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Funafuti Detailed Design Report
Tuvalu Coastal Adaptation Project
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1. INTRODUCTION

1.1 General

Consisting of nine islands and atolls spread over 72,000Nm², Tuvalu is the fourth smallest nation in the world in land area with a population of just over 10,000. It is one of the most vulnerable countries in the world to the impacts of climate change and particularly sea-level rise and the possibility of intensifying storm events. Recent cyclones have caused population displacement, significant loss and damage of infrastructure as well as destruction of agricultural resources, contamination of ground water and changes in shoreline systems. Such impacts negatively affect the wellbeing of communities and long-term sustainable development aspirations. In response to this increasing challenge, the Government of Tuvalu (GoT) and the Green Climate Fund (GCF) have jointly committed US$38 million for the Tuvalu Coastal Adaptation Project (TCAP).

The main island of Funafuti, as well as Nanumea and Nanumaga have been selected as target islands for the proposed GCF project. Funafuti was selected based on its concentration of economic, social, political and institutional assets. Previous feasibility studies including hydrodynamic and coastal processes, an ESIA, and financial and economic analysis highlighted the suitability of large-scale reclamation as the recommended coastal adaptation measure for Funafuti.

1.2 Project and report objectives

TCAP will build coastal resilience which is an urgent national priority. The project will address the financial and capacity constraints at all levels – from technical to community awareness. TCAP was approved in June 2016 and the project implementation commenced in September 2017. The project will run until September 2023. TCAP has 3 main outputs:

Output 1: Strengthening of institutions, human resources, awareness and knowledge for resilient coastal management.

Output 2: Vulnerability of key coastal infrastructure is reduced against wave induced damages in Funafuti, Nanumea and Nanumaga.

Output 3: A sustainable financing mechanism established for long-term adaptation efforts.

The following body of work progresses Output 2, which has two main task areas or Activities:

- Activity 2.1: Coastal protection design. Site-specific assessments and ESIA undertaken in all islands in a participatory manner.
- Activity 2.2: Coastal protection measures implemented.

The objective of this report is to provide detailed design parameters and present the finalised coastal protection measures on Funafuti ready for construction (implementation). This report is designed to be read in conjunction with the IFC drawings attached in Appendix A.
1.3 Report background

This report has brought together the findings of several investigations used to inform the design and implementation of the TCAP Funafuti Reclamation, these investigations include, but are not limited to:

- TCAP Concept Design Report (UNDP, 2020)
- Funafuti Environmental and Social Impact Assessment (SPC, 2020c)
- Geotechnical and UXO investigations of the lagoon and foreshore areas (SPC, 2020, 1995, 2016)
- Hydrodynamic and inundation investigations (SPC, 2005, 2021)
- TCAP Funafuti Reclamation Drainage Investigation (Arcadis, 2020)

These investigations accompany extensive stakeholder consultation, site investigations and interviews with contractors working in the region to inform the detailed design presented herein.

1.4 Report outline

The structure of this report can be summarised as follows:

- Section 2 presents the design life, a brief description of the site as well as the basis of design
- Section 3 presents a description of the TCAP reclamation design and associated aspects, bund and breakwater, drainage and boat Harbour design.
- Section 4 presents an overview of the project’s proposed implementation
- Section 5 provides a summary of the key findings of the Detailed Design and recommendations.
- Appendix A and B present the IFC drawings and Bill of Quantities
- Appendix C and D outlines the safety in design principles incorporated in the design and risk register
2. **Basis of Design**

2.1 **Design Life**

The Australian Standard Guidelines for the design of maritime structures (AS 4997-2005) specifically excludes the design of “coastal engineering structures such as rock armoured walls, groynes, etc.” As such, the design life of the different design elements of the Funafuti woks have been separated as follows:

2.1.1 **Geosynthetic containers**

The reclamation design presented in the Concept Design Report adopts geosynthetic sand container (GSC) armour units, which were originally expected to have a service life of at least 25 years in their earlier design iterations. Improvements in geosynthetics have been reported to have design lives exceeding 40 years (Bettington, 2018), this has been used as the design life of the bund structure. Geosynthetics have been selected for the bund material rather than rock or steel structures (which may have a longer design life) due to the GoT’s long-term strategy of further reclamation works (seaward of both the TCAP and QEI reclamation areas). Future burial of geotextile units will be more cost-efficient, then removing and replacing rock, concrete units or sheetpiles.

2.1.2 **Reclamation**

The reclamation has been designed to account for current worst case scenario Sea Level Rise predictions to 2100. As such, the design life of this structure is 80 years.

2.1.3 **Rock breakwater**

The rock breakwater protecting Catalina Boat Harbour has been designed to a 50-year design life

2.2 **Design event**

A 100-year Average Recurrence Interval (ARI) value has been adopted for the stability of any structures.

2.3 **Site**

Tuvalu is made up of a group of nine islands; three reef islands and six true atolls spread out between the latitude of 5° to 10° south and longitude of 176° to 180°, west of the International Date Line, see Figure 1. Funafuti Atoll, located in the extreme south-west of the island chain consists of at least 29 islets of which three are inhabited: Fongafale, Funafala in the south, and Amatuku in the north. The biggest is Fongafale, an L-shaped islet located on the eastern edge of the lagoon, it is also the most populated and serves as the administrative capital of Tuvalu. The coastal protection works proposed under TCAP are to be undertaken on the Vaiaku shoreline on the central arm of Fogafale, seen in Figure 1.
2.3.1 Bathymetry and topography

A marine Light Detection and Ranging (LiDAR) survey was undertaken of all Tuvalu’s nine islands in August 2019 for TCAP by Fugro. The resultant dataset provided a high resolution topographic and bathymetric digital earth model (DEM) to a depth of approximately 40m (Figure 1), the bathymetry and topography at the project site on the Vaiaku Foreshore is provided in Figure 2.
2.3.2 Geomorphology

Funafuti is the largest and most populated islet of Fogafale atoll, which is located on Tuvalu Seamount Chain, a submarine chain of extinct volcanos on the Mid-Pacific plate, orientated roughly NW-SE between the Gilbert Ridge and the Samoan hotspot. The islands making up the atoll are low-lying accumulations of reef-derived sediment. Fongafale is a long narrow (reverse) L-shaped island divided into three geographical areas: the south arm, the central area and the north arm. The project site at Funafuti is at the intersection of the north and south arms on the Vaiku shoreline. The island morphology controls the pattern of the longshore currents on the lagoon-side, which transport sand from both the northeast and southwest towards the central area, resulting in the formally well-established beaches in the central area (Vaiaku).

Profiles of three transects intersecting the north, central and south arms of the island can be seen in Figure 3, can described as follows:

- The offshore (outer) reef platform is generally narrow along both arms of the island (less than 100m) dropping very quickly to deep water (>50m) in less than 100m from the reef edge.

- A discontinuous cemented rubble bank is located on the inner reef flat believed to be the remains of a rubble rampart that was deposited 3m from the reef edge during Tropical Cyclone Bebe in October 1972 (Maragos and Beveridge, 1973).
A 5-10m wide conglomerate platform is located between the area of cemented rubble forming a steep beach face with a berm elevation of between 5-6m TGZ. The berm is formed by large, unconsolidated pieces of coral rubble and is seen to be the highest land formation of the island (Figure 3).

The lagoon shoreline has changed significantly since several boat channels, harbours and coastal structures have been built and subsequently built upon since 1945. The large Queen Elisabeth II reclamation was built in 2018 to the south side of the project site, covering the Vaiku shoreline with a thin (1-2m) layer of beach sand (a remnant of the 2018 QEII reclamation) overlying beach rock providing an approximate 30m wide beach. The nearshore area is seen to be a thin layer (<1m) of beach sand interspersed over the underlying reef flat and scattered (domal coral) bombies which extends for approximately 800m offshore before the lagoon deepens to greater than -10m.

Further information on the geology and geomorphology of Fogafale and Tuvalu can be found in both the Funafuti Geotechnical and ESIA reports (SPC, 2020a & 2020b).

Figure 3: Representative topographic profiles on Fogafale’s central arm.

2.4 Design inputs

2.4.1 Water levels

Funafuti experiences a semidiurnal tidal regime. The mean tidal range is 0.7m during neap tides and 1.7m during spring tides, with a maximum range of 2.5m. Tidal planes for the project site were derived from a harmonic analysis of the 25-year dataset of hourly water levels recorded at the nearby Funafuti (Tuvalu Port) tide gauge, Figure 4. Design water levels for TCAP are
provided in Figure 4: Tidal plane at Funafuti Port with respect to Tide Gauge Zero (TGZ). 
(source: CoSPac, 2020)

Table 1, further information on the determination of these levels is provided in the Concept Design Report (UNDP, 2021a).

