RECOMMENDATIONS FOR DESIGN OF A COASTAL PROTECTION SYSTEM FOR SHORELINE PROTECTION

YAREN DISTRICT, REPUBLIC OF NAURU (RON)

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TABLE OF CONTENTS

COASTAL PROTECTION

YAREN DISTRICT, REPUBLIC OF NAURU (RON)

ABSTRACT

This report presents preliminary results and design guidelines for a coastal protection system, for a section of an eroding coastline, in Yaren District, Republic of Nauru. These guidelines were drafted and prepared following a request from the office of the President, Republic of Nauru (RON), to SOPAC, to assess an appropriate protection system for a chronically eroding coast in Yaren District. Yaren District is located in the southwest part of Nauru and is the site of the capital of Nauru. The problem coastline is a segment of shorefront, just west and southwest of the airport runway and east of the Government buildings and Parliamentary complex. The residents in the District have also noticed significant erosion of the coastal areas, including loss of beach sand and loss of land over the past months. At the request of RON and with financial support of the RON, the author made a site visit and evaluated the erosion problem. The visit was conducted between 5^{th} – 7^{th} September 2000.

Following the visit and after briefing with officials of RON, including the Office of the President, SOPAC indicated that it would provide an appropriate coastal protection system and design elements for the eroding coastline. These guidelines, including dimensions and quantities, were sent to RON within five days of the site visit, and are the subject of this report. The author also indicated that a full analysis, in the contex of the causes of erosion and shorefront development, for the said coastline would be prepared in *SOPAC Technical Report 317*, to be delivered to RON later this year. In addition, the *SOPAC Technical Report* will contain recommendations for appropriate shorefront development, in particular guidelines for preparing EA and EIA for the coastal development. Key engineering and environmental issues will also be discussed and highlighted in the text as well as guidelines for preparation of a full EIA.

At this time, only a synopsis of a coastal protection design is presented. Additional and further details with be presented and discussed in SOPAC Technical Report 317. Design information has been produced after Numerical Analysis with Coastal Engineering Software CRESS and ACES. A multi-layered, free-draining rip-rap revetment is proposed for remediation of the erosion problem at the site (Table 1). This structure will also protect the problem area from future erosion by wave attack under similar hydraulic conditions discussed in Section 3.0. The rip-rap revetment should have the following design elements: two outer layers with a width of 10 m; this is the primary armor of the revetment; the revetment should be winged, that is, the ends of the revetment should not be open to wave attack, but should be built into the adjacent land or “closed”; the revetment should utilize natural dolomitic limestone rock from RON; it should consist of a granular filter layer or secondary armor layer, made up of 0.20-0.35 m diameter rocks; this underlies the primary armor; the revetment should have a 1:1.5 seaward slope; a geotextile filter fabric is also recommended for use in this structure; this fabric is a free draining artificial media; the geotextile fabric should have perforations with dimensions less that the diameter of the smallest boulders to which it is juxtaposed; two separate layers of the geotextile filter fabric should be used; one layer will underlie the primary armor of the revetment and overlie the granular filter media; the second liner should overlie the natural soil/land and underlie the secondary armor; the rock revetment should use 0.89 m nominal size dolomitised limestone boulders obtained locally (from RON).

Boulders for the outer layers of the revetment should have the following dimensions: D_{50} of 1.04 m; D_N of 0.89 m; $W_{50}/\wp\bullet$ of 1,745 kg; and Nauru’s dolomite limestone with densities at 2500 kg/m^3. The above dimensions are suitable for hydraulic conditions associated with 3 m high (HS) plunging breakers, associated with wave periods of 6 sec (T), approaching the shore (∝) at 015^0. Please note that we cannot design for nor do these dimensions cater for extreme oceanographic or weather events, like storms and cyclones, as that is beyond the scope of “normal engineering.” Please ensure that a qualified engineer supervises all of this work to ensure Quality Assurance and Quality Control (QA & QC).

KEYWORDS: *Yaren District, Republic of Nauru, RON, rip-rap, revetment design, coastal protection, and erosion assessment.*

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1 Background

This report presents the final results and design guidelines and recommendations for a coastal-protection system, for a segment of an eroding coastline, in Yaren District, Republic of Nauru (Figures 1-3).

These guidelines were drafted and prepared following a request from the office of the President, Republic of Nauru (RON), to SOPAC Secretariat.

The request was to assess the current problem and recommend an appropriate coastal- protection system/s for the chronically eroding coast in Yaren District (Figure 3).

Yaren District is located in the south-southwest part of Nauru, and is the site of the capital of Nauru (Figure 2).

The problem coastline is a segment of shorefront just west and southwest of the airport runway and east of the Government buildings and Parliamentary complex (Figure 3).

At the request of and with financial support from the RON, the author made a site visit and evaluated the erosion problem.

The visit was conducted between 5th - 7th September 2000. Following the visit, and after briefing with officials of RON, including the Office of the President, SOPAC indicated that it would provide recommendations for design of an appropriate coastal-protection system and design elements for the eroding coastline. These guidelines, including dimensions and quantities were sent to RON within five (5) days of the site visit, and are the subject of this report (Maharaj, 2001a).

