require a full ESIA process to allow development consent.

228. A set of draft Terms of Reference (ToRs) for the ESIA are provided below. These ToRs are based on the Tuvalu Environmental Regulation requirements, which are in line with World Bank/IFC requirements.

229. Hand in hand with the development of the ESIA will be the updating of the Project ESMP to ensure all recommendations to come from the ESIA process are captured and implemented faithfully. This will also ensure community safeguarding a redress mechanism and community outreach and awareness. The ESMP will also ensure adherence to appropriate OHS standards in the work-place.

7.1 DRAFT TERMS OF REFERENCE FOR ESIA

230. The following ToRs are based on the Tuvalu Environmental Protection (Environmental Impact Assessment) Regulations 2014 and World Bank ESIA General Guidelines and Guidelines for Ports.

7.1.1 Summary

231. The ESIA shall contain a summary of the development proposal and its consequences, including:

- a statement of all major conclusions;
- an outline of any issues that are controversial;
- an outline of issues that remain to be resolved;
- an outline of the preferred choice among any alternatives; and
- details of any proposals to mitigate significant adverse impacts

7.1.2 Introduction and Rationale

232. Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified

233. A description of the development proposal (including any phasing or sequencing of activities), a statement of its underlying purpose, and the long-term and short-term objectives sought by the proponent.

7.1.3 Study Area

234. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should adjacent or remote areas such as relevant developments and nearby environmentally sensitive areas (e.g. coral reef, sea grass. Mangroves, marine protected areas, special bird sites, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

[6] The ESIA will also encompass the Nanumea and Nanumaga berm components and will include further scoping of potential enviornemtnal and social risks of those outputs.

7.1.4 Description of proposed project

235. Details of the description of the development proposal, including:

- a general description of the proposal's technical, economic, and environmental characteristics, taking into consideration current engineering and supporting utility / infrastructural data;
- the precise location and boundaries of the proposal shown on a detailed map; and
- a justification of the rationale for the proposal including such supporting information as is appropriate.

7.1.5 Description of Environment

236. Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the project. All baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The description of affected environment including-

- a description of the local environment in the vicinity of the proposal as it exists before commencement of the proposal;
- a description of potential cumulative impacts that might arise in conjunction with other activities in the location;
- a review and evaluation of possible conflicts or inconsistencies between the development proposal and relevant applicable objectives of national, regional or local land use and marine / coastal plans and policies

7.1.6 Assessment of impacts

237. A review of the environmental impacts of the development proposal and any practical alternatives to the proposal, and in this section the proponent shall:

- review and evaluate all reasonable alternatives, including locations and methods, and the alternative of no action;
- identify the proponent's preferred alternative or alternatives;
- identify appropriate mitigation measures to minimise any significant environmental impacts arising from the preferred alternative;
- identify any significant environmental impacts that cannot be avoided and
- assessment of all foreseeable positive impacts

238. Analysis of the environmental consequences of the development proposal which shall include the following:

- a review of direct and indirect environmental effects, their significance, and risks;
- a consideration of cumulative environmental impacts;
- a consideration of the environmental effects of alternative;
- an assessment of the likely need for additional infrastructure, including energy and public utilities;
- an assessment of impacts on the area's physical locality and amenity (including visual quality), its historic and cultural resources, and the design of the built environment;
- an assessment of social impacts on the local population and its uses of the land and safeguards for the affected community such as :
  - employment and labour opportunities for the affected people;
  - housing supply and demand;
  - water and sanitation services;
  - public health and safety;
  - involuntary resettlement must be avoided or minimized;

  - cultural heritage and resources of cultural, archaeological, environmental or historical value to be safeguarded;
  - climate change impact and resilience measures in place;
  - disaster risks reduction;
  - gender inequalities;
  - marginalised and vulnerable groups to be protected; and
  - women empowerment."
- an assessment of the implications of the use of potential environmental pollutants;
- a review of options proposed to mitigate adverse environmental impacts;
- a description of any unavoidable adverse environmental impacts, including any permanent change in the physical, biological, social or cultural characteristics of the affected environment or in the possible future use of that environment;
- an analysis of the costs and benefits that may result from the development proposal;
- the identification of any irreversible or irretrievable commitments of resources required for the development proposal; and
- a description of induce environment impacts

7.1.7 Environmental Management Plan

An Environmental management plan must be developed and submitted with the ESIA.

The environmental management plan shall contain the following particulars:

- mitigation measures that:
  - identify any significant environmental impact that cannot be avoided;
  - identify appropriate mitigation measures to minimise any significant environmental impacts arising from the preferred alternative; and
  - recommend any proposed conditions.
- reporting requirements;
- capacity building and training;
- performance indicators;
- implementation schedule;
- cost estimates;
- actions and procedures for responding to environmental or social emergencies arising from the development; and
- an environmental and social mitigation and monitoring plan, including schedule.

239. The schedule outlining a programme of baseline and compliance monitoring must be appropriate to the scale of the proposed activity. The Schedule shall outline the baseline monitoring proposed to be undertaken and any subsequent monitoring (and with what frequency and method) that it is intended shall be undertaken against the baseline.

240. The implementation of the environment management plan will be the responsibility of the proponent and it will be monitored by the EIA Officer.

7.1.8 ESIA Team

The ESIA is to include a list of all persons who prepared the EIA, their qualifications, and organisations and persons who were consulted.

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