![Funafuti Port benchmarks](image)

Table 1: Calculated design water levels for TCAP

<table>
<thead>
<tr>
<th>Tidal Plane</th>
<th>Recorded Height (m TGZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark 22 (BM22)</td>
<td>4.01</td>
</tr>
<tr>
<td>Highest Recorded Water Level</td>
<td>3.44</td>
</tr>
<tr>
<td>Highest Astronomical Tide (HAT)</td>
<td>3.35</td>
</tr>
<tr>
<td>Mean High Water Springs (MHWS)</td>
<td>2.87</td>
</tr>
<tr>
<td>Mean High Water Neap (MHWN)</td>
<td>2.38</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>2.05</td>
</tr>
<tr>
<td>Mean Low Water Neap (MLWN)</td>
<td>1.72</td>
</tr>
<tr>
<td>Mean Low Water Spring (MLWS)</td>
<td>1.23</td>
</tr>
<tr>
<td>Lowest Astronomical Tide (LAT)</td>
<td>0.88</td>
</tr>
<tr>
<td>Lowest Recorded Water Level</td>
<td>0.56</td>
</tr>
<tr>
<td>Tide Gauge Zero (TGZ)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Figure 4: Tidal plane at Funafuti Port with respect to Tide Gauge Zero (TGZ). (source: CoSPac, 2020)**

**Table 1: Calculated design water levels for TCAP**

<table>
<thead>
<tr>
<th>Design parameter</th>
<th>Water level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2100 Sea Level Rise¹</td>
<td>0.75m</td>
</tr>
<tr>
<td>Wave setup²</td>
<td>0.21m</td>
</tr>
<tr>
<td>HAT Funafuti Port</td>
<td>3.35m TGZ</td>
</tr>
<tr>
<td>IBEmax³</td>
<td>0.28m</td>
</tr>
<tr>
<td>Design Water Level</td>
<td>4.59m TGZ</td>
</tr>
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</table>

### 2.4.2 Waves

Fogafale is affected by two wave regimes, Ocean (deep water) waves hitting the outer eastern and southern atoll coasts and wind-generated waves generated within the lagoon. The deep-

---

¹ IPCC 2019 upper limit of RCP8.5 range
² Calculated as 10% of depth-limited wave heigh at project site (Section 2.4.3)
³ maximum recorded value of Inverse Barometric Effect (IBE)
water wave climate off Fogafale’s east coast is seen to be dominated by swell waves (wave periods above 8 seconds), meaning wave energy is usually generated some distance from the atoll. Locally generated seas (wave periods below 8 seconds) only occur on average 3% of the time with a higher percentage seen in the dry season (5%). Average Significant Wave Height (Hs) is 1.8m with the largest waves occurring in the dry season attributed to Southern Ocean swells travelling from the south west. The dry season also sees a high frequency of waves generated along the east and south east trade fetch attributed to the strengthening and predominance of the trade winds during those months.

The wet season sees less frequent (and less intense) waves generated from the southerly sector, with a greater frequency in waves arriving from the north (NE to NW), these waves are most likely attributed to large events in the Northern Pacific. The largest waves can be seen to occur from the north and north west and are most likely attributed to the passage of tropical cyclones during the wet season.

The Pacific Community – Geoscience, Energy and Maritime Division has undertaken comprehensive wave inundation modelling (SPC, 2021) associated with the deep water, eastern shore of Fogafale Island. The wave inundation report shows that under SROCC (2019) RCP 8.5 projections out to 2050, direct landfall of the largest modelled cyclone event (ARI 250 year) would not impact the surface of the TCAP reclamation.
Figure 5: (clockwise from top left): CAWCR grid resolution around Funafuti and model extraction point, long-term and seasonal wave roses for the deep water CAWCR model extraction point (1979-2019).

Table 2: Long term statistics calculated for the CAWCR model extraction points in deep water offshore of Fongafale for the wave hindcast information 1979-2019

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistic</th>
<th>Long term average (40yrs)</th>
<th>Wet season (Nov- Apr)</th>
<th>Dry season (May – Oct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant Wave Height</td>
<td>Average</td>
<td>1.8</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Hs (m)</td>
<td>20%ile</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>90%ile</td>
<td>2.2</td>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td></td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Peak Wave Period</td>
<td>Average</td>
<td></td>
<td>11.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Tp (s)</td>
<td>20%ile</td>
<td></td>
<td>9.1</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>90%ile</td>
<td></td>
<td>15.9</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>% of Time</td>
<td></td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>% of Time Sea (Tp&lt;8s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% of Time</td>
<td></td>
<td>97%</td>
<td>99%</td>
</tr>
<tr>
<td>% of Time Swell (Tp&gt;8s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Wave Direction</td>
<td>Weighted Average</td>
<td>119</td>
<td>16</td>
<td>151</td>
</tr>
<tr>
<td>Dp (°N)</td>
<td>Standard Deviation</td>
<td>67</td>
<td>63</td>
<td>51</td>
</tr>
</tbody>
</table>

The largest waves within the lagoon are expected to occur during the passage of cyclones in the vicinity of the atoll and will be generated across the relatively small 20km north-south and 16km east-west fetches. Due to the relatively shallow lagoon areas fronting the reclamation, depth and fetch-limited wave heights have been calculated to determine conservative design wave heights at the toe of the reclamation as shown in Table 3.

Table 3: Calculated depth limited design wave heights within the Fogafale lagoon

<table>
<thead>
<tr>
<th>Wave parameter</th>
<th>Design value</th>
</tr>
</thead>
</table>
| Design (depth-limited) wave height, Hs | 2.1m

This value is considered conservative to the 1.7m design wave height calculated by AECOM (2015)
Wave parameter Design value

Associated wave period\(^5\), Tp 5sec

2.4.3 Currents
Current speeds in the vicinity of the reclamation are seen to be low at less than 1m/s in magnitude (Damlamian, 2005). The current regime can be described as generally low speed north to south directed flows for both ebb and flood tides during spring tides, with wind driven currents dominating during neap tides.

2.4.4 Wind regime
The wind climate at Funafuti was assessed using data extracted from a regional hindcast model from the Centre for Australian Weather and climate research (CAWCR). The wind roses in Figure 6 and wind climate statistics in Table 4 show prevailing winds are dominated by easterly trades of moderate strength. The range of wind directions is relatively larger during the wet season, with stronger wind speeds originating from the west.

Table 4: Wind climate statistics for Funafuti

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistic</th>
<th>Long term averages (41-years) - CAWCR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All seasons</td>
</tr>
<tr>
<td>Wind speed [m/s]</td>
<td>Mean</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>20%ile</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>50%ile</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>75%ile</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>90%ile</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>99%ile</td>
<td>10.9</td>
</tr>
<tr>
<td></td>
<td>99.5%ile</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>24.1</td>
</tr>
<tr>
<td>Wind direction</td>
<td>Weighted mean [°N]</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Standard deviation [°]</td>
<td>52</td>
</tr>
</tbody>
</table>

\(^5\) This has been based on the wave period calculated by AECOM (2015)
Figure 6: Annual, wet season and dry season wind roses for Funafuti.
3. Reclamation design

3.1 Overview

Full details on the design process and iterations of the Funafuti Reclamation can be found in the Concept Design Report (UNDP, 2021a) and is summarised in the following section. Appendix A: and Error! Reference source not found. provide the IFC detailed design drawings and bill of quantities of the reclamation design, Table 5 provides an overview of the key parameters.

Table 5: Overview of TCAP design parameters for Funafuti reclamation

<table>
<thead>
<tr>
<th>Design parameter</th>
<th>Design value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclamation length</td>
<td>704m (excluding Catalina Harbour breakwater)</td>
</tr>
<tr>
<td>Reclamation height</td>
<td>5.8m TGZ at crest of reclamation</td>
</tr>
<tr>
<td>Reclamation width</td>
<td>100m (average over reclamation length)</td>
</tr>
<tr>
<td>Reclamation volume</td>
<td>269,400m$^3$</td>
</tr>
<tr>
<td>Bund design</td>
<td>Stacked geotextile mega containers fronted by a protective revetment consisting of stacked 2.5m$^3$ GSC units. Rock breakwater protecting the Catalina Boat Harbour</td>
</tr>
<tr>
<td>Drainage</td>
<td>Minimum 1% slope from crest. 30% of reclamation area draining seaward over bund, 70% draining to excavated channels surrounding reclamation</td>
</tr>
</tbody>
</table>

Figure 7: Site plan of the TCAP Funafuti Reclamation
3.2 Structure details

It has been determined that the most suitable material for the reclamation bund is a combination of stacked Geotextile Mega Containers (GMC) used as the core of the bund revetment with smaller 2.5m³ Geotextile Synthetic Container (GSC) units used to protect the seaward face of the revetment, advantages and rationale of this design have been described in the Concept Design Report. A typical section of the reclamation bund is shown in Figure 8.

![Figure 8: Typical section of reclamation seaward face](image)

### 3.2.1 Geotextile unit sizing and stability

As shown in Figure 8, the stacked GMC units will offer the bunding for the reclamation volume. These units will be stacked 2 units high in a (2+1) pyramid formation. The GSC units will be stacked nine high on the seaward edge of the GMC bund to protect the GMCs from damage from vandalism or boat strikes. The slope of these units will be 1 vertical to 1.5 horizontal (1V:1.5H). These units will be stacked such that their short edge is facing seaward to increase inter-unit connectivity and stability. Recommended design dimensions for geosynthetic containers are provided in the IFC Drawings (Appendix A) and summarised for reference in Table 6.