The author also indicated that a full analysis, in the context of the causes of erosion and shorefront development, would be prepared as *SOPAC Technical Report 317* (this report), to be delivered to RON.

In addition, this report provides reference to recommendations for appropriate shorefront development, in particular guidelines for preparing EA and EIA for the coastal development.

Key engineering and environmental issues will also be discussed and highlighted in the text as well as guidelines given for preparation of a full EIA.

The component of the report that gives guidelines for preparation of an EIA are not written into this report, as they were drafted for another previous technical document, *SOPAC Technical Report 316*, also for the Republic of Nauru (Maharaj, 2001b). To prevent any repetition, *SOPAC Technical Report 316* will also be sent along with this report, so that the reader can refer to it for the relevant guidelines and details.

This work was executed and funded under SOPAC'S PROJECT AND TASK - NR 2000.007, Republic of Nauru (RON - Appendix I).

1.2 Needs and Rationale

The residents in the Yaren District have noticed significant erosion of the coastal areas, including loss of beach sand and loss of land, over the past months (Figures 4 and 5). This has resulted in the threat to residential property (Figures 4-6) and civil infrastructure, including houses, a nearby school and adjacent coastal roadway, along the periphery of the airstrip.

Since RON is a small island, with limited land area, the loss of any land or coastal property is significant. In addition, developing economies like RON can be seriously affected by damage to, or loss of, civil infrastructure and residential facilities from natural hazards, like coastal erosion.

Therefore, addressing these types of coastal problems are of paramount importance to Nauru's coastal communities and for the livelihood and well-being of residents and the nation as a whole. In the context of natural resource management, coastal erosion is also an important process that needs to be addressed, if future generations are to derive benefits from coastal resources like beaches and associated reefs.

2.0 METHODOLOGY

Information was collected during a site visit to the eroding coast. This included wave and littoral information, beach sediment characteristics, erosion characteristics, and damage to any critical facilities and infrastructure.
Beach sediments were described according to American Society for Testing Materials (ASTM, 1999) guidelines, which is in accordance with the Unified Soil Engineering Classification System. Rock classification and descriptions are based on ASTM (1999) guidelines and are based on International Society for Rock Mechanics (ISRM, 1981) standards and Smith and Collins (1993).

Beach slopes were measure with a Brunton compass and erosion scarps were measured with surveying equipment.

Positions in the field were determined with a Garmin hand-held GPS unit.

Information on waves was also obtained from vertical, colour, 1992 aerial photographs and Maharaj (2001).

Limestone rock strength was measured in-situ with an ELE Schmidt L-Type Hammer, while concrete strength was measured with an ELE Concrete Testing Hammer. Rip-rap/armourstone description and revetment evaluation are based on criteria of CIRIA (1991) and Pilarczyk (1996), Latham (1998), Geological Society of London (GSL, 1999).

Design information has been produced after Numerical Analysis with International Institute for Hydraulic Engineering, Delft University of Technology (IHE-Delft, 1999), Coastal and River Engineering Support System (CRESS) and the U. S. Army Corps of Engineers, Automatic Coastal Engineering System (ACES).

Computations of rip-rap dimensions, armourstone stability and wave run-up are based on numerical equations of van der Meer (1987 and 1998) and are modifications and improvements of the typical Hudson (1958) formula. Computations are therefore for random wave attack, more typical in the natural environments.

3.0 RESULTS

3.1 The Problem Site

The problem site has the following characteristics. In addition, the reader is asked to please consult Maharaj (2001), *SOPAC Technical Report 316*, for additional details of Nauru's coast. *SOPAC Technical Report 316* is also being sent along with this report.

Development Characteristics

- the coastline is a heavily developed strip of land, with many residential and infrastructure facilities; and
- housing, seawalls, an adjacent airstrip for the national airport, a school, the telecommunications facility and several Government buildings front the adjacent and immediate shoreline.

The Beach and Shorefront

- a medium to fine, carbonate sand beach,
- the beach is about 6 m wide with a 12-15° slope towards the sea (Figure 6);
- sands are clean, with less than 5 % fines;
- all sand grains are reef detritus, with more than 75 % coral detritus;
- Molluscs, foraminifera tests, and echinoderm tests compose most of the remaining 25 % of the sand fragments;
- the upper beach has a thicker sand accumulation, about 0.75 m, which is usually thicker during the early half of the year;
- small coconut palms and coastal shrubs line the coastal areas (Figures 4 and 5);
- shorefront vegetation is largely small shrubs currently being affected by erosion (Figure 4);
- residential properties front the upper beach and the shoreline (Figure 6);
- the erosion scarp at the problem coastline is between 0.80 m and 1.75 m high (Figures 4 and 5);
- the erosion scarp is vertical, with some overhanging sections where coconut palm roots still bind shallow and surface soils (Figure 4);
- the eroded scarp has exposed retaining wall and foundation support for several houses;

- in addition, older coastal protection is evident here at the study sites, from the litter of limestone boulders and masonry wall rubble, along the upper beach (Figure 4);
- the lower beach extends for about 200 m to the reef crest;
- the backreef area is a typical Holocene, elevated, almost featureless platform, with few pocket or depressions (Figure 7);
- the backreef is strewn with angular limestone boulder fragments (eroded from adjacent coastlines and in-situ) and also derived from failed coastal protection structures (Figure 7);
- all of these boulders are typical cavernous, dolomite limestone;
- the interface of the lower beach and backreef area is a depositional site for medium to coarse gravel (Figure 8);
- these gravels are generally rounded to sub-rounded and are 100 % carbonate grains;
- gravels in this areas are well sorted and free of fines;
- about 90 % of all gravel fragments are of coral debris, with less than 10% comprising invertebrate skeletal material (Molluscan fragments); and
- all gravel fragments have a high aspect ratio (Figure 8).

