ENVIRONMENTAL IMPACT ASSESSMENT REPORT

FOR THE PROPOSED LAND RECLAMATION (PHASE II) OF THE

GULHIFALHU ISLAND, KAAFU ATOLL, MALDIVES

PROPOSED BY

GLOBAL PROJECTS DEVELOPMENT COMPANY (PVT) LTD

PREPARED BY

CDE CONSULTING

JANUARY 2011

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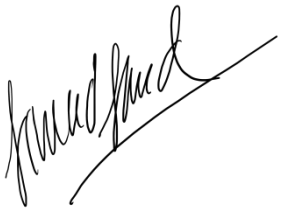
Lead Consultant's Declaration

I certify that statements made in this Environment Impact Assessment are true, complete and correct to the best of my knowledge and available information.



Dr. Simad Saeed (EIA 13/2007)

Executive Summary

This Environmental Impact Assessment (EIA) is an evaluation of the potential environmental, socio-economic and natural impacts of the proposed development of the lagoon at Gulhifalhu. The Project is being undertaken by Capital Investment and Finance Ltd (CIFL) registered in the UK. CIFL has signed a concession agreement with the owner of Gulhifalhu – Gulhifalhu Industrial Zone Limited – a state-owned company with objective to privately develop a qualitatively high and attractive residential and commercial area in the Maldives and lease out reclaimed land for 35 years.

Introduction

Project Background and Problem Analysis

The Government of Maldives (GOM) in its efforts to enhance the economic potential of the Maldives has been considering the reclamation and the development of the lagoon at Gulhifalhu as a potentially attractive investment opportunity in infrastructure, for the past several years. In 2010, GOM signed an agreement with Gulhifalhu Industrial Zone limited, Maldives and Capital Investment and Finance Limited, United Kingdom to develop Gulhifalhu as potential area to reduce the congestion and population pressure that Male' is facing. This is the second phase of the project; earlier 10 Ha of land is already being reclaimed. This phase will reclaim and develop appropriate coastal measures on 37 Ha land. The EIA is being developed as per the EIA regulation (2007) of the Maldives and the Terms of Reference that was developed by the consultant (CDE Consulting). The EIA is well represented as per the TOR and respective chapters describing the environment and potential impacts and mitigation measures are discussed in the consecutive chapters and most importantly all these work have being discussed with all the key stakeholders before submission and their views on the project is also being depicted in this EIA.

Project Description

Project location

The project location is Gulhifalhu Reef located on the southern rim of the North Male' Atoll. Gulhifalhu is in about 400m away from Villigili Island and about 300m east of Thilafushi

Island. The nearest resorts are Giraavaru Tourist Resort (5km) and Kurumba Maldives (6.7km).

Project Outline

There is an existing land area of 10 Ha in the Gulhifalhu region. The proposed overall project involves the reclamation of over 110 ha over Gulhifalhu. In Phase and Phase II of the project include dredging of approximately 300,000m^3 and 700,000m^3 of coral sand within atoll lagoon and pumping of the materials into reclamation area respectively. During this EIA commencement of reclamation and construction and development of Phase III and IV is unknown. The borrow area for this activity will take place within the atoll lagoon and the number of workers that would be hired during this process will be 47 out of them 12 will be specialist.

Selected method for the dredging

The method proposed is sourcing sand from the bed of the atoll lagoon using a Trailing Suction Hopper Dredger (TSHD). A TSHD is a normal sea-going ship equipped with one or two suction pipes. The material loosed by the drag head, together with some transport water, is sucked into the suction pipe by means of a centrifugal pump. The TSHD will transport the sediments to the reclamation where they will be brought to shore.

