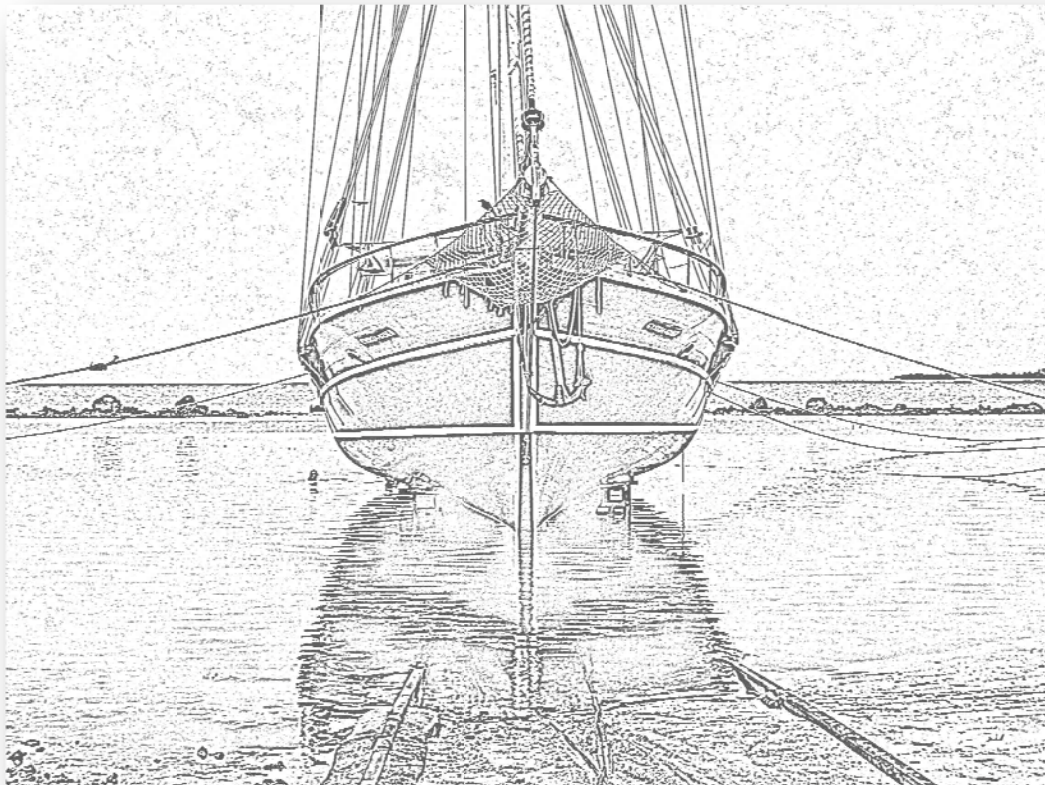

ENVIRONMENTAL IMPACT ASSESSMENT
For Development of a
Slipway at Raa. Vandhoo



Mohamed Fulhu

By Miruza Mohamed
2011

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Executive Summary

This EIA report is prepared in accordance with Environmental Impact Assessment Regulations, 2007 under the Environmental Protection and Preservation Act (Act No. 4/93). The purpose of this EIA is to fulfill the requirement of the Law and to conduct an assessment of possible impacts on ecological, biophysical and human environment arising from proposed development project of Slipway Development in Vandhoo in Raa Atoll, Maldives. The project is proposed by Mr. Mohamed Ali Fulhu (Naares, ID card number A-092574, Mobile: +9607784393) a successful businessman from the island of R. Innamaadhoo. The main construction activities of the proposed project involve development of a slipway and its associated infrastructures to accommodate working staff at Vandhoo. These include dredging a small basin and an entrance channel, construction of a small accommodation facility for 15 staff. All these development activities will be carried out at the land and sea area leased to the developer by the Government authorities. The allocated area is on the southeastern side of the island. The construction activities will be completed within six months from the start of the construction phase. The project cost is estimated as Maldivian Rufiyaa 11,383,300/00.

The proposed slipway is 300ft long and 200ft wide. The slipway will be attached to the coast of the island and consisted of concrete flooring at the lagoon area which is sloped to facilitate beaching of vessels. A narrow entrance channel of about 18m wide will be dredged to make access to the slipway possible. The main operation of the project will be boat building and repair operations. This will include boats of all types and sizes that are below 140 feet in overall length.

Baseline environmental conditions at the project site indicated that the coral cover around the slipway basin area was low (about 2%). The coastal vegetation around the proposed slipway area was mainly kaani, ruh, boashi, hirundhu and dhiggaa, and does not represent any specific preservation value.

Need and justification of the project

Vandhoo is on the eastern rim of geographic Raa Atoll. The island is uninhabited and remained as an agricultural island for the residents of near by island. There is no safe access to the island. Many people of R. Innamaadhoo and R. Rasmaadhoo would like to use the island as a site for boat building. To date most of the boat building of these two islands is being carried out within these small inhabited islands triggering health and other social problems. It is important to note that a school is also located adjacent to the boatbuilding area of Innamaadhoo causing disturbances. Hence it is very important to relocate the boatbuilding activities to an area away from human settlement. For this purpose no land is available at Innamaadhoo.

The Cabinet has also decided to lease a part of land from R. Vandhoo for the development of a slipway on its meeting at 31st August 2010 (Ref 2010-651 Press Release, The President's Office).

Thus the project is in conformity with the policies and strategies of the government. This project is also vital to reduce the impact of health hazards associated with boat building in Innamaadhoo.

Key impacts

Key impacts of the proposed development are related to a few activities of the project. These include impacts to the lagoon and reef area from slipway basin excavation, disposal of excavated materials and impacts to the coastal vegetation in the area. Project will also generate non-biodegradable waste including concrete waste. Key impacts of the project are found to be significant in short-term however, justified weighed against socio-economic positive impacts to the residents of Innamaadhoo.

Long-term ecological impacts of the proposed project can only be assessed through long-term monitoring of the entire island environment in relation to the proposed development and operation.

Mitigation measures

Mitigation measures were taken by conducting appropriate field surveys and environmental assessment of the island, proposed and alternative locations for development of the slipway. The proposed location is based on extensive field surveys to identify the best locations and scale of the proposed slipway. Consultation among the proponent, the community and the environmental consultants were conducted to find the most appropriate development options, methods, scale and timing in order to mitigate and minimize potential impacts due to the proposed development project. Optimum size and orientation of the slipway were proposed based on extensive consultations with the island community and technical experts. Specific measures will be taken during construction and of the slipway to reduce and mitigate negative environmental impact. These include selection of best location to protect the beach, selection of minimum required size of the slipway based on the size of boats used in the region. Waste minimization, relocation of the plants and corals that would be removed and environmental monitoring of the slipway development and operation will be conducted to mitigate negative impacts that may arise from the project.

Alternative development options

Alternative for the proposed development were alternative location of the slipway, and "no development" option. Alternative location of the slipway is moving the slipway about 300m west so that the slipway will be at the beautiful beach area. The alternative location was proposed by the EIA consultants with the consent of the island community. However, this alternative was found to have negative impact as it will have the potential to block the sand

movement creating potential erosion problems. Therefore, the proposed location of the slipway near bay area at the south east will be selected to. The alternative of 'no development' option was found to have negative socio-economic impacts such as health (respiratory) issues and noise pollution due to the continuation of boat building at the Innamaadhoo

Therefore, from an environmental and technical point of view and in light of the existing socio-economic developments it appears justifiable to carry out the proposed project.

Chapter 1

Introduction

1.1 Purpose of this EIA Report

This report is an Environmental Impact Assessment (EIA) for the construction of a slipway in R. Vandhoo . This document has been prepared to fulfill the requirements of Clause 5 of the Environmental Protection and Preservation Act (Act No. 4/93) and the EIA regulation (2007) of the Maldives.

1.2 Project Overview and Background

Boat building activities are mostly carried out in inhabited islands. To date most of the boat building of R. Innamaadhoo and R. Rasmaadhoo is being carried out within these small inhabited islands triggering health and other social problems. It is important to note that a school is also located adjacent to the boatbuilding area of Innamaadhoo causing disturbances. Hence, it is important to relocate the boatbuilding activities to an area away from human settlement. For this purpose no land is available at Innamaadhoo.

Vandhoo, an uninhabited island is an agricultural island for the residents of near by islands. Many people of R. Innamaadhoo and R. Rasmaadhoo would like to use the island as a site for boat building.

The Cabinet has also decided to lease a part of land from R. Vandhoo for the development of a slipway on its meeting at 31st August 2010 (Ref 2010-651 Press Release, The President's Office).

The Vandhoo Slipway Development Project aims to develop a modern facilitated slipway which will be customer satisfied to dock /undock and repair boats of all sizes and shapes in the country.

The project is expected to minimize the health and social problems arising from boat building activities carried out in the island of R.Innamadhoo. The project is also expected to create employment opportunities for Maldivian workers, with high priority given to islanders of R. Innamaadhoo.

1.3 Terms of Reference

The terms of reference for this EIA have been attached as an annex in Appendix A. This EIA has been prepared based on these terms of references.

Chapter 2

Policy, Legal and Administrative Framework

2.1 Overview

All the activities during both development and implementation stage of the proposed slipway development project will be carried out in accordance with existing plans, policies, guidelines, laws and regulations of Maldives and relevant international conventions to which Maldives is a party to.

2.2 Applicable Policies Laws and Regulations

2.2.1 Strategic Economic Plan

According to the Strategic Economic Plan, establishment of linkages among major ports, sub-ports and airports within the Maldives is very important particularly to fisheries, tourism and agriculture sector to facilitate the transportation of passengers and collection and distribution of marine and agriculture products. The Strategic Economic Plan highlights the following in its Ports and logistics services cluster.

Fisheries sector

- Collection and distribution of marine products around Maldives
- Export of fish through regional airports
- Replenishment of marine vessels

Agriculture sector

- Collection and distribution of vegetables and fruits around the Maldives
- Replenishment of marine vessels

Tourism sector

- Flying cruise
- Diversified group of visitors and business pursuits

Logistic services

- Attract freight forwarders and other logistic players to base in Maldives

Recommendations of Strategic Economic Plan included to ensure systematic and co-ordinate development of various key ports throughout Maldives as well as to avoid poor regulation of safety standards, adverse impact on environment and duplication of resources, development of a master plan for the port and logistic sectors.

2.2.2 Transport Master Plan

The Transport Master Plan highlights the issues of scattered geography and the limited transport opportunities that further add to remoteness and isolation of the island communities from the more developed centers and that isolation is an important element of poverty in many atolls.

Access problem were reported by half of the atoll population due to problems with slipways, absence of jetties, or enclosed nature of the islands by the coral reefs. These factors greatly contributed the unbalanced development in the atolls compared Male'. For the past three decades public investment in Male' was more than 50% higher than in atolls. Recognizing the problem of this unbalanced development the government shifted its development strategy to the atolls to stimulate regional development in five regional growth centers, north, north-central, central, south-central and south of the country which will facilitate balanced provision of economic and social services. The Transport Master Plan emphasizes regional development and provision of basic infrastructure which includes slipways that will connect regional centers and surrounding islands with Male'.

According to the Transport Master Plan having an efficient and effective transport network that systematically link Male', the regional centers and the surrounding atoll will be the key to ensuring that socio-economic development of the country is distributed equitably.

2.2.3 National Environment Action Plan III

The aim of National Environment Action Plan (NEAP III) is to protect and preserve the environment of the Maldives and to sustainably manage its resources for the collective benefit and enjoyment of present and future generations.

The NEAP III identifies the environmental priorities and policy directions for the next five years. It addresses key issues and measures towards the protection of the environment, which will benefit present and future generations. The NEAP III aims to achieve six results:

- Resilient Islands
- Rich Ecosystems
- Healthy Communities
- Safe Water
- Environmental Stewardship
- Carbon Neutral Nation

NEAP III also contains environmental policies and guidelines that should be adhered to in the implantation of Vandhoo slipway development project activities

2.2.4 National biodiversity strategy and action plan

The goal of the National Biodiversity Strategy and Action Plan (NBSAP) are:

- Conservation of biological diversity and sustainable utilization of biological resources
- Build capacity for biodiversity conservation through strong governance framework and improved knowledge and understanding
- Foster community participation and support for biodiversity conservation

Consideration of the goals of NBSAP shall be taken into account in implementation of Vandhoo slipway development project activities for minimizing potential loss of biodiversity in the area.

2.2.5 Protected Areas and Environmentally Sensitive Areas

Under article 4 of the Environment Protection and Preservation Act of Maldives, the Ministry of Environment is vested with the responsibility of identifying and designation of protected areas and natural and drawing up rules and regulations for the management of protected areas and natural reserves in the country.

In the proposed project site or in the vicinity of the site there is no protected area. The site surveys showed that there no environmentally sensitive areas close to the proposed slipway development site.

2.2.6 Environment Law

It is important to note that the Article 22 of the Constitution of Maldives provides guidance on the protection of the environment and sustainable development. According to this Article no development project will go ahead if its impacts are detrimental to the environment.

The environment law, Law No.4/93 Environment Protection and Preservation Act of Maldives was enacted in April 1993 as an umbrella law to protect and preserve the environment of the country. The articles and clauses of the law are given below. The clause 5 is directly related to slipway development project in Vandhoo and this study.

2.2.7 Environmental Protection and Preservation Act of Maldives (EPPA)

Introduction

1. The natural environment and its resources are a national heritage that needs to be protected and preserved for the benefit of future generations. The protection and preservation of the country's land and water resources, flora and fauna as well as the beaches, reefs and lagoons and all natural habitats are important for the sustainable development of the country.

Environmental guidance

2. The concerned government authority shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due considerations of the guidelines provided by the government authorities.

Environmental protection and conservation

3. The Ministry of Environment shall be responsible for formulating policies, as well as rules and regulations regarding the environment in areas that do not already have a designated government authority already carrying out such functions.

Protected areas and natural reserves

4. (a) The Ministry of Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protection and preservation.

(b) Anyone wishing to establish any such area as mentioned in (a) of this clause, as a protected area or a reserve shall register as such that at the ministry of Environment and abide by the rules and regulations laid by the Ministry

2.2.8 Environmental Impact Assessment (EIA)

5. (a) An impact assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment

(b) The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

The Termination of projects

6. The Ministry of Environment has the authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation

Waste disposal, oil and poisonous substances

7. (a) Any type of waste, oil, poisonous gases or any substance that may have harmful effect on the environment shall not be disposed within the territory of the Maldives.

(b) In case where the disposal of the substance stated in paragraph (a) of this clause becomes absolutely necessary, they shall be disposed only within the areas designated for the purpose by the government. If such waster is to be incinerated, appropriate precautions shall be taken to avoid any harm to the health of the population.

Hazardous/ Toxic or nuclear wastes

8. Hazardous/Toxic or Nuclear Wastes that is harmful to human health and the environment shall not be disposed anywhere within the territory of the country. Permission shall be obtained from the relevant government authority at least 3 months in advance for any transboundary movement of such wastes through the territory of the Maldives.

The penalty for breaking the law and damaging the environment

9. (a) The penalty for minor offenses in breach of this law or any regulations made under this law, shall be a fine ranging between Rf 5.00 (five Rufiyaa) and Rf 500.00 (five hundred Rufiyaa) depending on the actual gravity of the offence. The fine shall be levied by the Ministry of Environment or by any other government authority designated by the ministry.

(b) Except for those offenses that are stated in (a) of this clause, all major offenses, under this law shall carry a fine of not more than Rf 100,000,000.00 (one hundred million Rufiyaa) depending on the seriousness of the offense. The fine shall be levied by the Ministry of Environment.

Compensation

10. The government of Maldives reserves the right to claim compensation for all the damages that are caused by the activities that are detrimental to the environment. This include all the activities that area mentioned in clause 7 of this law as well as those activities that take place outside the projects that are identified here as environmentally damaging.

Definition

11. This law:

(a) The “environment” means all the living and non-living things that surround and effects the lives of human beings.

(b) A “project” is any activity that is carried out with the purpose of achieving a certain social or economic objective.

Ministry of Environment has the mandates for protection and preservation of environment. In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000. Coral or sand will not be used for any purpose for the proposed project.

2.2.9 Regulation on sand and aggregate mining

This regulation addresses sand mining from islands and bird nesting sand bars. Sand and aggregate mining from beaches of any island whether inhabited or uninhabited is banned for protection of the islands. Permissions for sand and aggregate mining from other areas shall be obtained from the relevant authorities.

2.2.10 Regulation on coral mining

Coral mining from the house reef of islands and the atoll rim reefs is banned through a directive from the President's Office dated 26th September 1990. According to this policy coral mining shall not be carried out from house reefs of islands and atoll rim reefs and common bait fishing reefs. Coral and sand mining is only allowed for house construction from designated sites and approval from the concerned authorities is required prior to mining activities. Request for coral and sand mining from residents of inhabited islands are required to be submitted to the Atoll Offices through the respective island offices. The island office is required to estimate the quantities of coral or sand required for the applied construction work of houses to ensure that the permission is granted for minimum amounts required. Every island is required to maintain a log book of permissions granted and the amounts mined and the site where mining was carried out.