Some Macrobenthic Biota

- the lower beach and backreef areas are 50 % covered with green filamentous algae (Figures 9 and 10);
- these indicate polluted and/or eutrophic (nutrient-enriched) waters; and
- macrobenthic species are common on the beach and backreef and include green algae, red algae, sea cucumbers; sea urchins and molluscs (Figure 11) attached to rock substrate.

Waves and Littoral Hydraulics

- waves are typically plunging, with sometimes surging breakers;
- wave heights measured at the site on this visit and previous visits, 1998-2000, average 2.5 m, but can be 3 m high;
- significant wave heights during extreme high water spring tides (EHWST), based on observations, discussions with the Harbor Master and the Fisheries Department is 3.0 m;
- a typical example of a plunging breaker wave sequence, and photographed at the site, is illustrated in Figure 12 (starting top left and following the arrows);
- as with typical plunging breakers, waves crash on the beach and run-up with significant speed, causing significant removal of loose/cohesionless beach sediments;
- with a narrow and almost flat, backreef at the site, and in the vicinity of the problem area, any disturbance of beach sediments and their removal, can lead to cross-shore sediment transport and removal from the backreef, across the reef crest, and into the deep water environment;
- most waves approach the shore at the study area almost perpendicular to the shoreline (at 015° from a line of intersection of the shoreline and approaching waves);
- longshore transport is largely to the west, from easterly approaching waves;
- with perpendicular-approaching waves, no longshore drift is generated;
- when westerly winds affect the area, longshore drift is to the east;
- winds are generally from the east; and
- Easterly winds generate easterly approaching waves.

Wave Diffraction and Shoreline Erosion

- waves approaching the problem area diffract around the airport extension reclamation and fill site, shown in Figure 3;
- diffraction is to both the east and the west (pink arrows; Figure 3);
- diffracted waves cause longshore currents (L; Figure 3) to be generated in opposite directions, from the seaward-most part of the reclamation and fill site (S; Figure 3);
- this causes longshore currents to flow both to the east and west of the fill site;
- both longshore currents are more significant at high tides, especially EHWST, when waves are larger and the

water depth (effective submergence) is greater in the area;
- both longshore currents cause erosion points to develop (from point S; Figure 3) on both sides of the reclamation/fill site;
- these erosion pockets have gradually progressed from there along the coast, causing significant removal of loose beach sand
- in addition, coastal protection structures have also failed, threating residential and public shorefront facilities;
- the coastal rip-rap revetment which fronts the reclamation/fill site and present airport facility has generally remained intact and prevented erosion of the fill site;
- the above situation has cause increased attack and erosion of the un-protected adjacent coast, next to the rip-rap revetment; this is more pronounced on the western side;
- these have caused loss of fine, loose and cohesionless carbonate sands and gravel from beaches to east and west of the airport extension site (S; Figure 3);
- the loss to the west has been greater than on the east, as longshore is dominantly to the south, reducing scouring to the east;
- longshore currents generated by these diffracting waves cause significant removal of beach sediment along the coast, at the problem site (areas in red; Figure 3); and
- the above mentioned phenomena leads to coastal erosion and create the type of problem observed today (Figures 13-32).

Further Details of the Problems Area

- Figures 13 and 14 show the airport reclamation and fill site;
- note the rip-rap revetment protecting the reclaimed site (Figure 15);
- the rip-rap is made of dolomitic limestone from Nauru;
- note also the green brown algae covering boulders in Figure 15;
- Figure 16 shows part of an old, almost vertical (85°), 1.65 m high and 0.75 m wide (at the top) masonry retaining wall at the problem site. Note strewn 0.30 m diameter, limestone boulders from damaged wall sections (also Figure 17);
- sand and fine gravel are deposited between boulders;
- Figure 18 shows basal scouring and undermining of the retaining wall shown in Figure 16;
- Figures 19-22 show large cavities in various sections of the masonry wall, produced by wave-induced erosion and scouring;
- eroded cavities like those above cause dislodgment of boulder aggregate from within the structure leading to loss of internal support;
- since masonry walls do not possess tensile strength, the wall eventually cracks due to loss of support and integrity and fails;
- Figure 23 shows erosion and scouring at the western corner of the rip-rap revetment system, at the airport fill site;
- the above is cause by flanking or the absence of protection at the end of the rip-rap revetment system and is the product of longshore currents;
- the height of the scarp is about 0.75 m and exposes coarse, angular limestone fill material (Figures 24 and 25), with undercut sections (Figure 25);
- the entire fill site is contained by a slightly curved (at the top) concrete gravity wall (Figure 26), about 6 m above mean sea level;
- the top of the wall is about 2.5 m wide;
- toe protection is provided at the base of the wall, in the form of 0.75-1.25 m diameter limestone rip-rap (Figures and 26 27);
- toe rip-rap may occasionally be dislodged by large waves and during extreme events (Figure 27) and therefore not entirely stable;
- Figures 28-30 show some features of the eastern part of the coastal rip-rap revetment at the airport fill site;
- from Figure 29 one can assess the extent of the reclamation and fill project, into the marine area, is about 175 m at its southern most point/seaward extremity;
- the beach on the eastern side of the fill site is gentle (5°) and is of fine to medium carbonate sands (Figure 31) with some small, in-situ karst limestone pinnacles in the surf zone;
- the residents on the eastern side of the airport fill site have also protected their property with limestone rip rap (Figure 32), indicating erosion problems there as well.