Stability of reclamation and revetments

Rate and volume of pumping sediment will be faster than the rate of erosion. Erosion is predicted to be severe in the short-term. The rest of the islands are expected to be very stable, but erosion is will be at peak during March and May in the eastern and northern side of the island. To prevent this excessive erosion the project also constructs appropriate coastal measures (revetments) along the coastline of the island. The major revetments proposed included a 1600 meter quay wall along the lagoon side (inner slop), 450 meters geotextile bags and sand cement bags between the channels and on the south side of the island a mixture of geotextile and rock armour will be placed around 1900 meters coastline.

Work Plan

The project is planned to be carried out in four phases. Phase II will be completed in eight to nine months. The preparatory work is expected to take one month. The Dredging activity is expected to take one week and reclamation work is expected to take two months. Followed by the construction activities mainly revetments will take five months.

Legal Framework

The main legal instruments of concern are the Environmental Protection and preservation Act (4/93), which is an umbrella law that provides wide statutory powers to the Environment Ministry regarding environmental regulation and enforcement and the Environmental Impact Assessment Regulation 2007 which provides comprehensive outline of the EIA process. The other act that are include and well referred during this whole EIA process includes Land Act, Fisheries Act Other important policy tools include "Aneh Dhivehi Rajje' – The Strategic Action Plan (SAP), Third National Environmental Action Plan (NEAP III), National Strategy for Sustainable Development, waste management Policy and population policy.

The related conventions, treaties and protocols that Maldives is member is also highlighted this is to ensure that all those international laws and treaties and conventions are emphasized. The main conventions and respective treaties highlighted are United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, United Nations Convention on Biological Diversity (UNCBD), United Nations Conference on Desertification (UNCCD), United Nations Convention on the Law of the Sea (UNCLOS), International Convention for the prevention of Pollution from Ships (MARPOL). The project is also legally backed by the regional declaration as well the major declaration includes Male' declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia.

Description of the Natural Environment

Geological Setting

Gulhifalhu is located on the southern rim of the North Male' Atoll. The reef is fairly large at about 365Ha. The reef flat is wider on the south side of the reef system (300m) and very narrow (90m) on the north, east and west side of the reef system. The water depth over the reef flat varies between 1.0m and 2.0m. Apart from a natural reef entrance on the eastern side, a reef entrance was made on the western side with the width of about 38 m. The inner lagoon is deep with around 8-9 m. The inner lagoon occupies about 63% of the total surface area of the reef system.

About 10Ha of land that has been reclaimed in the phase I of Gulhifalhu development at south western corner of the reef system is the only land seen on Gulhifalhu, above sea level. The elevation of this recently reclaimed land is +2.5 m above MSL. The island has been created from coral material from the atoll lagoon bottom. The new island is barren with no vegetation

and poorly established ground water system. There are not topographic variations on the island as it has been levelled.

Based on similar projects and proponent's experience, the material of the borrow area can in general terms be described as "loosely packed, silty, coral sand and shells". One vibro-core sample was taken in the area north of Gulhifalhu in June 2009.

Climatic Setting

The Maldives, in general, has a warm and humid tropical climate with average temperatures ranging between 25°C to 30°C and relative humidity ranging from 73 per cent to 85 per cent. The country receives an annual average rainfall of 1,948.4mm.

Monsoons of Indian Ocean govern the climatology of the Maldives. Two monsoon seasons are observed: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The southwest monsoon is the rainy season which lasts from May to September and the northeast monsoon is the dry season that occurs from December to February. The monsoons are relatively mild due to the country's location near the equator and strong winds and gales are infrequent in the Maldives.

The tides observed in the country are twice daily (semidiurnal), and typical spring and neap tidal ranges are approximately 1.0m and 0.3m respectively.

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. Currents which affect the sea area around the Maldives are caused by one or more of the following systems: oceanic currents, tidal currents, wind-induced currents, and wave-induced currents. There is a strong diurnal influence which governs the tides in the Maldives, but in general the tidal range is less than 1m.

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically strongest during April - July in the South West Monsoon period. The Maldives also experiences swells originating from cyclones and storm events occurring well south of the equator.