2.2.11 Regulation on cutting trees

The regulation on cutting down, uprooting, and digging out trees and export of trees and palms from one island to another was recently issued by the Ministry of Environment. Under Clause 5 (a) of EPPA prior to commencement of any project that may have a negative impact on the environment including cutting down, removal of trees/palms from one island and taking to another for the purpose of agriculture, island development/re-development, construction or to any other purpose shall conduct EIA. Such projects relating to impacts on trees can only commence upon approval from Ministry of Environment. Article 8 of this regulation requires permission to be obtained if more than 10 coconut palms that are grown to height of 15ft are to be removed. The Article 2 (d) of the regulation also enforces replacement of the vegetation that is lost by re-plantation. Logging of inhabited islands must be done under supervision of the island chiefs or an official appointed by the island chief.

2.3 International conventions, treaties and protocols

International conventions, treaties and protocols of most relevance to the proposed project may be identified as follows:

- **United Nations Convention on Biological Diversity (UNCBD).** The objective of UNCBD is “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies and by appropriate funding”.
- **The Marpol Convention.** International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Pollution and that from routine operations - and currently includes Prevention of

Pollution by Oil; Control of Pollution by Noxious Liquid Substances in Bulk; Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form; Prevention of Pollution by Sewage from Ships; Prevention of Pollution by Garbage from Ships; and Prevention of Air Pollution from Ships.

Chapter 3

Project Description

3.1 Project Proponent

The project is proposed by Mohamed Ali Fulhu, Naares R. Innamaadhoo. He has been working in this industry for the last 10 years.

3.2 The Project

The main construction activities of the proposed project involve development of a slipway and its associated infrastructures to accommodate working staff at Vandhoo. These include dredging a small basin and an entrance channel, construction of a small office/accommodation facility for 15 staff. A small workshop, powerhouse, Fuel and water storage tanks. All these development activities will be carried out at the land and sea area leased to the developer by the Government authorities.

The main operation of the project will be boat building and repair operations. This will include boat of all types and sizes that are below 140 feet in overall length.

3.3 Project location

The proposed development project is located in the island of Vandhoo in North Maalhosmadulu (Raa) Atoll at 05° 32' 07" N and 73° 02' 30" E. The closest islands to the project location are inhabited islands of Innamaadhoo approximately 1.5km and Rasmaadhoo about 3km north, and Iguraidhoo approximately 4.5km south of Vandhoo. The allocated area is on the southeastern side of the island Figure 1Error! Reference source not found..

Baseline environmental conditions at the project site indicated that the coral cover around the slipway basin area was low (about 2%). The coastal vegetation around the proposed slipway area was mainly kaani, ruh, boashi, hirundhu and dhiggaa, and does not represent any specific preservation value.



Figure 1: Location of the Slipway.

3.4 Project Duration and Schedule

The project is expected to commence as soon as the EIA clearance is sought and will be completed within 6 i 12 months.

3.5 Project justification

Vandhoo is on the eastern rim of geographic Raa Atoll. The island is uninhabited and remained as an agricultural island for the residents of near by island. There is no safe access to the island. Many people of R. Innamaadhoo and R. Rasmaadhoo would like to use the island as a site for boat building. To date most of the boat building of these two islands is being carried out within these small inhabited islands triggering health and other social problems. It is important to note that a school is also located adjacent to the boatbuilding area of Innamaadhoo causing disturbances. Hence it is very important to relocate the boatbuilding activities to an area away from human settlement. For this purpose no land is available at Innamaadhoo.

The Cabinet has also decided to lease a part of land from R. Vandhoo for the development of a slipway on its meeting at 31st August 2010 (Ref 2010-651 Press Release, The President's Office).

Thus the project is in conformity with the policies and strategies of the government. This project is also vital to reduce the impact of health hazards associated with boat building in Innamaadhoo.

3.6 Project boundaries

The construction work will be carried mainly on the reef-flat and lagoon of the island. The project site is rather un-altered. The dredging of the slipway will have a significant direct impact on the seabed and its associated flora and fauna. This direct impact area will be limited to the 300ft by 200ft slipway basin. The indirect impact area in relation to sedimentation will be felt all around the slipway area.

There will be a minimal loss of coastal vegetation near the slipway area to pave the way for slipway utilization. It is worth noting that a large portion of the land for slipway utilization was already cleared with a relatively low cover of coastal vegetation.

3.7 Project inputs and outputs

Major inputs of the project included:

- construction materials – cement, rock aggregates, river sand, iron bars, timber, wood-flakes etc.
- machinery and equipments – excavators, dump trucks, barges, concrete mixers.
- workforce – locals and expatriates.

3.7.1 Mobilization

Excavators, concrete machines and truck will be brought to the island in a barge. All other construction related material will be brought to the site on barges.

All materials will be stored at the project construction site. Activities and heavy equipments that will be used in this project are given below. These are equipments that are typically used in Access Improvement Program's slipway construction.

All workers for the project will be accommodated at the island. Rooms will be rented to accommodate project staff. A total of about 40 staff will be involved for the project's construction work.

Table 1: Activities and equipments to be used during the project.

Activity	Equipment & Machinery to be used
1. Excavation of access slipway entrance	1 Excavator of minimum 0.8m ³ bucket capacity per excavator
2. Excavation of slipway basin	1 Loader 1 Trucks – minimum 8.0 m ³ per truck
3. Installation of concrete railings of the slipway	1 Excavator

3.8 Method of construction

Land clearing

Trees are to be removed from the areas allocated as the slipway and the accommodation buildings. The coconut palms will be extracted in such a way that they can be planted. The open pits (tree wells) created on removing the trees could lead to groundwater contamination. The tree wells will be filled with soil and compacted using the excavator.

The immature trees and undergrowth removed from the project site will be stockpiled and then relocated.

Dredging the slipway basin

An area of 300ft by 200ft will be dredged to a depth of 3m from mean sea level adjacent to the slipway railings.

Construction of Slipway

A 200ft long slipway will be constructed on the shore to the mooring area using cement and iron bars, 1ft above mean sea level at high tide. The slope of the slipway would be 0.04. The construction of the slipway will be undertaken using an excavator and loader.

Construction channel to the slipway

An access channel will be dredged. This will enable easy access to the slipway area. Dredged spoil will be disposed on land and will be used for construction of buildings.

Powerhouse and fuel management

The two 50kVA generation sets will generate electricity at 400 volt, 3-phase, 50 Hz, according to the requirements of Maldives Electricity Regulation. One generator will be used as a backup. Fuel will be stored on site in appropriately banded storage steel tanks and distributed to generator sets. Fuel supplies will be made using a pipeline.

Water and sewerage

Water for the construction and operation of the facility will be obtained from the island aquifer and rain. A freshwater storage facility of 20 ton will be constructed. The tanks of this purpose will be plastic readily available ones. All roofs will be connected to these tanks. Special emphasis will be given on harvesting all rain water possible.

The sewerage system will be based on septic tanks located in the slipway plot. The maximum number of staff permanently working in the project will be approximately 15 and hence the quantity of sewage would not require secondary treatment. Hence, it is proposed to dispose the sewage through septic tank systems into the soil. The sludge will be periodically removed and could be used as fertilizers or disposed.

Waste management

Waste storage areas will be designated on the site and a schedule for the timely collection and removal of construction debris to an approved dump site. While stockpiling construction waste, it will be sorted as much as possible into recyclable and non-recyclables. Any wood, steel, or other recyclable material will be recycled.

The use of heavy duty machineries and vehicles will generate hazardous wastes during the construction and operation of the slipway. Below are types of hazardous wastes that will be generated;

- Grease
- Used engine oil and fuels
- Empty engine oil cans
- Used oil filters
- Batteries
- Chemical storage bottles

3.9 Project risks and impacts

Potential risks associated with the project are damage to the marine environment due to sedimentation by excavation and clearance works. Chronic impacts such as this could be cumulative and long term.

Coastal modification involved with this project may have minor impacts on the littoral movement of the island. At present very little net beach erosion is observed.

Death and damage to live coral is inevitable in this slipway construction project. Impacts involved are sedimentation and smothering of live coral that are near the construction areas.

Positive socioeconomic impacts are envisaged by the proposed project. The construction of the slipway will enable the islanders to interact with other islands in terms of economic and social aspects.

Chapter 4

Survey Methods

The data collection, analysis and compilation of this impact study included:

- Assessment of existing environment to identify significant environmental components that would be impacted,
- Public consultations to exchange information on the project, and
- Literature review.

Data on existing environment was collected during the field visit to Vandhoo on 3rd 5th April 2010. General information on the existing environment was based on available secondary data, such as climatic data from other regions.

Both quantitative and qualitative methods were used to assess the coastal vegetation, marine benthic substrate and fish at the survey sites. Where possible and appropriate a 0.5 by 0.5m quadrat were used to quantify benthic substrates. Belt transects were used to assess (count) the fish community structure. Fish count and the invertebrates count were conducted on the same area where the quadrat survey was done. Visual assessment was used in sites where physical or weather conditions hinder the use of quadrat methods. This was mainly carried out using the 'timed swims' techniques.

This study was complemented with photographs of the areas in question. Methodologies adopted for these surveys are internationally accepted (English et al. 1997) and are widely used to assess the status of coral reefs and other coastal areas in the Maldives as well.

4.1 Vegetation transects

Qualitative surveys of vegetation around the project site were carried out. These include estimates of percentage canopy cover and identifying the dominant species. These surveys in most cases documented bushes and trees that are just at the forefront facing the beach. The Line intercept transect (LIT) method was used here. The length of the each transect was 50m. Only those that intercept with the tape are recorded. The commonly encountered vegetation was documented in their local Dhivehi names.

4.2 The manta tow technique

The manta tow technique was used to assess general status of the benthic communities of the entire western side, and two other locations on the south and north of the island's reef. It enabled visual assessment of large areas of reef within a short time. This technique was frequently used to determine the effects of large-scale disturbances such as those caused by

coral bleaching, outbreaks of *Acanthaster* (crown-of-thorn starfish) and storm damage. The technique was useful for selecting sites that are representative of the large areas of the reef. The technique involved towing of an observer, using a rope and a manta board, behind a boat powered by engine. Tows are carried out at a constant speed around the perimeter of a reef and are broken into units of 3 minutes duration. During each 3 minute tow, observations were made on several variables (e.g. percent cover of live coral, dead coral, soft coral, dominant fish, commercially important fish and protected species). These were recorded onto data sheets as categories of integer values and analyzed to determine the status of coral reef system.

4.3 Quadrat method for benthic substrate assessment

Quadrat method was used to assess the benthic substrate at the survey sites. Data from 21 random quadrats (0.25m² each) were taken from the selected representative sites on and around the proposed slipway development area. Quadrats were thrown randomly overhead in a demarcated area. Percentage cover of each benthic substrate is then recorded.

Quantitative percent cover data of morphological characteristics of the reef community is obtained using this method and it can be repeated over time to obtain temporal changes. Disadvantages of this method include difficulty in standardizing the life form categories and the limitation of the data collected, on percent cover and relative abundance (English et al. 1997). Quadrat method surveys produce valuable data even though they require considerable effort and skills to record underwater.

4.4 Timed-swim surveys

These surveys were carried out using snorkelling gear for both fish and benthic communities including live coral, dead coral, algae and other sessile organisms. Swims on a straight path were done on the selected sites. The duration of each swim was 15 minutes for benthic cover and an additional 15 minutes for assessing mobile organism such as fish that are conspicuous. There is a tendency to underestimate fish when using this method of fish senses. This results due to rare species not being effectively sampled and failure to observe all the fish present. However this method represents a quick and easy way of obtaining data in a limited time frame. The data obtained is valid and dependable and can be replicated.

4.5 Public consultation

Consultations were carried out with the, local people. Their concerns were heard and incorporated in the impact statement. Apart from the committees, leading people from the community provided valuable inputs in terms of coastal processes and beach movements.

Chapter 5

Existing Environment

5.1 General Settings of Maldives

The Maldives is an archipelago of islands in a double chain of coral atolls, 80 – 120km wide stretching 860km from latitude 7° 6' 30" N to 0° 41' 48" S and longitude 72° 32' 30 E to 73° 45' 54" E. The 25 atolls that comprise the Maldives archipelago contain more than 1,200 reef islands, the formation of which is poorly understood. Maldivian islands exist in the India Ocean monsoon environment where the wind regime is marked by strong seasonal reversals in monsoon winds from the west and northeast that govern short-term changes in island shorelines. Maldives experiences two major seasons: the southwest monsoon (SW monsoon, the wet season) and northeast monsoon (NE monsoon, the dry season). The SW monsoon occurs from May through October and the NE monsoon is from December through March. April and November are transition periods for the respective monsoons. The atolls are separated by east-west running deeper channels. The atolls vary in shape from circular and oval to elliptical. The total reef area of Maldives is 4,493.85 km² while the total land area is 227.45 km². Approximately 80% of Maldivian land area is less than 1m above mean sea-level.

The reef characteristics of the island vary considerably from north to south of Maldives. The northern atolls contain broad banks of discontinuously fringed reefs with small coral island with various path reefs. In the southern part, the depth of the lagoons increases and patch reefs are rare.

5.2 Geographic location and general setting of Raa. Vandhoo.

North Maalhos-madulu (Raa) Atoll is a large and complex atoll with many reefs, faros, channels and islands. The island of Vandhoo is in North Maalhos-madulu (Raa) Atoll at 05° 32' 07" N and 73° 02' 30" E. The closest islands to the project location are inhabited islands of Innamaadhoo approximately 1.5 km and Rasmaadhoo about 3km north, and Iguraidhoo approximately 4.5 km south of Vandhoo. Figure 2 shows the location of the island.

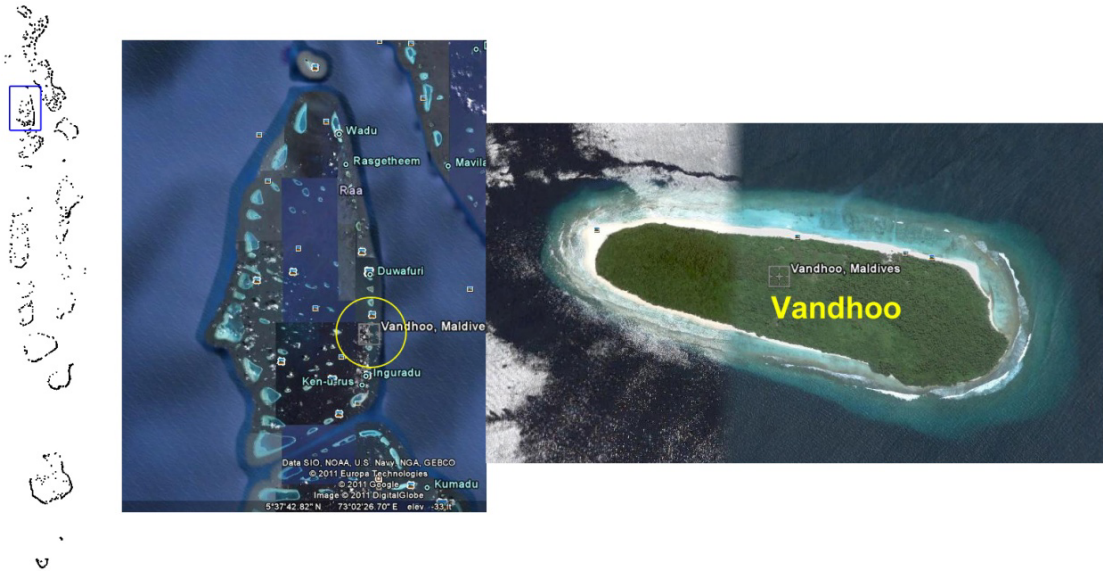


Figure 2: Location of Vandhoo.

5.3 Climatology

The Indian Ocean Monsoons governs the climatology of the Maldives hence monsoonal reversal plays a significant role in weather patterns. Two very distinct monsoons are observed: the Northeast (*Iruvai*) and the Southwest (*Hulhangu*) monsoon. Monsoons can be best characterized by direction of wind and the amount of rainfall. The southwest (SW) monsoon is the rainy season which lasts from May to September and the northeast (NE) monsoon is the dry season that occurs from December to February. The transition period of SW monsoon occurs from March and April while that of NE monsoon occurs from October to November. The results are summarized in Table 2.

Table 2: Summary of the seasons.

