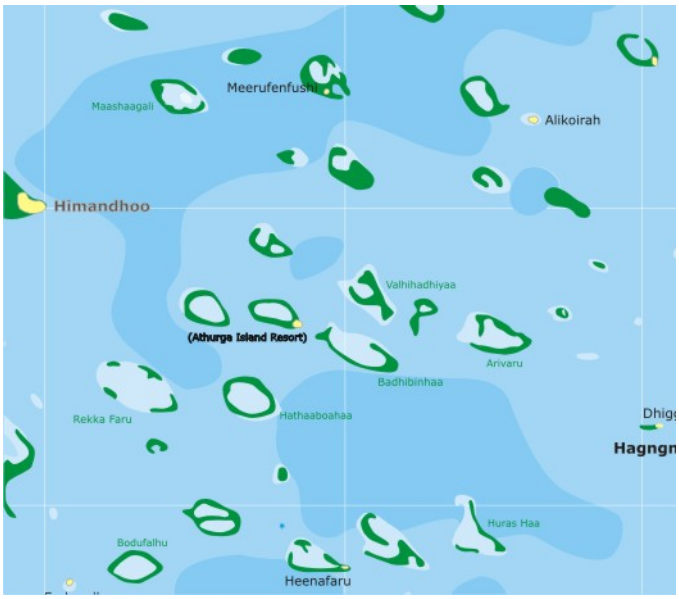
Addendum to

ENVIRONMENTAL IMPACT ASSESSMENT

For the proposed Upgrading and Redevelopment in Athuruga resort, South Ari Atoll, Maldives



Proposed by

Voyages Maldives

Signature:

Prepared by

Ahmed Jameel

For Water Solutions Pvt. Ltd., Maldives

December 2009

Non Technical summary

This is an addendum to the EIA submitted in May 2009 for the redevelopment of Athuruga resort in South Ari Atoll. This Addendum highlights the different modification to the initial redevelopment project that was proposed in the EIA report. These includes, deepening the existing entrance channel, undertaking the coastal protection component including construction of the groynes, nourishment of eroded beach and construction of breakwaters, reuse of corals from demolition wastes as an effective waste management strategy and the relocation of the proposed overwater restaurant from the northern side of the walkway jetty to the southern side. The other changes that had been brought to the redevelopment project includes reducing the number of over water bungalows from 25 to 23, reduce the number of house-keeping huts on the walkway jetty from 3 to 2, not developing the over-water spa in the southern side of the walkway jetty and changing the reception at the centre of the northern walkway jetty to a bar.

The new changes that had been brought to the master plan of the development would decrease the development foot print on the marine environment. The new component that had been included in the redevelopment project is the coastal protection component that was not initially proposed in the original project.

Groynes had been built in Athuruga for many years. This has helped to retain the beach and prevent severe erosion of the island. However, since the re-development project was initially proposed without the coastal protection component, this component has been proposed in this addendum in order to undertake the works as without coastal protection, it would be very challenging to manage erosion. The coastal protection component was not included in the redevelopment project, as the groynes existed on the island and these structures, which were made out of corals and coral rubbles, were moved around depending on the monsoon. Hence, it is proposed to build these groynes field around the island.

Since Athuruga has lost large amount of beach, replenishment of sand is required to prevent further erosion and sustainably manage the coastline. The proposed project includes pumping of 6,900 m^3 sand to the beach on the western, northern and eastern side of the island. Part of the materials for the beach replenishment would be obtained from the excavated spoil from the channel deepening component of the project.

It is also proposed to build a submerged breakwater at the northern and western side of the island. This has been proposed as a additional defence to prevent the continuous erosion that the island endures.

The project also proposes to deepen the existing entrance channel which is located on north western side of the island. The channel has become very shallow, causing difficulty for the boats to access the island during low tides. The project is proposed to deepen the existing channel to a depth of 3 meters at low tide. Since coral rubbles on a sandy sea floor is the main benthic substrate found in the existing channel, the channel deepening operations with an excavator is not expected to have a significant impact on the marine environment.

The concept of redevelopment is to capture the architectural signature that was originally created at the island. Therefore, with this intention, the new buildings which are constructed with building blocks is being planned to be decorated with a layer of corals that have been recovered in the demolition waste stream. In the original EIA, this issue was not extensively elaborated. Hence, this

addendum has included a section which deals with the reuse of the corals in the demolition waste stream.

The proposed changes appears justified from an environmental point of view as there are no additional moderate to major impacts on the environment due to the proposed changes.

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1 Introduction

This report is an addendum to the Environmental Impact Assessment which was developed by Water Solutions Pvt. Ltd. in May 2009 for the proposed upgrade and redevelopment project at Athuruga, South Ari Atoll.

The content of the report is based on the data presented in the initial EIA report, the report compiled by EPA in October 2009 following their visit to the island and further observations made from field trips to the island, and the new information provided by the proponent. Additionally, Information available from various reports has been used. Descriptions of the alteration to the project, the existing environmental conditions and the positive and negative environmental impacts of the alterations have been included. Furthermore, mitigation measures and monitoring options have also been presented where appropriate. The methodology for data collection and analysis given in the initial EIA report will be adopted; however, they will be used to assess the impacts of the alterations to the original plan.

This document has been produced in accordance with the 2007 Environmental Impact Assessment guidelines from the Ministry of Housing, Transport, and Environment and the guidance issued by the Ministry of Tourism, and other agencies. This document shall be read along with the *Environmental Impact Assessment for the Proposed Upgrade and Redevelopment in Athuruga Resort, South Ari Atoll, Maldives, May 2009,* as this document is an addendum to the report.

1.1 EIA Addendum Implementation

This EIA Addendum has been prepared by a local environmental consulting firm, Water Solutions. Water Solutions have been chosen by the proponent as the environmental consultants for this project. The team members were:

- Ahmed Jameel, Environmental Engineer (EIA Registration No: EIA 07/07)
- Verena Wiesbauer, MSc (Zoologogy/Marine Biology) Marine Biologist
- Amir Musthafa, B.Eng (Environmental) Student
- Mohamed Riyaz, Assistant Surveyor

1.2 Structure of the Report

The report has been structured to meet the requirements of the EIA regulations 2007 issued by the Ministry of Environment, Energy and Water.

The major findings of this report are based on qualitative and quantitative assessments undertaken during the site visit in December 2009. The impact assessment methodology has been restricted to field data collected, consultations, experience and professional judgment and available long term data.

2 Project Modification

2.1 Project Proponent

This project is proposed by Voyages Maldives Pvt. Ltd. Voyages Maldives is a company known for its service in the hospitality industry in the Maldives for over 20 years. The company is owned by multiple shareholders. The shareholders of Voyages Maldives are all experienced industry personnel.

2.2 Project Description

The project is proposed to upgrade and redevelop Athuruga island resort. The project takes place in the island of Athuruga, located inside south Ari atoll. At present, Athuruga island resort is closed for the redevelopment process. The redevelopment component of the project included the construction of an additional 23 water bungalows, 2 water bungalow suites, reception, lagoon spa, bar, restaurant, and housekeeping hut. The upgrading component of the project includes main restaurant & kitchen, boutique, library, dive school, executive staff rooms, staff kitchen and refurbishment of the mosque. For details of the development, refer to the project description section of the *Environmental Impact Assessment for the Proposed Upgrade and Redevelopment in Athuruga Resort, South Ari Atoll, Maldives* (May 2009).