Annual average rainfall in Maldives is about 1900mm. There is a marked variation in rainfall across Maldives with an increasing trend towards south. The annual average rainfall in north is 1977mm and for south is 2470mm.

Daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. The annual mean maximum temperature recorded for Male' during the period 1967-1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C.

Coastal Environment of the Existing Island from Phase 1

The only island on the reef system is the newly reclaimed 'Gulhifalhu Island' on the southwest corner of the island. The island is created from atoll lagoon bottom sediments, primarily containing fine to moderately coarse sediments.

The elevation of the island is 3.0 m and has been compensated for future natural settlement and wind erosion. The initial reclamation activities were followed by severe erosion on the southern side reaching 30 m inland from the reclaimed shoreline. Large chucks of these materials are deposited on the northern and eastern ends of the island. Coastal protection measures are being constructed on the western and northern side of the island. Coastal protection on the southern and eastern end of the island has been halted since these areas are planned to be reclaimed in phase II.

There have also been significant changes to the beach profile with the construction profile naturally adapting wave and current conditions.

Water quality tests conducted show that from December 2010 to January 2011 the salinity levels have reduced at all sampling locations.

The primary sources of natural hazard risks in Maldives are strong winds during monsoons or freak storms, earthquakes, island interior flooding caused by heavy rain, coastal flooding caused by high surf, storm surge, prolonged strong monsoonal wind, high astronomical tides or tsunamis, and sea level rise. Spatial variations in hazards are evident across Maldives.

Natural and Biological Environment

Reclaimed area of Gulhifalhu during phase 1 is on the south western corner of the Gulhifalhu reef system. The marine environment associated with this island is composed of an intertidal reef flat, a shallow lagoon area, a reef edge and a steep reef slope.

The intertidal reef flat extends approximately 5 m away from the islands low tide line, with a depth ranging approximately between 0.1 m to 0.5 m. The benthic cover of this area is dominated by sand and small broken off pieces of coral rubble.

The shallow lagoon area extends approximately 15 m, from the intertidal reef flat till the reef edge. The depth at the lagoon area ranges of 0.5 m to 1 m. The benthic cover is similar to the reef flat; dominated by coral rubble and sand.

The reef edge is approximately 3 m to 5 m in width from the shallow lagoon area till the reef slope. The depth varies between 2 m to 3 m at this location. The benthic cover of this area is dominated by large boulder shaped rocks, and large Porites.

The reef slope steep and extends approximately 30 m from the reef edge. Depth at the reef slope ranges between 3 to 30 m. The benthic cover is dominated by sand, rocks and dead hard corals.

The baseline condition of the marine environment of Gulhifalhu is derived from the marine surveys conducted by Hydrodynamics BV in June 2010. Surveys were conducted at seven sites across Gulhifalhu, details of which can be found in chapter 4.4.2.

In the Maldives there are 33 Marine Protected Areas (MPAs) of which 8 are located in the North Male' Atoll and 2 in the South Male Atoll. The closest MPA to Gulhifalhu is Hans Hass Place located just south of the Gulhifalhu reef.

A number of marine species have been protected in relation to the Convention on Biological Diversity (CBD). Some of the protected species were observed in the waters around Gulhifalhu reef. These include Napoleon wrasse, giant clams and conchs. Spinner dolphins were observed south of the Gulhifalhu reef.

In addition, 70 bird species (including 5 species which are native to the Maldives) are protected under the Environment Protection and Preservation Act (Act 4/93 of the Maldives).

Gulhifalhu is currently completely submerged and has therefore no beaches and no function as a turtle nesting area.

Economic and Social Environment

The present socio-economic environment of Gulhifalhu is outlined in relation to Male', Villigili, Thilafushi and nearby resorts. Socio economic changes caused by the establishment of Gulhifalhu Island cannot be evaluated at this stage because details of land leasing, types of industries and such information are unknown.