Season	Month
NE-Monsoon	December
	January
	February
Transition Period 1	March
	April
SW-Monsoon	May
	June
	July
	August
Transition Period 2	September
	October
	November

Since there were no site specific wind data, wind regime around the island was assumed to be that similar to the closest meteorological stations. The closest station is H. Dh Hanimaadhoo meteorological station. Wind data from Hanimaadhoo met station is used to analyze the wind pattern. Figure 3 below represents mean daily wind speeds and direction for H.Dh. Hanimaadhoo. As can be seen from the diagram the prevailing wind is from north-west and west for the majority of the year.

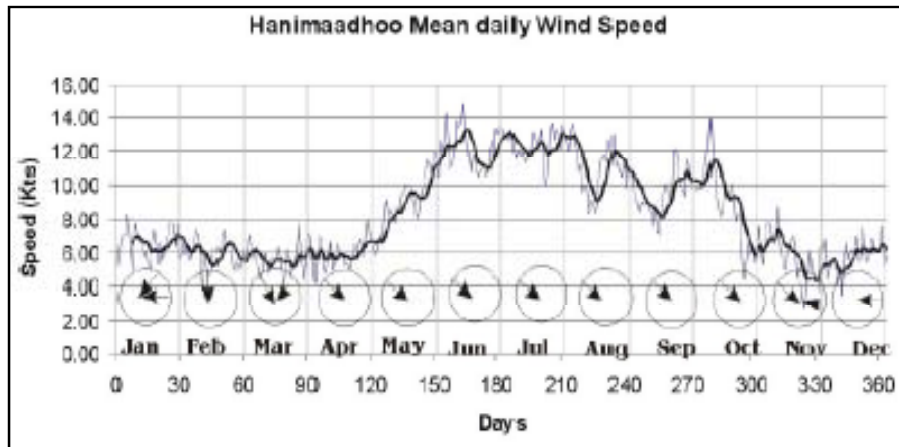


Figure 3: Mean daily wind speed and direction for Hanimaadhoo (Naseer, 2003)

In Figure 4 the right-hand side diagram is general wind rose for the Maldives (Environment 2005), central diagram is seasonally adjusted wind rose for B. Dharavandhoo (G.H Consultants 2006) and left is monthly average wind for HDh. Hanimaadhoo (DoM).

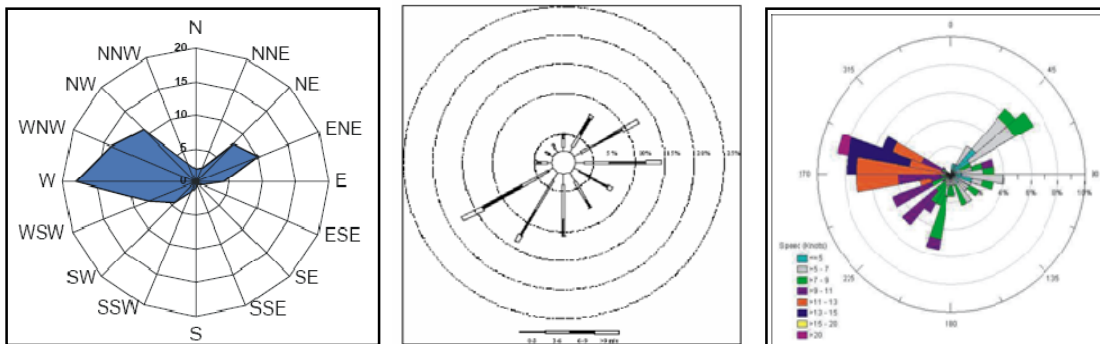


Figure 4: Wind characteristics

General wind characteristics for the Maldives and H.Dh. Hanimaadhoo shows that frequency of wind coming directly from the south is relatively less and the speed is low too. This suggests that the location of the Vandhoo slipway at the southern side of the island is appropriate since the slipway and the channel will be calmer most part of the year.

5.4 Tides and currents

Maldives experiences mixed semi-diurnal and diurnal tides with a strong diurnal inequality. Tide records at K. Hulhule, and HDh. Hanimaadhoo which can be applied for estimating tide levels at Vandhoo with reasonable accuracy. A tidal analysis (see Figure 5) shows that, the maximum tidal range to be about 1.20m. The highest astronomical tide level is +0.64m (Mean Sea Level) and the lowest astronomical tide level is -0.56m (MSL).

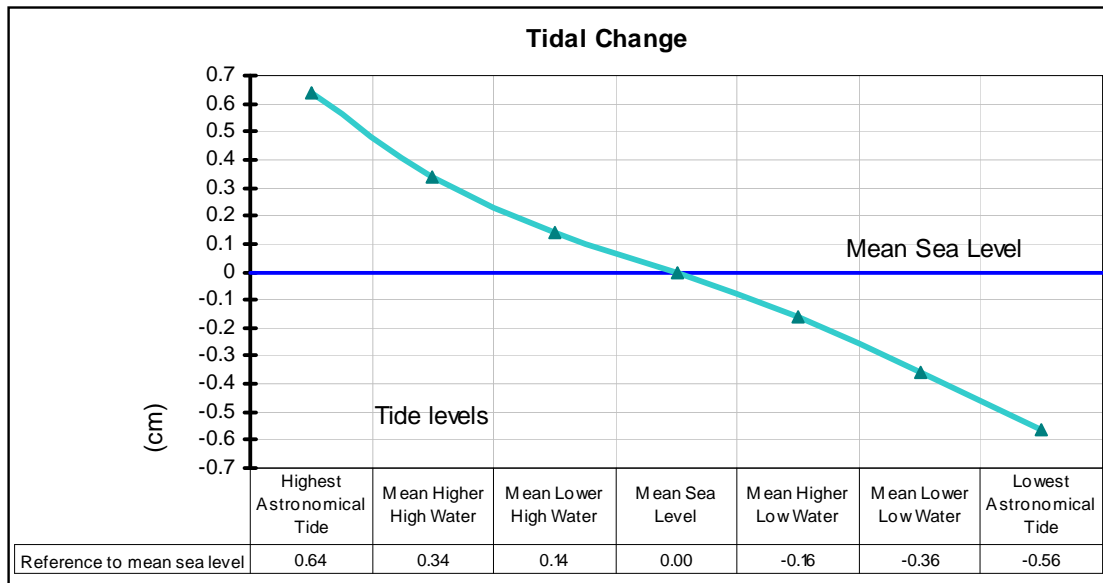


Figure 5: Astronomical tidal variation in Maldives, (Environment Maldives - SoE Maldives 2002)

In the Maldives tides have significant influence on the formation, development, and sediment movement process (coastal processes) around the islands. Tides also play an important role in lagoon and reef-flat water circulation.

The currents on the reef-flat and near the reef edge changes its direction daily with the ebb and flood tides. During the ebb tide the direction of current near at the slipway area is from west to east. When at flood tide the vice versa is seen. At flood tides the atoll basin is flushed with fresh oceanic waters.

During the low tide a large portion of the reef-flat is exposed to air in Vandhoo. The water level during the mean tide at the proposed slipway area is between 0.5 to 1m at MSL. In many cases some parts of reef-flat is exposed to air at low tide.

5.5 Waves

The coastal dynamics such as accretion and erosion of islands depends on wave energy. The type of beach and the beach materials also depends largely on the strength of wave energy. Vandhoo is exposed to waves generated by swells on the south-eastern side of the Island.

On the south-western, western and northern sides, short wind generated waves from the atoll lagoon are felt.

5.6 Sediment transportation

The beach and near-shore environments of Maldivian islands are composed of coralline and skeletal remnants derived from the reef. The sediments in this environment are mostly coral fragments, calcareous algae and foraminiferans. The major forces which produce sediment on the reefs are storm waves and waves driven by monsoon winds.

Tides and wave driven currents play a very important role in the transport of sediment around the islands. In Vandhoo, beach sediment movement is mostly from western to eastern side in SW monsoon. This movement takes place at the northern and southern sides. The sand pit on the north-eastern tip of the island grows very large at the later part of the SW monsoon.

During NE monsoon, the sediments on the northern side moves vice versa. The sand pit starts to shrink and the sand is thinly distributed on the entire northern coast.

Sediment movement is seen on the all parts of the island. In general beach around the island is quite stable except at eastern side where severe erosion is taking place.

5.7 The beach environment

Beach is normally defined as the white sandy area between the vegetation line and the lowest astronomical tide. Width of the beach varies with the tidal fluctuations. Several transects were obtained around the island to study the beach environment. Figure 6 shows the locations where the transects were obtained around the island.

ISLAND AND LAGOON SURVEY OF R. VANDHOO
PLAN MAP w/ BOUNDARIES

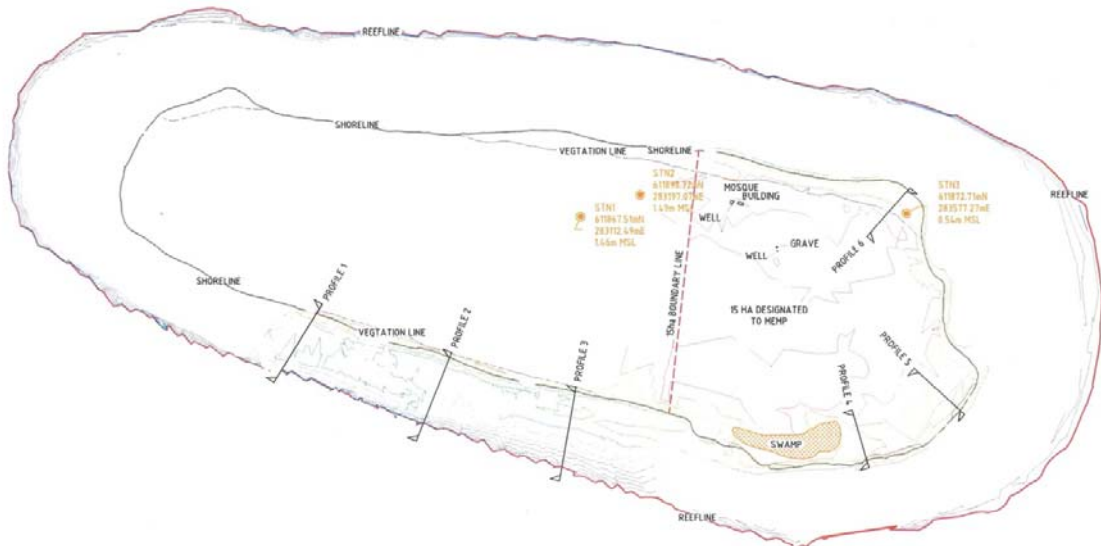


Figure 6: Locations where transects were obtained.

The beach area on the northern side of the island is larger compared to that on the southern side. Figure 7 shows a comparison of the beach area found on the northern and southern part of the island.

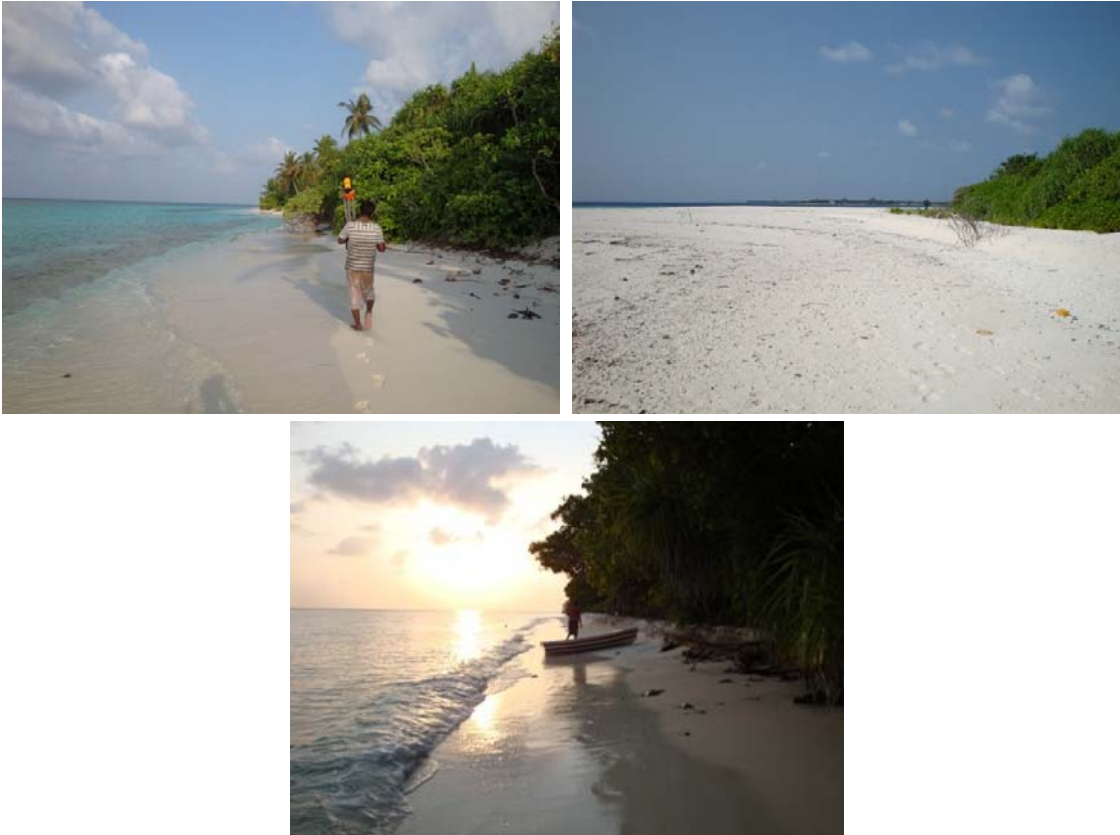


Figure 7: a) and b) showing the northern side beaches which are wider compared to the beach area found on the southern side.



Figure 8: a) beach around the project site and b) beach on the eastern side

Figure 8 shows the beach near the proposed project site and the beach on the eastern side. There is no significant beach area found on the project development site and the foreshore is dominated by beach rock. Due to wave action and erosion, there is beach found on the eastern side while it is dominated by rubbles. A large sand pit (*thundi*) was found on the

north-eastern corner of the island. Furthermore, a very large sandy area was on the western side of the island.

The island's shoreline is mainly made up of a sandy beach. Existing beach at the proposed slipway also consisted of fine grained sand derived from biogenic substances. Observations of the beach during the survey showed that the western, and northern side beach was much wider than the beach facing other sides of the island. The larger sand spit (*thundi*) on west of the island would be experiencing higher waves generated during the stormy SW monsoon. Therefore, it is likely that these sand pits undergo seasonal variations. No sign of net erosion at the proposed slipway area's beach was seen during the field visit.

5.8 Beach rock

Southern side of the island consisted exposed thin stretches of beach rock. This stretch of beach rock is approximately 100m long and 3m wide in average. The beach rock on south eastern side is approximately 100m long and 2m wide and less compacted than the beach rock on south eastern side. The rocky nature of the beach on the southern side is depicted in Figure 9.



Figure 9: Beach rock formations around the island

5.9 Beach erosion

Beach all around Vandhoo receives high wave energy due to the absence of extensive reef-flat all around the island. Continuous and seasonal beach erosion is found around the island. Continuous beach erosion is found in eastern and southern side of the island. Anecdotal information reveals that seasonal beach erosion in southern side of the island causes loss of coastal vegetation from this area.

In general continuous natural beach erosion of Vandhoo is considered slow however, the field surveys suggest that erosion in eastern side of the island is a serious issue.



Figure 10: Beach erosion on eastern side of the island

5.10 Beach profiles

Beach profiles give useful data on beach dynamics over long-term by providing beach height, beach width and estimated amount of beach materials in a given location at any given time. Beach profiles were taken in eight locations around the beach as a baseline for monitoring the beach sediment dynamics over long-term. The locations where the beach profiles were obtained are depicted in Figure 6. Beach profiles showed that beach height, beach width and beach materials are many times more in both ends of the island on western side.

Figure 11 and Figure 12 shows the beach profiles obtained on the western side of the slip way and that obtained on the north eastern side of the island respectively. The profiles too indicate that the beach area near the project location is virtually non-existent and a wider beach is seen on the north eastern side of the island. Rest of the beach profiles are found in Appendix F.