3 Proposed Modifications and Justification

The alterations proposed to the initial plan that was presented in the *Environmental Impact Assessment for the Proposed Upgrade and Redevelopment in Athuruga Resort, South Ari Atoll, Maldives (May 2009)* includes the following:

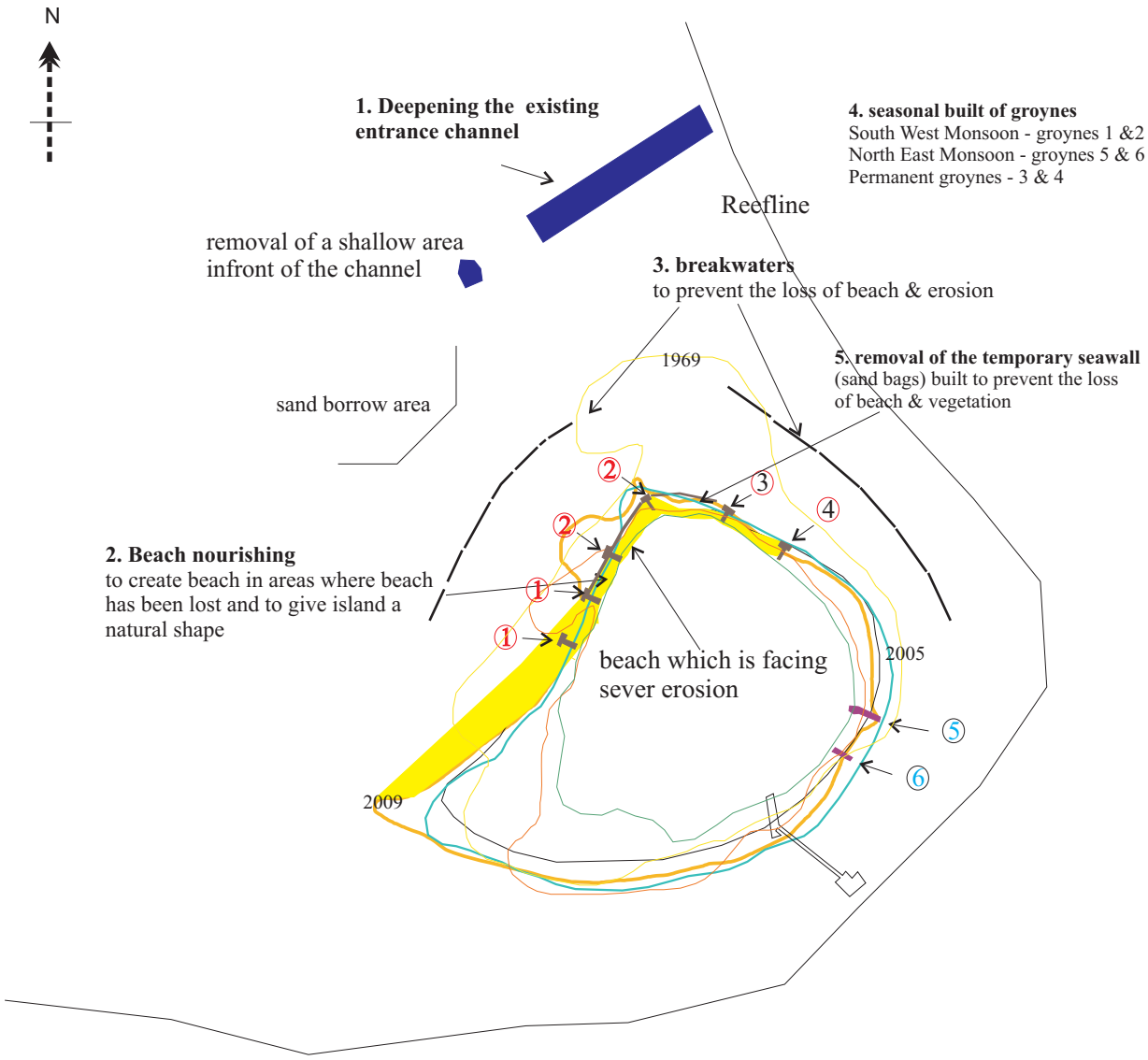
Addition to the previous plan

- Deepening the existing entrance channel
- Undertaking the coastal protection component including construction of the groynes
- Nourishment of eroded beach
- Construction of breakwater
- Reusing of corals from demolition wastes as an effective waste management strategy
- Relocation of the proposed overwater restaurant from the northern side of the walkway jetty to the southern side.

Omission from the previous plan

- Reducing the number of over water bungalows from 25 to 23.
- Reducing the number of house-keeping huts on the walkway jetty from 3 to 2.
- Not developing the over-water spa in the southern side of the walkway jetty

Additional Coastal components of Athuruga Redevelopment Project



Proposed Project

1. Entrance Channel Deepening

The existing entrance channel located on north side of the island has become shallow and has average depth of -1.0 m in low tide. It is proposed that the existing channel would be deepen to have a depth of - 3.0 at mean sea level. it is estimated that 2,400 m3 of sand would be excavated from this site.

2. Beach Nourishment

Erosion is sever on north eastern corner of the island and it is estimated hat Athuruga has lost has lost 4,016.05 **m2** of beach when compared to the registered land area of the island. It is proposed that **2,400** m3 of sand would be excavated from the entrance channel and **4,500** m3 of additional sand would pumped from the borrow area as shown in figure

3. Building Breakwaters (Phase 2)

It is also proposed to built **350** m of breakwater on north and north western side of the island to prevent further loss of beach, vegetation and beach villas. The materials for the breakwaters would be either rock boulders, geotextitle bags filled with sand or structures made from concrete

4. Seasonal Building of groynes

The beach of Athuruga has been managed over the past two decades by seasonal placement of the groynes at different locations of the island. Hence it is proposed that these groynes 1 & 2 be built before the beginning of South West Monsoon (April), groynes 5 & 6 before the beginning of North East Monsoon (November) and groynes 3 & 4 permanently. The materials for the groynes could either be coral rubbles which is presently be used or concrete structures that can be easily transported from one location to another

5. Removal of the temporary sand bags

The sand bag seawall which has been presently be laid would be removed, once the beach replenishment is started.