Physical modelling of commercially available geosynthetic sand containers has been undertaken by the University of New South Wales’ Water Research Laboratory (Coghlan, et al., 2009). Based on the published tables and graphs and following discussions with the Authors’ it has been determined that the 2.5m³ GSC unit armour layer is a suitable solution to withstand the wave climate at the project site, considering the GMC core utilised in the bund design.

<table>
<thead>
<tr>
<th>Type</th>
<th>Height (mm)</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5m³ GSC unit</td>
<td>600 – 700</td>
<td>2,400 – 2,600</td>
<td>1,600 – 1,900</td>
</tr>
<tr>
<td>GMC</td>
<td>1,500 – 2,100</td>
<td>20,000</td>
<td>1,500 – 4,800</td>
</tr>
</tbody>
</table>

### 3.2.2 Toe and crest levels

The GSC and GMC units are to be founded on the lagoon reef flat to ensure there is no scour under the structure. The crest elevation of the GSC armour layer has been designed such that it
exceeds the design water level (4.59m TGZ, Sec. 2.4.1) by more than 1m and is approximately 2m higher than HAT. There is potential that the GSC armour layer may be overtopped during extreme wave and water level events in excess of the design event. It is recommended that the seawall be inspected after any significant overtopping event, and maintenance be undertaken to fill any areas where erosion has occurred. A construction setback limit of 25m is recommended inland of the GSC crest. This has been designed to limit damage to structures during overtopping events and to ensure piling or other excavation work does not have the potential to damage the underlying GMC units.

3.2.3 Durability and maintenance
The geotextile used for the construction of the units will be designed to be vandal and UV-resistant, TEXCEL 1200R or similar. Full geotextile specifications are provided in the IFC drawings (Appendix A). The vandal deterrent containers are designed to withstand exposure to wave action, sunlight, high volumes of pedestrian traffic and recreational fishing; however, there is potential for the bags to be damaged by impacts from debris and vessel strikes during large events. Should units become dislodged or damaged, the Government of Tuvalu Public Works department (PWD) will be trained in the repair of the units. The superstructure of the buried GMC units is such that any damage to the armour layer of GSC units, will have little impact to the containment and overall stability of the reclamation.

3.3 Drainage
A drainage investigation was undertaken on the proposed reclamation by Arcadis, provided in Appendix C. The investigation defined minimum surface slopes of 1%, catchment areas and drainage channels to capture the 1% Annual Exceedance Probability (AEP) design stormwater runoff, an example section can be seen in Figure 9. The drainage design allows for runoff generated across the reclamation and surrounding catchments (including the QEII Reclamation and Vaiaku Village). Whilst the drainage system has been designed to cater for flows up to the 1% AEP storm event, it is anticipated that higher flows and tidal surge maybe experienced during extreme storm events such as cyclones. To that end it is expected that the drains may run full/overtop or be inundated. Full drainage and channel design is illustrated in the IFC Drawings, Appendix A.

A site access road has been designed to follow the crest of the reclamation. The access road will consist of rolled subgrade or larger overburden extracted through the dredging process. The raised access road creates a minimum 25m setback from the reclamation bund, separates drainage catchments and restricts north-south access (Village to Reclamation) to one access road, this will assist increasing the life of the drainage channels.
3.4 Borrow areas

Geotechnical investigations undertaken by SPC (Smith, 1995 & 2016) identified an area offshore of the project site with an estimated volume of up to 24Mm$^3$ of usable sediment which has been designated as the sand resource area (SRA). The yellow polygon in Figure 10 shows the location of the SRA and its proximity to the reclamation area. The final location within the boundary of the designated SRA will be determined by the successful contractor and is expected to be driven by the operational limits of the dredging vessel, pumping/haulage distances and quality of the sediments within the selected area. It should be noted that with the high possibility of future reclamation directly offshore of the project site, it is the preference of the GoT that sediment is sourced from deeper areas or those further afield from the project site within the designated SRA to reduce future infilling.

Smith (1995), Kaly and Peacock (2014), as well as recent dredging and sampling activities within the lagoon noted that there is a degree of variability in the quality of sediments across the SRA. Table 7 shows four samples taken on the south west corner of the SRA. The Required sediment characteristics for both the reclamation fill and the GSC and GMC units (as stated in the IFC drawings) have been split into two main categories based on the particle size distribution (PSD) of the sediment, these are provided in Table 8.

Recent dredging activities have revealed inconsistencies in the penetration depths during original investigations stated in the SPC reports and that the presence of coral bombies are prevalent throughout the SRA. The presence of this harder material needs to be considered during the selection of an appropriate dredging, transport and sorting methodology.
Figure 10: The olive-coloured zone is the established sediment resource area containing an estimated 24,000,000 m$^3$ of material which can be safely utilised (Smith, 1995). The larger red cross hatched zone is the area identified by Kaly and Peacock-Taylor (2014) as the “the zone of dead coral and eutrophication”. The yellow circle approximates the area which would be dredged to a depth of 3.5m to supply 350,000m$^3$. The red/yellow dots are the (JP#) sample points detailed in Table 7 (Source: UNDP, 2019 and Hall, 2018).

Table 7: Sediment sampling undertaken within the resource area. (Source: Smith, 2015)

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<thead>
<tr>
<th>JP#</th>
<th>Easting m</th>
<th>Northing m</th>
<th>% Clay</th>
<th>% Silt (0.02-0.006 mm)</th>
<th>% Fine sand (0.06-0.2 mm)</th>
<th>% Medium Sand (0.2-0.6 mm)</th>
<th>% Coarse Sand (0.6-2.0 mm)</th>
<th>% Fine Gravel (2-6 mm)</th>
<th>% Coarse Gravel</th>
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<td>0</td>
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<td>905579</td>
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<td>9055835</td>
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<td>0.7</td>
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<td>26.1</td>
<td>47.1</td>
<td>19.7</td>
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Table 8: Sediment size requirements for Funafuti reclamation.

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<td>TYPE A</td>
<td>≥90% passing 75mm sieve</td>
<td>Reclamation fill material</td>
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<td>300mm maximum particle size</td>
<td></td>
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<tr>
<td>TYPE B</td>
<td>100% passing 26.5mm sieve</td>
<td>GSC, GMC unit fill</td>
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3.4.1 Unexploded ordinance (UXO)

The presence of unexploded ordinance (UXO) has been found within the lagoon sediments as during WWII there were up to 174 vessels moored within the lagoon, with Funafuti being bombed on 9 separate occasions (JICA, 2011). Prior to the dredging work undertaken as part of the Borrow Pit and QEII Park reclamations, CSG Demining Consultants (CSG) conducted a Risk Assessment posed by Explosive Remnants of War (ERW). The key findings of the ERW risk assessment were that because there is minimal excavation required for the preparation and filling of the borrow pits, there is minimal potential for encountering ERW.

The report found potential to encounter ERW during dredging operations and made the following recommendations:

- A suitable ERW Awareness Brief be provided to all project staff and visitors.
- Ground-intrusive activities on land be avoided, or if essential, minimised. If significant ground-intrusive activities must be conducted, an ERW clearance of the location is to be conducted.
- The dredge system includes a screen on the dredge inlet, a bomb box with hydraulic door on the inlet pipeline and another bomb box on the outlet side of the dredge pipeline and deploy a UXO Technician for, at least, the first month of the dredging operation.

Prior to dredging for the Borrow Pit and QEII reclamation, magnetometer surveys were undertaken of proposed dredge areas and sent to the Principal for approval. It is recommended that this survey be undertaken by the Contractor prior to any dredging works and the above recommendations are also to be undertaken for the TCAP reclamation works.

3.5 Catalina boat harbour

The eastern extremity of the reclamation terminates at the location of the Catalina Ramp. A 30m long GMC core rock breakwater extends from the reclamation bund to create an all-tide access boat harbour for smaller local fishing vessels. The boat harbour provides vessel access to the shore and the reclamation area via a floating pontoon abutting the eastern reclamation bund. The detailed site plan of the boat harbour is shown in Figure 11. Key design elements of the boat harbour are as follows:

- A 60m long, 40m wide pontoon fronts the eastern extremity of the reclamation bund.
- The pontoon is made of modular floating dock system (CANDOCK or similar), with individual units added or removed to custom fit the required area. The modular system is anchored to the seabed.
- There are three ramps in the modular system that leave the reclamation and meet the long section of the pontoon. Each of these ramps can rise and fall with the tide and lay atop the geotextile units making up the reclamation bund. These ramp entrances have a gentler slope (1V:2H) than the adjacent 1V:1H eastern bun wall to ensure safe pedestrian access.

Full details and specifications of the boat harbour and docking system is provided in the IFC drawings.

