ENVIRONMENTAL IMPACT ASSESSMENT FOR THE DEEPENING WORKS RELATING TO A FLOATING PONTOON JETTY AT COCOA ISLAND - MAKUNUFUSHI – SOUTH MALÉ ATOLL

MAY 2010

ALYSEN SERVICES PVT. LTD.
MALÉ, MALDIVES

M. S Adam
EIA01/07

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

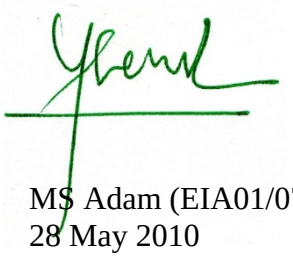
Tables:

Acronyms

MoFA	Ministry of Fisheries and Agriculture
MHTE	Ministry of Housing, Transport and Environment
EPA	Environmental Protection Agency
MAWC	Malé Aerated Water Company Pvt. Ltd.
MoTAC	Ministry of Tourism, Arts and Culture

Declaration of the Consultant

I certify that the statements made in this Environmental Impact Assessment study are true complete and correct.



MS Adam (EIA01/07)
28 May 2010

1 EXECUTIVE SUMMARY

1. Cocoa Island Resort (Makunufushi) is located in the South Malé Atoll sharing the same house-reef with the inhabited island of Maafushi. The closest resort islands Villivaru and Biyaadhoon lie west and Kandoomaa Resort in the south of Cocoa Island. The island was first developed as a resort in 1999. The ownership changed to Como Hotels and Resorts in the 2002 and an upgrade was undertaken by them to bring up to standard of a five-star plus resort. Cocoa Island Resort is now a sought after destination by discerning travelers and holiday makers around the world.

2. Recently Cocoa Island has acquired a new market mix including Asian (Koreans, Malaysian, and Singaporeans) and high end Europeans. To complement the clientele's taste, and following the Como Hotel's service philosophy, some aspects of the resort and services are being improved. One area required for improving is the arrival / departure experience.

3. Cocoa Island Resort has three jetties; an exclusive private jetty on the south for access to the deluxe over-water villas and other supply jetty and the arrival/departure jetties on the eastern side. All the jetties have their landing platforms on the reef edge. The design and layout was to avoid having to create a harbour basin in the lagoon.

4. A major draw-back in the design of arrival/departure jetty is its inconvenience for the guests. Presently the experience is not a pleasant one. Because jetty heads are on the edge of the reef the landing is raised with steps leading to the main platform. During periods of rough weather controlling the launch alongside the berthing area is often notoriously difficult. The problem gets worse during inter-monsoon period of the SW to NE (November and December) monsoon when the winds are blowing from the North and Northeast. On several occasions guests have to use the southern jetty which is designed to use only guest of the two deluxe water villas.

5. As part of the resort renovation programme, the management is proposing to address this issue by redesigning the landing area by additional fixtures. It is proposed to place a floating pontoon platform on the eastern side of the jetty. The floating pontoon and the existing landing area will be connected by the hinged metal walkway. The pontoon is to be fixed to the concrete piles using pile-guides that allow vertical movements of the pontoon.

6. The vessel will access pontoon on the eastern side across to the reef. However, this requires the area to be deepened to a depth of the -3.0 m. The current depth of the area is between 0.8 – 1.2m. The management proposes to deepen an area of about 200 sq m adjacent to the pontoon. This requires removing about 400 cubic meters of material from the area.

7. Survey of the substrate cover shows roughly 15-20% is live coral. However, during April 2010 about 60-70 % of these have been partially of fully bleached. Thus only a fraction of the living coral now exists in the area. Coral bleaching is a naturally occurring phenomenon in which the symbiotic host the zooxanathellae is expelled from the corals due to prolonged heat stress. Depending on the extent on severity of

the bleaching the corals may recover. Although wide spread levels of bleaching have not been reported so far in the Maldives, the status is being assessed by the Government authorities. Recently the weather has been favorable (high winds and rain) from beginning of May and so it is expected the situation has gotten much better.

8. Wind pattern analysis in the area shows prevailing wind directions are West and East / Northeast. Although the northeast winds (in NE monsoon) are brief the winds during the NE monsoon are stronger and unpredictable than the SW monsoon period. The NE (January and December, high tourist season) period also coincides with the time the jetty is most difficult to use of arrival and departures.

9. The impacts associated with the proposed activities range from immediate to potentially long term. The sedimentation and associated at the time of dredging will quickly disperse and the visible effect will be insignificant following completion of the work. Increased water movement resulting from increased wave energy is expected occur. This results in increased turbidity and likely erosion on the northern face of the island. Various mitigation measures have been proposed during the development and post-development periods.

10. Medium to long term changes and net shifts in sediment depositional patterns are discussed. Given the island has morphological features and orientation that are attributable to large shifts in shoreline, emphasis is laid on implementation of a beach monitoring programme. Findings of the monitoring programme should help to determine mitigation or remedial measure that may be required.

11. Overall the design and the project, its specification and the proposed methods of implementation are sound. The activities would lead to relatively low environmental impact to the reef / island environment. The monitoring programme must be enforced to help early detection of negative environmental impacts and timely mitigation measures.

++++++

2 PROJECT DESCRIPTION

2.1 BACKGROUND

Cocoa Island (Makunufushi) is located in South Malé Atoll east of Biyaadhoo and Villivaru Resort. The island shares the same house reef with inhabited island of Maafushi along with a small sand bank Vammaafushi north of Maafushi. The entire reef is roughly 5.5 km in length and about 2 km in the widest part. The official coordinates of Cocoa Island is 3° 55' 04''N and 73° 28' 11''E[1]. The recorded in the Official Atlas of Maldives[1] is <3.0 hectares (<0.03 sq km).

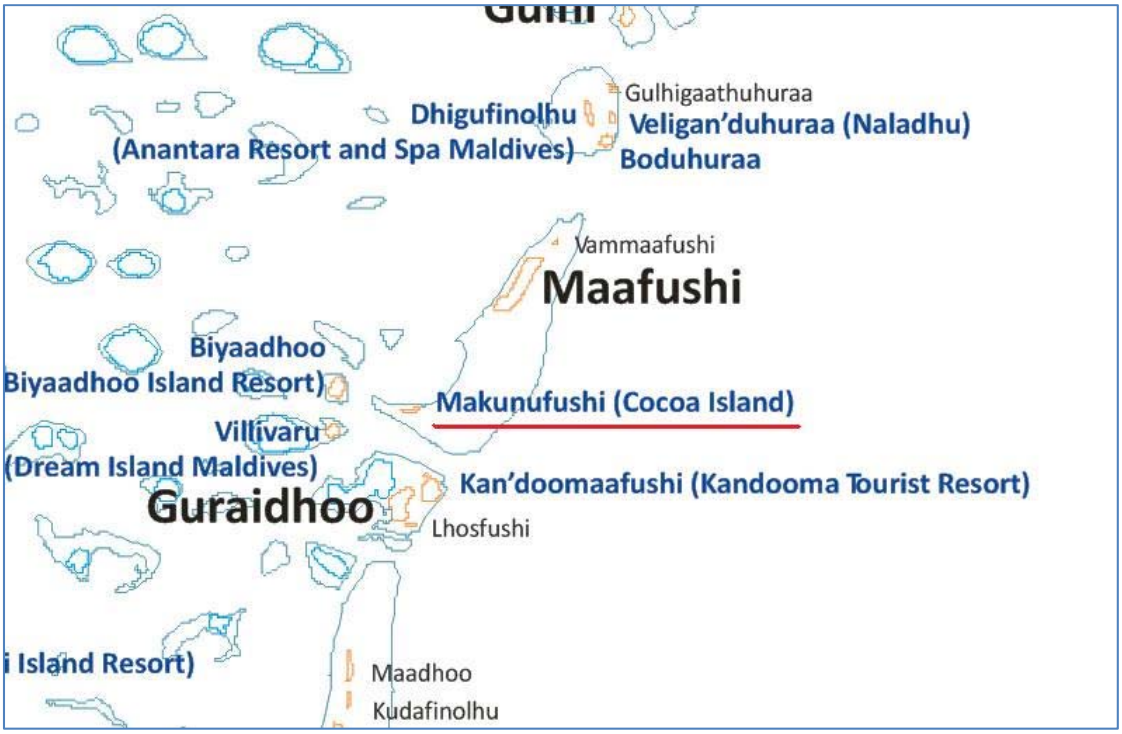


Figure 1: Location of Makunufushi in the South Malé Atoll.

Makunufushi was developed as resort in 1999. The resort operated with 23 water villas. Owing to the small size of the island the development followed the concept of minimal-intervention approach and so the jetties were laid out up to the reef edge to avoid having to deepen the lagoon for a harbour.