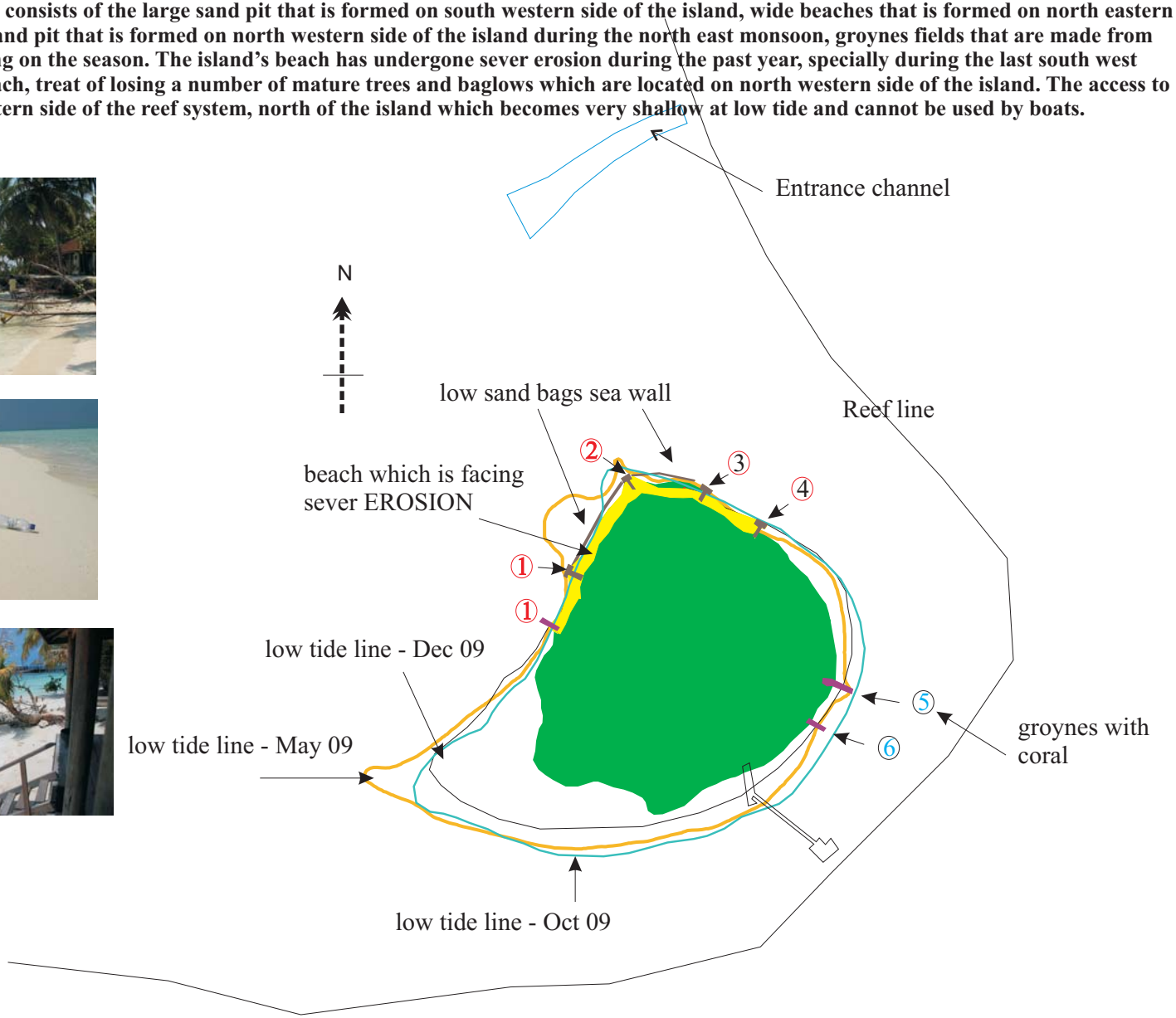
6. Reuse of the corals which are in the demolition waste stream

Athuruga was built 20 years ago with the coral that were mined. Hence, the buildings that have been demolished has produced coral as waste. The corals has been separated from the demolition waste stream. It is proposed to reuse these coral as a decorative elements on the outer layers on some of the walls of the new buildings. These buildings are built with blocks and corals will be placed as an additional decorative layer

Figure 1 : Additional components bringing modification to the proposed redevelopment project at Athuruga

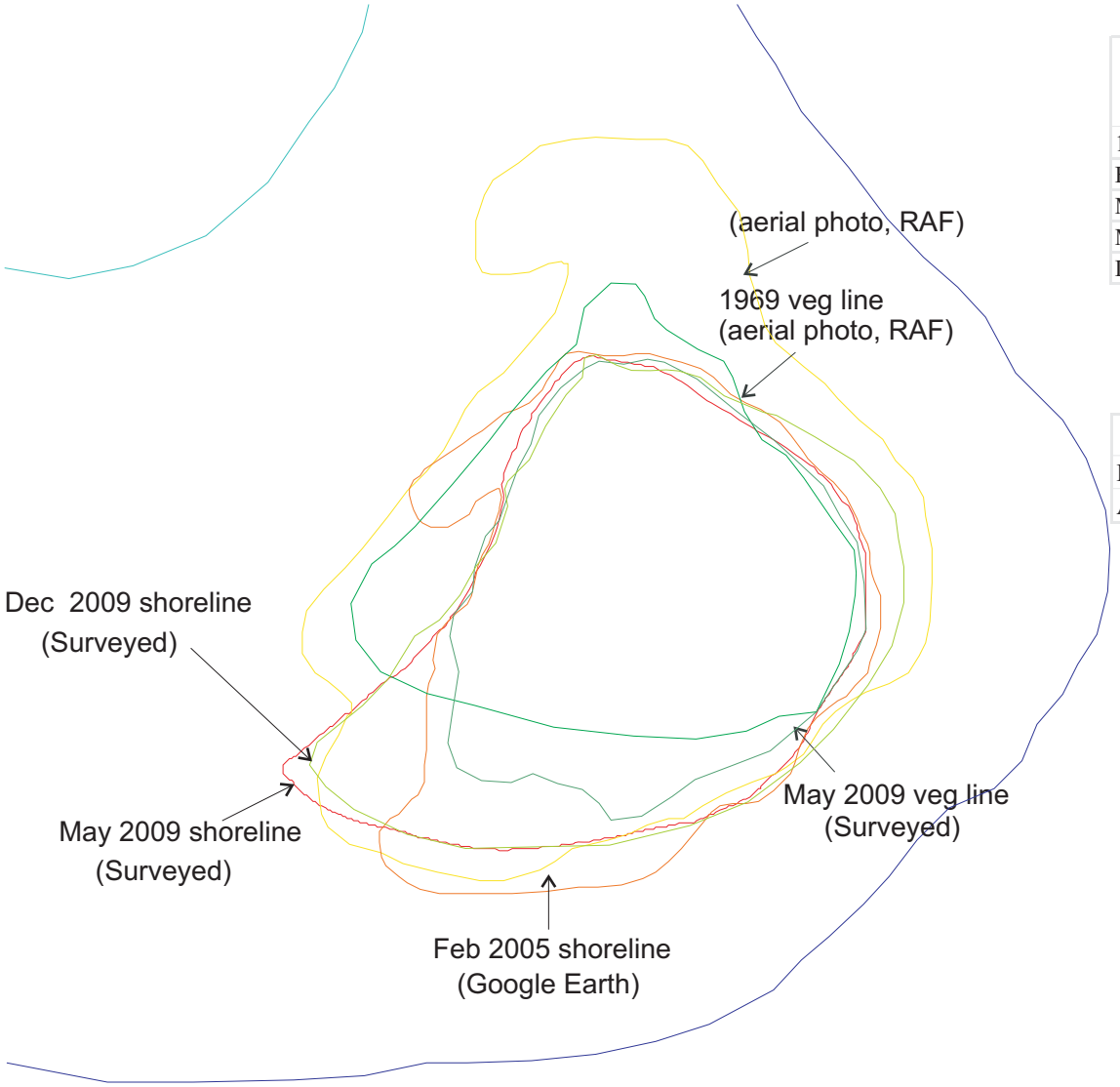
COASTAL Features of AD. ATHURUGA ISLAND RESORT

The coastal features of AD. Athuruga Island Resort consists of the large sand pit that is formed on south western side of the island, wide beaches that is formed on north eastern side of the island during the south west monsoon, sand pit that is formed on north western side of the island during the north east monsoon, groynes fields that are made from corals which are moved around the island depending on the season. The island's beach has undergone sever erosion during the past year, specially during the last south west monsoon. This has caused a lost of large area of beach, treat of losing a number of mature trees and baglows which are located on north western side of the island. The access to the island is from a channel which is located on eastern side of the reef system, north of the island which becomes very shallow at low tide and cannot be used by boats.