---

6 A remnant WWII dredged harbour and rock revetment where Catalina Seaplanes would berth
3.5.1 Rock breakwater

The Catalina Boat Harbour breakwater will reuse the rock on the two groynes that lie within the reclamation footprint (on Tausoa Beach), seen in Figure 12. The rock appears to be igneous or metamorphic boulders (most probably granite) with a mean diameter ($D_{50}$) of around 1250mm, with boulders of up to 2500mm also found. The approximate dimensions and estimated available volume of rock of each of the structures is provided in the table below. The rock is considered to be high quality and from superficial inspection appears of suitable size (and density) for the expected wave climate within the lagoon to remain stable if used in a breakwater structure at this location.
As the proposed boat harbour is expected to be a long-term feature that is likely to remain undeveloped for a longer period in comparison to the reclamation bund, it is recommended that the armouring of the boat harbour breakwater be of this reused rock material. The core of the breakwater will consist of stacked GMC units as shown in Figure 12. Full details of the breakwater design are provided in the IFC drawings (Appendix A).

<table>
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<th>Structure</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Mean height (m MSL)</th>
<th>Mean bed level (m MSL)</th>
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<td>7</td>
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<td>-0.5</td>
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<tr>
<td>Catalina groyne</td>
<td>43</td>
<td>9</td>
<td>0.9</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

Figure 12: Rock sources for reuse in the Catalina Harbour Breakwater; Vaiaku and Catalina groynes
4. PROJECT IMPLEMENTATION

4.1 General

The United Nations Development Programme (UNDP), Pacific Office in Fiji act as the Project Management Unit (PMU) for TCAP, implementing the project in partnership with the GoT. Assistance throughout the implementation phase has also been provided by the Pacific Community (SPC) has also been engaged by UNDP to conduct the ESIA, coastal vulnerability and geotechnical components.

The following section describes non-design related aspects of the project implementation.

4.2 Project governance and oversight

TCAP has been led at the highest political level by a Technical Working Group (TWG) comprising key government departments and Non-governmental Organisation (NGO) associations representing vulnerable communities. The GCF financing, through TCAP, will enable the GoT to address the financial and capacity constraints at all levels – from technical to community awareness – that have so far prevented a sustainable coastal protection solution.

TCAP will strengthen institutional and community capacity for sustaining and replicating project results. It is envisaged that the project will help to strengthen governmental capacity for coastal management and its legacy will be a Coastal Management Strategy for Tuvalu with internal agency capacity for its implementation.

4.3 Procurement strategy

Due to the works complexities stemming from the remote location of the project sites, the unique atoll environments and the nature of the construction works in Tuvalu, UNDP have proposed a 3-stage Interactive Dialogue Procurement Strategy. The construction works will be tendered as a complete package of works encompassing Funafuti, Nanumea and Nanumaga. The procurement stages are briefly described below:

- Pre-qualification (PREQ): The PREQ procedure is aimed at identifying qualified applicants for the next stage of the procurement process based upon their expertise, financial and technical capacity, and experience in construction in remote undeveloped atoll islands.

- Request for Proposal (RFP): A formal RFP will be issued to pre-qualified tenderers to provide both a formal technical and financial response to the tender. A pre-bid conference will be undertaken prior to the submission of the tenderer’s RFP response.

- Interactive Dialogue (ID): The interactive dialogue allows UNDP and tenderers to discuss the scope and complexities around the project and for tenderers to understand better the RFP requirements. ID offers significant and clear benefits; enabling risk and assumptions to be thoroughly tested, innovative solutions to evolve and the foundations established for ensuring a successful contractual outcome of the tender. After completion of the ID sessions, the offerors are expected to submit their proposals within the stipulated deadline. The evaluation of the proposals including the contract award will follow the standard UNDP RFP process.
4.4 Contract delivery

The works contract will be delivered through UNDP’s standard construction contract. Terms of the contract and any proposed departures by the tenderers will be discussed during the ID phase of procurement in the presence of the UNDP Legal and Procurement Teams as well as the PMU. Contractual discussions and verifications through the ID phase will minimise the risk of contractual disputes during construction as the ID sessions provide an opportunity for both parties to explore contingencies and project risks prior to signing and commencement of works.

4.5 Construction Environmental and Social Management Plan (C-ESMP)

The planned works on Funafuti have the potential to create a variety of impacts through their implementation. These impacts can be either positive (e.g., improved coastal protection for community members) or negative (e.g., loss of trees, loss of beach access for recreation and fishing) depending on the activity and receptors involved. The impact of this project on the physical, biological, and social environment has been assessed and is described in detail in the Funafuti Environmental and Social impact Assessment undertaken by The Pacific Community – Geosciences, Energy and Maritime Division (SPC, 2020c). The key potential project impacts and risks have been identified as the following:

- Increased water turbidity from dredging works
- Changing access to, and use of, coastal marine environment
- Increased risk of traffic accidents
- Solid waste management
- Use of heavy machinery on the beach leading increased sedimentation
- Fuel or other hazardous spills
- Noise and dust disturbance

This ESIA contains the recommended mitigation measures for Funafuti for pre-construction, construction, and operational phases to avoid, reduce, or mitigate all identified impacts. The Contractor for the TCAP works will be required to produce a Contractor’s Environmental and Social Management Plan (C-ESMP). The C-ESMP will be the Contractor’s governing document for the implementation of this ESIA’s recommendations during works. The C-ESMP will be reviewed and approved by the TCAP Project Management Unit and disclosed prior to commencement of civil works. A summary of the key protective mitigation measures is provided in the table below.

| Table 9: Key protective environmental and social mitigation measures as part of the design, implementation and operation the TCAP Funafuti Reclamation (Source: SPC: 2020c) |
### Impact Area: Dredging and Fill Works

- Develop and implement a site-specific Dredge and Fill Operations Plan to address water turbidity and water quality management.
- Dredge method will be via a pipeline for conveying slurry to fill sites to minimise losses to lagoon waters.
- Dredging will be limited to the sand excavation area identified in the ESIA.
- No ecologically significant areas are included in the design. Dredging concentrates on damaged parts of the lagoon.
- Dredge plume to be monitored and dredge works halted if plume extends over a large area.
- Dredge waters will be discharged within the revetment wall to allow filtering and control of dredge wastewater.
- Strict control on de-watering release – by pumping to a contained area by using sediment curtains, and by route monitoring of turbidity – will be required in the C-ESMP. Care will be taken to ensure de-watering does not occur towards the island.

### Impact Area: Retaining Structure

- The retaining geotextile structure will be designed to absorb and reduce wave energy, prevent overtopping, and minimise any wave reflection issues.
- Reclamation works will not extend to existing terrestrial vegetation line.
- Reclaimed land will drain to stormwater drain.
- Set back area will be defined 20m from seaward edge of reclamation.
- Catalina Harbour will be designed with safe loading of passengers in mind.
- Areas accidentally damaged during works will be restored by clean-up, re-contouring, and planting.
- The removal and transfer to safer ground of epifaunal species such as sea cucumbers will be carried out by the Contractor to avoid burial.
- Ensure that any erosion- and sediment-control devices are installed, inspected, and maintained as required.
- No trees in the vegetation line will be removed or damaged during construction works.

### Impact Area: Noise and Vibration

- Minimise nuisance from noise, especially closer to residential areas and sensitive receptors, through establishment and communication to affected parties of working hours, including night works.
- Care will additionally be taken to avoid increase of noise and quantity of work equipment at outside of advertised hours. Advertise working hours at the site entrance.
- Signage to outline complaints procedure and to provide contact details of recipient of complaints.
- Contractor will develop a work schedule or operations with Kaupule to identify hours and days of no work due to religious and cultural activities.
<table>
<thead>
<tr>
<th>Impact Area</th>
<th>Key Management Measures</th>
</tr>
</thead>
</table>
| **Community Services and Infrastructure** | • Through ongoing consultations, determine if the coastal reclamation could negatively impact fisherfolk, boat owners and users, and other potentially vulnerable groups in the community adjacent to the project site.  
• Explore additional and more culturally sensitive options for boat mooring for the adjacent community, other than the Catalina Harbour option.  
• Waste management practices will prioritise reduce, reuse, recycle  
• Preference shall be given to materials that can be used to construct the project that would reduce the direct and indirect waste generated.  
• All hazardous or contaminated waste will be exported from Tuvalu under the conditions of the Waigani Treaty and will be coordinated through the WMD  
• Disposal of waste shall be carried out in accordance with the Government of Tuvalu requirements. Waste that cannot be recycled, reused, composted, or otherwise disposed of in Tuvalu will be exported and disposed of in a licensed facility in another country.  
• Any dangerous goods (including batteries) stored on site shall be stored in accordance with Tuvalu regulations and international best practice.  
• The Contractor will be responsible for repairing any damage caused by construction works to the existing road network. |
| **Hazardous Substance Management**   | • Prepare spill management plan addressing measures.  
• Store and handle all chemicals, fuels, oils, and potentially hazardous materials as specified in relevant standards and guidelines.  
• Hydrocarbon wastes shall be stored in colour-coded and labelled drums placed in secure storage areas on site.  
• Where possible, fuel and chemical storage and handling shall be undertaken at designated petrol stations on the island or at the project site on impermeable, bunded surfaces (preferably over drip trays).  
• Onsite storage of fuel and chemicals shall be kept to a minimum.  
• Emergency clean-up kits for oil and chemical spills will be available onsite and in all large vehicles. |
| **UXO/ERW**                         | • Contractor will undertake an updated magnetometry survey of the proposed dredge area  
• The dredge will be fitted with a suitable screen to exclude explosive remnants of war (ERW) at the cutter head and a beach-screening cage to capture ERW at the discharge end of the dredge pipe as was used in the Tuvalu Borrow Pit Project.  
• Contractor will undertake an updated magnetometry survey of the proposed dredge area.  
• The Contractor’s C-ESMP will detail their protocols for safely handling and disposing of UXO. |
<table>
<thead>
<tr>
<th>Impact Area</th>
<th>Key Management Measures</th>
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<tr>
<td>Social Environment</td>
<td>• Ensure opportunities to incorporate men’s and women’s views and interests into project decisions and implementation are purposefully created and enabled in the stakeholder engagement processes throughout the project life.&lt;br&gt;• Develop and implement a communication plan for the project and in particular the messaging that the Catalina Harbour is a public facility for all community members.&lt;br&gt;• The communities, in coordination with their Kaupule, will provide the Contractor with a list of skilled and unskilled laborers. The Kaupule will also coordinate with the villages to ensure that job opportunities are distributed. Women will be encouraged to participate in the workforce and in uptake of job opportunities. Persons with disabilities will also be encouraged to participate in the workforce and with jobs that are appropriate and significant.&lt;br&gt;• Communities on the island will have the opportunity to provide food, beverages, and housekeeping services for incoming workers to the island for 3-4 months. Provision of food services; provision of fresh water or coconuts; sale of food items such as local fruits, root crops, vegetables, etc.; sale of handicrafts; and laundry services are examples of income-generating activities.</td>
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</table>
5. SUMMARY AND RECOMMENDATIONS