A public consultation was carried out with inhabitants of Villigili and with project beneficiaries.

The general attitude was positive and important areas of concern was lack on information on the project.

Gulhifalhu is located about 5 km away from Capital Male', which is considered as the main gateway to the country and all the service related industries within the community including civil service, construction activities, retail and whole sale trade and cargo transport to other international hubs.

Thilafushi Island is located about 0.36 km away from Gulhifalhu. The primary purpose of Thilafushi is to solve the issue of waste on Male' and has been in use for landfilling for the last 18 years.

Kurumba Maldives (6.5 km north east of Gulhifalhu) and Giraavaru Island Resort (5 km to the west of Gulhifalhu) are the two resorts located in close proximity to Gulhifalhu.

Stakeholder Consultation

Stakeholder consultations were carried out with the project beneficiaries, inhabitants of Villingili, Divers Association of Maldives (DAM), nearby resorts and government agencies. In general, all groups welcome the development and would like the project completed as it is beneficial to the Maldives. DAM noted that following phase 1 reclamation the reef in the area is overall in good condition and that appropriate measures such as silt screens should be used in phase 2 reclamation. Inhabitants of Villingili, Atoll Office and Province Office noted a lack of information on the project.

The fact that no plans have been devised yet for the phases 3 and 4 and the operations stage of phase 1, made it difficult to conduct consultations for these specific phases. Hence, only phase 2 was considered in the public consultation covering land reclamation and planned land use.

Environmental Impacts and Mitigation Measures

Proposed project will have both negative impacts as well as positive impacts to the country in general. This chapter involves a closer analysis of the major environmental impacts of the project. This is represented in a flow chart in a chronological and logical manner. This order starts from the activity to casual factor, leading to the negative environmental impacts and finally duration of the impacts.

Sedimentation is highlighted as the major impacts to the natural environment; this is mainly

due to the dredging and reclamation activities. These cause several impacts ranging from smothering of coral to permanent loss of marine habitats. Other impacts include pollution to the environment, impacts to the protected coral reef area. As flagged out in the EIA for the Phase I, the Phase II will be causing irreversible damage to the marine habitat and biota. Thus adequate mitigation measures are addressed in this chapter to enable less impacts to Marine habitat and especially to the Marine Protected Area. During the project it is also expected there will be change in the current patterns which is experienced by similar projects in the past. The methodology adopted by the project is TSHD this ensures the project to be more environmentally sound. Several mitigation measures are also taken prior to commencement of the project and during and after the project. This ensures the project to be following EIA process. Measures with their respective costing like developing sedimentation basins, silt screen and bund walls during the reclamation process are used.

The Other major impact of this project is extensive and increase in cost for the waste barge operator (Male' Municipality), that is after the commencement of this Phase the waste barge will be de routed forever thus having its own cost implications. And this EIA also climaxes cumulative impacts of the proposed development due to the present development that took place as Phase I.

Apart from the negative impacts, the positive impacts of this Phase is also being touched upon and it reveals different and important impacts which included elevating of poverty, directly contributing to the MDP –Alliance manifesto pledges (Affordable Living cost and the affordable housing). This project also full fills the re directing the population migration from other Atolls to Male' with availability of more lands at cheaper rate.

The chapter is concluded with the approximate cost for the proposed mitigation measures, however this cost will be subjected to change and it depends on the economic level at county level and at globally.

Environmental monitoring

The monitoring programmes include three main sections, they are; Information Needs, Monitoring Programme and Monitoring Reports.