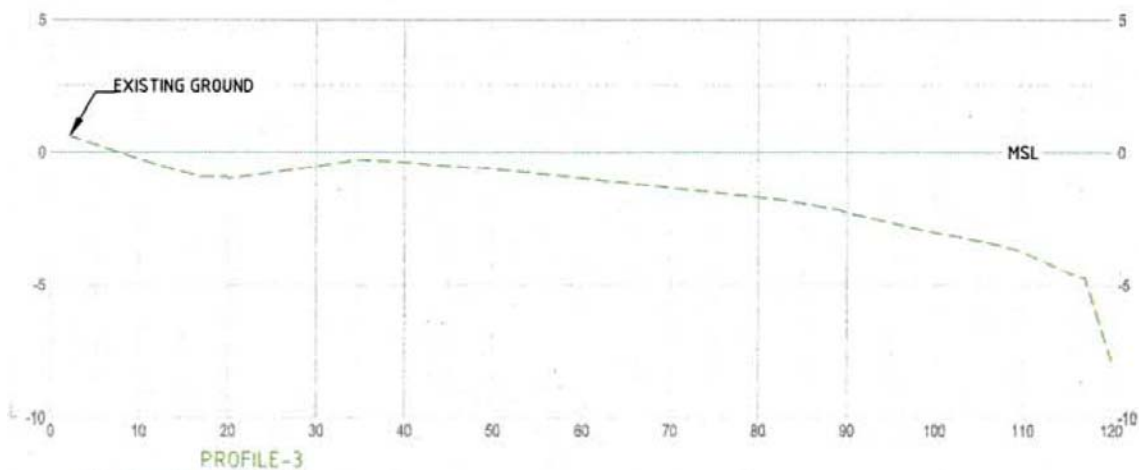


Figure 11: Beach profile 3 obtained on the western side of the slipway.

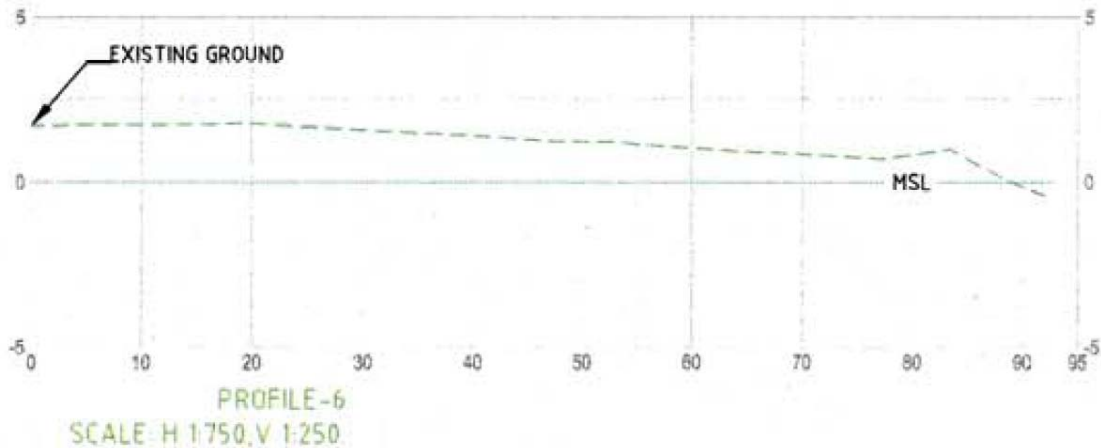


Figure 12: Beach profile 6 obtained on the north eastern corner of the island.

5.11 Coastal vegetation

Vegetation of the island can be categorized into two different main types; they are the coastal or the peripheral vegetation and the inner vegetation or the vegetation inside the island. The vegetation inside the island can be divided into thickly vegetated area at the central portions of the island, and sparse vegetation in other areas. Coastal vegetation is a belt of vegetation around the island that consists of more salt tolerant and bushy plants that are more adapted to coastal environment and plays an important role in protecting the island from beach and soil erosion. The inside vegetation consisted of larger and older trees that are less tolerant to salty water. The non-vegetated area is approximately 4.7 hectares which is 4% of the land area. The total vegetated area of the island is approximately 30 hectares. Figure 13 shows vegetation found near the existing jetty which is the proposed slipway area.



Figure 13: Coastal vegetation at the slipway area

Coastal vegetation around the island is intact in most areas except the northern side that are adjacent to arrival area. Quantitative surveys of the coastal vegetation in representative location and location that may be impacted were conducted. Three different areas were studied:

- **Area 1** – Western side of the slipway
- **Area 2** – At the slipway location
- **Area 3** – Eastern side of the slipway

Area 1 – Western side of slipway

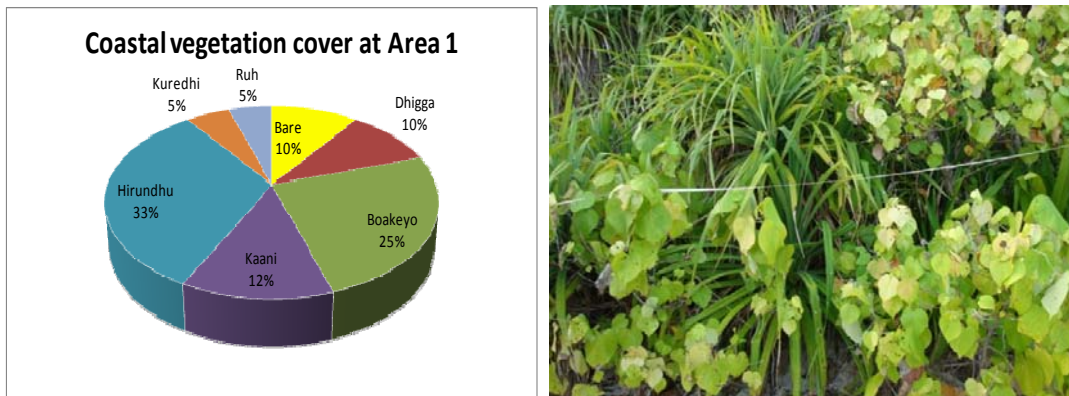


Figure 14: Coastal vegetation at Area 1, dominant vegetation Hirundhu

Area 1 is the west of the proposed slipway area. Three transects were carried out here. The coastal vegetation at this site consisted of four species and is dominated by Hirundhu covering approximately 33% of the area. Boakeyo in this area covered approximately 25% and Kaani covered approximately 12%. About 10% of this area has no vegetation.

Area 2 - proposed slipway area

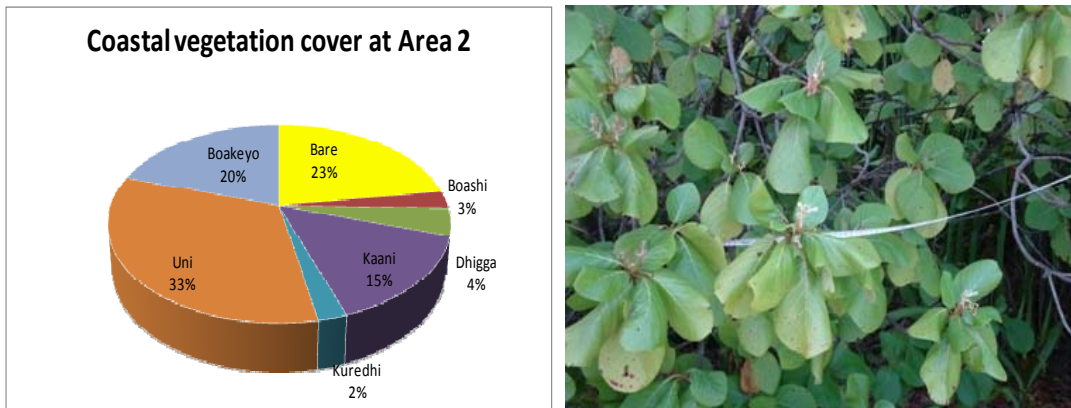


Figure 15: Coastal vegetation at Area 2, dominant vegetation Uni

Area 2 is the coast of the proposed slipway area. Three transects were carried out here. The coastal vegetation at this site consisted of six species and is dominated by uni covering approximately 33% of the area. Boakeyo in this area covered approximately 20% and Kaani covered approximately 15%. About 23% of this area has no vegetation.

Area 3 - eastern side slipway area

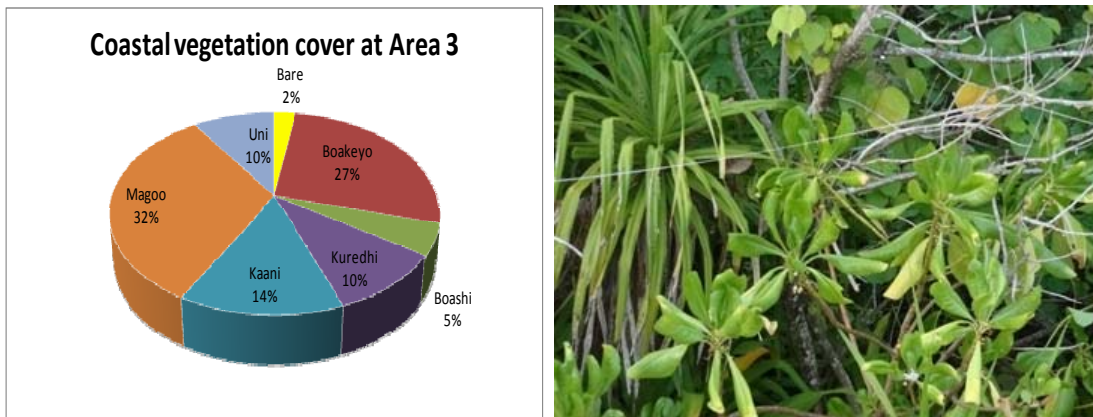


Figure 16: Coastal vegetation at Area 3, dominant vegetation Uni

Area 3 is the south-eastern side of the island. Three transects were carried out here. The coastal vegetation at this site is more diverse and consisted of six species and is dominated by Magoo covering approximately 32% of the area. Boakeyo in this area covered approximately 27% and Kaani covered approximately 14%. Only about 2% of this area has no vegetation.

Coastal vegetation of Vandhoo compared to most islands can be said as similar in terms of species types, diversity and percentage cover. However, composition of species is different compared to most similar island.

5.12 Soil Profiles

Soil profiles taken at the project location (Figure 17 and Figure 18) showed that soil was stratified into three main parts. They are dark soil containing the humus made of vegetation decay on the top, white a layer of coarse white sand below the dark soil without humus content and compacted sand forming the bedrock. Water was found below this bedrock. Dark soil was found to an average depth of 50 cm ground water level was found at a depth of 100 cm to 115 cm during the mean tide level. Soil profile taken lengthwise showed that soil with humus content and the ground water level are very uniform throughout the island. The soil surveys carried out showed that the island is comparatively fertile despite the small size of the island. Soil profiles taken from four locations of the island showed that soil of the island was relative fertile compared to small size of the islands. Humus layer and nutrient contents of the soil was found to be comparable to some of the larger islands in the country. Lush and thick vegetation of the island also showed that the soil is fertile and enables growth of vegetation.

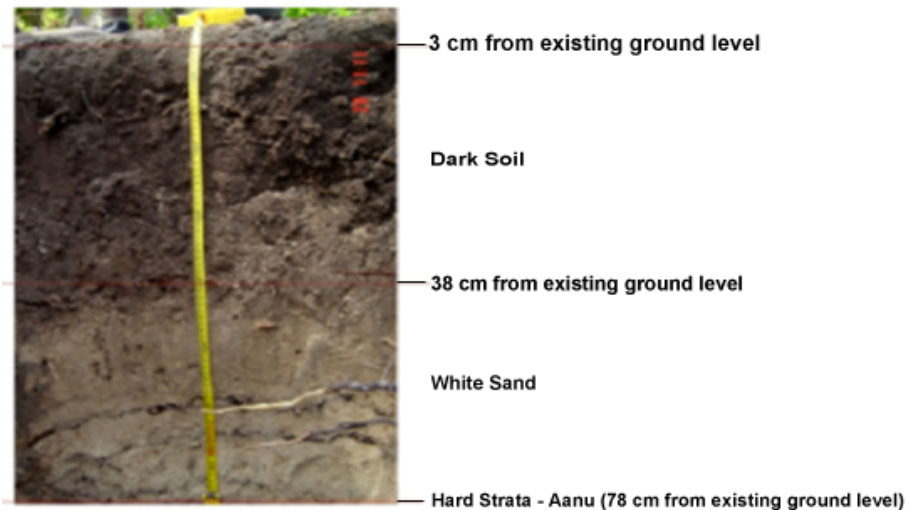


Figure 17: Schematics of the soil profile.



Figure 18: Soil stratification profile onsite.

5.13 Groundwater

Groundwater lens of the island was found to be shallow at an average depth of 1m to 1.2m at mean tide. Figure 19 shows some of the groundwater wells that were used in the island. Ground water sample was obtained from the location S3 and S4 shown in Figure 28.



Figure 19: Some of the groundwater wells found in the island and survey sites.

Results of the groundwater and marine water tests are given below. Samples of groundwater taken from of the island showed that conductivity, pH and salt contents (sulphates, nitrates etc...) are well within the normal range. With reference to the MWSC and EPA reference levels, it could be concluded that the water on the island could be used for domestic purposes.

Table 3: Water quality test results at the four locations.

Parameter	Analysis Result				Test Method	Guideline for Drinking Water		Unit
	Sea Water		Ground Water			WHO Guideline	EPA Guideline	
	1	2	3	4				
pH	8.26	8.21	7.70	8.14	EM	6.5-8.5	6.5-8.5	NA
Conductivity	40600	41200	779	566	EM	<1500	<1500	µS/cm
Salinity	28.46	28.85	0.41	0.30	EM	NA	NA	‰
Bromine	0.00	0.10	0.08	0.23	PM	NA	NA	mg/l
Chloride	20250	19750	126	80	TM	<250	<200	mg/l
Nitrate	0.0	0.5	0.3	0.5	PM	<50	<10	mg/l
Nitrite	0.000	0.003	0.001	0.031	PM	<3	NA	mg/l
Phosphate	1.16	0.16	0.16	0.20	PM	NA	NA	mg/l
Sulphate	1750	2000	28	20	PM	<250	<400	mg/l
TSS	1	0	3	2	PM	NA	NA	mg/l
BOD	0.63	0.79	3.49	2.95	*	NA	NA	mg/l
Turbidity	0.283	0.217	0.801	0.353	PM	<5	<5	NTU
DO	8.63	7.70	4.65	4.95	EM	NA	NA	mg/l

5.14 Marine environment

The marine environment around Vandhoo is being somewhat modified since the manual clearance of entrance channels on reef-flat of the Island. These modifications may have changed the hydrodynamic flow patterns a little. The environmental impacts of these coastal modifications are not known since there was no systematic monitoring of the effects of these coastal modifications in the Maldives (Kench et al. 2006).

Marine environment of the island can be categorized into two main components; the coral reef environment, and the lagoon environment. Different habitats are found within each of these categories of marine environment. The coral reef environment has reef-flat and reef-slope having distinctive habitat characteristics. The total reef area covers approximately 37 hectares out which the reef-flat covers approximately 7 hectares.

The reef-slope and edge on the southern side of the island is not very well developed with about 1 - 20 percent live coral cover. The bottom of reef-flat of the proposed slipway area was dominated by rock and rubble. The reef-slope on the southern side forms a gradual slope.

No detailed surveys were conducted at other sides of the island due to the large size of the reef system. It is unlikely that these sides will be impacted from the proposed project since the predominant monsoonal current is from the west to east.

5.14.1 Coral reef system

The coral reef system of Vandhoo was quantitatively, semi-quantitatively and qualitatively surveyed using standard marine environmental survey methodologies. Reef-slope was surveyed using manta tow technique. Quadrat surveys were conducted on 3 areas that were selected on the reef-flat for assessing benthic substrate cover. The surveyed sites are shown in Figure 20.



Figure 20: Location of the marine survey sites.

5.14.2 Reef aesthetics

Reef aesthetic is semi-quantitatively determined by manta tows or timed swims on the island reef system. Aesthetic value of Vandhoo eastern reef-slope was found to be fairly good as live coral cover, other reef benthos, diversity and abundance of fish life are relatively good and the reef structure is somewhat complex. Result of the reef aesthetic survey is given in Table 4 below.

Table 4: Results of reef aesthetics

Reef attributes	Comments
General aesthetics	Fairly good
Live hard coral cover	Good
Rugosity	Good
Recruitment of corals	Low
Coral bleaching	Low
Coral diseases	None
Herbivory	Average
Fish life	Good
Physical damage	Low

5.14.3 The reef slope

Manta tow survey was conducted on the reef around selected areas the island. The result of the manta tow revealed that coral cover around the reef slope to be between 0 – 30%. The dominant benthic substrate was rock. The dominant fish encountered here was *Odonus niger* belonging to the family Balistidae.