The ownership of the Cocoa Island changed in 2002. The new management, Como Hotels and Resorts[2], redeveloped the resort with additional water-villas on the south eastern side of the island. Presently the resort has 33 water villas which include 2 executive suites and 4 deluxe villas. Yoga pavilion, spa treatment rooms, restaurants and back-of-the house activities are located on the island.

[1] Official Atlas of the Maldives, Ministry of Planning and National Development, Republic of Maldives, 2008.
[2] Como Hotels and Resorts is an international chain of hotels "defined by a special Asian spirit: a quiet commitment to servicing guests to ensure the total respite'. Aside from the Maldives, they have hotels in London, Bangkok, Bali, Bhutan and Turks and Caicos.

The island is served by three jetties; one on the southern side serving executive suites and other, supply and arrival jetties on the eastern side (Figure 2, Figure 3and Figure 4). All jetties are extended to the reef edge. The main arrival jetty on the north east of the island has a gazebo with reception facilities.

Figure 2: Cocoa Island – Makunufushi. Aerial view of the island looking from south east of the reef

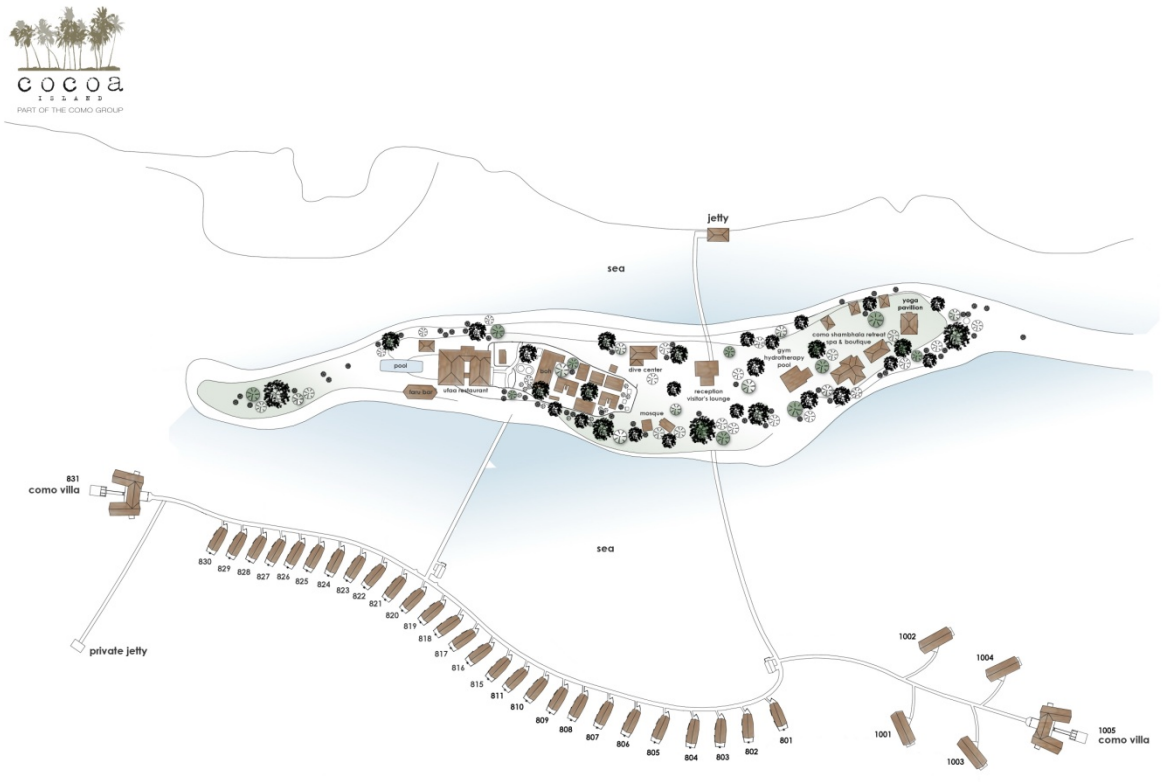


Figure 3: Layout of the Cocoa Island Resort, Como Hotels and Resorts – May 2010. The arrival jetty is on the northern side of the island (top).

2.2 NEED FOR IMPROVEMENTS IN ARRIVAL JETTY

Under the management of Como Hotel and Resorts, Cocoa Island, Maldives, has become a popular destination. Cocoa Island is one of the most sought after, small tropical paradise, in the Maldives for the most discerning travellers. Close to capital Malé it has been one of the favoured destinations in the Maldives.

Over the last 8 years Cocoa Resort's market reach and mix has improved. Most of these include the emerging high-end Asian market (Korea and Singapore) and Europeans. Most of the VIP guests are from European nationalities. Room rate for VIP category is high contributing a substantial proportion to the sales revenue. More recently the occupancy of these high-bracket VIP guests has improved requiring refurbishments of the facilities and improving the overall outlook and service of the service of the resort.

A problem area for the resort has always been the issue of the arrival/departure jetty. As explained earlier, the jetty is located on the northern side of the island facing into the atoll lagoon (Figure 3). During the Northeast Monsoon period, particularly during the change over period from Southwest Monsoon season to NE monsoon season (November and December) the winds are strong, and unpredictable. As a result the area is rough and the wave conditions make it very difficult and often dangerous to use the jetty.

There have also been incidents in the past where guest were hurt because of the rough weather. The management also notes that jetty arrival area needs to be repaired regularly as fenders get worn out or damaged. Fenders are regularly replaced every 6 months.

Figure 4: Birds eye view of the looking from the western side. Three jetties are present on the island; two on the northern side and on southern side.

The jetty is designed to serve the small crafts (Gulf Craft – 16 pax). However, the resort now requires larges luxury boats (like Ambassador 55) to be able to alongside the jetty to prove more effective and pleasurable arrival and departure experience.

In order to improve arrival experience to match the resort's service, elegance and sophistication, the management is proposing the have a floating pontoon deployed on the eastern side of the arrival jetty. A hinged walkway will connect the pontoon and the landing

making seamless transfer of guests from the boat to the arrival area. A complete technical description and specification of the proposed pontoon and gangway is given in Appendix 4

2.3 FLOATING PONTOON AND GANGWAY

After careful consideration and several iterations of the plan and its design, the management has proposed that floating pontoon will increase the landing area (berthing space). A schematic diagram of the placement of pontoon and gangway is shown in Figure 5. The pontoon and the walkway are manufactured for the specific requirements.

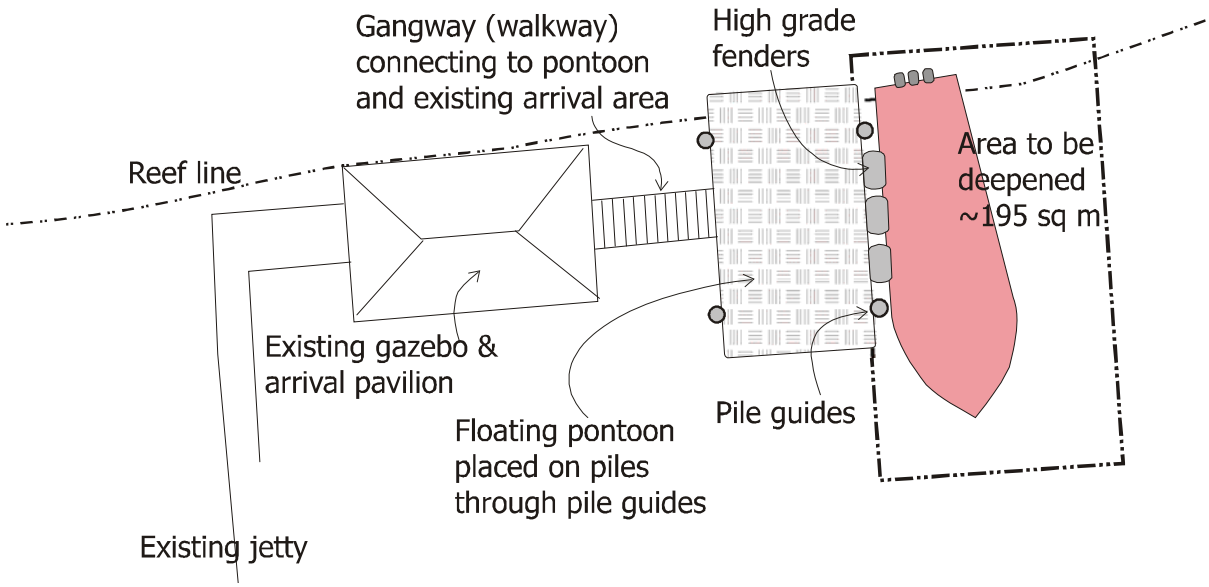


Figure 5: Schematic diagram of the floating pontoon placed on pile guides alongside (on the east of) of the existing arrival jetty and gazebo. The area to be deepened is demarcated with dotted lines and is roughly 200 sq m.