5.1 Summary

This report is the culmination of the design process for the Funafuti Reclamation as part of the TCAP. It finalises the design narrative undertaken in the Concept Design Report (UNDP, 2020) and draws on extensive stakeholder consultation, site investigations and interviews with contractors working in the region. The basis of design, structure parameters and the project implementation framework is presented herein. A safety in design (SiD) investigation which presents a design and construction risk assessment is provided in appendix D for reference.

The Funafuti Reclamation can be summarised as follows:

- A bunded reclamation located on the Vaiku Foreshore to the east of the QEII reclamation in Funafuti, consisting of approximately 270,000m$^3$ of sediment sourced from the Fogafale lagoon within 2Nm of the project site. Approximated dimensions of the reclamation are 700m x 100m raised at its highest point to 5.8m TGZ at crest of reclamation.

- The design of the reclamation bund design incorporates stacked geotextile mega containers fronted by a protective revetment consisting of stacked 2.5m$^3$ GSC units.

- Drainage slopes and channels are to be levelled into the reclamation surface to cater for flows from the reclamation itself, the adjacent village and QEII reclamation.

- A small boat harbour has been designed along the eastern extremity of the reclamation catering for small vessels. The harbour consists of a floating modular dock system abutting the GSC reclamation bund. A 30m long rock breakwater protects the harbour, the rock is to be sourced from the two rock groynes on Tausoa Beach.

5.2 Recommendations

The following recommendations are included as the TCAP moves through the implementation stage:

- Any uncertainties or omissions within this Detailed Design Report and associated IFC drawings should be conveyed by the tenderers to UNDP during the ID phase of the procurement strategy.

- The submitted C-ESMP should address as a minimum the risks presented in Table 9.

- A post-construction monitoring and maintenance strategy should be established with clear tasks, roles, training and budget allocated to GoT.

- Wherever possible a UNDP representative engineer should be present during the construction phase to ensure the reclamation is constructed as to the specifications presented.
6. REFERENCES


GA, 2018. *Geosciences Australia*


Hall, 2018. *Collection of site photos sourced from the Borrow Pit and QEII Park Reclamation Projects*. Kindy supplied by Hall Contracting to aid in project scoping.


PCCSP, 2015. Current and future climate of Tuvalu

PSLM, 2019a. Tuvalu – Vaitupu 2019 Tide Predictions Calendar. Climate and Oceans Support Program in the Pacific. A Pacific Islands Program supported by the Australian Government and Australian Bureau of Meteorology. GPO Box 1289 Melbourne Victoria 3001 Australia

PSLM, 2019b. Tuvalu – Vaitupu 2019 Tide Predictions Calendar. Climate and Oceans Support Program in the Pacific. A Pacific Islands Program supported by the Australian Government and Australian Bureau of Meteorology. GPO Box 1289 Melbourne Victoria 3001 Australia

Smith, R. 2015 (SPC Geoscience Division Technical Report PR209)


Funafuti Environmental and Social impact Assessment undertaken by The Pacific Community – Geosciences, Energy and Maritime Division (SPC, 2020c)
Appendix A: Funafuti Reclamation IFC Drawings
**TUVALU COASTAL ADAPTATION PROJECT (TCAP)**

**FUNAFUTI**

### LOCALITY PLAN

**SCALE 1: 25,000**

### FUNAFUTI DRAWING LIST

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**HORIZONTAL DATUM**

**UTM-WGS84 / UTSM60S EPSG:32760**

**VERTICAL DATUM**

**CHART DATUM (CD) TGZ**

**ISSUED FOR**

**AW**

**TUVALU COASTAL ADAPTATION PROJECT (TCAP),**

**FUNAFUTI**

**1/1874 Gold Coast Highway
Burleigh Heads
QLD, 4220. Australia
+61 (0) 412 393 703**

**www.bluecoastconsulting.com.au**

**TUVALU COASTAL ADAPTATION PROJECT (TCAP),
FUNAFUTI**

**P19012**

**COVER SHEET AND DRAWING LIST**

**P19012-FN-CV-00-01**

**A**
SITE PLAN
SCALE 1:1,000

SEAWALL RETAINING STRUCTURE
SAND FILLED GEOCONTAINERS AND MEGA BAGS

BRENSHATTER STRUCTURE
ROCK ARMOUR AND MEGA BAG CORE

REPLANTED VEGETATION

FLOATING PONTOONS AND ACCESS RAMPS

MATCH TO EXISTING ROCK BREAKWALL

CATALINA BOAT HARBOUR
SAND FILLED GEOCONTAINERS

OPEN CHANNEL
4m WIDE ACCESS PATH (TYP)

JL
AW

TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI

UNFINISHED DRAWING

www.bluecoastconsulting.com.au
GENERAL CONSTRUCTION NOTES

1. THE WORKS SHALL BE PROTECTED AND/OR MANAGED TO ACCOUNT FOR HIGH WINTER LEVELS WAVE ACTION AND STORMWATER.
2. THE WORKS SHALL BE COMPLETED IN A MANNER WHICH LIMITS THE EXTENT OF THE WORKS EXPOSED TO POSSIBLE DAMAGE FROM HIGH WATER LEVELS, WAVE ACTION AND STORMWATER AND ENSURE THAT IT DOES NOT ADVERSELY AFFECT AREAS AdjACENT TO THE WORKS.
3. DEMOLITION AND EXCAVATION SHALL BE Undertaken IN A CAREFUL MANNER WITH A MINIMUM OF DISTURBANCE AND WITH EVERY POSSIBLE PRECAUTION TO PREVENT DAMAGE TO PROPERTY AND INJURY TO PERSONS.
4. CARRY OUT ALL WORKS IN ACCORDANCE WITH THE APPROVED PROJECT DOCUMENTATION, RECORDS AND HAVE AUTHORIZED ANY CHANGES MADE TO THE WORKS UNDER THIS DOCUMENTATION IN ACCORDANCE WITH QUALITY PROCEDURES.
5. ALL DISCREPANCIES SHALL BE REFERRED TO THE UNIP EngINeer FOR RESOLUTION BEFORE PROCEEDING.
6. DURING THE CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE WORKS INCLUDING ADJACENT STRUCTURES IN A STABLE CONDITION AND ENSURING NO PART IS OVERSTRESSED.
7. ALL DIMENSIONS ARE IN METRES AND ALL LEVELS ARE METERED RELATIVE TO CHART DATUM (CD).
8. ARRANGE SETTLEMENT IN LUSTON WITH GOVERNMENT OF TUVU LANDS AND SURVEY DEPARTMENT, NOTIFY SURVEY CO-ORDINATOR A MINIMUM OF 24 HOURS IN ADVANCE.
9. CATCHMENT BASED ON DIGITAL MODEL (DB) PROVIDED BY FUGRO (2019).
10. ELEVATED PORTION TO BE THE HIGHEST POINT OF RECLAMATION TO ALLOW OVERLAND FLOWS FROM MAJOR STORM EVENTS TO BE CONVEYED OFF THE RECLAMATION, REFER DETAILED DESIGN REPORT FOR DETAILS.
11. ALL DIMENSIONS RELATED TO EXISTING WORKS, GROUND AND SEARCH LEVELS, OR ITEMS SUPPLIED BY OTHERS, SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO COMMENCEMENT OF ANY FABRICATION AND ERECTION WORKS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THEIR CORRECTNESS.
12. ALL PROPRIETARY ITEMS SHALL BE INSTALLED STRICTLY IN ACCORDANCE WITH THE MANUFACTURER’S SUPPLIERS INSTRUCTIONS.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPORARY SITE DRAINAGE AND UNRELATED WORKS (RENEWAL OF THE AREA OVERTAKEN) / YIELD JUGS.
14. THE CONTRACTOR SHALL RECORD PHOTOGRAPHIC EVIDENCE OF ALL EXCAVATIONS PRIOR TO ANY BACKFILLING.