ATHURUGA BEACH LINE with time

The beach line of Athuruga is very dynamic and has undergone many changes over the past 50 years.



	Vegetation (m2)	Island Area (m2)	Beach Line (m)
1969	22,583.56	45,661.41	928.51
Feb '2005	20,985.41	30,629.68	778.00
May '2008	20,985.41	31,159.62	734.84
May '2009	20,782.78	32,256.74	660.32
Dec '2009	20,043.13	30,267.34	600.40

	Island Area (m2)
Registered Land area	34,283.39
Area lost (as of Dec 2009)	(4,016.05)

3.1 Changing the concept of the overwater structures layout

Reducing the number of over water bungalows and other infrastructure including, house-keeping huts and spa was decided mainly due to economic reasons. However, this would also result in the added benefit of having even less impact to the marine environment at Athuruga. Please refer to the new master plan for the modification for the re-development.

3.2 Establishment of a groyne field

The beach at Athuruga has been maintained by a set of groyne field built on the western, northern and eastern side of the island. In the past, the groynes fields have been utilised as a soft engineering solution to the erosion issue by building these when and where it was needed. The groynes which were built to protect the beach on the western side of the island during the south west monsoon would be removed and moved to the north eastern side to protect the beach on the northern side of the island during the north east monsoon. This method had worked quite effectively at Athuruga. Hence, it is proposed to build this type of groynes field at Athuruga as continued protection for the island's beach. The groynes will function well, when the area between the groynes are nourished with sand. This would be carried out while replenishing the eroded area as identified in section 3.3.

The gap between groynes is usually about two or three groyne lengths, where groyne length is defined as the distance from the beach berm crest to the groyne's seaward end. Groyne spacing is often selected based on an analysis of desired shoreline alignment following groyne construction, which depends on the wave and long-shore transport at site. Shoreline alignment following groyne construction depends mainly on prevailing wind direction and subsequent incident waves. When incident wave crests are nearly parallel larger groyne spacing can be used; when incident wave crests make a larger angle with the shoreline, closer groyne spacing is required. In the case of Athuruga, the wave crests on the northern and western beaches shores are primarily parallel to the shoreline. Therefore, it is proposed to keep groynes as far away as possible given the short length that can be achieved. This has been observed to function in the past years. The effectiveness of the proposed groynes will be assessed in the monitoring programme.

The design of the groynes is given in Figure 1. These design considerations take into account existing long-shore currents and wave overtopping. The crest of the groynes is based on the "significant wave height". However, under calmer conditions with low crested waves, as is the case in Athuruga, structures are designed to allow for overtopping. Overtopping often helps to minimize the effects of stagnation in the lee of the breakwater thereby improving water quality in the leeward side. In fact, a significant increase in strength of the crest can be achieved by careful placement of the armoured rocks to ensure good interlocking and by the use of gabion boxes or wire mesh in case of rubble structures.

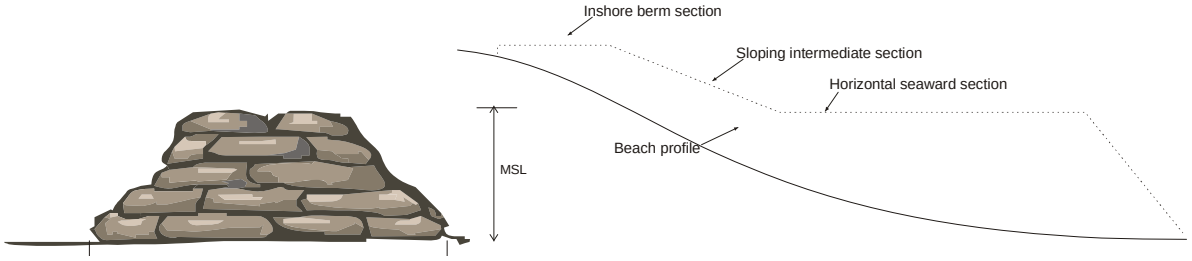


Figure 2: cross-sectional design of a groyne

For the selection of construction materials, the existing materials which had been used to build the existing groynes will be re-used. According to the report compiled by EPA, the island had 4 new groynes and 4 old groynes that were built around the island. Additional materials, if required to finish the groyne fields, will be cement-sand bags. The purpose of using the existing corals is to reuse the existing corals that had been used. One of the principles of waste management is to recover what is usable and valuable in the waste stream and it would be a waste to dispose the corals which have been used to construct the existing groynes. Hence it is proposed to reuse these corals and to use additional sand-cement bags as additional materials to complete the groynes.

3.3 Replenishment of the eroded beach

Athuruga has undergone severe erosion in the past 50 years. Table 1 show that the area covered by the vegetation line and the land area covered by the low tide line has fallen since 1969. According to the survey that was carried out by Water Solutions in December 2009, the total land area of the island has been reduced by 4,016 m^2, that of the registered land area at the Ministry of Tourism. The reduction of the land areas has been mainly due to the erosion that is seen in the northern side of the island.

Period	Vegetation (m2)	Vegetation area change compared to 1969	Island Area (m2)	Island area change compared to registered area (m2)	Beach Area (m2)	Beach Line (m)
1969	22,584		45,661	11,378	23,078	929
Feb '2005	20,985	(1,598)	30,630	(3,654)	9,644	778
May '2008	20,985	(1,598)	31,160	(3,124)	10,174	735
May '2009	20,783	(1,801)	32,257	(2,027)	11,474	660
Dec '2009	20,043	(2,540)	30,267	(4,016)	10,224	600

Table 1: change of Athuruga's land area

The main problem with the beach face is that the beach face has not been nourished with fine sand to maintain the loss that had occurred due to erosion. Hence, it is proposed to replenish the beach with 6,900 m^3 of beach sand. The sand would be borrowed from the shallow lagoon west of the island. The replenishment would be carried out so that the berm at the replenished area would have a height of at least 0.5m. Fill profile for beaches around the nourished area on the north and western side of the island are shown in Figure 3.

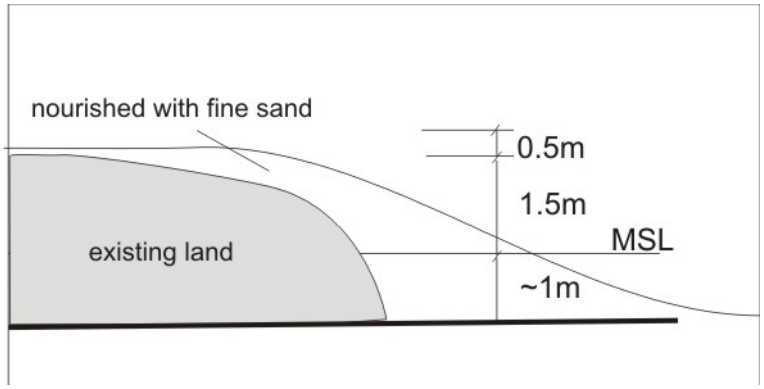


Figure 3: fill profile for the nourished area

Beach nourishment would be undertaken using a sand pump. This is to ensure that beach material is not compacted and that the beach is softer. It is generally considered appropriate that deposition of material should be along the upper beach, above the high water line and along the eroding berm face. Natural redistribution of the placed material along shore and cross-shore will occur, particularly for sand. Sand will be pumped from the western lagoon.