Four concrete piles (stilts) will be used to station the pontoon at the desired position. Guides going round the pile that are fixed on the pontoon allow vertical movement from the tidal fluctuations. A hinged steel structure gangway will connect the pontoon and the existing landing area. Technical drawings of these configurations are given in Appendix 5.

2.4 DEEPENING REQUIREMENT

The pontoon is placed is some 10-15 m away on the east of the arrival jetty on the reef flat. Boats will alongside the pontoon on the east (Figure 5). The area is about 1.0 m deep. However, the draft of the boats that will be used for the guest transfer will be about 2.0 – 2.5 m. It is therefore proposed to deepen an area of about 200 sq m to -3.0 m. This would mean removing 2m of substrate extracting about 400 cubic meters.

Fortunately the area has some clearance, presumably due to a channel used an earlier time. The area is clearly seen in Figure 6. Deepening will involve use of an excavator mounted on a shallow-bottomed flat top barge. The excavated material will be placed on the barge itself

and brought to shore (north western section of the island). There the material will be sorted, graded.

Some live corals are present in the area (see section on Existing Environmental Conditions). The management proposes to relocate the live corals colonies to the western side of the arrival jetty. The dive school operator is very keen to help the resort in relocating these corals.

Transplanting live corals is routinely practiced in Landaagiraavaru, Four Season's Resort in Baa Atoll. They have been extremely successful in that it quickly grows filling horizontal space of the coral trays[3]. It may be useful for the resort to seek their advice and expertise in relocating of live corals.

Figure 6: Birds eye view of the island and reef looking from south east towards to the north. The arrival area and the clearance in the east of the existing arrival jetty are clearly seen.

2.5 DISPOSAL OF THE DREDGED MATERIAL

A large proportion of the dredged material is expected to be sand. However, a fraction of the material will be rock and rubble. The resort has plans to dispose the material in two ways. First any sand that can be used for beach nourishment will be retained on the beach. To ensure the maximum quantity of sand is extracted the dredged material will be sieved. The sieved sand will be used nourish the beaches on the northern western face of the island (Appendix 1). Secondly large rock and rubble material may be disposed on the reef flat area on the south eastern side of the island.

[3] Corals are fixed, using plastic cable ties, on a metal frame, fabricated from deformed bars. The metal frame is in the shape of a tray, placed upside down. Coral pieces (or colonies) are attached on the frame

Assuming 50% of the dredged material is usable sand for nourishment, and that sand is spread to a height of 0.5m on the proposed area of the beach (Appendix 1), it is expected beach width of the proposed fill area will increase no more than 3 linear meter. The current regulation of the EPA is that maximum extent of beach nourishment is not more than 10 linear meters.

2.6 SCHEDULE OF WORK

The total number of days that will be required for this work is expected to be 43 working days. This includes the undertaking the EIA followed by the deepening works and fixing the pontoon and the gangway. A more detailed works schedule is given in Appendix 6.

EIA Cocoa Island - Makunufushi

Dreding Activities Relating to Floating Pontoon and Gangway

Today's Date: (Sat)

Start Date: (Mon)

WBS	Tasks	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**EIA for the Cocoa Island - Makunufushi**	5/03/10	6/15/10	43	7%	32	3	40
1.1	C1 Schedule and AP-2 Form submit to authorities	5/03/10	5/04/10	1	100%	2	1	0
1.2	Field Works at Makunufushi	5/07/10	5/09/10	2	100%	1	2	0
1.3	Scoping Meeting at EPA	5/07/10	5/14/10	7	5%	6	0	7
1.4	Analysis and Reporting	5/09/10	5/19/10	10	0%	8	0	10
1.5	Submit to EPA for Review	5/18/10	5/24/10	6	0%	5	0	6
1.6	Issuing of Decision Note	5/25/10	5/26/10	1	0%	2	0	1
2	Dreding works	5/26/10	6/02/10	7	0%	6	0	7
2.1	Disposal of dreged material	6/01/10	6/09/10	8	0%	7	0	8
2.2	Placing pontoon	6/09/10	6/13/10	4	0%	3	0	4
2.3	Fixing the walkway	6/13/10	6/15/10	2	0%	2	0	2

Figure 7: Indicative work schedule including the expected duration for the identified tasks.

2.7 TERMS OF REFERENCE

The scoping for the project was under taken as per regulation of the MoTAC and EPA. First a C1 scoping schedule (for Development Screening Decision) was submitted to EPA through MoTAC. EPA decided that the project requires further information in the form of an environmental impact assessment study for making an informed decision.

An AP-2 form along with the C2 schedule was then submitted. AP-2 form contained information of the resort's land area and length of the beach and the nature of the proposed work including maps delineating the area where the dredged material will be spread (see Appendix 1).

A scoping meeting was held at EPA on 26 May 2010 which determined the scope of the project. The official TOR for this EIA is given in Appendix 3.

3 POLICY CONTEXT

3.1 ENVIRONMENTAL PROTECTION AND PROTECTION PRESERVATION ACT

Regulations relating environmental protection and conservation are made under the Environmental Protection and Preservation Act (Law 4/93). The law provides provisions for the sustainable use of natural resources and their protection and conservation. Under Article 5 (a), Environmental Impact Assessment (EIA) is mandatory for any project that may have the potential to harm the environment. The report has to be submitted to the Environmental Protection Agency (EPA) of the Maldives Housing Transport and Environment (MHTE) for approval before commencement of a project.

In addition to the provisions for the EIA process, the articles of the EPPA address the following aspects of the environmental management:

1. Guidelines and advice on environmental protection shall be provided by the concerned government authorities
2. Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MHTE.
3. Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
4. An EIA shall be submitted to EPA / MHTE before implementing any developing project that may have a potential impact on the environment.
5. Project that has any undesirable impact on the environment can be terminated without compensation
6. Disposal of waste oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purposes of the Government.
7. Hazardous / toxic or nuclear waste shall not be disposed anywhere within the territory of the country. Permission should be obtained for any transboundary movement of such wastes through the territory of the Maldives.
8. The penalty for breaking the law and damaging the environment are specified
9. The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

3.2 MALDIVES TOURISM ACT

This Act encompasses the issues related to the development of tourism in the Maldives. It came into effect in 1999, repealing the Law on Tourism in the Maldives (Act#. 15/79) and the Law on Leasing of Uninhabited Islands for the Development of Tourist Resorts (Act#. 3/94). Act#. 15/79 was the primary legislation that was passed by the Citizen's Majlis in November 1979. The major objective of this Act was to provide for the collection of a bed tax from the visiting tourists and to regulate tourism in the Maldives in general. While this Act only dealt

with tourist resorts, hotels and guest houses, the amended act (Act#. 2/99) incorporates the determination of zones where tourism development can occur, as well as the development and management of marinas and the operation of tourist vessels, diving centres and travel agencies. This is evidence that the tourism industry has expanded since the enactment of the initial laws, both in magnitude and in the diversity of facilities that are provided for the visiting tourists.

The environmental legislation that directly applies to the development of resorts is outlined under article 15(a) and (b). Article 15 (a) provides for the dredging of lagoons, reclamation of land or any other activity that may cause permanent change to the natural environment of an island leased as a tourist resort. It states that the activities mentioned above can only be carried out after obtaining written permission from the Ministry of Tourism & Arts and Culture (MoTAC) and in accordance with the relevant regulations.

Under Article 15(b), a justification has to be provided for such an activity, as well as an environmental impact assessment, which has to be submitted to and approved by the Ministry of Environment Energy and Water (see below).

In addition to the Tourism Act and the relevant regulations, there are circulars issued by the MoTCA, advising the tourism industry of their new policies or strengthening the existing ones.

1. Circular #. 21/90 (April 21, 1990) advices all resorts having filled jetties to be modified so that they allow free flow of currents through them or new jetties composed of reinforced stilts to be built in their place by the end of June 1991.
2. Circular #. CIR-ES/98/07 issued on the January 27, 1998 states that all resorts have to obtain permission from the Ministry of Tourism and Civil Aviation before commencing any coastal modifications. Hard engineering solutions are discouraged while environmentally friendly structures are encouraged.