Table 5: Results of manta tow

TowNo.	LC	RK	RL	S	SC	DomCoral	DomFish	Commercial species
1N	2	3	3	2	-	<i>Porites</i>	<i>Acanthurids</i>	Lethrinidae (4), Lutjanidae (2)
2N	1	5	2	2	P	<i>Porites</i>	<i>O. niger</i>	Lethrinidae (4), Lutjanida (2)
3E	1	5	2	2	P	<i>Acropora</i>	<i>O. niger</i>	Lethrinidae (3), Serranidae (1)
4E	3	4	2	1	P	<i>Porites</i>	<i>O. niger</i>	Lethrinidae (3), Serranidae (1)
5S	1	5	2	2	-	<i>Acropora</i>	<i>O. niger</i> , Caesionids	Lethrinidae (3), Serranidae (2)
6S	2	4	3	1	-	<i>Acropora</i>	<i>O. niger</i>	Lutjanidae (2), Serranidae (1)
7W	2	3	4	1	-	<i>Porites</i>	<i>Acanthurids</i>	Lutjanidae (3)
8W	1	6	2	1	-	<i>Porites</i>	<i>O. niger</i> , <i>Acanthurids</i>	Serranidae (2)

The benthic substrate cover was given in a range of 1 to 10 where 1 represents 1-10% cover, and 10 representing 91 to 100% cover. The integers 1 up to 10 each represent an interval of 10%. The letter 'P' represents the presence.

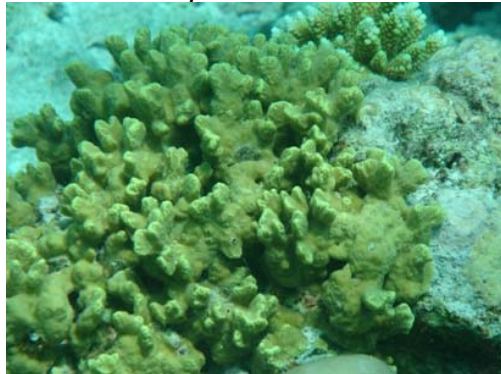
Live coral cover was dominated by small individual colonies of *Porites* spp and *Acropora* spp. Other coral genera documented included the laminar coral *Echinopaora*, branching forms of *Acropora*, *Pocillopora* and *Porites*. Massive types such as *Favia*, *Favites*, *Montastrea* and *Goniastrea*. *Fungia*, *Pavona* and *Galexea* are also seen. The figure below shows the benthic substrate cover at the northern reef-slope area.



Tabulate *Acropora*



Favites and *Echinopora*



P. rus



Reef slope



A Giant clam



Soft coral and Table coral

Figure 21: Benthic substrates encountered at the reef-slope.

Commercial fish species such as serranids and lethrinids were documented during the manta tow. The parentheses next to the commercial species represent the number of individuals encountered in each of the given family. The dominant fish species *O. niger* was ubiquitous. Several other species of reef fish were also seen. Among these are schools of *H. zoster* are worth noting due to their abundance. Some of the fishes encountered at the reef slope are shown below.



A Pomacentrid (damselfish)



An assemblage of fish



A. nigripes on *H. magnifaca*



Z. cornutus



H. zoster



O. niger (trigger)

Figure 22: Some of the fishes observed at the reef-slope.

5.14.4 South-eastern reef-flat

The coral cover of south eastern reef-flat of Vandhoo is very low and it amounts to be less than 5% around the slipway area's reef-flat (see Figure 23). The percentage of live coral cover differed slightly within the three sites. The benthic covers are given in percentages of the bottom area surveyed. LC = live coral, SG = seagrass, RK = rock, RL = rubble, and S = sand.

Most of the area close to the proposed slipway area was covered with rubble and rock. Percentage of rock was highest at the Site 2. The percentage of live coral was highest, i.e. 3.2% in Site 1.

Branching forms of *Acropora* spp. and *Porites* spp. and other genus like *Pocillopora*, *Pavona*, *Favia*, *Goniastrea*, *Laptoria*, *Heliopora* and *Montipora* were encountered at the survey sites. Massive type corals namely *Porites* were encountered.

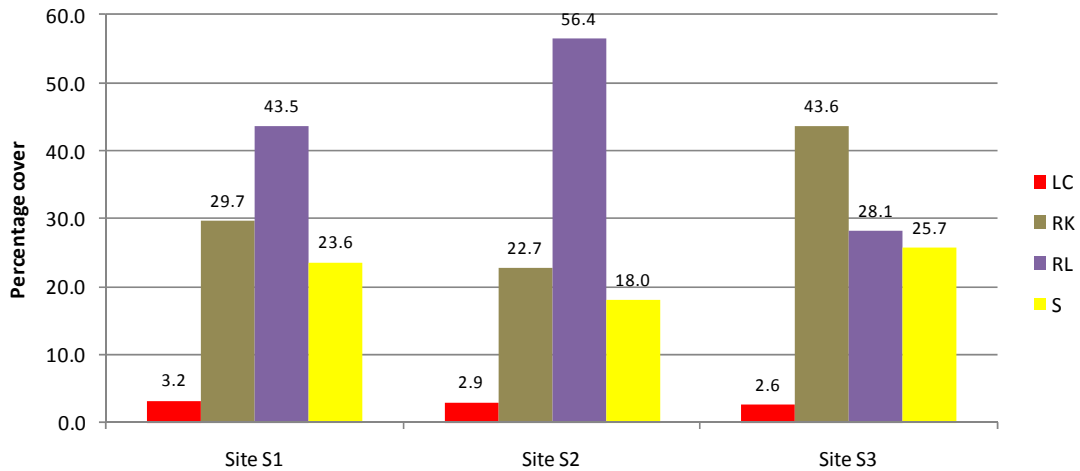


Figure 23: Benthic substrate cover on southern side.

Based on the survey data of the 3 reef-flat sites, rubble, rock and sand were found to be dominant on the proposed slipway region. The photographs below provide an idea of benthic cover present at the survey sites.

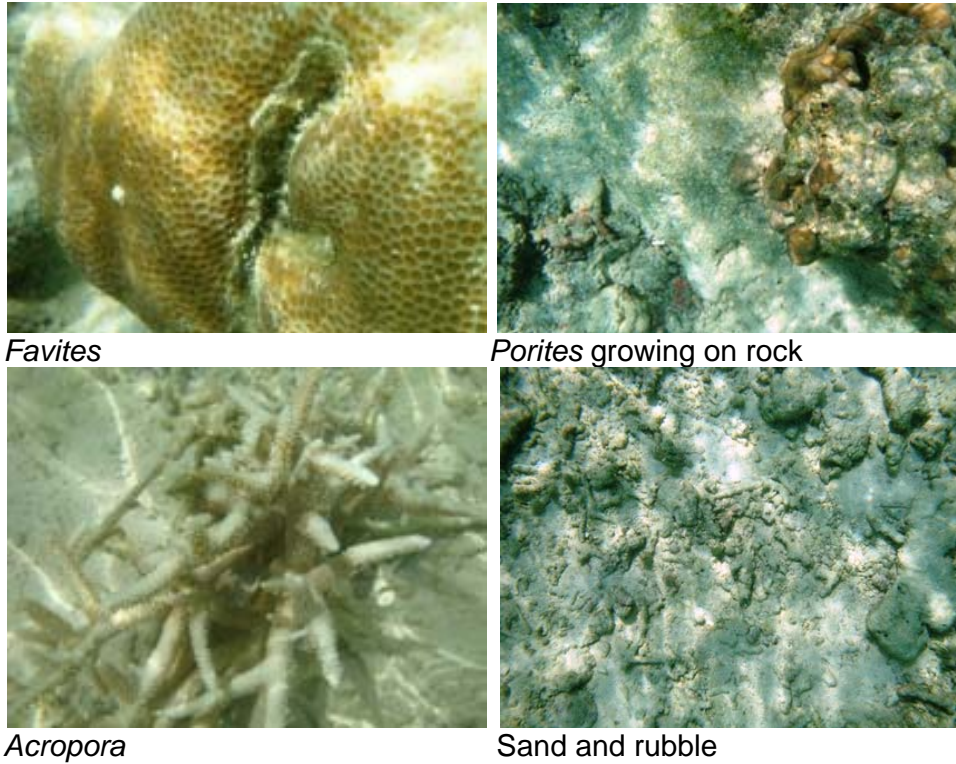


Figure 24: Benthic substrate present at the reef-flat sites

5.14.5 Fish Communities at sites

The result of 15 minutes swim for fish count around each site on the reef flat revealed that the abundance and diversity of fish is moderately good at these sites. The fish population structure and distribution appears similar at these sites (see Table 6). Dominant fish species encountered at these sites included grazers belonging to the families Acanthuridae, Labridae, Pomacentridae and Chaetodontidae.

Table 6: Results of fish surveys at northern reef-flat and lagoon

Family	Species	Abundance		
		Site 1	Site 2	Site 3
Acanthuridae	<i>Acanthurus lineatus</i>	R	C	-
Acanthuridae	<i>Acanthurus leucosternon</i>	-	R	-
Acanthuridae	<i>Ctenochaetus sp.</i>	C	R	-
Baslitidea	<i>Balistapus undulatus</i>	-	-	-
Chaetodontidae	<i>Chaetodon kleinii</i>	-	-	R
Chaetodontidae	<i>Chaetodon auriga</i>	-	R	-
Kyphosidae	<i>Kyphosus sp.</i>	-	R	R
Labridae	<i>Helichoeres hortulanus</i>	-	-	R
Labridae	<i>Helichoeres scapularis</i>	C	C	-
Labridae	<i>Labroides dimidiatus</i>	-	C	-
Labridae	<i>Stethojulis strivigenter</i>	R	-	R
Labridae	<i>Thalassoma hardwicke</i>	R	C	-
Lethrinidae	<i>Monotaxis grandoculis</i>	-	-	R
Mullidae	<i>Parupaneus bifasciatus</i>	-	R	-
Pinguipedidae	<i>Parapercis sp.</i>	R	-	-
Pomacentridae	<i>Abudefduf septemfasciatus</i>	-	C	-
Pomacentridae	<i>Dascyllus aruanus</i>	-	C	R
Scaridae	<i>Cetoscarus bicolor</i>	-	R	-
Scaridae	<i>Scarus sordidus</i>	C	-	-
Scaridae	<i>Scarus frenatus</i>	-	C	-
Serranidae	<i>Cephalopholis miniata</i>	-	R	-
Serranidae	<i>Epinephelus merra</i>	-	-	R
Zanclidae	<i>Zanclus cornutus</i>	-	-	R

The abundance of fish was given in abundance categories. A = Abundant, C = Common, R = Rare. Commercial fishes belonging to the families Lethrinidae, and Serranidae were observed at the survey sites.



Scarids

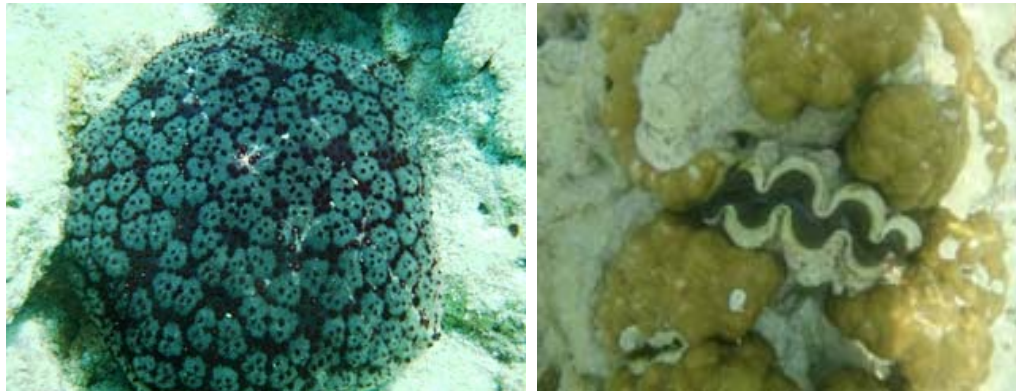
D. aruanus

Figure 25: Some of the fishes seen at reef-flat

5.14.6 Reef invertebrates

Four species of echinoderms and two species of mollusk were encountered during the survey near the slipway area. The density of large invertebrates was observed to be very low near the slipway area. What is observed during the timed swims are:

- Common star fish
- Diadema urchin
- Pencil urchin
- Cushion star
- Giant clam
- Spider shell and



Cushion star

Pencil urchin

Figure 26: Some of the invertebrates seen near the proposed slipway area

In general, the southern reef-slope of Vandhoo is apparently recovering (after 1998 bleaching event) in terms of diversity and percentage live coral cover. The diversity and abundance of life forms were higher at the reef edge. Many colonies of live corals - mostly *Porites* were seen at the reef-crest as well. Species richness and diversity of corals were low at the reef-flat and the lagoon.

5.14.7 Lagoon environment

The shallow lagoon area around the island was calculated as approximately 29 hectares. The lagoon on the on all sides of the island are shallow (see Figure 27).

The average depth of the lagoon on northern side of the island is deeper than on other sides. Lagoon bottom consisted of mostly sand, rubble. Waves in the western and northwestern sides of lagoon are higher as the wind waves generated by the southwest monsoon directly reaches the lagoon on this side.



Figure 27: Lagoons around the island

5.14.8 Rare or endangered species

During the course of the baseline survey no marine protected species were encountered. The impacts from the proposed project on the rare and endangered species are not clear since there were no such species adjacent to the proposed slipway area.

5.14.9 Potential nuisance species

The dredging of slipways is associated with a shift in the bottom conditions of the slipway basin. The accumulation of silt at the bottom of the slipway may attract fishes and other living things that prefer such habitats. It has been known that the Striped eel cat fish (*Plotosus lineatus*) has infested some of the dredged slipway basins. This species has got deadly poisonous spines which makes it a potentially dangerous species. It is not clear that whether this species will infest the Vandhoo slipway basin. Based on the past experience with the slipways, there seemed to be no major problems associated with potential nuisance species.

5.14.10 Bathymetry

Bathymetric surveys were conducted around potential slipway area on southern side of the island. The bathymetric surveys results are shown in Appendix C. The bathymetry surveys showed that the lagoon on surveyed area has a depth range of 1 to 1 – 1.5m in average.

Depth of the lagoon increases moving away from the shoreline and the depth decreased as it reaches the reef-crest.

5.14.11 Marine water quality

Marine water samples were taken at 2 locations around the island to establish the baseline status of the water quality in terms of pH, salinity, phosphates, nitrates and turbidity. Some of the parameters describes in the ToR such as COD could not be performed due to technical difficulties of the authorized water testing agencies. Notification that this could not be carried out is attached in Appendix D.

Locations where the water samples were collected (both marine and ground water) is shown in Figure 28.

S1 – at the reef slope near the entrance channel (lat 5° 31' 44.16", lon 73° 02' 33.67")

S2 – within the slipway basin (Lat 5° 31' 47.76", Lon 73° 02' 35.85")

S3 – ground water sample (lat 5° 31' 48.18", lon 73° 02' 35.84")

S4 – ground water sample (lat 5° 31' 54.83", lon 73° 02' 33.24")



Figure 28: Water sampling locations.

5.15 Hazard vulnerability

Hazard vulnerability of Vandhoo is assessed based on the literature available and field data collection. The report prepared by the UNDP (2006) on disaster risk assessment of Maldives is used as the main reference. The scale is given as the likelihood of occurring an event. This

is based on historical evidence, anecdotal information, the geologic and climatic processes and the location of a given island on the Maldivian archipelago. The value 5 represents 'highest risk' and the value 1 is 'lowest risk'. The table below summarizes the vulnerability of Vandhoo region based on UNDP (2006).

Table 7: Hazards and vulnerability

	Hazard	Vulnerability (scale 1 – 5)
1	Tsunami	4 (high)
2	Cyclone (thunder storm)	4 (high)
3	Storm surge	4 (high)
4	Earthquake	1 (very low)

Chapter 6

Environmental Impacts & Mitigation Measures

6.1 Introduction

Impacts on the marine environment from the proposed project have been predicted through analysis of the project, discussions with the project proponent, field surveys, observations and assessment as well as based on field experience of similar works in the country. Quantitative and qualitative data collected from filed work were analyzed to predict the extent and significance of the impacts that may arise from the proposed slipway rehabilitation project's activities.

The four components of the environment that will be impacted are identified as the beach, coastal vegetation, coral reef benthos and reef-flat waters, and associated nektons. Quantitative assessment of potential direct and indirect impacts due to the proposed project was based on area calculation of the affected area.

6.2 Impacts on the environment from the project

Slipway projects have both construction and operational impacts on the coastal environment. These impacts may be either short term reversible or long term irreversible damage or alterations. The impacts identified here will be according its location and magnitude. The intensity or severity of the impacts is further grouped into negligible, minor, moderate and major. This will help in identifying and carrying out remedial and mitigation measures. A description of the impact categories are presented below (LaMer 2006).

- Negligible: no significant impact on environment
- Minor: the impact is short term and cause little damage to the environment which may be reversible on the long run.
- Moderate: Impacts are significant, may cause long term environmental concerns but are likely to be short termed, acceptable and justifiable
- Major: long term impact, large scale environmental alterations

Potential environmental impacts predicted for this project will be the damage during construction and irreversible modification of environment as a result of excavation. These impacts are presented together with mitigation measures in the Table 9.

Dredging and excavation work generally lead to major impacts on reef habitats, lagoon and coastal hydrodynamics. The Impacts of excavation and dredging may range from smothering of live corals and other flora and fauna. Coastal modification involved in the construction of

the slipway can have short to long term impacts on the on the coastal processes and beach profiles of the island.