3.2 Recommended Design

At this time, only a synopsis of a coastal protection design is presented. Additional and further details with be presented and discussed in *SOPAC Technical Report 317*.

Design information has been produced after Numerical Analysis with Coastal Engineering Software CRESS and ACES.

A multi-layered, free-draining rip-rap revetment is proposed for remediation of the erosion problem at the site (Table 1). This structure will also protect the problem area from future erosion by wave attack under similar hydraulic conditions discussed in Section 3.0.

The rip-rap revetment should have the following design elements:

- two outer layers with a width of 10 m; this is the primary armor of the revetment;
- the revetment should be winged, that is, the ends of the revetment should not be open to wave attack, but should be built into the adjacent land or "closed";
- the revetment should utilize natural dolomitic limestone rock from RON;
- it should consist of a granular filter layer or secondary armor layer, made up of 0.20-0.35 m diameter rocks; this underlies the primary armor;
- the revetment should have a 1:1.5 seaward slope;
- a geotextile filter fabric is also recommended for use in this structure; this fabric is a free draining artificial media;
- the geotextile fabric should have perforations with dimensions less that the diameter of the smallest boulders to which it is juxtaposed;
- two separate layers of the geotextile filter fabric should be used;
- one layer will underlie the primary armor of the revetment and overlie the granular filter media;
- the second liner should overlie the natural soil/land and underlie the secondary armor;
- the rock revetment should use 0.89 m nominal size dolomitised limestone boulders obtained locally (from RON).

Boulders for the outer layers of the revetment should have the following dimensions,

- D_{50} of 1.04m,
- D_N of 0.89 m;
- $W_{50}/\wp$ of 1,745 kg; and
- Nauru's dolomite limestone with densities at 2500 kg/m^3.

The above dimensions are suitable for hydraulic conditions associated with 3 m high (HS) plunging breakers, associated with wave periods of 6 sec (T), approaching the shore ($\propto$) at 015°.

Please note that we cannot design for nor do these dimensions cater for extreme oceanographic or weather events, like storms and cyclones, as that is beyond the scope of "normal engineering."

Please ensure that a qualified engineer supervises all of this work to ensure Quality Assurance and Quality Control (QA & QC).

Sea Level Rise

In Nauru, coastal areas have average elevations of 3-7 m, but elevations between 3-5 m are typical. Shorefront slopes are typically vertical and rocky. However, extreme high water spring tides (EHWST) for Nauru is an additional 1.03 m above MSL, while wave set-up associated with predominantly easterly gusts and rough seas can cause water levels to rise additional 2.3 m. Coastal land elevations are relatively low with respect to monthly and seasonal EHWST or HWST. In addition, these coastal areas are the sites of concentration of commerce, population and major infrastructure. Under normal EHWST, all these coastal areas are frequently overtopped by waves. Further, during low-pressure systems, overtopping is significant, with considerable overwash.

Calculations of wave run-up on coastal areas, for 10 sec., 3.9 m high (1-year return interval; Maharaj, 2001) waves, with average easterly wind of 4.34 m/sec, during EHWST, can exceed the average elevations (4 m) of coastal areas and overwash shorefront facilities, with overtopping greater than 60 litres/sec.

Under 10 sec., 4.48 m (5-year return interval) waves, with easterly winds of 13.37 m/sec (maximum wind speeds), overtopping increases to 127 litres/sec; and to 225 litres/sec, under a 5 m (25-year return interval) and to over 300 litres/sec, under a 5.34 m (50-year return interval) wave.

Typical storms affecting Nauru generate 16-20 sec., 3.9-5.2 m high waves, and are associated with winds of 8-27 m/sec. These cause overtopping in excess of 200 litres/sec.

If we add the projected Intergovernmental Panel on Climate Change (IPCC) sea-level rise maximum prediction of about 1m (by the year 2100), to the above scenarios, and therefore, submerge Nauru by 1 m, then coastal overtopping and inundation, for the four wave regimes above will be 176, 333, 530, 680 litres/sec respectively, an increase by more than 300 % in some cases.

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This project was supported by the *Commonwealth Secretariat (COMSEC)*, under *The Commonwealth Fund for Technical Co-operation (CFTC)*. The *Commonwealth Secretariat/CFTC* funded the author.