More recently there has been a review of the tourism rules and regulation with regards to environmental protection and conservation. It addresses 6 main areas:

1. Issues relating to environmental protection in building and construction works on the resorts
2. Protected species and protected areas
3. Planting trees, use of pesticide, and having pets
4. Solid waste disposal
5. Storage of water
6. Disposal of sewage and sewage water
7. Coastal modification and beach replenishment

A number of new regulations have been formulated to cater for the rapidly evolving legislative framework following adoption of the Constitution. Drafts new regulations are presently on MoTAC's website for comment. Some of these include

1. Boundary Regulation

2. Submission of the Annual Report of Registered Travel Agency
3. Regulation on Tourist Guest Houses
4. Draft of Tourist Guide Regulation
5. Regulation on registration of tourist vessel names (88-LR/CIR/2010/04, Dated 02 February 2010) states that all vessel that are used for tourism purposes shall be registered with the MoTAC

3.3 RESORT DEVELOPMENT CONTROLS

The Tourism Act empowers the MoTAC to impose strict regulations and guidelines for resort construction and operation. In the development of tourist infrastructure, MoTAC has taken up numerous measures so as not to exceed the 'carrying capacity of the islands. The Government encourages the preservation of islands and in their original natural conditions (both marine and terrestrial). Removal of indigenous vegetation, disruption of marine ecology, redirection of natural current patterns and disruption of wave movements within the lagoon by way of artificial structures, are discouraged. The measures taken to control and limit developments of resort islands include:

1. limiting the maximum built-up area to 20% of the total registered land area of the island;
2. the maximum height of the building has been limited to two storeys, provided that there is vegetation on the island to conceal these buildings;
3. In the construction of tourist accommodation, all rooms should face the beach and five linear meters of beach line has to be allocated to each guest in front of their rooms.
4. Only 68% of the beach length can be allocated to guest rooms, as 20% has to be allocated to public use and 12% left as open space; and
5. Construction on reef flats and lagoons are discouraged.
6. Over-water bungalows are permitted to be constructed provided equal open space is left on the land for each building developed on the lagoon.
7. Solid waste disposal is also regulated in that bottle crushers and incinerators has to be in place before the permit for resort operation is given.
8. Control and mandatory replacement for each tree that is cut down (certain rare and large trees have to be avoided when constructing buildings);
9. All buildings have to be located well away from peripheral vegetation – at least 5 meters away from the shore line – to ensure that peripheral vegetation most important to coastal protection is preserved;
10. Allocating space for vegetation between buildings. This is to ensure that substantial areas of indigenous vegetation are left untouched;
11. Construction of rock-filled jetties, groynes, seawalls and detached and submerged breakwaters are restricted. Instead, promotion of greater coral colonization on the peripheral reefs and other natural methods to protect shorelines are encouraged;

12. Coral and sand mining from resorts and inhabited islands and from their house reefs is strictly prohibited. Specific locations have been allocated for sand mining. Construction of structures using coral, is now controlled
13. To preserve the aesthetic integrity of resort islands, the height of buildings are restricted to the height of the foliage of the vegetation.
14. All coastal works and larger projects must prepare and present a thorough environmental impact assessment (EIA) report;

The Tourism Regulation in the Maldives ensures that carrying capacity of the island and ecosystems are well within limits and negative effects of the development are minimal. The Ministry also issues circulars on several occasions and when necessary to discourage activities such as sand and coral mining, development of coastal environment and waste disposal which may cause harm of damage to the natural environment, which is the main tourism product.

Tourism regulations strictly discourage modifications to the natural environment of sand around the island. Therefore, Tourism Regulation requires that special permission from the MoTAC be sought before commencing any coastal modifications works on any tourist resort. More recently the MoTAC has introduced the AP-2 form which for any development or redevelopment involving the dredging and beach nourishment. As a general rule, EPA does not allow to beach replenishments that reclaim more than 10 linear meters of the beach.

It is also stated that hard engineering solution are not encouraged and construction of solid jetties and groynes be controlled and shall only be undertaken after conducting and EIA study. Similarly, design of the boat piers, jetties and other such structures are required to be in such as way that these shall not be obstruct current and sediment circulation patterns of the island.

4 EXISTING ENVIRONMENTAL CONDITIONS

The field work was undertaken on 07 May 2010. Visual assessment of the reef area in the east and west of the arrival jetty was undertaken. Underwater photos at random were taken to qualitatively assess the substrate cover.

A proper GPS survey of the beach-line (high tide) and the vegetation line were done. Climate data (air temperature, wind and rainfall) were obtained from the Department of Meteorology.

4.1 CLIMATOLOGY

In general Maldives is affected by the Southwest monsoon (SW) (May – September) and the Northeast monsoon (NE) (November – February). The period between March and April is the transition period from the NE monsoon to SW, while the transition period from SW monsoon to NE monsoon is from October to November. The SW monsoon is generally rough and wetter than the NE monsoon.

In Maldives storms and gales are infrequent and cyclones do not reach as far south as the Maldivian archipelago[4]

Summaries of wind data from January 2000 to April 2010 were made available from the Department of Meteorology. Frequency of wind speed and direction are given in Figure 8.

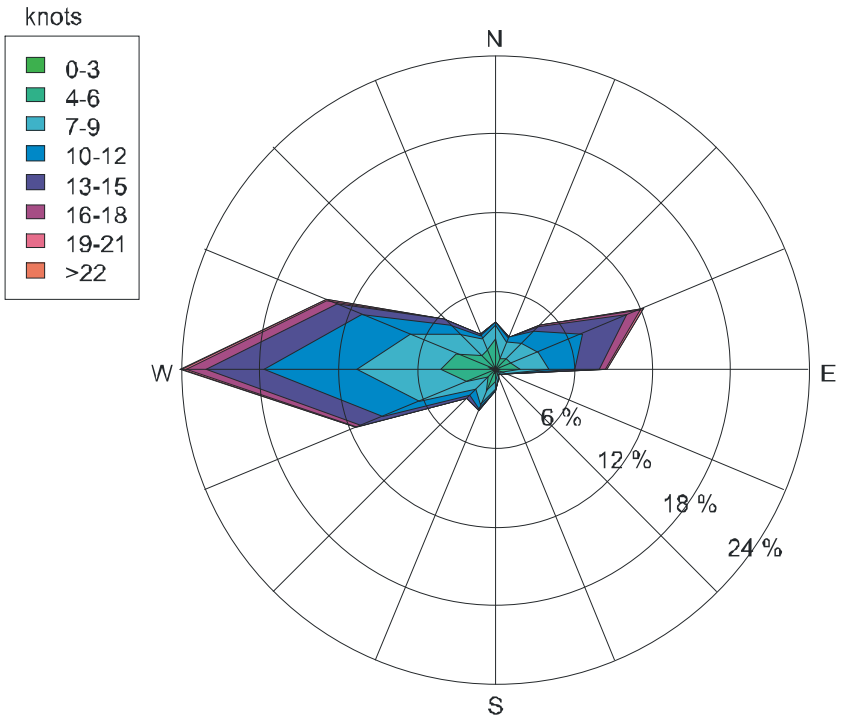


Figure 8: Frequency distribution of [surface] wind speed and direction at Hulhule as reported by the Department of Meteorology, Jan 2000 – April 2010.

[4] Ministry of Construction and Public Works. (1999). Environmental/Technical Study for Dredging/Reclamation Works Under the Hulhumale Project, Maldives – Draft Final Stage 1 Report.

Roughly two thirds of the wind observations were from west with an average speed of about 8-10 knots. Monthly breakdown is shown in Figure 9. Winds were strongest during December and January and the predominant direction of the wind during this period was from NNE (22.5° compass bearing) (Figure 10).

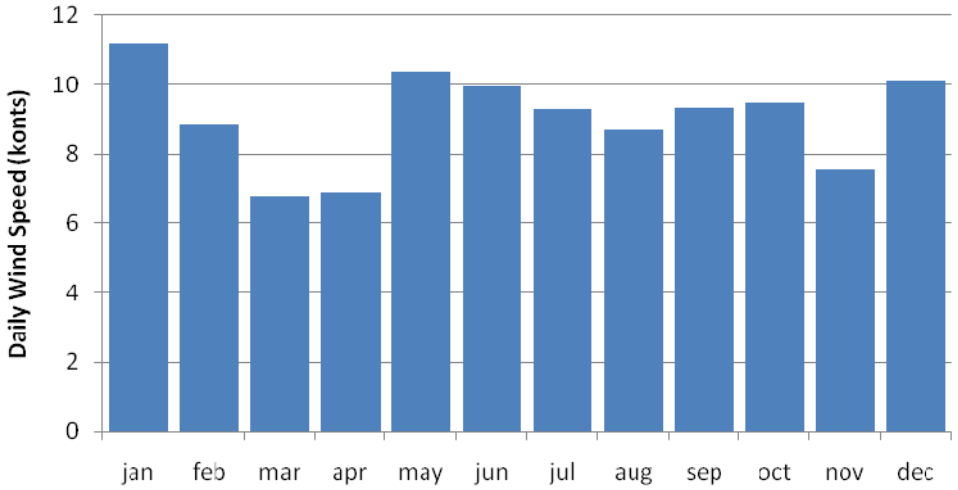


Figure 9: Average daily wind speed by month, Jan 2000 – 30 April 2010, Data: Department of Meteorology.