Specific impacts on the marine environment arising from the proposed project will be mainly an alteration of the bottom of reef-flat where dredging is done and a moderate impact on the sediment movement along the shore-line and near the entrance channel. There is also a moderate impact on the benthic and nektonic communities that inhabit in the possible impact zone.

Indirect impacts will be felt to the adjacent coastal vegetation, pelagic organisms inhabiting the reef-flat, lagoon and coral reef areas close to the development locality.

6.3 Mobilization impacts

The transport and supply of construction material, the excavators and other heavy equipments may have an impact as a result of increased traffic with barges and other large vessels. The impacts may arise from:

- Accidental spillage of construction materials (cement bags, timber, iron bars).
- Accidental oils and other chemical spills.
- Accidental grounding of large vessels.
- Anchor damage from the vessels.

6.4 Impacts from construction materials and other waste

Construction materials such as cement, timber, metal, and fuel for excavators and trucks have the potential to damage environment. Pollution of the lagoon and reef system can be caused by waterborne and windblown debris escaping from the construction site.

6.5 Impacts due to construction work

Deepening work of the entrance channel and slipway basin will be carried out using excavators. Therefore the negative impact of sedimentation is unavoidable even with the construction of sandy bund walls. The impacts of sedimentation are short termed since the currents will aid in the dispersal and removal of fine suspended materials. Growth and recruitment of live corals may have moderate short term negative impact due to sedimentation.

The impacts of excessive sedimentation on coral habitats include:

- Direct physical impacts like smothering of corals and other benthic organisms,
- Reduced light penetration reducing the productivity of corals.
- Formation of false bottoms due to unstable shifting of sediments.
- Eutrophication due to increased fine sediments leading to algal blooms.
- Formation of anoxic (black) bottoms under the fine sediments.

Construction of wharfs and protection walls may have impacts on the reef-flat habitat by seepage of cement material. This work includes a lot of manual transport of materials, trampling and breakage of live coral is possible at the seaward side of the slipway basin and the sides of the entrance channel.

Vegetation clearance and site-hardening is un-avoidable in slipway construction projects due to the use of large and heavy vehicles.

6.6 Impacts of built coastal structures

The impact of anthropogenic physical structures such as breakwaters, access channels and slipways on the coastal processes and marine life, can be quite significant and often permanent. Some of these include:

- Change in near-shore hydrodynamics
- Erosion and loss of vegetation at the low energy areas during either monsoons.
- Sedimentation and turbidity resulting poor water quality which negatively impacts vitality of marine organisms.
- Alteration of bottom substrate.
- Degradation of sea water quality e.g. due to turbidity.

6.7 Impacts due to slipway operation

Impacts associated with the slipway operation can be considered as minor to moderate and short to long term. These impacts include (but are not limited to):

- Poor water quality due to siltation and stagnation of water.
- Impacts due to accidental spillage of oils, other chemicals and waste.
- Hydrodynamic changes forming dead zones in the inner slipway where litter accumulates
- Erosion and its associated impacts like the loss of coastal vegetation.

6.8 Significance of the impacts

Impacts that may arise from the activities of the proposed slipway project were categorized into the characteristics described in Table 8.

The significance of impacts was determined based on these characteristics and analysis of the impacts from this project and other analogous projects. These impacts correspond in the worst case scenario and after mitigation measures were taken. The Table 8 shows the main impacts that would arise from the proposed project activities and their significance based on impact characteristics.

Magnitude of impact is calculated in relation to the total area. Direct geographic range of impact felt will be the immediate proposed development area and indirect impacts on the

environment will be felt on a larger area due spreading of fine sediment and vegetation clearance of adjacent areas. Duration of the impact is predicted in terms of severity of impacts. The impacts are likely to be felt on an estimated 10% of the reef-flat and less than 10% of the lagoon.

Reversibility of impacts was predicted based on natural recovery of the habitats affected. Coral reefs naturally take longer to recover than the lagoon habitats. Significance of the impacts is predicted based on the nature, geographic range where impacts are felt, magnitude, duration and reversibility of the impacts.

Table 8: Significant impacts of the proposed slipway project

Impact characteristics	Dredging (slipway basin and channel)	Dredged spoil discharge
Nature of impacts	Cumulative	Cumulative
Magnitude of impacts	Moderate - negative	Moderate - negative on coastal ecosystems. Major +ve on socioeconomic aspects – sand for various purposes
Geographical range and environmental attributes	Direct impact on 5,000m ² of reef-flat and lagoon Direct impact on coral reef on 1000m ² Indirect impact on 8,000m ² of reef-flat	5,000m ² - Direct impact on land Negligible impact on coral reef
Duration of impacts	Short term on coral reef and long term on reef-flat and beach	Long term
Reversibility of impacts	Permanent alteration of physical and biological system of the slipway basin, Short term reversible impacts on coral reefs, and reef-flat adjacent to the slipway basin	irreversible

6.9 Mitigating the impacts

Several actions can be taken to minimize the above mentioned impacts. Expert consultations, past experience and local knowledge are essential in reducing the impacts. Mitigation measures are employed to eliminate or reduce the severity of any predicted impacts. The predicted impacts on the coastal environment of Vandhoo can be mitigated by joint cooperation and careful environmental planning. All parties, the proponent and the contractors must work carefully to eliminate or reduce the identified risks. Given the magnitude of impacts for this project, the adverse effects can be mitigated at virtually no cost if best environmental practice and precautionary principles are used. Specific mitigation measures for potential impacts are given below;

Supervision and inspection of the project activities are imperative to minimize adverse impacts. Therefore, competent government staff with experience in same or similar work in the local environment will be consulted and allowed to inspect and monitor the work activities of the project life-cycle. Supervising party will carry out compliance monitoring and reporting to ensure that the predicted impacts are not exceeded. If predicted impacts were exceeded, the work will be halted and impacts re-assessed and reported.

Proposed project's marine work will be carried out to coincide with low tide and easterly current so as to minimize effects of sediment on the reef. The work will be carried out in calm weather condition.

Machinery, equipment and vessels used in the project activities will be maintained in good condition and operated in a manner that they do not pose a risk of environmental degradation. All activities will be kept to a minimum period of time to reduce impacts on the environment.

The Table 9 below provides more information on potential impacts during construction and operation of the slipway project and mitigation measures.

Table 9: Potential impacts during construction and operation of the slipway project and mitigation measures to minimize the impacts

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Littering on environment	Avoided by proper planning in transportation and waste disposal. Use 3R. Proper garbage disposal	Reef-flat, and land	During construction	Minor to moderate, short term -ve impact. Reversible	Contractor, Proponent	N/A
Alteration to localized hydrodynamic regime	Maintaining water exchange not keeping sand-beds along the sides of the entrance channel	Reef slope, reef-flat, beach	During construction	Moderate, long term, likely irreversible	Contractor, Proponent	N/A
Damage to reef by Loading/unloading works	Raising awareness and utilizing environmental best practice, careful planning	Reef-flat and reef slope	During construction	Minor, short term –ve impact. Reversible over long run	Contractor, Proponent	N/A
Sedimentation and siltation on the reef and lagoon due to excavation works	Creation of a sandy bed to reduce the sedimentation impact, this bed would reduce sediment spreading; work to be carried out in low tides.	Reef-flat and reef slope	During construction	Moderate, short term –ve impact. Reversible over long run	Contractor, Proponent	N/A
Impacts from sewer system	Maintaining the system well, use of water saving toilets, Regular checking of ground water at slipway site	Land, groundwater	During construction and Operational phase	Moderate, short term –ve impact. Reversible over long run	Contractor, Proponent	N/A

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Loss of habitat, damage or death of coral at slipway basin and concrete structures	Clearly marking the areas to be excavated. Coral transplantation before operation starts	Reef-flat,	During construction	Minor, long term –ve impact. Most likely irreversible	Contractor	N/A
Habitat modification at the spoil disposal site and loss of vegetation accommodation building area	The material will be disposed at the sites where there was virtually no life. Trees will be cut only in unavoidable circumstances. Once the slipway is complete, new trees will be planted.	Land, coastal area	During construction and Operational phase	Minor –ve impact Positive impacts due to availability of sand for multiple purposes. +ve impacts once the new trees grow. Reversible	Contractor, Proponent	N/A
Impact from powerhouse and fuel usage	Proper maintenance of engines, and fuel pipelines and tanks, Regular checking of emissions and noise.	Air, Land	During construction and Operational phase	Minor, short term –ve impact. Reversible over long run	Contractor, Proponent	N/A
Impact from welding and metal works	Conduct welding and thermal cutting activities in the slipway shed or any place with proper discharge containment	Land, coastal area	During construction and Operational phase	Minor, Short term –ve impact, Reversible	Contractor, Proponent	N/A

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts due to groundwater usage	Reduce the usage. Harvesting rain water. Maintenance of taps and pipes.	Land, groundwater	During construction and Operational phase	Minor, long term -ve impact Reversible	Proponent	N/A
Air pollution	Completing the excavation works as soon as possible.	Air	During construction	Negligible, short term -ve impact. Reversible	Contractor	N/A
Possible erosion due to obstruction of littoral sediment movement	Keep part of the dredge material on the Island to supplement areas showing erosion	Beach	Operational phase	Minor, long term and unpredictable -ve impact. Most likely irreversible	Contractor, Island authorities	difficult to estimate as impact unpredictable
Solid waste	Employee a staff for monitoring and cleaning the slipway	Slipway area	Operational phase	Minor, long term -ve impact Reversible	Contractor	monthly salary equivalent to 8000.00
Accidental spillage	Put up sign boards	Slipway area	Operational phase	Minor, short term -ve impact Reversible	Contractor, Proponent	15000.00 - 20000.00
Impacts of antifouling removal	All antifouling contaminated waste materials will be collected in the bunded sump and must not be burnt off	Slipway area	Operational phase	Minor, Long term -ve impact, Reversible	Contractor, Proponent	N/A
Impacts of fibre glass usage	All spray emissions should be contained in the slipway shed	Slipway area	Operational phase	Minor, Short term -ve impact, Reversible	Contractor, Proponent	N/A

In addition to the above, to minimise the risk of other negative impacts during the operational phase, a proper housekeeping activities of the facilities can be under taken, such as;

- Compile a list of facility rules and environmental management conditions, associated with the use of the slipway and wharf for clients and contractors to sign before slipping and working on their boats.
- Maintain a slipping register containing the details of all vessels slipped and of the work done on each vessel. Vessel details should include the name of the vessel, distinctive numbers or letters, length, gross tonnage, paint history (types of hull coatings applied and application dates) and recent voyage history (i.e. whether from intrastate, interstate or overseas).
- Keep a record of all anti-fouling work done and record the following information for all vessels slipped:
 - Type of anti-fouling system used;
 - Dates of application of anti-fouling system;
 - Name of anti-fouling system manufacturer;
 - Name and colour of anti-fouling system;
 - Type, name and colour of sealer coat, if applied; and
 - Date of application of sealer coat.
- Maintain a list of all liquids and powder products kept on the premises together with up to date copies of all Material Safety Data Sheets (MSDSs).
- Establish a daily checklist to ensure that key work areas are kept clean and that appropriate storage, work and management procedures are being adhered to. Assign different inspection responsibilities to specific facility staff members.
- Use the Environmental Management Plan for Operational Best Practice to develop a procedures manual for common activities carried out at the facility.

6.10 Uncertainties in impacts identification

Although measures will be taken to mitigate known impacts, there is always the probability that an unforeseen impact may occur. It is also important to note that some of the impacts may turn out to be far greater than predicted. This could make mitigation measures less effective. To avoid or reduce the chances of such events it is vital to monitor key important parameters at the vicinity of the project.

Chapter 7

Socioeconomics and Stakeholder Consultations

7.1 Socio-economic status

North Maalhosmadulu Atoll consists of altogether 88 islands out of these 15 are inhabited and the rest are uninhabited. The atoll capital is Ungoofaaru about 22.5 km north of Vandhoo. The island of Vandhoo is an uninhabited island. The project is likely to improve socio-economic conditions of the island of Innamaadhoo and other islands near by providing employment opportunities at the slipway. The social and health issues faced in the Innamaadhoo due to boat building will be reduced once the operation of the slipway starts.

7.2 Stakeholder consultation

7.2.1 Aim

The stakeholder consultations were aimed at understanding the Government and the community's need for a slipway in the island and its environmental consequences and social and economic benefits for the island community.

7.2.2 Objectives

The objectives of the consultations were to:

understand government policies and reservations with respect to slipway development in Vandhoo

- discuss and define the scope of the work of the proposed slipway
- discuss and define the methodologies that will be adopted in construction and operation of the slipway
- discuss and define costs and duration of construction
- identify parties responsible for operation and maintenance of the slipway
- identify the needs and wishes of the island community
- identify how to minimize conflicts over location of the slipway within the various community groups within the island
- identify the best location for a slipway in terms of minimal environmental impacts and maximum social and economic benefits
- discuss, learn and understand the coastal and beach dynamics of the island from the experiences of the locals

7.2.3 Outcomes of the stakeholder consultations

Government

Consultations were carried out with the Atoll Councilor and Island Councilor of R. Innamaadhoo. Both the Atoll Councilor and Island Councilor stressed the importance of this project. They would like to see this project go ahead faster. They expressed their fullest support for the project.

Community

Since Vandhoo is an un-inhabited island, consultations were carried out with the key parties engaged in boat building at Innamaadhoo. All of the parties supported the project. In addition the School student and parents expressed their support for the project since the boat building activities in Innamaadhoo near the school are causing several issues.

7.3 Conclusions of stake holder consultations

Consultation was an important part in the production of the EIA of Vandhoo slipway development project in several ways:

- most importantly the project could potentially alter the beach dynamics leading to irreversible erosion of the beach and causing tremendous damage to the island
- slipway for the island community was one of urgent needs that the community has been expecting for a very long period of time
- the main environmental issue was protection of the natural beach and its aesthetic beauty and prevention of potential erosion of the island.
- the main social and economic issue was that the community wants to get rid of the boatyards at Innamadhoo.
- community is satisfied about the proposed location of the slipway.

The stakeholder consultations conducted for the EIA study of construction of slipway in Vandhoo provided invaluable information both on environmental and socio-economic impacts that may arise from the project. The consultations will also help to minimize potential negative impacts through taking mitigation in light information collected on physical environment and social environment of Vandhoo. Aim and objectives of the stakeholder consultations were achieved to a satisfactory level.

Chapter 8

Alternatives

8.1 Alternative Locations

The current project location and orientation was proposed based on the allocation of land from the R. Atoll Office. Therefore alternative location to build the slipway is not possible.

8.2 Construction Method

Conventional old style slipway can be constructed with lower cost. However these types of slipways are not very suitable for the large vessels used today. The type of sea-lift to be used here will be much safer for the larger boats.

8.3 No Project Scenario

If “no project scenario” was considered, environmental impacts associated with the project could be avoided completely. Consider this option is not worthwhile since the reef system and the coastal areas (beach and vegetation) have no significant features that could be labeled as significant environmental assets.

The “no project scenario” can also be ruled out since the current policy of the government is to develop a slipway at this island.

Chapter 9

Environment Management & Monitoring Plan

This Chapter outlines the monitoring plan for the project. Adoption of appropriate mitigation measures can significantly reduce the environmental damage caused by a development project. However, occurrence of unforeseen impacts is still possible, even with proper implementation of mitigation measures. Moreover, some of the predicted impacts may turn out to be greater than predicted, necessitating different or more rigorous mitigation measures. Therefore, regular and frequent monitoring of the environment is vital, in order to avoid or reduce the chances of such events, and to minimize the impact and cost of unforeseen events by taking prompt remedial action if such events occur.

Since most environmental changes occur over long period of time, it is important to implement a specific long-term monitoring program for the marine and coastal environment. It is important to monitor the effects of development prior to, during and after project implementation. It will also be important to ensure that environmental design criteria are met during construction. This can be achieved by inspections at appropriate intervals during the construction phase. Recent environmental supervision or inspection has proven to be an effective tool in minimizing the impacts and in ensuring that appropriate precaution and care is employed. The proponent is fully committed to carry out environmental monitoring of the development and operation of the slipway.

9.1 Aim of monitoring

The primary aim of the monitoring is to provide information that will aid impact management, and secondarily to achieve a better understanding of cause-effect relationship and to improve impact prediction and mitigation methods.

The objectives of this monitoring program are to detect and document the changes occurring to the reef system due to the proposed project. The purpose will be to:

- 1) assess the magnitude of the impacts resulting from the various stages of the proposed work and
- 2) to take mitigation measures to minimize the negative impacts and protect the reef and the lagoon system as well as terrestrial ecosystem of the island.