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The Department of Industry and Economic Development, RON provided logistic support during the survey.

The survey was conducted with the assistance of personnel from the Department of Industry and Economic Development. Mr. Tyrone Deiye (Project Officer) and Mr. Andrew Kaierua (Atmospheric Radiation Measurement Project Administrator) provided in-country support during the course of the site investigation.

The co-ordination of activities before and during the conduct of this survey by Mr. Tyrone Deiye, Department of Industry and Economic Development is gratefully acknowledged.

Discussions were held with Office of the President, RON; the Secretary for Industry and Economic Development; officials from the Fisheries Department, representatives from the Nauru Phosphate Company (NPC); and representatives from the village communities. These discussions and meetings with various representatives are gratefully acknowledged.

This work was executed and funded under SOPAC's PROJECT AND TASK – NR 2000.007, Republic of Nauru.

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LIST OF FIGURES

Figure 1. Location map of the south Pacific showing the location of Nauru.

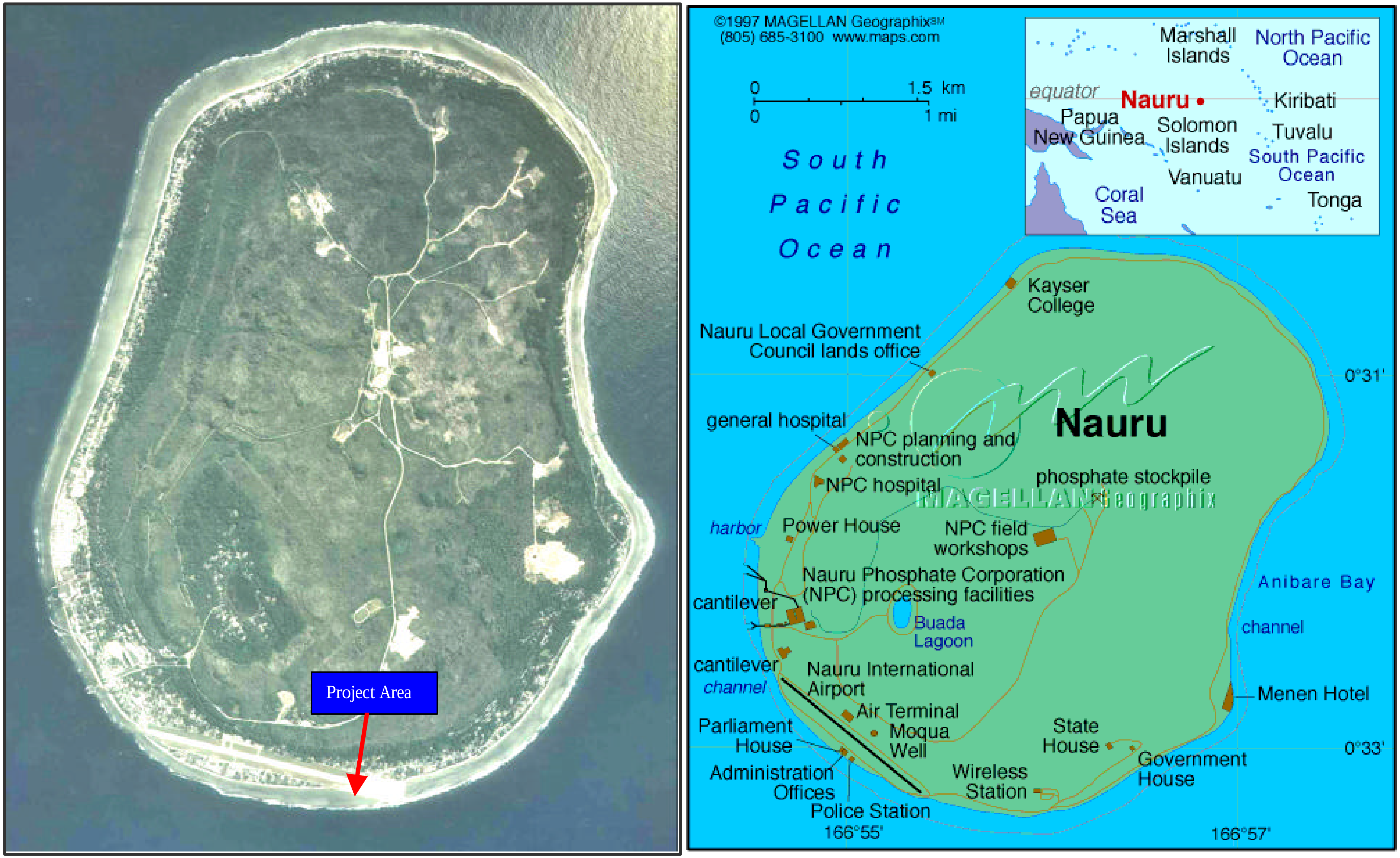

Figure 2. Location map of Nauru and the project area.