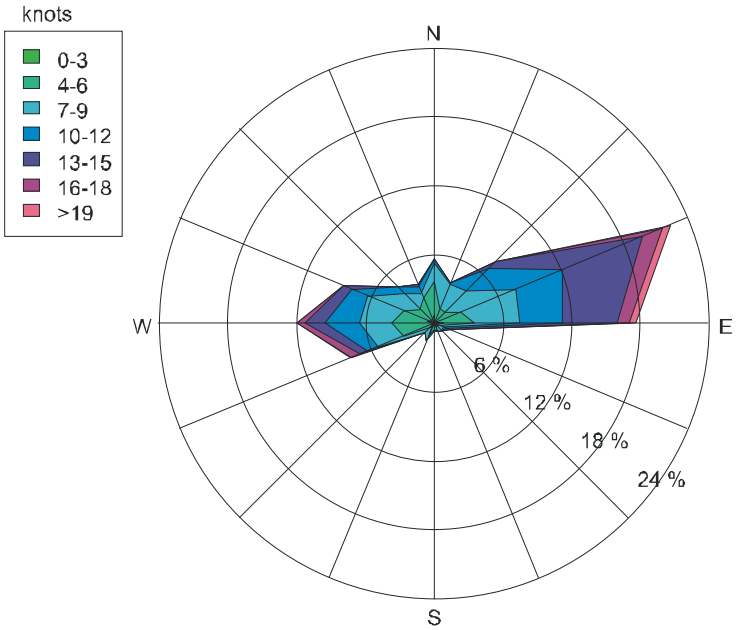


Figure 10: Frequency distribution of the daily [surface] wind speed and direction for Nov-Dec as reported by Department of Meteorology, Jan 2000 – April 2010.

A comparison of wind speeds during the SW and NE monsoon is given Figure 11. The distribution of wind speeds during the north east monsoon has a distinct feature in that frequency of high speed winds (> 12.5 knots) are more frequent in during the NE monsoon. It is known that winds are unpredictable and gusts may reach to gale-force speeds during the *halha* period. Interesting this is the period when the resort finds most difficult to use the jetty.

The period also coincides with the winter of northern hemisphere and therefore most number of guests visit the Maldives during this period.

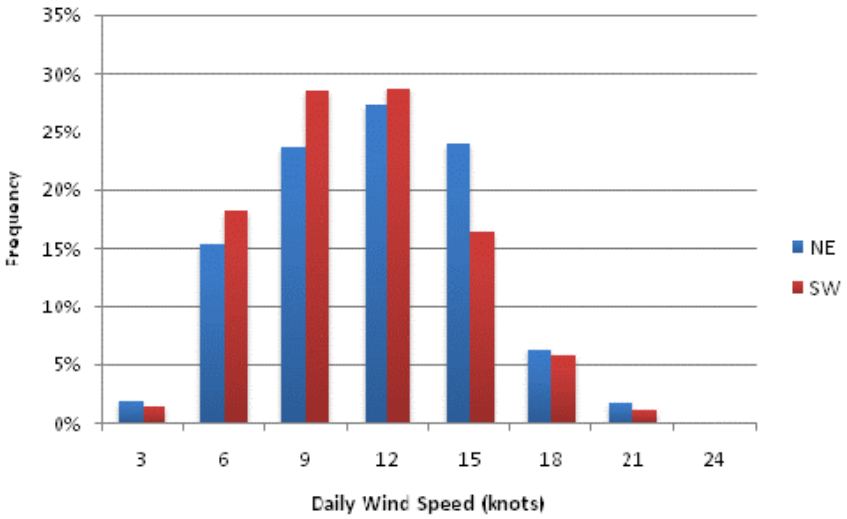


Figure 11: Comparison of the frequency distribution of wind speeds during the SW (May – Aug) and NE (Dec – Jan) monsoon season.

4.2 SUBSTRATE COVER

The area proposed for dredging is shallow reef flat on the east of thee existing jetty area. The depth of the area is 0.8 – 1.5 m (Figure 15). In terms coral cover, Cocoa Island Reef may be considered above average (10-20% live coral cover) compared with average reefs of the Maldives (5-10%). Qualitatively the reef is relatively in good shape. Acropora dominate the area with Pocillopora, Porites, Fungids and Favids. The section on the eastern section of the jetty is rugose with average diversity of species. The reef is recovering well following the mass coral die-off event of 1998/1999. Some of the Acropora colonies are 15-20 cm in diameter while few are more than 20 cm diameter One staff who has been on the resort for over 9 years (soon after the resort was opened) notes that earlier the area was completely devoid of live coral. The coral growth that is presently seen in the area is recruitment and growth after the mass die-off following the bleaching event in 1998/1999.

Unfortunately most of the corals in the area, on the shallow reef flat, are bleached. The fresh and white colour of the virtually all bleached corals indicate the incident happened a few days (or weeks) ago. Similar observations were made in several areas of the Maldives during April 2010[5]. It is estimated that roughly 70% of the live corals on the reef flat were bleached. These included Pocillopora, most Acropora and even some Porites.

Mass coral bleaching is caused by unusually high water temperatures that stress corals. Coral polyps will expel the symbiotic algae that live in their tissues, exposing the white skeleton underneath. Corals typically recover from mild bleaching, gradually recovering their colour by repopulating host algae. However, if the bleaching is severe or prolonged, individual polyps or whole colonies will die.

[5] Maldives MMS Group. Email communications made in 7-10 May 2010. Bleaching were reported from Baros Island and Four Season's Landaa Giraavaru.

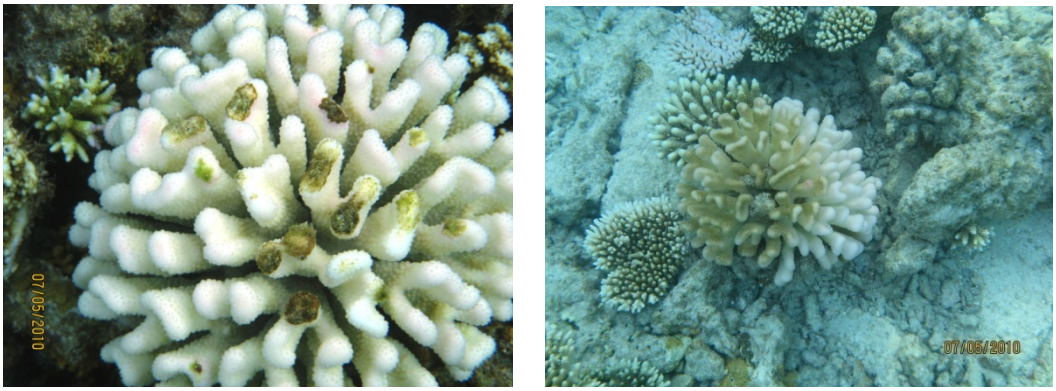


Figure 12: Close of bleached corals. Both corals have signs of dying as the algae have taken over in both the colonies.

March / April in Maldives are generally warmer and often coincide with periods of the slack or no wind. It is these periods that coral bleaching is mostly likely to occur. The coral bleaching watch website of the NOAA (http://coralreefwatch.noaa.gov/satellite/index.html) showed that during April 2010, a 'bleaching watch' alert was assigned for the Maldives area (Figure 13)

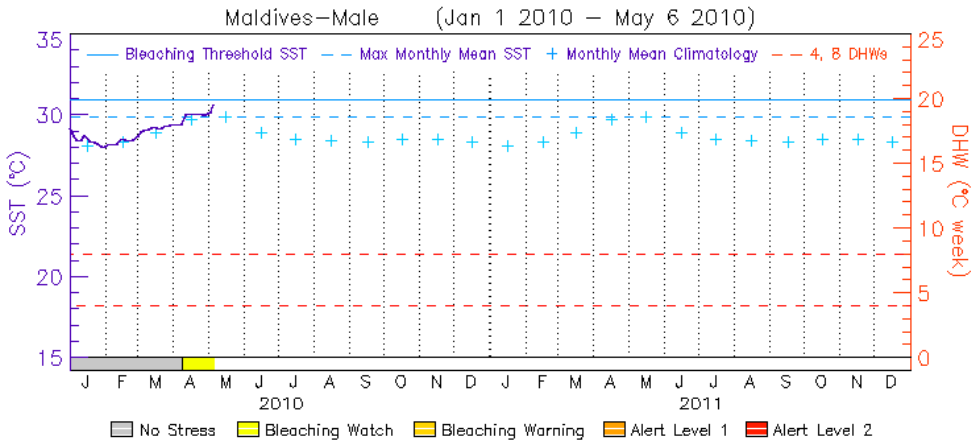


Figure 13: Sea surface temperate and degree heating week (DHW) indices for the Maldives area during 2010. DHW measure how long it has stayed above the threshold level (which is zero on this chart)

The extent of coral bleaching during the period is not clear. At the time of this writing the authorities are compiling a report on based on the information received from the MMS Discussion Group.