9.2 Monitoring of coastal and beach environment

Coastal and beach monitoring must focus on both construction and operation stages of the proposed project. Coastal and beach monitoring should also consider monsoonal changes and the transitional period and therefore long-term coastal monitoring shall be carried out at least in every six month intervals. The following monitoring requirements may be

adequate for the purpose of evaluating potential environmental effects from the proposed development in order to implement more effective mitigation measures.

- Beach profiles will be taken at designated locations at not more than 200m distance from one another to provide enough data to establish changes in coastline at designated locations and around the island.
- Bathymetry of the lagoon will be conducted every year to assess sediment dynamics
- Currents will be monitored using current meters or drogues.
- Wind and tide data will be obtained from the meteorological records. However, it would be useful to measure wind speed and directions at the site
- If available, periodic aerial photos may also be used to assess long-term changes to the hydrodynamic and littoral regimes.

9.3 Monitoring program for the beach and coastal zone

Following table shows coastal and beach monitoring program suggested for the proposed slipway development project in Vandhoo island. The monitoring program will last for one year from the completion of the project

Table 10: Beach and coastal monitoring program

Parameters / Method	Frequency of monitoring	Purpose
Beach/erosion & accretion Beach profiles	Before and after project implementation and every six months afterwards	Understand the changes to the beach profile of the island and how sand moves around the island
Sediment dynamics Currents (using drogue or current meter)	Before and after project implementation and every six months afterwards	Understand how currents vary in the coastal system and assess its relation to sand movement around the island
Sediment dynamics Bathymetry	Every six months before and annually after project implementation	To monitor the effects of shoaling
Sediment dynamics Waves and tides	Once or twice a year	Understand effects on coastal environment including erosion & accretion

9.4 Monitoring program for the terrestrial environment

Table 11: Terrestrial environment monitoring program

Parameters / Method	Frequency of monitoring	Purpose
Coastal vegetation Transects and visual observations	Twice a year	Understand the changes to the vegetation and vegetation cover as percentage of the island
Ground water Water quality test	Twice every year	To monitor any possible toxic leakages in the ground

9.5 Monitoring program for the marine environment

Suggested marine environmental monitoring program to assess and mitigate possible major negative impact on the marine environment is given below. The impacts predicted above and the effectiveness of the control and mitigation measures proposed must be evaluated during the work and changes brought if necessary.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project activities and operation are included in the monitoring plan. These include turbidity and nutrient contents of lagoon water, sedimentation and live coral cover and coral recruitment. Monitoring will be carried out as part of the environmental impact assessment and mitigation of possible negative impacts from the proposed project of the proposed slipway development.

The following marine environment monitoring plan is used to measure impacts that occur during the proposed project activities and determine the accuracy of impacts that are predicted and the effectiveness of mitigation measures. The objectives of the monitoring plan are to measure:

- the amount of sedimentation on the reef
- water quality and visibility
- coral cover and recruitment and
- beach erosion

To ensure that these measurements are kept within the baseline limits and predicted impacts are accurate and mitigation measures taken are effective.

The following table shows methods, monitoring parameters, frequency and purpose of the marine environmental monitoring program.

Table 12: Marine environment monitoring program

Methods / Parameter	Frequency of Monitoring	Purpose
Ambient Environmental Temperature, Salinity, Turbidity/light penetration, Currents	Once during the work And once every six months thereafter	Important to the 'health' of living marine resources, reefs and fish populations and other benthos
Coral reef Manta Tow Technique or Time Swim, or Quadrat	Once after the work is completed And once every year thereafter	Broad scale qualitative and Semi-quantitative assessment of general status of the reef system / coral and other benthic organisms
Marine Environmental Aesthetic Survey using Time Swim and Manta Tow Technique	Once after the work is completed And once every year thereafter	Broad scale semi quantitative assessment of anthropogenic activities e.g. wastes disposal, amount of rubbish on the reef and general appeal of the reef system
Fish populations Underwater Fish Census	Once after the work is completed And one every year thereafter	Quantitative assessment of fish population of selected species
Coral cover/recruitment Quadrats	Once after the work is completed And twice every year thereafter	Quantitative assessment of temporal changes in the reef system e.g. coral growth rates
Sedimentation Sediment traps deployment/collection	Once during work and Once every 6 months thereafter	Quantitative assessment of sediment loading on the reef benthos.
Water quality Water quality test	Once during work and Once every year thereafter	Quantitative assessment of Nitrogen and Phosphorous contents and other parameters: Assess total Dissolved Solids

9.6 Breakdown of monitoring yearly monitoring cost

Table 13: Estimated cost of environmental monitoring

Activity	Quantity	Cost USD
Establishment of baseline environmental status for monitoring	1	1,000/-
Field work	20	3,000/-
Document preparation	4	1,000/-
Logistics (for 12 trips)	1	3,000/-
Travel and accommodation for a team of four	12	3,000/-
Total		11,000/-

9.7 Monitoring Report

Based on the data collected, a mid-term monitoring report will be compiled and submitted to the relevant authorities for compliance. This report shall include methodologies and protocols followed for data collection and analysis, quality control measures.

9.8 Commitment by the Proponent

The proponent is fully committed to undertaking the monitoring program outlined in this Chapter (refer **Appendix E** of this report).

Chapter 10

Conclusion and Recommendations

10.1 Conclusions and Recommendations

This environmental impact assessment study demonstrated that the proposed slipway development project will cause both short-term and long-term significant impacts to the marine and terrestrial environment of the island. The impact to the marine environment will be felt on the lagoon environment on northern side of the island. The impact will be loss of the natural habitat for fauna of the lagoon environment due slipway basin excavation and channel deepening. Short-term impacts of this will be spreading of fine sediment in the lagoon water. The negative impacts will be minimized through appropriate mitigation measures such as timing of excavation and completing the project in as short period as possible.

The impacts on the marine environment will be the dredging of a small portion seabed and marine concrete works. This would mean loss of a large portion of benthic habitats on the northern side of the island. The impacts of live corals will be minimized through careful removal of the corals and relocation of these in location other locations.

The impacts to the terrestrial environment will be vegetation clearing and site hardening. The removed plants and trees will be replanted on the bare areas of the island. One the slipway is complete more trees will be plants to make the slipway area green.

Socio-economic impact of the proposed project will be very positive. The project will ease social and health issues related to the operation of boatyards in Innamaadhoo.

This assessment showed that the negative impacts to the island environment arising from the proposed project are moderate and the project is justified in terms of its benefits to the socio-economic environment of the island community of R. Innamaadhoo.

10.2 Declaration of the Consultant

This EIA has been prepared according to the EIA Regulations 2007.

We certify that the statements in this Environmental Impact Assessment study are true, complete and correct, to best of our knowledge and ability.



Name: Miruza Mohamed (EIA Registration No: EIA 01/10)

Reference:

- Clark, S., Akester, S. and Naeem, H. 1999. *Conservation and Sustainable Use of Coral Reefs: Status of Coral Reef Communities in North Male' Atoll, Maldives; Recovery Following a Severe Bleaching Event in 1998*, MacAlister Elliot and Partners Ltd.
- E-CAD Associates 2008. *Environmental impact assessment report for H.A. Utheemu slipway development project*, ERC website, Male' Maldives.
- E-CAD Associates 2008. *Environmental impact assessment report for R. Vaadhoo slipway development project*, ERC website, Male' Maldives.
- Department of Meteorology (various years). Wind data for the Maldives.
- English, S., Wilkinson, C. and Baker, V 1997. *Survey Manual for Tropical Marine Resources*. Australian Institute of Marine Science, Townsville, Australia. 390pp.
- Garrad Hassan Consultants 2006. *Solar energy and wind energy feasibility study for Dhuvaaafaru Island Malhosmadulu (Raa) Atoll Republic of Maldives*, Garrad Hassan Consultants.
- Google Earth (online) Images of the Maldives.
- Kench, PS & Brander, RW 2006. 'Response of reef island shorelines to seasonal climate oscillations: South Maalhosmadulu atoll, Maldives', *Journal of Geophysical Research*, vol. 111, F01001, doi:10.1029/2005JF000323
- Kenchington, R.A. 1984. *Large Area Survey of Coral Reef, UNESCO Report in Marine Science*, 21: 92-103
- Kenchington, R.A. 1990. *The Republic of Maldives, Managing Marine Environment*, Taylor and Francis New York Inc.
- Land and Marine Environmental Resource Group Pvt Ltd. (LaMer) 2006. *Environment Impact Assessment of V. Thinadhoo slipway development project*. LaMer, Maldives, 52pp.
- Loya, Y. 1978. *Plotless and Transect Methods*. Stoddart, D.R. and R.F. Johnnes (editors). "Coral Reefs: Research Methods". UNESCO, Paris.
- Ministry of Environment, Energy and Water (MEEW) 2005, *State of the Environment Report 2004: Male'*, Ministry of Environment, Energy and Water. Male', Maldives.
- Ministry of Home Affairs, Housing and Environment 2002. *State of the Environment (SoE)*, 2002, Ministry of Home Affairs, Housing and Environment, Male', Maldives.

- Naseer, A 2003. The integrated growth response of coral reefs to environmental forcing: morphometric analysis of coral reefs of Maldives, Dalhousie University, Halifax.
- Open University 1994. *Waves, Tides and Shallow Water Processes*, Elsevier Science Ltd. Oxford.
- Pernetta, J.C 1993 ed. *Marine Protected Area Needs in the South Asian Region*, Volume 3: Maldives, IUCN, Gland, Switzerland.
- Roe D, Dalal-Clayton & Hughes, R 1995. *A Directory of Impact Assessment Guidelines*. International Institute for Environment and Development, Russell Press, Nottingham, UK.
- Salvat, B 1997. *Dredging in Coral Reefs. In Human Impacts on Coral Reefs: Facts and Recommendations*. B. Salvat, ed. Antene Museum . E.P.H.E., French Polynesia.
- Segal, B. and Castro, CB. 2001. A Proposed Method for Coral Cover Assessment: A case study in Abrolhos, Brazil. *Bulletin of Marine Science*, 69 (2): 487-496.
- State of the Environment (SoE), 2002. Ministry of Home Affairs, Housing and Environment - Maldives.
- State of the Environment (SoE), 2004. Ministry of Environment and Construction, Maldives.
- Woodroffe, CD 1992. Morphology and evolution of reef islands in the Maldives. *Proc 7th Int Coral Reef Symp.* 2: 1217 – 1226
- UNDP 2006. *Developing a Disaster Risk Profile of the Maldives*, UNDP, Male', Maldives
- USACE 2001, *US Army Coastal Engineering Manual*, USACE
- Viles, H. and Spencer, T. 1995. *Coastal Problems: Geomorphology, Ecology and Society at the Coast*, Edward Arnold, a division of Hodder Headline PLC, 338 Euston Road, London

Appendix A – Terms of Reference

Environmental Protection Agency

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Terms of Reference for Environmental Impact Assessment

The following is the TOR based on the scoping meeting held on 25th May 2010 for undertaking the EIA for the proposed slipway Development in Vandhoo, RaaAtoll, Maldives. This is the second ToR issued for this project as the validity of the previous ToR expired and due to a change in consultant.

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the audit report.

1. **Introduction** - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment.
2. **Study Area** - Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project
3. **Scope of Work** - The following tasks will be performed:

Task 1. Description of the Proposed Project - Provide a brief description of the proponent, how the project will be undertaken, full description of the relevant parts of the project, using clearly labeled maps and scaled site plan.

The report should outline how the vegetation clearing activities (if any) will be undertaken including work method and a vegetation map of the location for land clearing for land structure construction and agricultural use. Demonstrate what measures are taken to comply with the **Regulation on Cutting Down, Uprooting, Digging Out and Export of Trees and Palms from One Island to Another.**

Provide a matrix of project inputs and outputs during the construction and operational stage and how waste (solid waste, sewage and sewerage) and emissions will be managed. It should also include details of construction methodologies, details of the construction of jetties including, infra structure, water supply, powergeneration and fuel management with particular emphasis on waste oil management.

Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the survey and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of (likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.



WORLD ENVIRONMENT DAY - 5 JUNE 2010

4th Flr Jamaaluddeen Complex

Nikagas Magu

Male', Rep. of Maldives

Tel: 333 5949 / 333 5951

Fax: 333 5953

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Email: secretariat@epa.gov.mv

Website: www.epa.gov.mv

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INTERNATIONAL YEAR OF FORESTS - 2011



Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area and disposal sites, focused on the marine environment, including the following:

a) **Physical environment:** geomorphology, meteorology (rainfall, wind, waves and tides), sea currents, surface hydrology, long shore sediment transportation patterns, climatic and oceanographic conditions in the area, marine receiving water quality (including parameters .. turbidity, dissolved oxygen, salinity, suspended solids, pH, Nitrate, nitrite, phosphate, COD, and BOD among other chemical parameters) ground water hydraulics and the ground water quality.

b) **Biological environment:** a detailed vegetation map (vegetation assessment), sensitive marine, terrestrial, vegetation and fauna, brief description of the marine environment, including lagoon and reef system, rare or endangered species , species of commercial importance species with the potential to become nuisances or vectors.

c) **Socio-cultural environment:** job opportunities and indirect business opportunities for the surrounding communities and community perception of the development and populations of the region.

e) At least four beach profiles at different locations should be provided to establish the baseline statistics giving GPS positions of each site.

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies, if available should be presented.

All survey locations shall be referenced with Geographic Positioning System (GPS) including sampling points, reef transects, vegetation transects, manta tows and soil sampling sites. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. Absence of facility in the country will not exempt the proponent from providing the required water quality data. The report should outline the detailed methodology of data collection utilized to describe the existing environment

Task 3. Legislative and Regulatory Considerations- Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. This section should also include how the proposed project conform with the existing plans, policies, guidelines regulations, laws and also the phytosanitary measures and other relevant processes under international conventions ratified by the Maldives.

Task 4. Determine the Potential Impacts of the Proposed Project- the EIA report needs to identify the direct and the indirect impacts to the environment (biophysical, economic, human environment etc.) Identify the impacts for both construction and operational phase. Distinguish between significant impacts that are positive and negative, direct and indirect .short and long term. Identify impacts that are cumulative, unavoidable or irreversible. The report should outline the uncertainties in impact prediction. Identify any information gaps and evaluate their importance for decision-making. Special attention will be paid to:

- Effects of the project on water quality and existing coastal ecosystems and resources, area of house reef that are likely to be impacted should be defined
- Effects of vegetation clearing, construction and other proposed project activities on land.
- Effects of the project activities on ground water.(impacts of ground water extraction and pollution)
- Impacts from solid waste and their disposal



4th Flr Jamaaluddeen Complex

Nikagas Magu

Male', Rep. of Maldives

Tel: 333 5949 / 333 5951

Fax: 333 5953

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Email:

secretariat@epa.gov.mv

Website:

www.epa.gov.mv

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INTERNATIONAL YEAR OF FORESTS - 2011



- Impacts on soil system

Task 5. Analysis of (Alternatives to the Proposed Project)- Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative with at least two option alternatives. This includes alternative construction methodologies; alternative technologies, material, locations and mitigation options. Determine the best practical environmental options.

Task 6. Mitigation and Management of Negative Impacts- Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to vegetation clearing-coastal modifications, marine environment of the proposed agricultural development and dispersal/sedimentation control.

Cost the mitigation measures, equipment and resources required to implement these measures should also be provided.

Commitment for budgeting and implementation of the mitigation measures should be submitted by the responsible person. Mitigation measures should be identified for both construction and operational phase Contingency plan in case of accidents like fire need to be included.

Task 7. Environmental Management Plan and Monitoring- A time frame should be outlined for monitoring focused on the construction and operational phase.

Detail of the monitoring program me including the physical and biological parameters for monitoring, frequency, duration and cost.

Commitment from responsible person to implement the monitoring program, detailed reporting time table and ways and means of undertaking the monitoring program me should be included.

Task 8. Stakeholder and Public consultation- Major stakeholder consultation to include Ministry of Housing, Transport and Environment and any other relevant stakeholders. Public consultation. Methodology of how the data was collected should be included with names of people groups consulted.

Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.