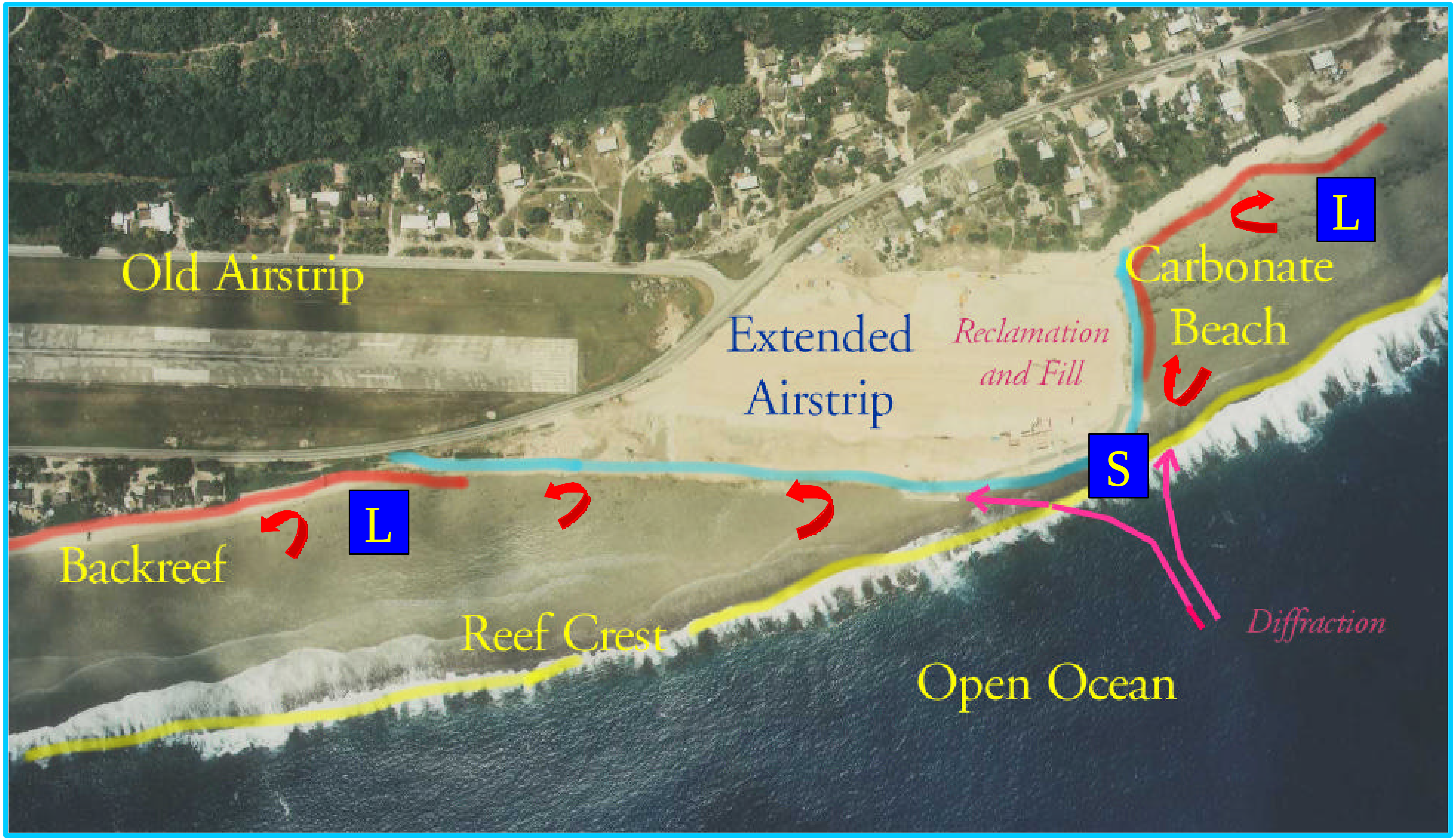

Figure 3. Location of Yaren District, the eroding coast (red), the reef areas and adjacent reclaimed and filled new section/extension of the airstrip.L-longshore current; S-seaward part of fill site.

Figure 4. Erosion characteristics of the problematic coastline.

Figure 5. Erosion characteristics of the problematic coastline.

Figure 6. Characteristics of the eroding beach (looking west).

Figure 7. Elevated, Holocene backreef area covered with green algae.

Figure 8. Carbonate gravel deposited along the lower beach. Note pen for scale.

Figure 9. Filamentous green algae covering the backreef area.

Figure 10. Filamentous green algae on underlying limestone bedrock.

Figure 11. Molluscan fauna on limestone substrate on the lower beach.