FILL MATERIAL

1. ALL FILL MATERIAL SHALL BE NON-CORROSIVE, GRANULAR MATERIAL, COMPRISING HARD, DENSE AND DURABLE PARTICLES WHICH SHALL BE FREE FROM ORGANIC AND CARBONACEOUS MATERIALS.
2. GRADING OF FILL MATERIAL SHALL COMPLY WITH THE FOLLOWING PROPERTIES:
   - TYPE A: 20mm MINIMUM PARTICLE SIZE
     - 100% PASSING 75mm SIEVE
   - TYPE B: 100% PASSING 20mm SIEVE

EXCAVATION AND FILL WORKS

1. THE UNIP CONSTRUCTION SUPERVISOR SHALL BE ADVISED WHEN DEMOLITION, EXCAVATION AND FILL WORKS ARE TO COMMENCE.
2. THE RECLAMATION BOUNDARY SHALL BE PREPARED ALONG THE ALIGNMENT AND IN ACCORDANCE WITH THE LEVELS AND SIDE SLOPES SHOWN ON THE DRAWINGS.
3. STOCKPILING OF ROCK FROM THE TAUSON BEACH DINESSH SHALL NOT IMPED BUILED VEHICLE ACCESS AND WILL BE MADE IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE UNIP REPRESENTATIVE.
4. ROCK FROM THE TAUSON BEACH DINESSH SHALL BE STOCKPILED INTO TWO DISTINCT SEPARATE PILES REPRESENTATIVE OF THE ARMOURSTONE AND UNDERLAY ROCK MASS ORIGINS.
5. STOCKPILING OF SAND SHALL BE LIMITED TO THE MINIMUM EXTENT PRACTICAL FOR CONTINUITY OF THE WORKS.

GEOTEXTILE PLACEMENT

1. THE GEOTEXTILE SHALL BE TUCKED 150MM OR APPROVED EQUIVALENT WHICH COMPLIES WITH THE FOLLOWING MINIMUM REQUIREMENTS:
   - UNI WEIGHT TO AS1579.1
   - GRAB STRENGTH TO AS1579.3.3
   - TRAFFICABLE TEAR RESISTANCE ASTM D1117
   - WATER PERMEABILITY (10 CM HEAD)
   - 1000 g/hr
   - 1000N (MN) IN ANY DIRECTION IN PLANE OF GEOTEXTILE
   - 60N (MN) IN ANY DIRECTION
   - 500mm (20in) MINIMUM

2. THE PLACEMENT OF GEOTEXTILE FILTER SHEET SHALL SATISFY THE CRITERIA BELOW:
   - GROUND PREPARATION: SHARP-EDGED ROCKS, STUMPS AND THE LIKE ARE TO BE REMOVED PRIOR TO LAYING OF THE GEOTEXTILE
   - JOINING FABRIC ELEMENTS: FABRIC ELEMENTS MAY BE JOINED BY EITHER OVERLAPPING OR SEWING. OVERLAP WIDTHS SHALL BE NO LESS THAN 0.6M WITH THE DIRECTION OF OVERLAP TAKING INTO ACCOUNT THE OVERBURDEN MATERIAL SUPPLY DIRECTION. FOR DESIGNING ASSEMBLY L 1.5M OVERLAP IS SUFFICIENT TO ENSURE CONTINUITY OR TO MANUFACTURER’S INSTRUCTION.
   - LAYING IN WATER: RAPID IMMERSION REQUIRES BALLASTING OF FABRIC.
   - JOIN GEOTEXTILE AS TO RETAIN ADEQUATE FILTER FUNCTION.

GEOTECHNICAL SAND CONTAINERS

1. PLACEMENT OF THE GEOSYNTHETIC SAND CONTAINERS SHALL ACHIEVE THE FOLLOWING TO UMBRELLA:
   - A TOLERANCE OF 0.5M FOR THE SLOPE ALONG THE RECLAMATION BOUNDARY OF INDIVIDUAL GEOSYNTHETIC SAND CONTAINERS
   - A TOLERANCE OF 1.0M FOR THE SLOPE ALONG THE RECLAMATION BOUNDARY OF INDIVIDUAL GEOSYNTHETIC SAND CONTAINERS
   - MAXIMUM 500mm VERTICAL OFFSET BETWEEN THE ENDS OF ADJACENT GEOSYNTHETIC SAND CONTAINERS
   - MAXIMUM 500mm HORIZONTAL SEPARATION BETWEEN ADJACENT GEOSYNTHETIC SAND CONTAINERS.
2. GEOSYNTHETIC SAND CONTAINERS SHALL BE FILLED USING TYPE B FILL MATERIAL.
3. GEOSYNTHETIC SAND CONTAINERS SHALL BE FILLED AND SEALING IN ACCORDANCE WITH PROCEDURES PROPOSED BY THE MANUFACTURER AND IN ACCORDANCE WITH THE CONSTRUCTION PROCEDURE.
4. THE FILLING METHODS SHALL BE HYDRAULICALLY ASSESSED AND SHALL ACHIEVE SAND CONTAINERS DIMENSIONS WITHIN THE RANGE SPECIFIED BELOW.

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5. THE GEOTEXTILE SAND CONTAINERS SHALL BE PLACED ON A GEOTEXTILE TO PREVENT THE LOSS OF FINISHES THROUGH THE STRUCTURE IN ACCORDANCE WITH THE DRAWINGS AND THIS SPECIFICATION.
6. THE CONTAINERS SHOULD BE PLACED USING SPECIALISED FILLING PLACEMENT EQUIPMENT, IN ACCORDANCE WITH THE MANUFACTURER’S RECOMMENDATIONS.
7. THE AMOUNT OF SANDS SHALL BE MINIMISED TO ENSURE THE GEOSYNTHETIC SAND CONTAINER RETAINS ITS FORM AND SHAPE, AND TO REDUCE THE STRAINS PUT ON THE GEOTEXTILE AND BEAMS. THE GEOSYNTHETIC SAND CONTAINERS SHALL BE PLACED IN SUCH A WAY AS TO MINIMISE EXPOSURE OF THE ON-SITE BOUNDARY.
8. THE GEOSYNTHETIC SAND CONTAINERS SHALL BE PLACED IN A STRAIGHT BOND LAYOUT TO ENSURE EFFECTIVE INTERLOCK AND STABILITY.
9. IF VESSELS TRAFFICKING ATOP THE GEOSYNTHETIC SAND CONTAINERS IS REQUIRED DURING PLACEMENT, A MINIMUM SAND COVER OF 300MM IS REQUIRED OVER THE GEOSYNTHETIC SAND CONTAINERS.

TIDE CHART - DATUMS

CHART DATUM MSL = +0.60
RL +3.35m CD HAT
RL +2.95m CD LAT
RL +1.30m CD TGZ

Funafuti Tide Gauge Datum Relationships and MSL Correction” (source: Fugro, 2019). Source SPC, 2019
ROCK WORK (BREAKWATER)

1. Boulder size shall be round igneous or metamorphic rocks clean and free of topsoil, and organic matter, sourced from the Tauranga Beach gravel as follows:
   - Size 280 to 300mm
   - 5% over 300mm
2. Rock fill shall be round igneous or metamorphic rocks clean and free of topsoil, and organic matter, sourced from the Tauranga Beach gravel as follows:
   - Size 280 to 300mm
   - 5% over 300mm
3. The rock works shall be constructed in the location shown and to the levels, widths and side slopes indicated on the drawings. Where transitions or variations in slope level or geometry are shown in the drawings, they shall be smooth and linear over the length of the transition with no abrupt changes in the outer surface of the rock structure.
4. Stable rock placement batters with slope not exceeding 1:1.5 (vertical to horizontal) for all rock works to be achieved.
5. Rock works shall be placed to satisfy the following:
   - Rock shall be placed to minimise its breakage on handling, production of fines and water contamination
   - Rock shall be placed carefully to avoid damage to the geotextile filter layer.
   - Rock shall be placed to achieve an even distribution of rock sizes without concentrations of smaller rock
   - The finished slope shall be no steeper than the slope specified on the drawings.
   - Underlayer rock shall not be compacted.
   - Underlayer rock shall be placed to achieve a placement density equivalent to random placement.
   - Standard armour placement shall be achieved by individually placing rock to achieve a fully interlocking layer with each rock having at least three points of contact with other rocks in the same layer.
   - Rocks shall be wedged and locked together such that they cannot be moved without disturbing adjacent rocks.
   - Voids below the finished profile level shall not exceed 0.6 m³ and the underlayer shall not be visible at any location.
   - Placement of rock shall commence at the toe and proceed upwards towards the crest.
   - There shall be no free rocks on the surface of the armour layer, pieces of armourstone broken during handling or placement shall be removed immediately at the contractors' expense.
   - Subject to the approval of the Works Representative, broken pieces of armourstone may be included in smaller gradings.
   - No layer shall be covered by a subsequent layer until the profile of the former layer has been approved by the Works Representative.
   - Surface of the armourline slope shall present an angular uneven face to the water, armour rock smaller than the specified mass grading shall not be used to fill voids or to pro-placer armour units in order to achieve the required profile.