Figure 14: Photo-images of the coral reef area on east of the jetty. Most of the live coral have been affected by the warm weather in April 2010.

4.3 BATHYMETRY OF THE AREA

Soundings using a hand-held echo sounder were taken at random noting the GPS position of those points. Over 70 measurements were taken, 12-15 m east of the jetty, covering an area about 200 sq m. The reef flat was about 0.8 – 1.2 m deepening gradually to about 2-6 m at the reef edge and the slope of the reef (Figure 15).

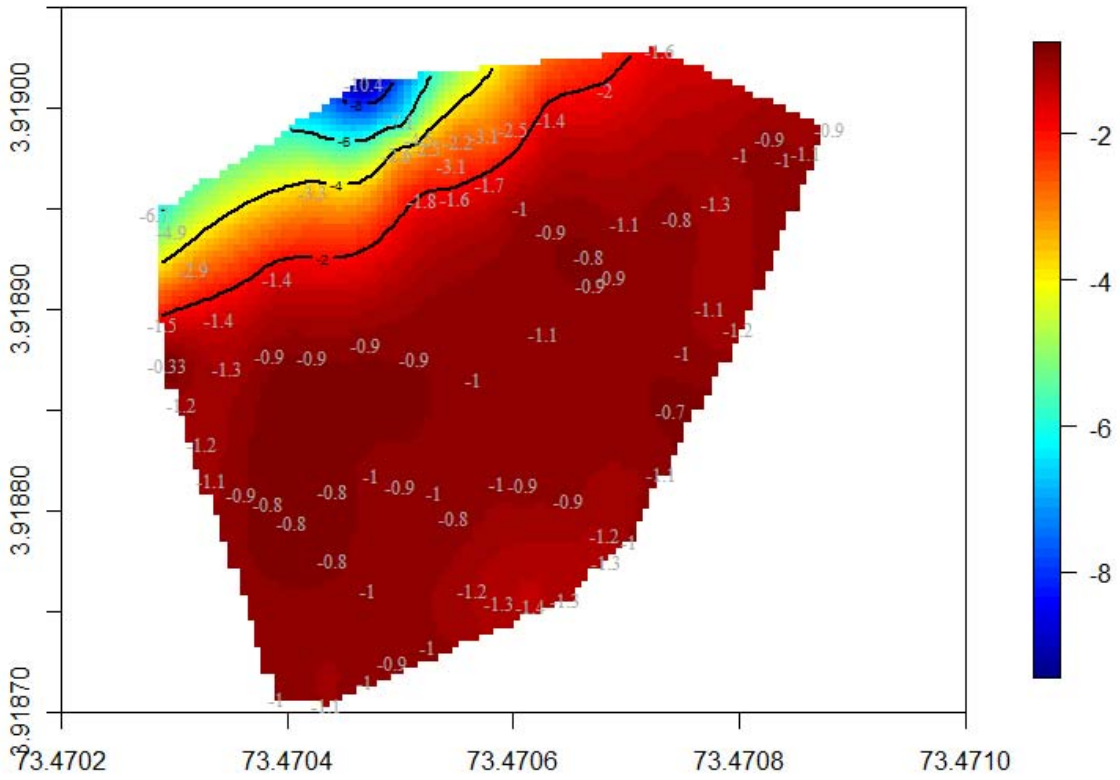


Figure 15: Bathymetry of the reef area proposed for dredging. The points (shown as depth in the figure) were used to draw the contours using by employing a krigging technique using R statistical software.

4.4 SHORE LINES AND NEARSHORE HABITATS

The shoreline of Cocoa Island Resort has undergone remarkable changes over last five years. Staff who has been working on the resort for over 9 years recalls that accumulation of sand and shallowing of the southern side of the island following the development of new overwater bungalows in the southeastern side (Figure 18; cf. two images on the top panel). Presently the shallow sandy lagoon on the southern side is extensive forming wedge (corner) at the base of the jetty extending to the water villas.

The two ends were narrow and eastern end extending into a sand spit. Accordingly these areas are very dynamic and change their shape due to seasonal oscillations in wind direction. The beach of the northern side is very narrow. In some areas, especially on the north western side of the island, the distance between beach toe and vegetation line is < 1.0m. Sand is frequently pumped to this area to maintain the beach line of the island.

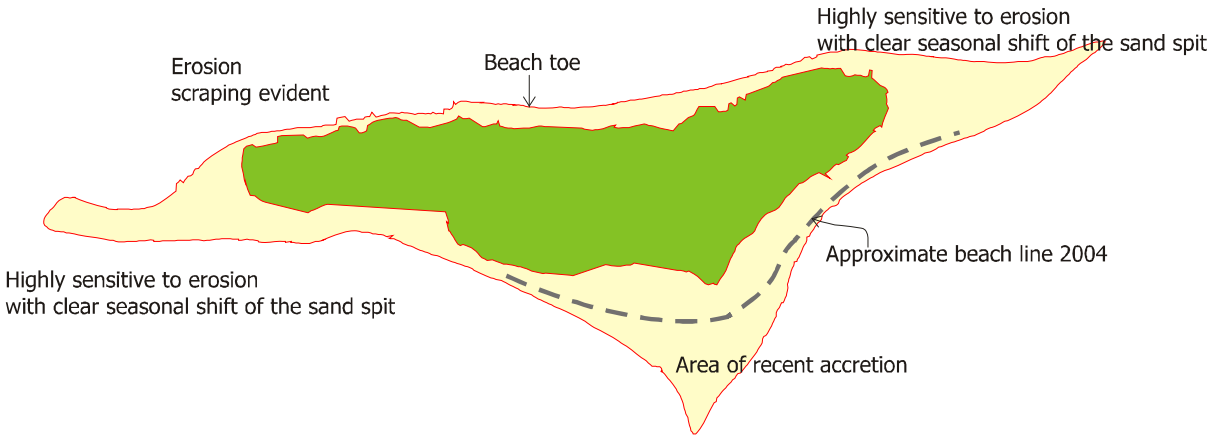


Figure 16: Present (May 2010) beach line showing approximate beach line of the southern side in 2004/2005 and areas vulnerable to erosion.

4.5 WATER QUALITY

Water sampling was not done during the field visit and therefore site specific results have not been reported here. It is likely the water test results from Cocoa Island Resort would very similar, if not identical to test results from an uninhabited island. Such a result is given in Table 1. Water quality tests should be done and reported as an addendum to this report prior to the issuance of the Decision Note.

Table 1: Typical water quality test results for an uninhabited island[6]

	Western Sea, Sample #1	Eastern Sea, Sample #3	East Lagoon, Sample #4	West lagoon, Sample #2
Physical Appearance	Clear	Clear	Clear	Clear
Suspended solids	4 mg/L	5 mg/L	6 mg/L	6 mg/L
Salinity	35500 mg/L	35600 mg/L	35500 mg/L	35300 mg/L
Ammonia	0.00 mg/L	0.00 mg/L	0.00 mg/L	0.00 mg/L
pH	8.3	8.3	8.3	8.3
Electrical conductivity	54900 us/cm	54600 us/cm	53600 us/cm	54700 us/cm
Nitrate	0.0 mg/L	0.44 mg/L	0.89 mg/L	0.89 mg/L
Phosphate	0.15 mg/L	0.03 mg/L	0.02 mg/L	0.11 mg/L
Sulphate	3375 mg/L	3375 mg/L	3500 mg/L	3375 mg/L
Turbidity	1 NTU	0 NTU	0 NTU	0 NTU
Nitrite	0.006 mg/L	0.007 mg/L	0.007 mg/L	0.006 mg/L

[6] The test results were of the Baa Atoll Kihaavahuravalhi when it was an uninhabited island, 2008.

5 IMPACT PREDICTION AND ANALYSES

This section describes the impacts from the proposed development activities, namely the dredging and beach nourishment. In general impacts relating to resort development in the Maldives have been described for many resorts. All developments are carried out on a coral reef island surrounded by coral reef habitats. The nature and characteristics of impacts are very similar in most resort developments. Coral reefs in the Maldives are homogeneous in nature and therefore much of what's described below are largely based on experiences and outcomes from other similar projects. However, the surveys and assessment of the local environmental conditions help to single out aspects of the environment that stand out in a given reef.