The material required for the beach nourishment works would be obtained from the material excavated from the proposed channel deepening and by excavating or pumping sand from the western lagoon. The total volume of material that may be obtained from the excavation of the channel is about 2,400m^3, assuming that the channel would be dredged to a depth of -3m at mean sea level. This leaves the total volume of material to be pumped from the western lagoon to about 4,500 m^3.

3.4 Construction of a submerged breakwater

It is important the eroded beach is replenished as a coastal protection measures. The accelerated beach erosion is not only causing a loss of land area but also threatening the loss and destruction of a large number of mature trees and beach bungalows respectively. Having no beach infront of the beach bungalows makes guest complains and in many instances ask for unreasonably compensations. This causes huge losses of revenue and has financial difficulties to make the operations sustainable.

It is been proposed that submerged breakwaters are to be built on western, northern and eastern side of the island to protect these beach, if the beach needs further protection after it has been replenished with beach sand. This would be monitored in the monitoring programme as outlined in the monitoring section.

Offshore breakwaters are structures built approximately parallel to the beach but some distances offshore. The purpose of offshore breakwaters is to reduce the intensity of wave action in inshore waters and thereby reduce coastal erosion. Emerged breakwaters are not aesthetically acceptable for a tourist resort. However, the current breakwater barricade near the mouth of the harbour is an emerged structure. Submerged breakwaters are similar to natural reefs. Submerged breakwaters or artificial reefs, unlike emerged breakwaters, allow sand to pass over their crest and aids long-shore transport between the reef and the shoreline.

Based on existing wave conditions in the area, the following design has been suggested.

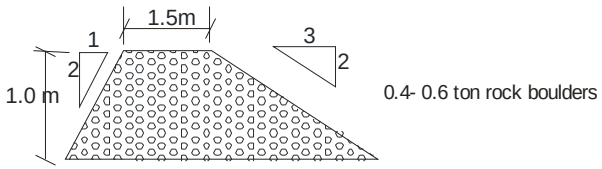


Figure 3-4: Design of proposed submerged breakwaters - cross section

The length of the new set of breakwaters is about 50m each and the gap between the breakwaters is about 2-5 m. Figure 1 shows the location of the submerged breakwaters and their possible orientation.

3.5 Deepening the existing channel

The existing channel which is located on the north western side of the island is the only channel that boats have to use frequently to get into the lagoon. The channel has become very shallow at less than 1.0 m at low tide making the boats difficult to access the island in low tide causing disruption to the supply to the island. Hence, it has been proposed to deepen the channel as to allow easy and safe access to the island by boats.

Figure 5. Coral rubble on a sandy seafloor is the main benthic substrate in the entrance channel

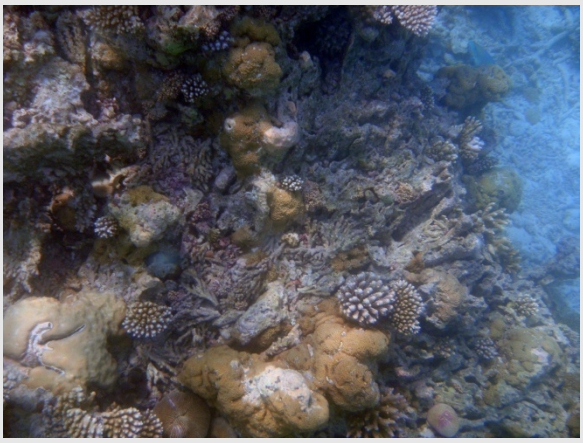


Figure 6. Corals have colonized the walls of the channel like the rest of the house reef

3.6 Reusing coral from demolition waste

Twenty years ago, the most common material for the construction of the resorts was corals. These were mined from reefs with a permit when the island was developed. As such, Athuruga was also built with legally obtained corals. However, due to the demolition of old buildings, Athuruga has generated corals in the demolition waste stream. According to the EPA analysis report on their visit to Athuruga (7 October 2009), 530 cubic feet of corals has been recovered from the demolition waste stream.

The concept of redevelopment is to capture the architectural signature that was originally created at the island. Hence, with this intention, the new buildings which are constructed with building blocks is being planned to be decorated with a layer of corals that have been recovered in the waste stream. Also, since one of the principles of waste management is to recover what is usable and valuable in the waste stream, it would be a waste to dispose the corals which have been recovered and separated from the demolition waste stream. Hence it is proposed to reuse the recovered corals in the waste stream.

4 Environmental Impacts and Mitigation

4.1 Impact Identification and Assessing Impacts

Environmental impacts of the proposed work have been examined through a number of processes. These include consultations with the stakeholders, field surveys, observations and assessment, and field experience gained from similar development projects implemented throughout the country. Potential positive and negative impacts on the environment have been considered.

Possible negative impacts on the environment have been considered in worst-case scenario to recommend mitigation measures in the best possible ways so that these impacts would be minimized and perhaps eliminated in both constructional and operational phases.

This EIA Addendum identifies and quantifies the significance of adverse impacts on the environment from the proposed additional activities of the project. Impacts on the environment were identified and described according to their location/attribute, extent (magnitude) and characteristics (such as short-term or long term, direct or indirect, reversible or irreversible) and assessed in terms of their significance according to the following categories:

Negligible – the impact is too small to be of any significance;
Minor– the impact is minor;
Minor adverse – the impact is undesirable but accepted;
Moderate adverse – the impact give rise to some concern but is likely to be tolerable in short-term (e.g. construction phase) or will require a value judgement as to its acceptability;
Major adverse – the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project.
Positive – the impact is likely to bring a positive change in the sense that it is aimed at further minimizing the impacts as a result of the proposed actions.

4.2 Uncertainties in impact prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. There is also limited data and information regarding the particular site under consideration, which makes it difficult to predict impacts.

However, the level of uncertainty, in the case of Athuruga is expected to be low as many similar projects have been undertaken in Maldives on a much larger scale. Channel excavation is standard construction protocols for islands in Maldives and appropriate and adequate information on construction methodology are available. Therefore, there is very little uncertainty involved in this project. There is a high degree of accuracy in prediction of the impacts.

The following table outlines the major environmental impacts and their mitigation measures proposed.