RECLAMATION BUND

1. The area behind the landward edge of the reclamation bund is subject to wave overtopping.
2. All buildings and other structures shall be set back 20m (min) from the reclamation bund.
3. Vehicular access is provided for construction vehicles during emergencies.

FILL PLACEMENT

1. The placement of dredged sediment shall be carried out in the areas and to the lines and levels shown on the drawings. To accommodate unforeseen situations, JLC reserves the right to amend the lines and levels of placement of material, in these general areas from those shown on the drawings.
2. The surface of the reclamation shall be kept moist by spraying with water to suppress wind-borne sand transport (losses) when the forecast or recorded wind speed, 10m above the ground surface, exceeds 30km/h.
3. Deviations from the levels, lines, grades and dimensions indicated on the drawings shall only be permitted to the extent that any deviation complies with the following construction tolerances:
   - A tolerance of ±15mm for horizontal deviations from the lines indicated on the drawings.
   - A tolerance of ±10mm/300mm for vertical deviations from the levels indicated on the drawings.
4. In addition to meeting the construction tolerance requirements, the surface of the reclamation shall be spread evenly over the designated area to achieve a smooth profile and avoid areas of ponding or abrupt changes in elevation. Assessment and acceptance of any such areas shall be at the discretion of the Works Representative.
5. Where drawdowns specify compacted fill, materials using the compacted layer method or by hydraulic placement to ensure that the fill is well compacted and free of significant pockets or voids.
6. Fill material that will be in contact with the geotextile shall not have protrusions that may damage the geotextile during installation or in service.

REINSTATEMENT, SITE DISESTABLISHMENT AND CLEANUP

1. Except to the extent that the site has been repaired and upgraded in accordance with the works, the site shall be reinstated to its pre-construction condition and any structures damaged during the course of the works.
2. Upon completion of the works, the site shall be cleared of all surplus materials, plant, fencing, site sheds, notice boards and the like, to the satisfaction of the Works Representative.
3. Upon completion of the works, removal and lawful disposal of site of all surplus spoil, rubbish or excess material, and for the final cleaning up of all areas covered by the contract shall be left clean and tidy upon completion.
OUTLET OF CHANNEL RL 2.41 (T/GZ); PROVIDE
RECLAMATION DREDGED MATERIAL
LIGHTLY COMPACTED.
ELEVATE APPROXIMATELY 100mm
ABOVE SURROUNDING EARTHWORKS.

REPLANTING OF EXISTING PALM TREES
(NOMINALLY WITHIN 5m CORRIDOR
BEHIND GEOCONTAINERS)

NOTE: GEOCONTAINERS TO BE PLACED
WITH 'LONG' EDGE PERPENDICULAR TO
THE CONTROL LINE

EXTEND THE GEO
CONTAINERS INTO CHANNEL

LOCATIONS OF PATH ENTRY / EXIT TO
RECLAMATION TO BE CONFIRMED.
LOCATION OF DRAIN TO BE CONFIRMED ON SITE
TO ENSURE NO DAMAGE TO PROPERTIES.
REFER ALSO TO SITE GRADING PLAN

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CONSULTING ENGINEERS
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+61 (0) 7 5449 7000
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TUVALU COASTAL ADAPTATION
PROJECT (TCAP),
FUNAFUTI

LEGEND

ROCK ARMOUR PROTECTION
FLOATING PONTOONS
GEOCONTAINERS
REPLANTING (INDICATIVE ONLY)
MEGA BAGS (UNDER)
RECLAMATION
ACCESS PATH
INVERT OF CHANNEL
EXPOSED BATTER SLOPE

GENERAL ARRANGEMENT PLAN
SHEET 1
P19012-FN-CV-03-01

UNFINISHED DRAWING
NOTE: GEOCONTAINERS TO BE PLACED WITH LONG EDGE PERPENDICULAR TO THE CONTROL LINE.

2.9m WIDE RECLAMATION DREDGED MATERIAL LIGHTLY COMPACTED ELEVATE APPROXIMATELY 100mm ABOVE SURROUNDING EARTHWORKS.

LOCATION OF DRAIN TO BE CONFIRMED ON SITE TO ENSURE NO DAMAGE TO PROPERTIES. REFER ALSO TO SITE GRADING PLAN.

NOTE: GEOCONTAINERS TO BE PLACED WITH 'LONG' EDGE PERPENDICULAR TO THE CONTROL LINE.

DECIMALS FOR DRAWS ARE SHOWN AS "0.0"

LEGEND
- ROCK ARMOUR PROTECTION
- FLOATING PONTOONS
- GEOCONTAINERS
- REPLANTING (INDICATIVE ONLY)

PLAN
SCALE 1:500

TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI

GENERAL ARRANGEMENT PLAN
SHEET 2
Catalina Boat Harbour Detail Plan

Scale 1:250

Ensure placement of geoccontainers is in a uniform pattern as shown with maximum 5m from rock armour.

Transitional Area from geoccontainers to rock armour. Place rock armour first and blend geoccontainers to suit rock face and structure. Ensure placement of geoccontainers is in a uniform pattern as shown a maximum 5m from rock armour.

Replanting of palms (indicative only).

4.0m wide access path (typical). Reclamation dredged material lightly compacted.

Provide min 3m wide ramp for 4.0m wide pontoons.

Provide 1 in 1 geoccontainer batter slope at edges of ramp.

Outlet of channel RL 2.41 (TGZ). Watch to existing levels.

Limit of geoccontainers at the proposed channel outlet.

Rock armour placed from top of batter (RL 5.45 TGZ) to existing surface (Apprx. RL +0.5 TGZ).

Transitional area from geoccontainers to rock armour. Place rock armour first and blend geoccontainers to suit rock face and structure. Ensure placement of geoccontainers is in a uniform pattern as shown a maximum 5m from rock armour.

Geoccontainers in this area to be placed at 1 in 3.

Candock (or equivalent). Full cube floating pontoons 480L x 480W x 360D. Total width 4.0m.

Replanting (indicative only).

MEGA BAGS PLACED ON RECLAMATION FACE AND BREAKWATER BENEATH GEOCONTAINERS AND ROCK ARMOUR.

Legend:
- Rock Armour Protection
- Floating Pontoons
- Geoccontainers
- Replanting (Indicative Only)
- MEGA Bags (Under)
- Reclamation
- Access Path
- Invert of Channel
- Exposed Batter Slope

Bluecoast Consulting Engineers
TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI

JL
AW

UNFINISHED DRAWING

P19012

P19012-FN-CV-03-01
GRADING IN THIS AREA FROM CREST LEVEL (PATH) TO FREEBOARD OF OPEN DRAIN

LOCALISED FILLING IN THIS AREA TO MATCH FREEBOARD LEVELS OF OPEN DRAIN. FILL TO MATCH BASE OF DWELLINGS WHERE APPLICABLE.

NOTE: DETAILED SURVEY NOT AVAILABLE. ADJUST LOCATION OF DRAIN ON SITE TO ENSURE BATTER SLOPES DO NOT UNDERMINE EXISTING DWELLINGS.

OUTLET LEVEL OF DRAIN TO +1.61 (TGZ)

GEOCONTAINERS, MEGA BAGS AND PLANTING NOT SHOWN. REFER TO GENERAL ARRANGEMENT PLANS

SCALE 1:500 AT ORIGINAL SIZE

SITE SETOUT AND GRADING PLAN SHEET 1

TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI P19012
VOLUMES TABLE

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TOTAL CUT: 2295.889
TOTAL FILL: 271680.273
TOTAL BALANCE: 269384.384

NOTE: TOTALS ARE FOR THE ABOVE DEPTH RANGES ONLY

FILL
MATERIAL PLACED FROM EXISTING SURFACE TO EARTHWORK LEVELS EXCLUDING ALL ROCK, GEOCONTAINERS AND WET BAMS.