Owing to the small size of the size of the Cocoa Island Resort the impacts (over to medium to long term) is likely to be affected to the entire reef (Figure 17). It is highly likely that visible environmental impacts will be greater on the northern side of the island.

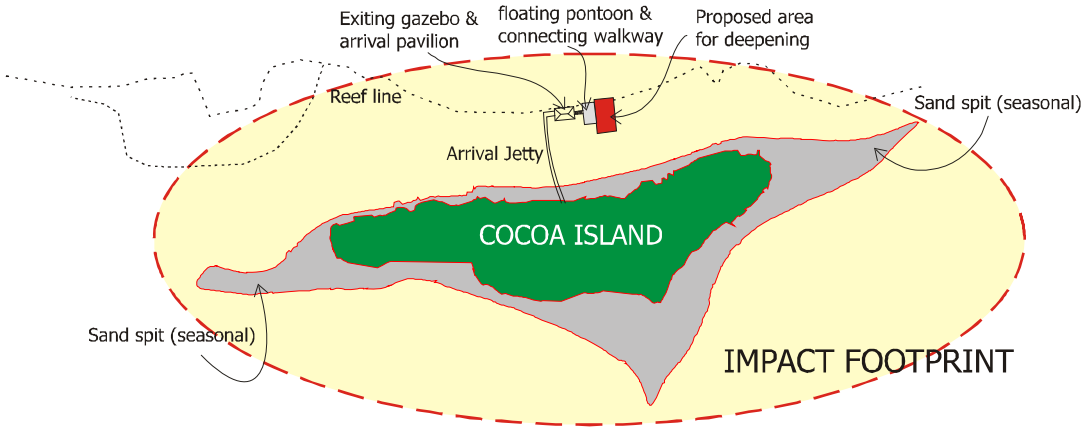


Figure 17: Likely impact foot print from the proposed development activity.

Impacts resulting from the dredging activities are predicted and described. They are predicted on the following aspects:

1. Technical aspects of the project (Project description)
2. Survey of the existing environment (Section 4)
3. Experience and observations on other similar projects in the Maldives
4. Scientific and expert opinions of personal in such project developments and assessments

A summary table of the impacts, mitigation measures and associated costs are given in Table 2.

5.1 IMPACTS ASSOCIATED WITH DREDGING

Dredging using an excavator will produce copious amounts of fine sediments which will remain in suspension for short period of time. This cannot be avoided in any way in this project. Experience from other similar dredging activities on reefs suggests that suspended

sediments disperse quickly after the dredging stops. Given the small size of the area to be dredged it is considered this method is most suitable for this project. It is also observed that the dredging will only take place for not more than 7 working days. The lagoon of Cocoa Island and its adjacent is areas are well flushed and it is likely that sediments will diffuse to negligible levels quickly.

Impacts: Impacts of sedimentation are well known on coral reefs. Corals and coral reef organisms are simply "suffocated" by settling of fine sediments. Loss of habitats for fish and small marine life is possible. Settling fine sediments may create an anoxic layer of soft sediments at the bottom of the lagoon if the area is shallow and with minimal water movement. It is unlikely that such situation will occur on the Cocoa Island lagoon.

It is noted the area has relatively high cover of live coral, although a high proportion of them have been bleached. Research has shown reefs are maintained to significant levels through self-recruitment. Removal of habitat will take away this potential source of seeds. But given the area proposed for removal is about 200 sq m this will not be significantly loss of recruitment potential in real terms.

Removal of reef flat creates a channel which would increase the water flow in the lagoon. This is simply because the reef barrier is removed that water mass flowing through the channel will create local eddies and swirls in boundary areas where depth changes abruptly. The result is increase turbidity and therefore reduced underwater visibility. The most important tourism product in any resort is the rich under water life and crystal clear water. Therefore increased turbidity will compromise the quality of the overall tourism product. It is likely the increase in turbidity would be feature that may even in the long term.

Noise will be an issue during the dredging period. It may also be minor issue in the longer term. Spa and the treatment room are just opposite to the proposed area of development. Arrival and departure events will always be associated increase in ambient noise levels mainly due to the boat entrance and departure. Although at present time boat activities are norm, the additional development will increase the overall noise level in the area.

Mitigation: Dredging (or excavation) should be carried out from a small excavator mounted on flat-top barge. The material should be kept on barge itself for transporting back to the shore as required. The transport should ensure dredge spoil is not released into the lagoon.

In order to avoid the seepage of fines into the lagoon, piling of the dredged material may be placed high on the beach. Seepages may also occur during the sorting and sieving of the material and re-transporting of the larger material. Close supervision of this work is important to ensure activities are monitored.

Oils and construction materials should be collected and removed and stowed away properly so that they can be properly disposed at Thilafushi Waste Management Site and per government regulations on solid waste management. Extra precautions should be undertaken to accidental discharge of waste oils and solid wastes into the sea area.

5.2 POTENTIAL FOR SHORELINE CHANGE

Studies on responses of shorelines to seasonal climate oscillations have shown that reefs in Maldives are quite dynamic (Kench and Brander, 2006)[7]. The dynamicity is highly variable depending on the shape and orientation of the islands. In general elongate island (high ellipticity) with pointed beach areas when oriented off-axis to the main direction of the prevailing wind may show quite large seasonal shifts in shorelines. Cocoa Island may fall under this category. This is in agreement with what was been briefed by the island staff.

It has been mentioned that shoreline of the Cocoa Island is quite dynamic. A major shift in sediment depositional pattern was observed following the re-development of 2002 (Figure 18). The requirement of active sand pumping to maintain beach of the northern side suggest that dynamics has not reached a long-term equilibrium. In equilibrium states the net accretion of inshore lines is presumed to be relatively small (Kench and Brander, 2006).

Impacts: Surveys for longer periods would be required to predict the likely change in shoreline. The post-development monitoring programme should involve regular shoreline monitoring to enable the resort management to respond proactively should remedial intervention is necessary.

The increased water flow of the northern side will definitely change sediment depositional patterns. It was observed that sand was much coarser on the north than on the southern side. Further increase in sediment size on the beaches of northern side (particularly the area opposite) may occur.

Figure 18: Cocoa Island at various time periods – Photos from Google Image Archives showing that southern beach has shifted westward and drawn along the jetty forming an acute angle.

[7] Kench, Paul and Brander, Robert W (2006). Response of reef island shorelines to seasonal climate oscillations: South Maalhosmadulu atoll, Maldives. Journal of Geophysical Research, Vol III. F01001, doi: 1029/2005JF000323, 226.

Increased erosion on the northern side is likely. According to the resort staff the most vulnerable area at present is western section where sand is actively pumped. This is also the area proposed for nourishment from the dredged material.

The assumptions underlying the proposed impacts are essentially the increase in wave energy (water movement) due to deepening. In reality, however, the explanation is not so simple. For instance, Kench and Brander (2006) showed that island shape is more an influential factor than wave energy in determining the susceptibility of shorelines to morphological change. This means that deepening may be of less significance to shore line change. The erosion processes that are currently observed may be, to a greater degree, related to the island morphology and orientation. Systematic monitoring of the shoreline would help to respond for better environmental management of the island.

Mitigation: As mentioned earlier, the management has been nourishing beach areas on the northern side through sand pumping. It is important to be more vigilant and maintain the activity. The resort should give a high priority to the proposed monitoring programme. The monitoring programme should reveal vulnerable areas and allow proposing or refining the nourishment programme.

Table 2: Summary of the potential impacts, their mitigation and costs associated with them.

Possible Impacts	Mitigation Measure	Location	Time Frame	Impact Intensity	Institutional Responsibility	Estimate Cost
Sedimentation due to dredging	Restrict dredging to slack tide to avoid sediment dispersion; Use of silt screen fencing is recommended if sedimentation is to be heavy or persistent	north eastern side of the reef	Immediate to short term	High	Developer	Included in the project cost
Increased erosion on the northern side of island	Soft engineering solutions such as artificial growth of the corals (on coral trays). In worst case placing of groynes or sea-walls	Northern side of the island	medium to long term	Potentially high	Contractor	US$ 10 - 15,000 over a period of 3 years
Loss of the biota due to the removal of habitat	Relocation of the live corals to other areas of the reef.	Dredged area.	Short to medium term	Moderate, in the short term, gradually declining over time	Developer	US$ 1,000 over a period of one month
Increased turbidity in the area due to increase in water movement	Implement soft engineering measures, such as the artificial growth of "coral-trays" covering the area	Lagoon in the northern side of the island	short, medium and possibly long term	Moderate	Developer	Same as row #2
Increased noise levels	Temporary closure of the spa and treatment room on the north eastern side of the island. Plan and/or restrict the use of machinery and equipment during early morning and evening; Inform guest about work that is being undertaken	Northern side of the island	Construction period	Minor	Contractor, developer - the project manager on site	Included in the initial cost of the project
Noise pollution	Avoid use of heavy machinery during night time	Land	construction phase	Minor, short terms	Contractor	N/A (same as above)

6 ALTERNATIVES TO DEVELOPMENT

In an EIA process it is normal to consider the various development options and weigh consequences of environmental impact of each option being considered. In this EIA three options are being considered. All have been carefully evaluated and discussed with the management. Of the several development options that were discussed only two are presented here. The options are:

1: No development option.