Environmental Aspect	Potential Impacts to the environment	Mitigation Measures proposed
Impacts during construction stage		
Impact due to deepening the entrance channel	Most of the negative impacts on the marine environment arising from the proposed project will mainly be from excavation of the entrance channel. In this project, excavators will be used to deepen the entrance channel and therefore sedimentation will be an ultimate outcome which will be unavoidable. Despite this, it has to be noted that this is only a short term effect and will only last during the excavation period. The entrance channel will be excavated to a depth of 3 meters at mean sea level (MSL). The sea bottom of the entrance channel currently consists mainly of either coral rubble Figure 5 which was left behind after the creation of the channel, and sand. A small amount of coral patches could establish themselves on the sand inside the channel (Figure 6). Therefore, when deepening the channel, the few coral patches in the middle of the channel will be permanently destroyed. An indirect impact will be felt on the nearby reef due to sand smothering. Both work phase and operation phase will have direct and indirect negative impacts. Direct impacts during work phase will result from the removal of lagoon bottom areas to deepen the lagoon and make the navigation channel. This impact will include damage to corals, loss of lagoon bottom benthos namely burrowing worms and crustaceans. Indirect impacts will result from release of sediment to the water column and increase in turbidity during the work phase. Lagoon bottom is an important habitat for certain organisms such as worms, mollusks, amphipod etc. which are important food sources for bottom feeders such as certain species of fishes. By removing sand from the lagoon bottom would disturb habitats of these organisms.	Following are the specific mitigation measures that will be taken to mitigate negative impacts on the marine environment that are likely to arise from the proposed project activities. • Channel deepening will be restricted to the width of the existing channel. • Undertaking work during low tide. • The monitoring programme specified in this report will be followed and reported in order to take necessary mitigation measures. • Channel will be deepen to the required depth of – 3.0 m at low tide. • Sedimentation and siltation resulting from the proposed work activity will be minimised and contained within the area by using appropriate techniques such as undertaking the works in low tide to reduce spreading of sediment and silt plumes to the lagoon floor, lagoon water and the coral reef. • The excavation will be carried out by placing the excavator on a barge. • The excavated material will be transported to the island and will be used as a beach replenishing material.
Establishment of a groyne field	Groynes are coastal structures built approximately normal to the shoreline. Their purpose is to trap sand and thereby increase the width of the beach. For groynes to be effective, there must be a supply of sand from either longshore transport or from beach nourishment. Since the island has lost large amount of sand.	Following are the specific mitigation measures that will be taken to mitigate negative impacts on the coastal environment that are likely to arise from the proposed project activities. • Groyne fields will be designed in such a way that the number and length of groynes are kept to a minimum so as to reduce visual impacts. Groyne fields have greater visual impacts than

Environmental Aspect	Potential Impacts to the environment	Mitigation Measures proposed
		submerged breakwaters. • The groyne fields will be developed using the existing materials which had been used to construct the groynes. Additional materials will be used as cement-sand bags. • No corals will be mined to construct the groyne field.
Construction of a submerged breakwater	The construction of the breakwater will have a significant positive impact on the northern, western and eastern side beachline in stabilizing the beach. The impact of proposed breakwaters would be mainly related to changes to hydrodynamics and sand transport. Since the breakwater can be dismantled and removed if necessary, the impact of constructing breakwaters is considered reversible. The impact on sand transport around the island would be a significant impact but a desirable one. Wave energy will be considerably reduced by the breakwaters and therefore long shore transport sedimentation will be reduced thereby stabilizing the shoreline.	Following mitigation measure is proposed. • It is important to undertake work at low tide hours, especially when laying the based of the submerged breakwaters. However, if wave action is too high, mean to high tide hours may be better.
Replenishment of the eroded beach	The replenishment of the eroded beach will undertake by using the excavated material from the channel deepening and the sand pumped from the lagoon western side of the island. Beach erosion is a major environmental issue facing the island. Even at present, several large trees have been lost due to erosion. Beach replenishment will be undertaken on northern and western side of the island. Therefore the lagoon in this area will be directly impacted due to complete alteration of the lagoon bottom and spreading of sediment plumes from the filling material. Approximately 4000m² of the lagoon will be directly impacted during filling period. With this, there is the possibility of increased sedimentation in the lagoon. If the work is carried out in north-east monsoon, then the impact of sedimentation will be felt mostly on the western side of the island reducing the chance of impacting on the coral reef which is located on northern side of the island. Beach replenishment and filling is usually associated with the direct and permanent alteration of the fill area and indirect impacts resulting due to sedimentation. Turbidity increase is almost an unavoidable consequence but can be minimized. In general, the following impacts will be felt. • Turbidity increase in the water column from spreading of silt plumes. When lagoon floor is disturbed by filling, fine sediment and silt may be released	The most important mitigation measure is to control sedimentation as it is the main factor that can cause the greatest impact on the coral reef. Hence, most of the mitigation measures proposed are centred around reducing sedimentation. More specifically the following measures will help to reduce the impacts. • Working during low tide hours. • Creating a bund wall around the fill area initially and then filling inside this bund using excavated material. The existing sand cement bags could be used as this bund wall. The bund will be removed after the beach replenishment work. • Completing the filling works in the shortest possible time period. • Only replenish the required area of the beach • Using coarse dredge material to make the bund rather than fines.

Environmental Aspect	Potential Impacts to the environment	Mitigation Measures proposed
	into the water column. • Lagoon sediments consisting of varying sizes of particles may be suspended for hours in the water column cutting down light to photosynthetic reef benthos. The magnitude of this impact will depend on various factors such as size of particles; hydrodynamic conditions; and reef and lagoon topography. In addition to this many infauna and their habitats will be lost. • Possible siltation and excessive sedimentation in the lagoon system • Excessive sedimentation and siltation on coral reefs is detrimental to corals and other reef benthic organisms as it cuts down necessary light and physically smothers corals. It is not expected that the beach replenishment will have an impact on the coral reef system of the island Long-term ecological impact arising from the proposed work activities is not predicted to be significant as the proposed work is limited and localized in a small part of the island system. However, long-term monitoring is required to identify ecological impacts more completely and thoroughly.	
Reusing coral from demolition waste	The executive arrangement for managing the waste, as mentioned in the initial EIA is to recover the reusable material from the construction waste stream and then dispose the residual construction waste at a designated waste disposal facility. Therefore, it is best to recycle them as aforementioned decorating purposes which would not result in any impact to the environment. One aspect that has not been included in the initial EIA is reusing coral rubble from old buildings in the construction of new buildings for decorative purposes. The 530 cubic feet big coral rubble that have been collected would be re-used only on the outer layer of building walls, while concrete blocks would be utilised as the main building material. The reusing of the corals that had recovered from the demolition waste stream does not have any impact on the natural, biological and a biotic environment of the island.	The coral that had been recovered from the demolition waste stream will be reused. Hence, no new corals will be mined or corals from the existing corals will be used. The project manager at the site, will ensure that no new coral is mined and existing corals on the groynes is for this purpose.

Table 2: Matrix of the impacts, their significance and characterization

Impact indicator	Impact type (NEG or POS) +	Significant (H/M/L)*	Direct	Indirect	Magnitude # (N/M/MA/MoA/MaA)	Short term	Long term	Unavoidable	Reversible	Irreversible	Cumulative	Mitigation Required
Deepening the existing channel	Neg	M	X	X	M	X	X	X		X		X
Sand pumping for beach nourishment	Neg	L	x		N	X		X	X	-	-	X
Establishment of the groyne fields	Neg	L	X	X	M	x		x	x			x
Construction of the submerged breakwater	Neg	L	x	x	M	x		x	x			x
Replenishment of the eroded beach	Neg	L	X	x	M	x	X	x	X		X	X
Re-use of corals recovered from the waste stream	Neg	L		x	N	x			X			

+ POS = positive impacts, NEG= negative impacts

* H=high, M=Moderate, L=Low

N=Negligible, M=Minor, MA=Minor Adverse; MoA= Moderate adverse; MaA=Major Adverse

5 Alternatives

EIA Regulation requires two alternatives to be suggested for such developments and therefore two alternatives have been suggested in addition to the no project alternative. The no project option has been described in the EIA report and hence that aspect has not been covered in this Addendum. These alternatives are discussed below:

5.1 Alternative methods to protect the beach

There are a number of options for shore protection on the western and northern side of the island. Since wave action is the main concern in Athuruga, a structure that protects the area in its lee from wave attack, i.e. a breakwater is considered the most suitable solution. Some impractical options such as floating breakwater and regular beach replenishment have not been considered.