Information Needs

In this monitoring plan, which includes the construction phase and the long term (both of which will be the responsibility of the project proponent), the most relevant information needs

are:

- water quality aspects; including suspended sediments and sedimentation;
- ecological aspects related to coral;
- turbidity and sedimentations
- the re-colonization of the borrow area created by a CSD
- erosion around the borrow area
- erosion around the reclaimed island
- changes to currents and waves in proximity to Gulhifalhu

Monitoring Programme

The proposed monitoring activities below should be combined with phase I monitoring. In fact, the programme below has been aligned with the parameters identified in the First Phase EIA

- water quality monitoring
- monitoring the marine environment
- erosion around the borrow area
- erosion around the reclaimed area
- changes to currents in close proximity to Gulhifalhu
- other monitoring needs:
    - Daily monitoring to ensure that the cleared areas and other construction processes are not creating any significant dust nuisance for the local environment.
    - Daily monitoring of vehicle refuelling and repair to ensure that these exercises are carried out on hardstands and to ensure that they are done properly. This is to reduce the potential of soil contamination from spills. Spot checks will be conducted by the site supervisor.
    - Monitor borrow areas to ensure only the designated areas are dredged.
    - Regularly monitor bundwalls of silt screen lining to ensure they are intact.
    - Monitor dredger activity activities to check for spills.

Monitoring Reports

The weekly reporting will be based on the monitoring results, site inspections and the evaluation/interpretation of the monitoring results.

Based on the weekly monitoring results the effectiveness of the operational controls, the mitigation measures employed and the need for supplementary mitigation measures will be discussed between the Engineer and the contractor on a weekly basis.

A detailed annual environmental monitoring report is required to be compiled and submitted to the Ministry of Transport, Housing and Environment based on the data collected for monitoring the parameters included in the monitoring programme. This report may be submitted to the relevant Government agencies in order to demonstrate compliance.

In addition to this more frequent reporting of environmental monitoring will be communicated among the environmental consultant, project proponent, the contractors and supervisors to ensure possible negative impacts are mitigated appropriately during and after the project.

Conclusion

The reclamation of Gulhifalhu with proposed coastal protection can be done with moderate impacts on the surrounding environment in the phase 2. However, during the dredging and reclamation activities, good care should be taken to minimize the impacts of the suspended sediments. Preventive measures will be in place to ensure minimal loss of suspended sediments. All the feasible measure will be taken to minimize the amount of coral damage by dredging.

The Socio economic benefits are large in relation to the duration of dredging and reclamations works needed. This project will provide new land for warehousing, logistics and distribution and housing. And it is believed that an existing and immediate need for the land and space in the Male' region would be fulfilled by this project.

1 Introduction

This Environmental Impact Assessment (EIA) is an evaluation of the potential environmental, socio-economic and natural impacts of the proposed land reclamation and coastal protection measures in proposed Gulhifalhu Island. This is the EIA for the Phase II of the project which involves reclamation of additional land. A separate EIA was prepared and approved for the Phase I of the project before the reclamation commenced.

The main component of the project includes land reclamation of 37 Ha areas on the Gulhifalhu Lagoon and associated coastal protection. The supporting developments for the island will be submitted in a separate EIA as the details of those developments are yet to be finalised. Similarly, there are plans for further reclamations which will be addresses in subsequent EIAs.

1.1 Background of the Study

The Government of the Maldives (GOM) in its efforts to enhance the economic potential of the Maldives has been considering the reclamation and development of the lagoon at Gulhifalhu as a potentially attractive investment opportunity in infrastructure, for the past several years. The rationale for the development of Gulhifalhu lagoon is to provide an alternative location in the proximity to Malé, to carry out various commercial and light manufacturing activities, easing out the current congestion in Malé.

Gulhifalhu Industrial Zone limited, Maldives and Capital Investment and Finance Limited, United Kingdom, have entered into a concession agreement with GOM, represented by the Ministry of Economic Development to reclaim and develop the Gulhifalhu lagoon on 18th March 2010.

The complete reclamation of Gulhifalhu will consist of IV phases. Phase I of the Gulhifalhu development project includes the reclamation of approximately 10 Ha of land along with the necessary shore protection. This project has been completed at the time of this EIA. Phase II of the Gulhifalhu project concerns the development of a further 37 Ha. The Phase III will consist

of a 75 Ha and Phase IV of 115 Ha.