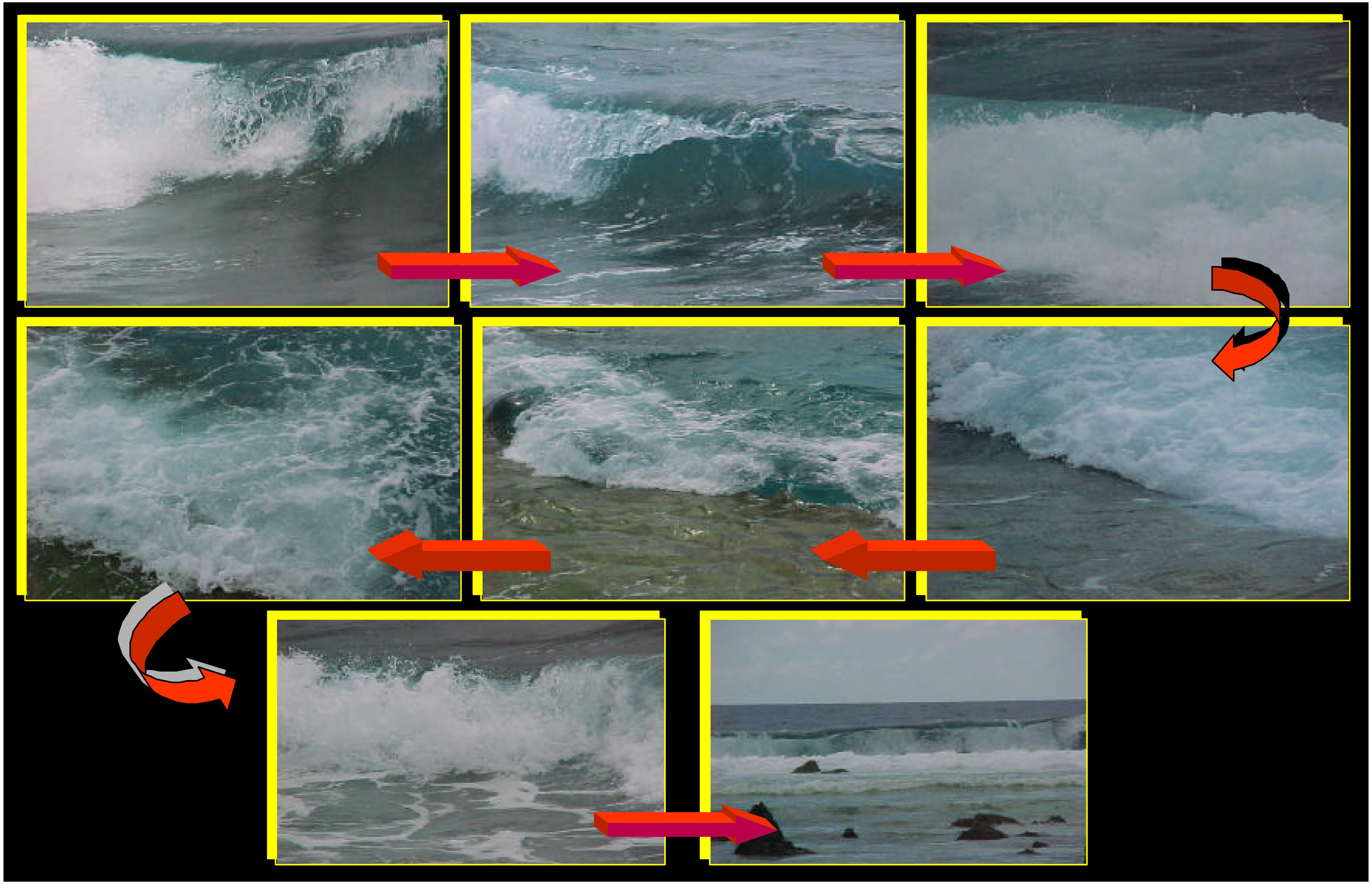

Figure 12. A plunger breaker wave sequence photographed at the site.

Figure 13. Location of the airport fill site.

Figure 14. Details of the fill protection using rip-rap revetment.

Figure 15. Details of the limestone rip-rap revetment along the airport fill site.

Figure 16. Part of an old masonry retaining wall at the erosion site.

Figure 17. Limestone boulders from failed coastal protection structures.

Figure 18. Basal scouring of the retaining wall in Figure 16.

Figure 19. Details of the scoured western section of the scoured retaining wall.

Figure 20. Large cavities at the base of the scoured retaining wall.

Figure 21. Removal of boulder aggregate at the base of the retaining wall on the eastern side of the structure.

Figure 22. Scouring and removal of wall aggregate due to wave action and abrasion.

Figure 23. Erosion scarp at the western end of the airport rip-rap revetment.

Figure 24. Details of the erosion scarp in Figure 23. Note dislodged gravel and small boulders.

Figure 25. Characteristics of the scoured area at the erosion scarp in Figures 23 and 24. Note the exposed aggregate fill.

Figure 26. Gravity concrete retaining wall at the outer perimeter of the airport fill site. Looking east.

Figure 27. Dislodged limestone rip-rap boulder removed from the base of the gravity wall (Figure 26).

Figure 28. View looking east of the coastline at the airport fill site. Note rip-rap in foreground.

Figure 29. View looking east of the beach at the airport fill site. Note the change in orientation of the natural and built coastline.

Figure 30. View looking north-northeast showing the rip-rap revetment protecting the airport and coastal roadway. Note limestone pinnacles in the surf zone (to the right).

Figure 31. Details of Figure 30, showing the gentle, carbonate sandy beach and limestone pinnacle.

Figure 32. View looking northeast, showing randomly placed limestone boulders for protection of residential property along the natural coastline to the East of the airport fill site. Note the gentle sandy beach and natural limestone pinnacle in the water.

LIST OF TABLES

Table. 1. Preliminary rip-rap design guidelines.