2: Developing a harbour involving dredging of significant area of the lagoon and making a reef cut.

3: Use of a floating pontoon adjacent to existing arrival jetty and deepening of 200 sq m on the reef flat.

6.1 NO DEVELOPMENT OPTION

Under no development option the Cocoa Island Resort will continue to use the existing jetty structures for arrival and departures. In this case Como Hotels' objective of improving the arrival and departure experience is not achieved. Guest paying very high-end rates will have to go through the inconvenience and risk of an accident during the arrival and departure times. The two most important months, the so called high season, during which most number of guest visit the resort, the management will have to find alternatives; including the uses of the exclusive private jetty in the south or make use of the air-taxis in the worst case scenarios

In the event, the management will be over-burdened with unexpected logistic issues and bear additional expenses that have not been budged for in the overheads of the resort's day-to-day expenses. The overall tourism experience of the Coco Island Resorts will be diminished and the Como Hotels image may be questioned losing business eventually.

6.2 DEVELOPMENT OPTION #1

Two major reasons should have lead to the first developers of the resort in deciding to place the jetties on the northern side and up to the reef edge. By studying the orientation of the island and the prevailing wind directions in the area the calmer waters would be on the northern side. The lagoon in the northern side does not have enough space for creating a harbour basin and so a compromise was to have the jetty heads placed right on the edge of the reef.

The issue at hand is those jetties have not been safe enough for comfortable, safe and secure arrival and departure experience for the guests. The resort, however, have been operating with this inconvenience and putting up all the logistical difficulties.

If option #1 were to be implemented it would have to be on the **southern side**. The activities that would require undertaking include dredging a substantial area (large enough for large boats to manoeuvre easily) and creating a channel (involving a reef cut or widening and deepening of the existing channel).

The issues that have to be dealt are complicated and costly **and** with greater environmental risk in the medium to long term. All guest rooms (water – villas) are located on the southern side. The issue of noise, aesthetics, but more critically of negative environment impact and its uncertain consequences outweighs the decision for an alternative.

6.3 DEVELOPMENT OPTION #2

The development option #2 is the preferred option and what has been proposed this EIA report. The use of the floating pontoon with the existing arrival jetty creates safe and ample berthing space for the Ambassador 55-type large boats. The low rise of the platform will be safer and also doubles as arrival area. Use of hinged walkway to the main arrival gazebo avoids development of an additional reception facility for the guests. Use of piles (4 of them) minimizes the environmental impact related to mooring the platform on to the reef. The piles require no maintenance and so the physical impact to the reef will be a one-off event, occurring only during the clearance and deepening of the bases for the piles. The piles are normally cast on land and placed in position.

The issues under this option are related to the requirement for the deepening of the reef flat adjacent to the pontoon. The activity is equivalent to creating a small channel on the reef. Presently the reef flat is about the 0.8 – 1.2 m. The proposed area for deepening also has a clearing which appear to have been used as an entrance channel sometime in the past (cf. Figure 6).

The management of the resort is acutely aware of the potential implication of dredging activity as explained in the section on Impact Prediction and Analyses. The management of the resort is committed to bear any costs associated in the mitigation and remedial action that may be necessary in the medium to long term. The management is also committed in implementing the migration measures during the dredging phase.

Given the requirement of the resort and alternatives that is available, Option #2 is considered to be reasonable. The activities would lead to relatively low environmental impact to the reef / island environment. As mentioned earlier, following the redevelopment in the 2002 the a net change in the island has occurred where by sediments are accreted on the southern side with widening of beaches and shallowing of the reef flat on the southern side. On the other hand the net erosion has been occurring on the northern side, and beaches are maintained regularly through active pumping of sand (by a sand-pump) – the usual practice nearly in all the resorts.

7 MONITORING AND EVALUATION

Reefs and islands in nature are at some equilibrium state. This involves maintaining a set of dynamic interactions with the biotic (living) and abiotic (physical – non living) components of the ecosystem under question. When the system is perturbed a compensatory change takes place to re-establish a new equilibrium state.

Effectively the main objective of an environmental impact assessment study is to predict that change when it shifts to the new equilibrium so that developer (the proponent) and contractor can plan activities accordingly and in a timely manner. In doing so the EIA establishes the baseline conditions for which this change can be measured against. The nature of the intervention determines the degree and magnitude of this change and the post-development monitoring is directly related to the degree and extend of the likely impact.

The degrees to which the coral reefs can adapt and maintain their resilience[8] to withstand and cope with the stresses depend on how healthy the biotic components are. Stressors on Maldivian reefs include, but not limited to, pollution (sewage, solid waste), dredging activities (sedimentation, and associated change in water movement), and shore line changed due to coastal developments. It should also be noted that reefs have undergone a heavy toll during the mass bleaching event of 1998/1998. The national coral reef monitoring programme[9] has shown that reefs in Maldives, in general, are recovering from this event. Many reefs have small coral colonies (10-25 cm diameter), mainly of Acropora and Pocillopora indicating reefs are recovering.

The current assessments of the Cocoa Island reef indicate coral bleaching has yet again occurred in April 2010 to significant levels (see section on Existing Environmental Conditions) increasing the stress levels of the reef system.

Given that deepening works would create an irreversible damage in the short to medium term with changes in water movement and therefore changes in accretion and erosion patterns, it is proposed to monitor the reefs and shore lines on a quarterly basis for a minimum period of two years. Monitoring should be flexible to allow inclusion of additional parameters deemed necessary. Monitoring reports should be carefully evaluated and the recommendations should be implemented on a timely basis.

The following table summarises the proposed monitoring plan immediately following the development activity. Reports must be compiled and the submitted to the government authorities accordingly.

[8] The ability of the system to maintain key functions and processes in the face of stresses or pressures by either resisting or adapting to change. For coral reef ecosystems, resilience characterises the capacity to maintain the dominance of hard corals and/or to maintain morphological diversity, rather than shifting to a predominantly algal state or a single coral morphology. Resilience also includes the potential of the system to reorganise and build its capacity to adapt to change. Reference : *Marshall, P. and H. Schuttenberg (2006). A Reef Manager's Guide to Coral Bleaching, NOAA, IUCN and Australian Government.*

[9] www.mrc.gov.mv / section on coral reef research programme, accessed in May 2010.

Parameter	Frequency and cost and indicative cost per sampling period
Reef Resilience Issues: 1. Substrate cover (live coral, soft coral, rock/rubble and sand cover 2. Extent of herbviory; extend of the herbivores on the reef 3. Extent of local recruitment: Colony count per given area and size 4. Fate of bleached corals: Visual inspection.	Once every three months for the first two years, after which may be reviewed following the monitoring report. US$ 500.00
Change in shore line: Shore line GPS survey to monitor the change in shore line shape, including any significant change in slope if necessary.	Once every three months, for the first two years. Reviewed subsequently following the monitoring report; US$ 500
Sedimentation: The opening of the reef and dredging is likely to increase sedimentation. This is also an indicator the wave energy in the lagoon. The measured variable is the turbidity	Once every three months for the first two years, pending review after the submission of the monitoring report. US$ 10.00
Water quality: General water quality test to follow the change water quality following the dredging and the from the baseline conditions; Need to measure Nitrates, Nitrites, Sulphates, Anomia, pH, Conductivity, Turbidity, BOD and COD	Once every three months in the first two years. Should be reviewed following the submission of the monitoring report at the end of the period; US$ 100.00

+++

8 APPENDICES

1. Appendix 1: Current layout plan of the resort (page 1) and the area showing the where the dredged material will be spread out.
2. Appendix 2: Commitment letter from the management of the resort
3. Appendix 3: Approved Terms of Reference of the EIA
4. Appendix 4: Specification of the pontoon and gangway
5. Appendix 5: Detailed drawings on placement on pontoon.
6. Appendix 6: Detailed work schedule of the development activity.
7. Appendix 6: Details of the concrete piles with the beam-footings for fixing the pontoon.