Planning of the phases will be in agreement of the concession agreement between the developer and the GOM.

The planned activities for these phases of the project are restricted to dredging, land reclamation, and shore protection. The impacts of the development of houses, roads and warehouses will be assessed in a separate EIA.

The GOM will offer the Joint Developers a long term lease on the land with the right to sub-lease the land for undertaking selected investments approved by the GOM. The GOM will also accord other incentives to the investors operating on the newly reclaimed land.

The present report contains a proposal for the Environmental Impact Assessment (EIA) for the dredging, reclamation and shore protection works of phase II of the Gulhifalhu land development. For the reclamation of phase III and IV a separate EIA will be made. This report has been prepared by CDE Consulting, Maldives.

1.2 Problem Analysis

1.2.1 Land scarcity in the Malé area

Land is extremely scarce in the Maldives, which acts as a constraint on the development of the country. This is especially true for Malé, the capital city of the country, with a population of more than 100,000 people, concentrated in just two square kilometers. Due to a lack of employment opportunities in the outer atolls in recent years, many people migrated from small islands towards Malé. The percentage of the country's total population living in Malé has increased from 25% to 35% during the period 1990 - 2006. This concentration seems to continue, especially after the 2004 tsunami, despite efforts of GOM to discourage people coming to Malé. The continuing overcrowding in Malé has resulted in a lot of economic and social problems: high land rental rates, no room for industrial/commercial development, environmental issues, crime, etc. To ease out the current congestion and enhance the economic potential of Malé, the GOM is considering and/or has undertaken several land development projects in the Malé area. The Gulhifalhu land development project is one of them.

1.2.2 Population pressure

The population growth in the Maldives has recently been as high as 2 to 3%; in the outer atolls the majority of the population is below 20 years of age. Due to the significant population

growth, many of the islands are completely full. This means that there is no place for additional people, for further communal and/or commercial activities, and for migration from smaller islands to the bigger regional centres.

Due to the relatively small populations (average 500-1,500 persons) per island, the costs of providing community infrastructure (electricity, water supply, sewerage, waste collection) and communal services (health, education, local administration) is extremely high. Further, the limited depth of the islands ports and the low transport volumes, lead to high per-ton transport costs for import of food, construction materials and other goods.

In a country with high GDP growth, and a society that is rapidly modernizing, demand for better infrastructure and services will often grow at a much faster pace than even GDP growth.

Both the population pressure and the high costs of communal infrastructure and provisions in the smaller islands will in time result in migration to larger islands, often to Malé.

1.2.3 Extreme weather conditions and sea-level rise

At the Maldives virtually no cyclones occur, but sometimes there are significant storm surges with up to one meter sea level rise. In April 1987 there was a storm surge at Malé, which resulted in unusually high waves. One third of Malé was inundated by about 60 cm of water. Again in 1991 a storm surge occurred near Malé. Although the damage was minimal, the experience was a forceful reminder of how vulnerable the Maldives can be to even a small rise in water level. Then of course there was the December 2004 tsunami and the resulting waves and flooding in Malé and other islands.

Climate change and predicted sea level rise are of great importance to the Maldives, due to the low elevation of the islands, making them vulnerable to even small rises in the sea level. During the past century the global temperature increased by about 0.6 degree. Climate models calculate that the global mean surface temperature of the earth could rise by about 1 to 4 degrees by 2100. During the past century the average sea level increased by about 15 to 20 cm. The estimated predicted sea level rise in the period 2000 to 2100 will be, according to the latest UN/IPCC (Intergovernmental Panel on Climate Change) report (Jan 2007), between 18 and 59 cm, average 0.4 meter. This sea-level rise combined with more frequent extreme weather occurrences makes the Maldives one of the most vulnerable countries to climate change and sea level rise.