Based on the above, the suitable options that may be considered during the design of the second phase are:

- Emerged breakwater
- Artificial reef
- Artificial headland
- Seawall or revetment along the coast

5.1.1 Emerged breakwater

The emerged breakwaters were popular coastal protection features in the resorts. However, the emerged breakwater has an aesthetic impact that had become unpopular. The emerged breakwater functions like a submerged breakwater but these are designed to prevent overtopping of waves and keep the lee side of it calm. The biggest disadvantage with emerged breakwaters is that the complete prevention of wave overtopping will make the leeward side too clam that sediment build up reaches to a level that will result in the beach connecting to the breakwater. This is a result that is not desirable. Hence, emerged breakwaters are not considered.

5.1.2 Artificial reef

Artificial reefs on the western, northern and eastern side would be similar to submerged breakwater in terms of design but with a greater base and lower crest. Since the western side is the sandy lagoon area, creating an artificial reef using submerged structures similar to “reef balls” or similar substrate may be useful. Once the reef balls are in place, coral growth will take place, if not, it can be induced by artificial coral transplantation that helps to populate the area with live corals.

Figure 7: Mould of a reef ball structure - a habitable environment for marine organisms

5.1.3 Artificial headlands

The natural headlands of a pocket beach restrict long-shore sand transport. Such headlands act as groynes. Artificial headlands can be constructed to achieve a similar effect. On the open coast, this form of protection requires large and expensive structures. Consequently, their use has been restricted to more protected shallow areas with less severe wave conditions. Therefore, it is not considered suitable for Athuruga. Yet, these would be given further consideration during the final design of the second phase of the proposed project.

5.1.4 Seawall or revetment

Instead of submerged breakwaters or groyne field, a seawall, low retaining wall or a revetment along the entire length of the western, northern and eastern shoreline may be considered. The seawall is considered inappropriate for the resort because it is seen at all times, whereas a low retention wall would be seen only when exposed after a storm event or following wave attack during the southwest monsoon. A revetment is similar to seawall but is inclined according to the profile of the beach. In Athuruga, revetments on eastern and northern side would have to be made quite strong if they were to be kept intact. Hence, revetments, seawalls and low retention walls are considered inappropriate for Athuruga. However, they will help to protect the properties behind them from the threats of erosion.

5.2 Alternative method to deepening the entrance channel

The current project proposes to excavate the channel using an excavator placed on a barge. This method will have significant logistical difficulty during the construction stage. One alternative to minimize this impact is to employ a cutter-suction dredge which will be easy to operate and will reduce the amount of silt suspended in the water column. Use of cutter-suction dredger is not very suitable for such a small scale project, and therefore is not economically justifiable due to high cost of mobilization and operation.

The other option would be to use a sand pump. Sand pumps are less costly and causes less sedimentation. Even if sand pumps were to be used, the sand shall be pumped onto barge and transported to land as the distance to cover if the pump were to pump directly to land would reduce the efficiency of the pump. Also, similar to the dredger the pumped sand would be more compact than excavated sand. Therefore, excavator is preferred over the sand pump to minimize compaction and ensure that the sand can be easily sorted or sieved and used for future beach replenishment, etc.

5.3 Continuous Re-nourishment of the beach

Re-nourishment would be an ongoing process, but the proposed coastal protection measures such as the groyne field and the breakwaters would help to minimize the frequency of re-nourishment. It is estimated that re-nourishment may be required twice a year if no coastal protection is undertaken.

5.4 Alternative to Corals recovered from demolition waste

An alternative to reusing the coral rubble that is recovered from the waste stream is to destroy the corals completely so that it cannot be further reused or transport it to the landfill at Thilafushi.

Destroying the coral rubble that had already been collected from the demolition waste stream can be done in several ways, all of which would not be of any particular benefit to the environment. It is not guaranteed that even if recovered corals are transported to Thilafushi that it would be destroyed. It is most likely that these corals will be picked by scavengers at Thilafushi and sold in the market.

The destruction would also include an additional cost, which could be easily avoided by opting for a simple, yet effective waste management strategy such as reusing or recycling the corals.

6 Environmental Management and Monitoring

The monitoring programme given in the EIA report will be followed. No further monitoring needs are considered at this stage. It is also worth mentioning here that additional monitoring (not included in the EIA report) are being considered using satellite imagery and aerial photography.

6.1 Monitoring Report

A detailed monitoring report will be compiled after the completion of the construction period based on the data collected for monitoring the parameters included in the monitoring programme. This report will be submitted to the Ministry of Tourism, Arts and Culture. Annual monitoring reports will be provided at the end of every monitoring year in order to adhere to Schedule M of the EIA Regulations, 2007.