CUT
EXCAVATION TO EARTHWORK LEVELS.
RECLAMATION WITH DREDGED MATERIAL
EXISTING DWELLINGS
LOCALISED BACKFILLING AS REQUIRED TO ENSURE FREEBOARD IN CHANNEL
REPLANTING COCONUT TREES (TYP)
APPROX 60m (WIDTH VARIES)
BASE WIDTH VARIES
OPEN STORMWATER CHANNEL
LONGITUDINAL GRADE 0.3%
RL VARIES
LOCALISED BACKFILLING AS REQUIRED TO ENSURE FREEBOARD IN CHANNEL
VARIES 2.5% to 5.5%
CONTROL SETOUT POINT FD01 / FD02
3%
30m FROM SEAWARD BUND CREST
4000mm
CONTROL SETOUT POINT
RL +5.85 CD (ON LONG EDGE OF RECLAMATION)
ACCESS PATH TO BE LIGHTLY COMPACTED
RL +5.45 CD
REFER DETAIL OF GEOTEXTILE SAND CONTAINER
REPLANTING COCONUT TREES (TYP)
CONTROL SETOUT POINT FR01
1.5 (APPROX)
1%
1%
3%
4.0m
ACCESS PATH
REFER DETAIL
PATH CROSSFALL TOWARDS LANDWARD CHANNEL OR PONTOONS (WHERE APPLICABLE)
PATH LEVELS TO BE MIN 100mm HIGHER THAN SURROUNDS (TYP)
4000mm
REL. +0.00 CD (LONG EDGE OF RECLAMATION)
CONTROL SETOUT POINT
3%
TYPICAL SECTION - ACCESS PATH
SCALE 1:100
TYPICAL SECTION - RECLAMATION
SCALE 1:100
TYPICAL SECTION - CATALINA BOAT HARBOUR BREAKWATER

EXCAVATION TO REEF TOP

CONTROL SETOUT

POINT FR01

NOTE: ALL ROCK EXCAVATED AND SORTED FROM GROYNES ON TAUSOA BEACH

TEXCEL 1200R (OR SIMILAR)

GEOTEXTILE LAYER

RL +5.45 CD

APPROX RL -1.0 CD

EXISTING SEABED

REPLANTING COCONUT TREES (TYP) IN BACKGROUND

GEODETAINERS IN BACKGROUND NOT SHOWN

GEOCONTAINERS IN BACKGROUND NOT SHOWN

CONTROL SETOUT

POINT FR01

RL +1.45 CD

MIN 10m

MAX 15m

GEOTEXTILE MEGA BAG SOIL FILTER AUSTRALIA

TYPE 3 (TYPICAL) OR EQUIVALENT

1.5

1

PRIMARY ARMOUR

SIZE 250 to 3000kg

50% OVER 2000kg

SECONDARY ARMOUR

SIZE 50 to 800kg

50% OVER 270kg

EXCAVATION TO REEF TOP

TYPICAL SECTION - CATALINA BOAT HARBOUR BREAKWATER

SCALE 1:50

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TYPICAL SECTION - CATALINA BOAT HARBOUR SEWARD FACE

SCALE 1:50

EXISTING SEABED

CONTROL SETOUT POINT FR02

GEOTEXTILE SAND CONTAINER (GSC) ELCOROCK ER250V OR EQUIVALENT SHORT EDGE (1800mm) FACING SEAWARD

CANDOCK (OR EQUIVALENT) FULL CUBE FLOATING PONTOONS 480 L x 480 W x 360 D

SEABED ANCHORS (INDICATIVE ONLY) TO BE PLACED AT SAND CONTAINER TOE DESIGN TO BE PROVIDED BY PONTOON SUPPLIER

INDICATIVE LENGTH OF PONTOONS 18m. (SHOWN AS LOCATED AT LAT). LENGTHS TO BE CONFIRMED ON SITE

NOTE: DETAIL SIMILAR FOR NORTHERN AND SOUTHERN RAMPS

TYPICAL SECTION - CATALINA BOAT HARBOUR PONTOON (MID) RAMP

SCALE 1:50

EXISTING SEABED

DREDGED BACKFILL RECLAMATION

GEOTEXTILE SAND CONTAINER (GSC) ELCOROCK ER250V OR EQUIVALENT SHORT EDGE (1800mm) FACING SEAWARD

SEABED ANCHORS (INDICATIVE ONLY) TO BE PLACED AT SAND CONTAINER TOE DESIGN TO BE PROVIDED BY PONTOON SUPPLIER

INDICATIVE LENGTH OF PONTOONS 18m. (SHOWN AS LOCATED AT LAT). LENGTHS TO BE CONFIRMED ON SITE

NOTE: DETAIL SIMILAR FOR NORTHERN AND SOUTHERN RAMPS

TYPICAL SECTION AND DETAILS SHEET 5
**GEOTEXTILE SAND CONTAINER**

NOT TO SCALE

- **Long edge** 2500mm
- **Short edge** 1800mm

**SETOUT CONTROL LINE**

- Long edge placed perpendicular to the setout line
- Setout stepped out of geocontainers as per batter slope shown on plans

**Geotechnical Sand Container (Type T3)**

- Total bag length (long edge) = 2.5m
- Assumed area of bag shown = 1.05m²

**Geotechnical Mega Container (Type T3)**

- Centreline of lower bags = 20.0m
- Length of mega bag = 20.0m
- Assumed area of bag shown = 8.0m² (circumference of bag = 10.8m)
- Sand fill, filling with sand-water slurry via filler neck (intend to use locally sourced sands)

**Sand (mega) container (Type T3)**

- Scale 1:20

**Tuvalu Coastal Adaptation Project (TCAP), Funafuti**

- UNFINISHED DRAWING

**TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI**

TL: 0412 393 703

www.bluecoastconsulting.com.au
LONGITUDINAL SECTION FR01

MATCH SAND CONTAINERS INTO ARMOUR ROCK

BREAKWATER AND ENTRY TO CATALINA HARBOUR

RL +5.45 CD
SAND FILLED GEOCONTAINERS (IN BACKGROUND)

RL +5.45 CD
SAND FILLED GEOCONTAINERS (IN BACKGROUND)
### Sheet 1

#### Scale 1:250

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<th>Channel</th>
<th>Offset (LHS+RHS)</th>
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<td>CH 100</td>
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<td>CH 150</td>
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<table>
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<th>Control FSL</th>
<th>Existing Surface</th>
<th>Offset (LHS+RHS)</th>
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<tr>
<td>Control FR01</td>
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</tbody>
</table>

**Survey Provided By:**
- Horizontal Datum: UTM-WGS84 / UTM-60S EPSG:32760
- Vertical Datum: Chart Datum (CD) TGZ

**Issued For:**
- Tuvalu Coastal Adaptation Project (TCAP), Funafuti

**Contact:**
- 1/1874 Gold Coast Highway, Burleigh Heads, QLD, 4220, Australia
  - +61 (0) 412 393 703
- www.bluecoastconsulting.com.au

**Datum:**
- Existing Surface
- Reclamation FSL (Control FR01)
- Control FR01
- Control FR01
MINIMUM CHANNEL DEPTH INCLUDING 150mm FREEBOARD
FALL FROM RELAMATION VARIES 2% TO 6%
CHANNEL DESIGN PROFILE
WATER SURFACE LEVEL
MIN. 1.0% FALL
SECTION A
SCALE 1:50
CONTROL SETOUT POINT (FD01 OR FD02)

MINIMUM CHANNEL DEPTH INCLUDING 150mm FREEBOARD
FALL FROM RELAMATION VARIES 2% TO 6%
CHANNEL DESIGN PROFILE
WATER SURFACE LEVEL
MIN. 1.0% FALL
SECTION B
SCALE 1:50
CONTROL SETOUT POINT (FD01 OR FD02)

MINIMUM CHANNEL DEPTH INCLUDING 150mm FREEBOARD
FALL FROM RELAMATION VARIES 2% TO 6%
CHANNEL DESIGN PROFILE
WATER SURFACE LEVEL
MIN. 1.0% FALL
SECTION C
SCALE 1:50
CONTROL SETOUT POINT (FD01 OR FD02)

MINIMUM CHANNEL DEPTH INCLUDING 150mm FREEBOARD
FALL FROM RELAMATION VARIES 2% TO 6%
CHANNEL DESIGN PROFILE
WATER SURFACE LEVEL
MIN. 1.0% FALL
SECTION D
SCALE 1:50
CONTROL SETOUT POINT (FD01 OR FD02)

NOTES:
1. FOR FURTHER DRAINAGE INFORMATION (CATCHMENTS AND DATA) REFER TO ARCADIS REPORT 'FUNAFUTI RECLAMATION DRAINAGE INVESTIGATION', 15.07.2020 Ref 0001-30056428-MEMO-AAR-02.
2. OPEN CHANNEL SECTIONS REPRODUCED WITH PERMISSION FROM ARCADIS PLAN No SK-01-Rev 02 WITHIN REPORT NOTED ABOVE.
3. DETAILED SURVEY NOT AVAILABLE. ADJUST LOCATION OF DRAIN ON SITE TO MINIMISE UNNECESSARY EARTHWORKS AND ENSURE BATTER SLOPES DO NOT DAMAGE OR UNDERMINE EXISTING DWELLINGS.

EXTEND 1 in 4 BATTER TO EXISTING SURFACE
TRIM (AND FILL IF REQUIRED) TO ENSURE MINIMUM 1% GRADE TO CHANNEL.

BATTER TREATMENT ON LANDWARD SIDE (TYPICAL)
- EXTEND 1 in 4 BATTER TO EXISTING SURFACE
- TRIM (AND FILL IF REQUIRED) TO ENSURE MINIMUM 1% GRADE TO CHANNEL.

REFERENCE:
HORIZONTAL DATUM: UTM-WGS84 / UTSM60S EPSG32760
VERTICAL DATUM: CHART DATUM (CD) TGZ

ISSUED FOR:
MLC
AW

TUVALU COASTAL ADAPTATION PROJECT (TCAP), FUNAFUTI

P19012

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