RIP-RAP REVETMENT FOR YAREN COASTLINE, REPUBLIC OF NAURU	
For:	
1. Significant wave height, Hs, Plunging Breakers	*3.0 m*
2. Significant wave period, Ts	*6 seconds*
3. Angle of incidence of wave approaching the shoreline	*015 degrees*
4. Density of seawater	*1025 kg/cubic metre*
5. Density of cavernous re-crystallised limestone, from Nauru	*2500 kg/cubic metre*
Use and Prescribe:	
1. Diameter of stones required, D50	*1.04 m*
2. Nominal diameter of stones, Dn50	*0.89 m*
3. Required weight of stones, W50	*1745 kg*

1. These stones form the outer layer/primary armour and the toe of the rip rap revetment.
2. Use two (2) layers of these larger boulders/rocks, each placed separately to ensure proper packing and interlocking.
3. Each of the outer layer (with large rocks) should have a thickness of 2 x Diameter of the rock required (1.04 m): approximately 2 m X 2 layers.
4. Underlying the primary armour, there should be smaller rocks, grading to smaller boulders and finally into the edge of the land.
5. These smaller rocks should be between 0.50-0.70 m in diameter, above a layer of boulders 0.20-0.35 m in diameter.
6. Therefore, we envisage four (4) main aggregate layers.
7. A double outer layer with 1.04-m boulders, over a layer with 0.5-0.7-m boulders, over an inner layer of 0.2-0.35-m boulders.
8. The interface of the primary armour and the underlying 0.5-0.7-m boulders should be a geotextile filter fabric.
9. A similar geotextile fabric layer should be placed between the 0.50-0.70-m boulders and the underlying 0.20-0.35-m boulders.
10. The rock layering and geotextile fabric will minimise scouring due to wave run-up, between the boulders and within layers.

Table 1. Cont'd.

And Use:	
1. A 1:1.5 seaward slope for the revetment	*That is: 0.20-0.35 m rocks*
2. A granular filter layer, with 50-100-kg size rocks	*At least 0.60 m for 50-kg rocks and 0.80 m for 100-kg rocks*
3. The filter layer thickness should be 2 x Diameter of filter layer rock size	*4 m wide*
4. The top of the rip-rap revetment, the crest, should be about	*5-6 m + the crest width*
5. The rip-rap revetment should be the same width as the present airport protection	
Length of the Coastline for Protection:	
1. Build the revetment from where the present airport rip-rap stops, and take it West to just before the Primary school.	
2. The end of the rip-rap revetment should be winged, that is, curved towards the land at the Westward end.	
3. Protect only the problematic area, not the whole coastline.	
Notes:	
1. Do not remove ANY BEACH SAND IN THE PROCESS.	

APPENDIX I

COASTAL ENGINEERING DESIGN FOR A SHORELINE PROTECTION SYSTEM, REPUBLIC OF NAURU (RON)

Task: NR 2000.007 SOPAC Unit: Coastal Unit Proposed: September 2000 Started: September 2000

Objectives: Advise RON on the scope of works necessary for design of a coastal protection system, for protecting an eroding coastline, Yaren District, Nauru.

Proposed Output: A SOPAC Preliminary and Technical reports detailing the necessary scope of work and technical guidelines.

Background: .Following a request from the office of the President, Republic of Nauru (RON), SOPAC was requested to assess an appropriate protection system for a chronically eroding coast in Yaren District. Yaren District is located in the southwest part of Nauru and is the site of the capital of Nauru. The problem coastline is a segment of shorefront, just west and southwest of the airport runway and east of the Government buildings and Parliamentary complex. The residents in the District have also noticed significant erosion of the coastal areas, including loss of beach sand and loss of land over the past months. At the request of RON and with financial support of the RON, the author made a site visit and evaluated the erosion problem. The visit was conducted between 5th – 7th September 2000. Following the visit and after briefing with officials of RON, including the Office of the President, SOPAC indicated that it would provide an appropriate coastal protection system and design elements for the eroding coastline. These guidelines, including dimensions and quantities, were sent to RON within five days of the site visit, and are the subject of this report. The author also indicated that a full analysis, in the contex of the causes of erosion and shorefront development, for the said coastline would be prepared in SOPAC Technical Report 317, to be delivered to RON later this year. In addition, the SOPAC Technical Report will contain recommendations for appropriate shorefront development, in particular guidelines for preparing EA and EIA for the coastal development. Key engineering and environmental issues will also be discussed and highlighted in the text as well as guidelines for preparation of a full EIA.

Equipment Desktop PC computing resources, digital camera, field GPS, Sokkia filed survey equipment; CRESS and ACES hydraulic engineering software.

Work Plan:

1. Evaluate the problem coast.
2. Conduct site visits and evaluate the erosion site.
3. Evaluate environmental concerns.
4. Identify possible environmental impacts.
5. Advise on a scope of works for remediation of the coastal problem and a coastal protection system.
6. Comment on any preliminary environmental assessment already done by RON.
7. Identify any monitoring exercises needed before, during and after construction of the coastal protection system.

Clients: Government of the Republic of Nauru (RON).

SOPAC Personnel:Russell J. Maharaj

Other Personnel: RON, Island Development Industries (IDI) personnel.

Report: SOPAC Technical and PreliminaryReports.