1.3 Justifications and Objectives of the Project

There are three main objectives of the project:

1) Increase the useable land-space in the Greater Malé area, allowing extra space for industrial activities, housing, and services, including related infrastructure, which should be provided on the new island against reasonable costs.
2) Build the new island as a safe-island, providing reasonable safety against the sea for at least the next 50 years.
3) Provide efficient transport facilities for the new industries and services, and the people employed on the new land.

The economy of the Maldives is growing and with it the population, transportation of goods, the need for harbours, schools, hospitals, housing and warehouses and industrial activities increase as well. The necessity of space for all these activities is extensive. In Kaafu atoll, there are currently more development projects in execution or planned.

Table 1-1 Main Projects in the area

Area	Main land use
Hulhumale 1	Residential (+light industry)
Hulhumale 2	Residential
Hulhumale DP World	International shipping
Hulhule airport ext	International air traffic
Male NW port area	Shipping
Thilafushi	Heavy Industries

Gulhifalhu is located close by Malé in the southern rim of Kaafu Atoll (see next chapter). Overall some 200 hectares of land could be developed in/on Gulhifalhu reef and lagoon; this land will border (enclose) a large protected anchorage area, accessible virtually at all times. After its implementation the project is expected to have a huge effect on employment in the Greater Malé area. When completed Gulhifalhu Island will be a part of the urban corridor on the south-east side of Kaafu Atoll consisting of (west to east) Thilafushi, Gulhifalhu, Villingili, Malé island, Hulhule' airport, and Hulhumale residential landfill.

1.4 Potential users

The key functions for the development of Gulhifalhu include the relocation of some industrial activities from Malé, the relocation of logistics inter-island redistribution activities, and it caters for related population growth.

The Maldivian Foreign Investment Services Bureau (FISB) confirmed in its Letter of 17 October 2006 which activities could be operated on Gulhifalhu. The Joint Developers made an assessment of these operations and concluded that the potential users as identified in Table 1-2 were to be included in the master planning for Gulhifalhu.

Table 1-2: Potential Users for Gulhifalhu

Potential Users
Warehousing Complex
Cool and Cold Storage
(Business) Hotel
Maritime Training College
Social Housing
Low Cost Labour Housing
Hospital
Duty Free Shopping / shopping mall
Offshore Banking, Finance and Insurance
Power Generation
Bonded Stores
International school

1.5 Project Proponent

The project proponent is Capital Investment and Finance Ltd (CIFL) registered in the UK. CIFL has signed a concession agreement with the owner of Gulhifalhu – Gulhifalhu Industrial Zone Limited – a state-owned company with objective to privately develop a qualitatively high and attractive residential and commercial area in the Maldives and lease out reclaimed land for 35 years.

Global Projects Development Company (Pvt) ltd, Maldives, a subsidiary of CIFL, is the local SPC currently being registered to execute the development of the Gulhifalhu.

1.6 Aim and scope of EIA

The present scope of the EIA is based on the EIA Regulations from the Ministry of Housing, Transport and Environment (EIA Regulations 2007, ref. 1) and on EIA"s for several other, similar, projects in the Maldives (Vilufushi Island Reconstruction, Viligili Island Reconstruction, Three Islands Project, and Gulhifalhu reclamation phase I). The EIA report covers both the natural and the social environment and includes the following main aspects:

- a description of the project including the usefulness and need of the project
- the policies and plans of which the project is a part and the legal framework of the project;
- information about the general environmental settings of the project area, covering both the marine and terrestrial environment and including physical and climatological characteristics;
- information on the social and economic baseline conditions;
- information on potential impacts of the project and the characteristics of the impacts;
- information on potential mitigating measures to minimise undesired environmental and social impacts;
- assessment of the best alternative for the project or for certain project components;
- basic information for formulating the environmental monitoring program and the environmental and social management plan;
- inventory of possible gaps in presently available information.