25th May 2010



4th Flr Jamaaluddeen Complex
Nikages Magu
Male', Rep. of Maldives

Tel: 333 5949 / 333 5951
Fax: 333 5953

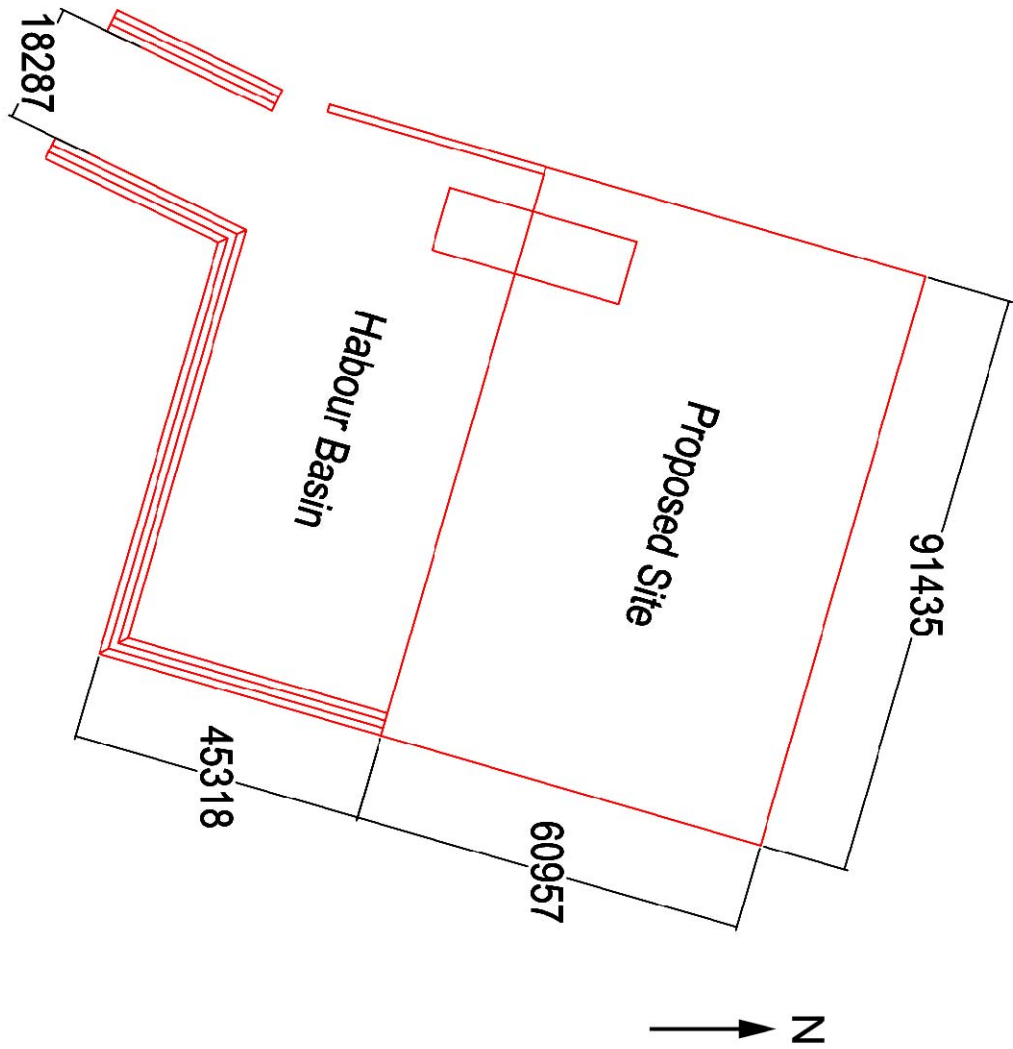
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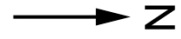
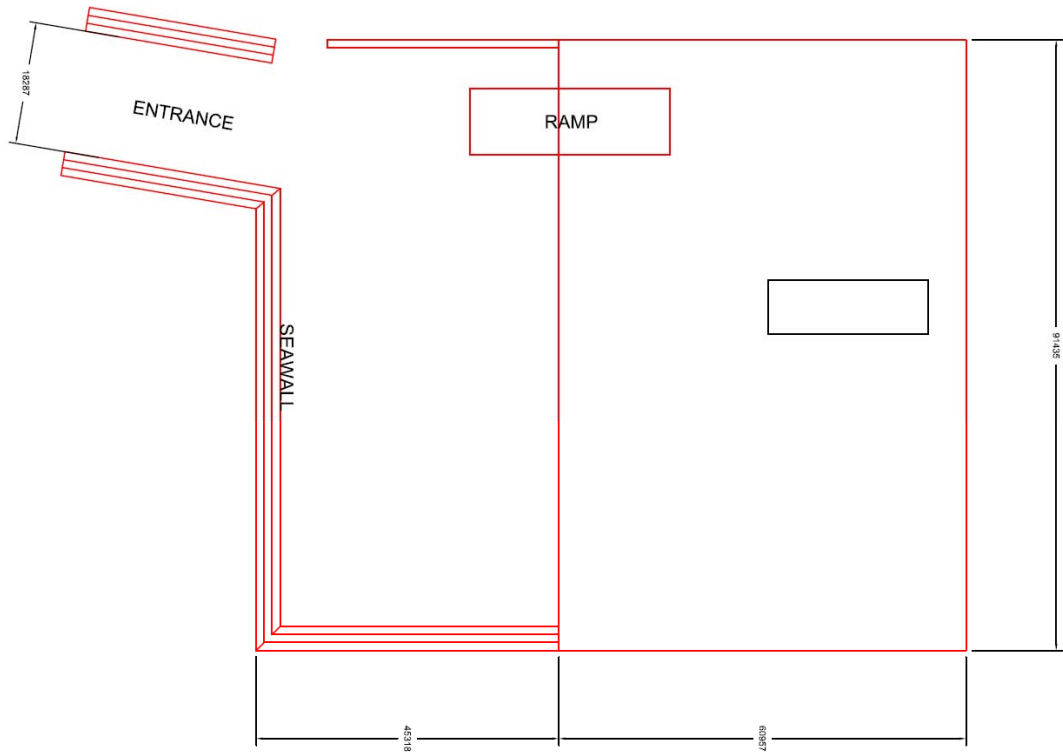
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Website: www.epa.gov.mv

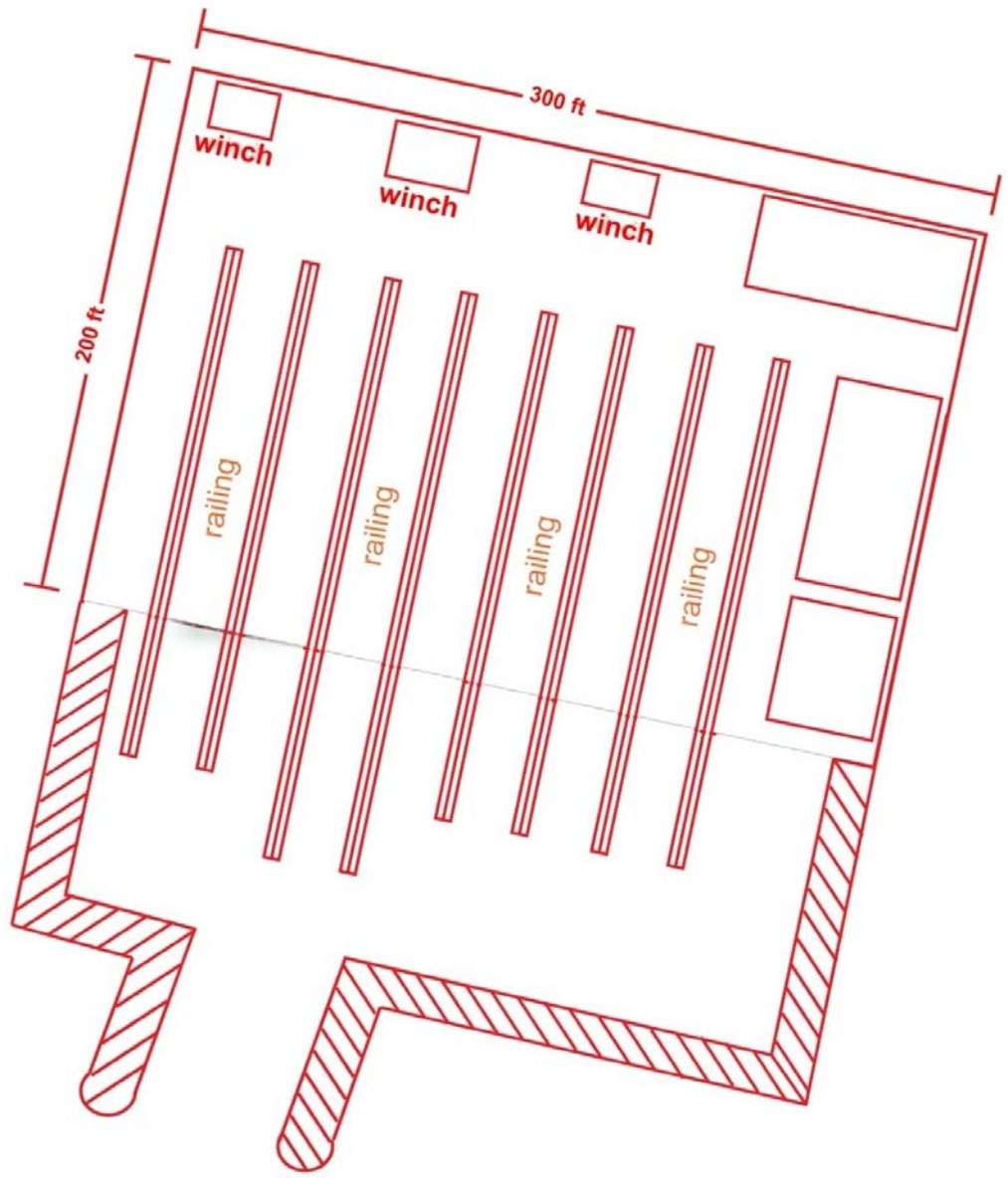
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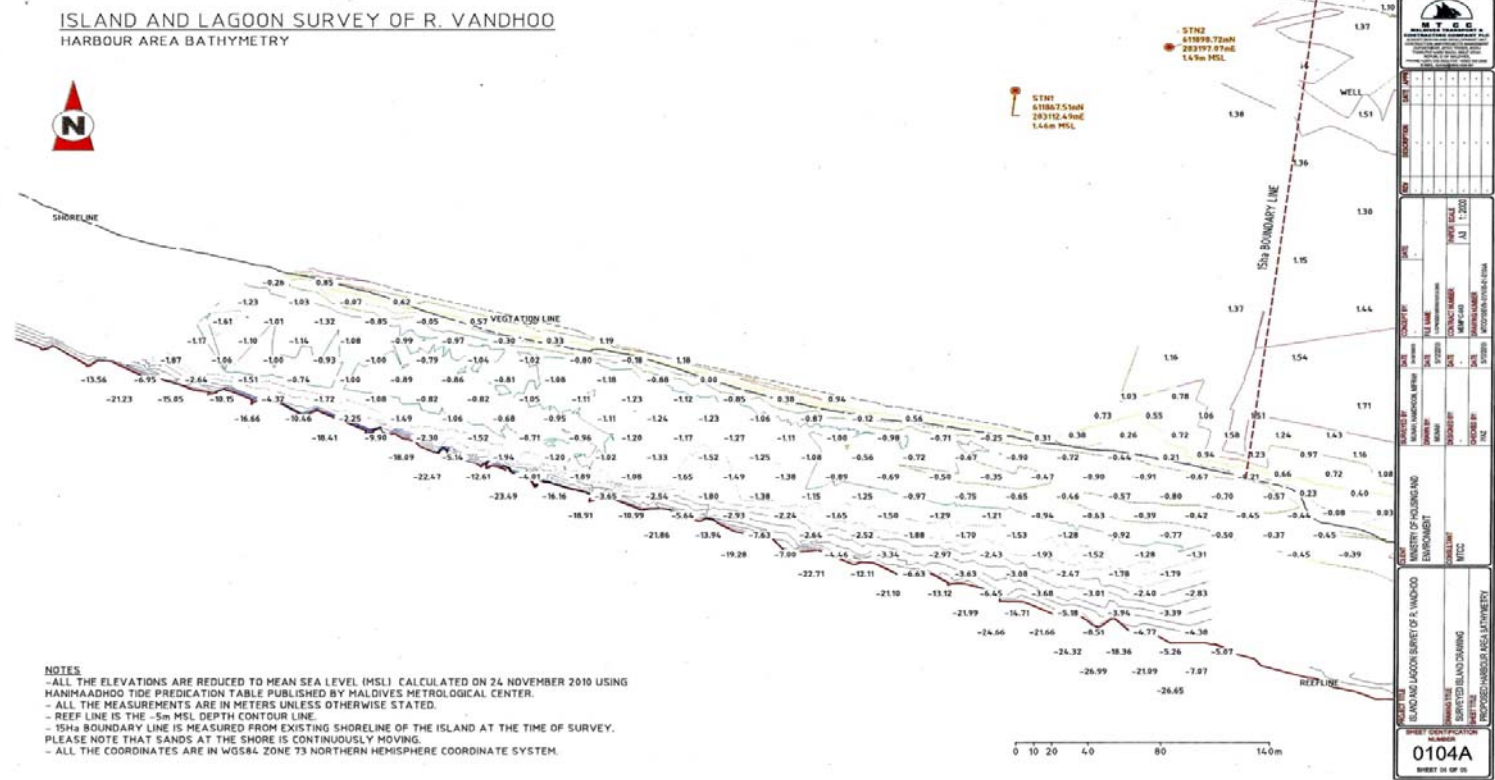
Appendix B – Layout Plans







Appendix C – Bathymetry



Appendix D – Water Quality Test Results

Male' Water & Sewerage Company Pvt. Ltd.
Water Quality Assurance Laboratory



WATER QUALITY TEST REPORT

Test Report No : 1047 / 2011 / 01

Sample Source : Ground water & Sea Water
Sample Location : R.Vandhoo
Sample Collection Form no : F196
Sample Date : 27th June 2011
Date of Analysis : 28th – 29th June 2011
Issued To : Mr.Ali Shareef

Parameter	Analysis Result				Test Method	Guideline for Drinking Water		Unit
	Sea Water		Ground Water			WHO Guideline	EPA Guideline	
	1	2	3	4				
pH	8.26	8.21	7.70	8.14	EM	6.5-8.5	6.5-8.5	NA
Conductivity	40600	41200	779	566	EM	<1500	<1500	µS/cm
Salinity	28.46	28.85	0.41	0.30	EM	NA	NA	‰
Bromine	0.00	0.10	0.08	0.23	PM	NA	NA	mg/l
Chloride	20250	19750	126	80	TM	<250	<200	mg/l
Nitrate	0.0	0.5	0.3	0.5	PM	<50	<10	mg/l
Nitrite	0.000	0.003	0.001	0.031	PM	<3	NA	mg/l
Phosphate	1.16	0.16	0.16	0.20	PM	NA	NA	mg/l
Sulphate	1750	2000	28	20	PM	<250	<400	mg/l
TSS	1	0	3	2	PM	NA	NA	mg/l
BOD	0.63	0.79	3.49	2.95	*	NA	NA	mg/l
Turbidity	0.283	0.217	0.801	0.353	PM	<5	<5	NTU
DO	8.63	7.70	4.65	4.95	EM	NA	NA	mg/l

Keys:




UNITS: mg/l: Milligrams per litre, ‰: Parts per Thousand, NA: Not Available, µS/cm: Micro Siemens per Centimeter, NTU: Nephelometric Turbidity Unit

TEST METHODS: PM: Photometry, EM: Electrometry, TM: Titrimetry, *HACH method 8043

- BOD: Biological Oxygen Demand, TSS: Total Suspended Solids, DO: Dissolved Oxygen

Notes:

1. This report, in full or in part, shall not be published, advertised, used for any legal action, unless prior permission has been secured from MWSC.
2. This tests report is ONLY FOR THE SAMPLE TESTED.

Analyzed by:  Nashath Ali, Lab Technician	Checked by:  Mohamed Eyman, QCO	Approved by:  Adam Rasheed, SWQAO
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-----END OF THE REPORT-----



15
Years of Service
1995-2010

MALE' WATER & SEWERAGE COMPANY PVT. LTD.
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03rd July 2011

Our Ref. MWSC-26/2011/ 2408

Mr. Ali Shareef,
H.Meerubahuruge aage,
Male'
Maldives

Dear Sir,

Re: Unavailability of Testing Services at MWSC WQA Laboratory.

It is with regret that we inform you that the following tests are unavailable in our Laboratory at the time of your request (27th June 2011) due to the shortage of reagents/chemicals;

- Chemical Oxygen Demand (COD)

With increase in demand for such tests we are in the process of upgrading our laboratory such that the above tests are always available in our Laboratory.

Sincerely yours,
Male' Water & Sewerage Company Pvt. Ltd.

Adam Rasheed
Senior Water Quality Assurance Officer

Ibrahim Akram
Asst. Manager Marketing

Appendix E – Letter of Commitment

Hon.Mohamed Aslam, Minister,
Ministry of Housing and Environment,
Male', Republic of Maldives.

Date: 22nd June 2011

Dear Sir,

Environmental Impact Assesment for Development of a slipway at Raa.Vandhoo

As the developer of the above mentioned project, I hereby confirm my commitment to carry out and bear costs of environmental mitigation measures and monitoring outlined in the audit report.

Yours sincerely



Mohamed Ali Fulhu

Naares, Raa. Innamaadhoo