Appendix

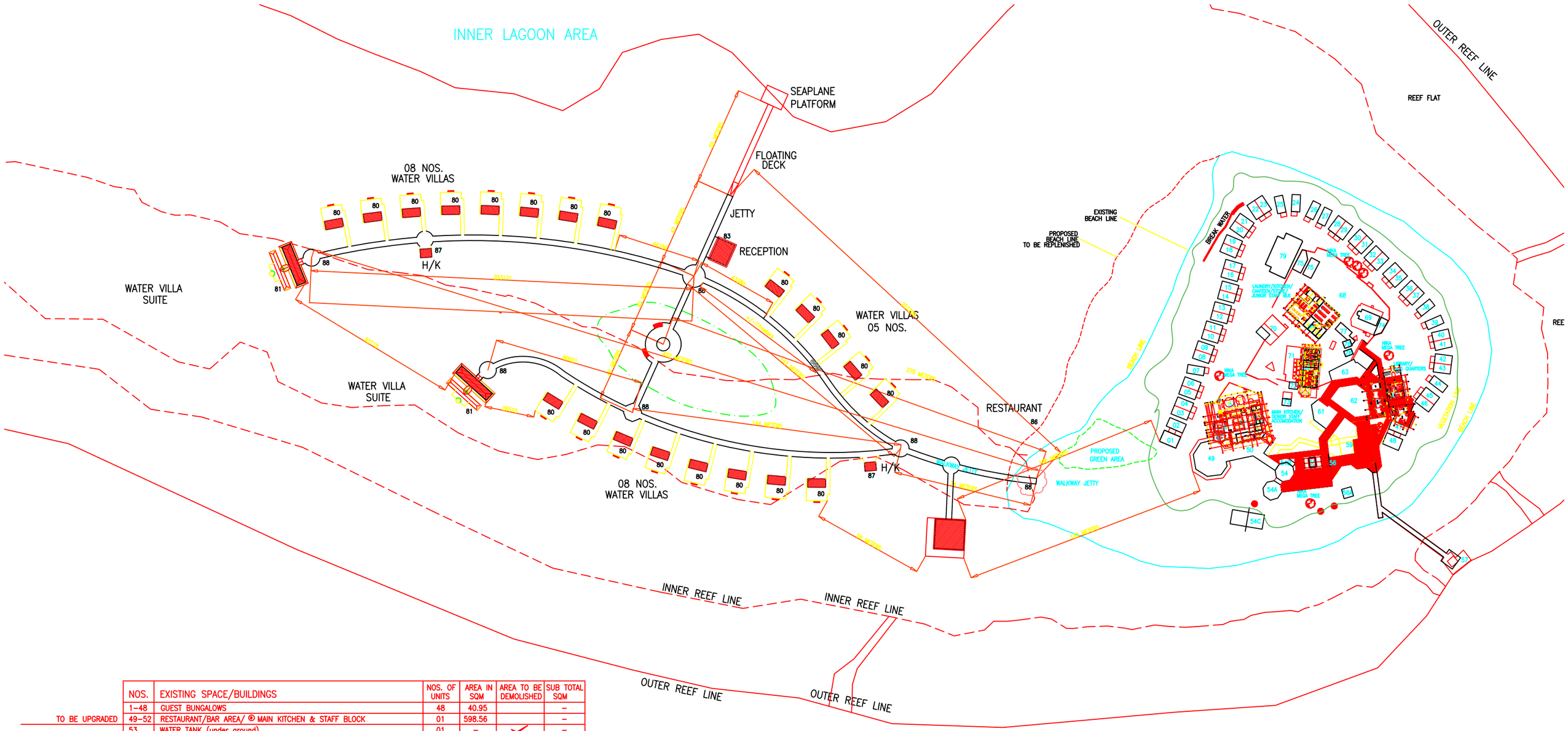
Plate 1: Erosion is causing severe damage to the terrestrial vegetation on western side of the island

Plate 2: Erosion is treating the some of the beach bungalows on northern side of the island

Plate 3: A groyne and sand cement bag near shore breakwater constructed to combat erosion

Plate 4: recovered corals from the demolition waste stream

New Site Plan



	NOS.	EXISTING SPACE/BUILDINGS	NOS. OF UNITS	AREA IN SQM	AREA TO BE DEMOLISHED	SUB TOTAL SQM	
	1–48	GUEST BUNGALOWS	48	40.95		–	
TO BE UPGRADED	49–52	RESTAURANT/BAR AREA/ ⓒ MAIN KITCHEN & STAFF BLOCK	01	598.56		–	
	53	WATER TANK (under ground)	01	–	✓	–	
	54	DISCOTECH	01	66.35		–	
	54 A	DISCOTECH EXTENSION	01	66.35		–	
	54 B	DJ BOOTH	01	15.46		–	
	54 C	VOLLEY COURT	01	–		–	
	55	BEACH BAR	01	17.87		–	
	56	WATER SPORT CENTRE	01	28.23	✓	–	REVISED
	56 A	SAIL HUT	01	26.19		–	
	57	MAIN JETTY	01	–		–	
TO BE UPGRADED	58–61	RECEPTION/OFFICE/DIVE SCHOOL/ROOM–TO BE REPLACED OF BOUTIQUE	01	606.94		–	
	62	COURT YARD (Open Area)	01	–		–	
TO BE UPGRADED	63	SHOP/BOUTIQUE TO BE REPLACED OF LIBRARY/GM QUARTERS	01	120.70		–	
TO BE UPGRADED	63 A	SHOP/BOUTIQUE TO BE REPLACED OF DIVE SCHOOL	01	139.95		–	
TO BE UPGRADED	64	STAFF ROOMS TO BE REPLACED OF EXECUTIVE STAFF ROOMS	01	139.93		–	
	65	POWER HOUSE AND DESALINATION PLANT	01	92.74		–	
TO BE UPGRADED	66–68	STAFF KITCHEN/QTRS/MECHANICAL ROOM/LAUNDRY	01	698.39		–	
TO BE REFURBISHED	69	MOSQUE	01	47.94		–	
	70	INCINERATOR WITH TEMPORARY SHED/PHONE BOOTH	01	41.75		–	
	71	OIL FARM STORAGE	01	–		–	
	72	COMPRESSOR ROOM	01	24.36		–	
	73	DIVING EQUIPMENT ROOM	01	16.81		–	
	74	HOUSEKEEPING STORAGE	01	33.18	✓	–	
	75	TEMPORARY DRYING AREA	01	100.68	✓	–	
	76	PUMP ROOM/OVERHEAD WATER TANK	01	14.62	✓	–	
	77	TEMPORARY WORKSHOP AREA	01	45.75	✓	–	
	78	TEMPORARY STORE	01	14.62	✓	–	
	79	LAND SPA (TO BE CONVERTED AS PER CLIENT DECISION)	01	265.96		–	
					EXISTING BUILD UP AREA	5188.94	
					TOTAL BUILD UP AREA TO BE DEMOLISHED	237.08	REVISED
					TOTAL EXISTING BUILD UP AREA AFTER DEMOLITIONS	4951.86	REVISED

NOS.	PROPOSED SPACE/BUILDINGS	NOS. OF UNITS	AREA IN SQM		SUB TOTAL SQM	
80	PROPOSED WATER BUNGALOWS	21	42.75		897.75	REVISED
81	PROPOSED WATER BUNGALOW SUITE	02	120.99		241.98	
83	PROPOSED RECEPTION	01	89.35		89.35	
84	PROPOSED LAGOON SPA	01	228.98	OMITTED	–	REVISED
85	PROPOSED BAR	01	89.35	OMITTED	–	REVISED
86	PROPOSED RESTAURANT	01	237.15		237.15	
87	PROPOSED HOUSKEEPING HUT	03	27.00		81.00	
88	PROPOSED BUGGY CART ROUND–BOUT	01	–		–	
				PROPOSED TOTAL BUILD UP AREA	1547.23	REVISED
				TOTAL EXISTING BUILD UP AREA AFTER DEMOLITIONS	4951.86	
				TOTAL PROPOSED BUILD UP AREA	6499.09	REVISED

NOTE:

EXISTING BUILDINGS

EXISTING BUILDINGS TO BE DEMOLISHED AND TO BE UPGRADED/REPLACED OF NEW BUILDINGS.

PROPOSED NEW BUILDINGS

TOTAL LAND AREA =	34,283.39 SQM	
EXISTING BUILT–UP AREA =	4951.86 SQM (14.44%)	REVISED
PROPOSED BUILT–UP AREA =	1547.23 SQM (04.51%)	REVISED
TOTAL BUILT–UP AREA =	6499.09 SQM (18.95%)	REVISED

SITE PLAN 1:2000

LAND AREA = 34,283.39 sqm

N

ATHURUGAU ISLAND RESORT

ALIF DHAALU ATOLL

19 APRIL 2009

ARCHITECT
Hannan Yoosuf Architects
RADIUMGE (1ST FLOOR) RAHDHEBAI MAGU
GALOLHU MALE' 20004 MALDIVES
TEL: (960) 331 8765 FAX: (960) 331 8763
EMAIL: info@hyarch.net WEB: hyarch.net