The focus of this EIA is very much on the construction stage of the second phase of the project. This is limited to dredging, land reclamation and the coastal protection of a 37 ha area designated for the second phase of the project.

It is difficult at this stage to undertake a full scale assessment of the remaining phases of the project as they are the detailed plans for them are yet to be finalized. Moreover, the detailed plans for further development of the second phase of the project are yet to be finalized. Hence, this EIA explicitly looks into the construction stage of the phase II of the project.

1.7 Terms of Reference

The Terms of Reference (TOR) for this EIA were submitted to the Ministry of Housing and Environment on 2nd January 2011. A scoping meeting was held on 29th December 2010. Based on this meeting the TOR was adjusted and a final version was submitted on 2nd January 2011 and approved by the EPA on 3rd January 2011. The TOR follows the Environmental Impact Assessment Regulations 2007, as prepared by the Ministry of Environment, Energy and Water.

The approved Terms of Reference can be found in Annex 1.

1.8 Experience of proponents with similar projects

The project proponent, Capital Investment and Finance Ltd.(CIFL), has contracted Royal Haskoning, an internationally renowned engineering and consultancy, to make engineering designs for the project. Royal Haskoning is one of the largest port development consultants in the world and has wide experience in the fields of urban development and water & environment.

CIFL has also contracted Royal Boskalis Westminster to do the dredging and reclamation works necessary for the development of Gulhifalhu. Boskalis has worldwide experience in dredging and reclamation works and has worked for the Government of the Maldives on tsunami reconstruction projects at Vilufushi, Thaa Atoll (2005-2006) and Viligili, Gaafu Alifu Atoll (2007-2008).

In addition, the proponent and contractor now have experience from the first phase of the project in this specific setting.

1.9 EIA Methodology

The process followed in the preparation of this environmental impact statement consists of five components: scoping consultations; literature review; field surveys; analysis of results; and output.

The first step of the process covered consultations with client and government agencies to determine the scope of the impact assessment. The scope was decided and the TOR was finalised on 3rd January 2011 based on the information contained in the EIA Regulations 2007. During this stage the client clearly outlined their development needs and assessment was geared to match the development plan and environmental assessment needs.

During the second stage, a literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of the proposed developments in similar island settings. In this context, the Draft Environmental Guidelines for Tourist Resort Development and Operation issued by the MTCA, the EIA Regulations 2007. The timeframe for assessment was small given the geophysical setting of Maldivian coral islands. Hence, a reliance on scientific studies undertaken in similar settings around Maldives and historical publications are a necessity during assessments in Maldives.

The third stage involved field assessment both on the island and in neighbouring areas covered

by the EIA scope. Conditions of the existing environment were analysed using established appropriate scientific methods. Coastal and hydrographical conditions were studied through field surveys which involved using DGPS, echo-sound meters and remote sensing applications. Aspects of the marine environment were assessed using established surveying and recording procedures such as Manta tows, random swims, line transects and photo quadrates. In addition, data from regional studies, particularly climate and wave data were used to assess environmental impacts.

In addition, field assessments were undertaken in the Viligilli community to determine the socio-economic impacts on them using established social assessment methods such as random interviews.

The fourth stage involved in-house analysis using scientific analysis methods. These methods will be explained in detail in later sections.

The final stage involved compilation of individual consultant findings and consultations with the developer to adjust certain elements of the designs which were deemed to have significant affects on the operation of the islands and the resorts.

The field work necessary for the environmental and social impact assessment was carried out by expert professionals from CDE Consulting. This EIA refers extensively to the Phase I report as their content is highly relevant to this report, particularly for cumulative impact assessment. The Phase I report was prepared by Hydronamic, Netherlands and CDE Consulting, Maldives. Due credit is given to the consultants of the previous report.

1.10 Report Outline

This EIA is organised into nine sections. They are:

Chapter	Brief Description
Chapter 1	Executive Summary
Chapter 2	Introduction
Chapter 3	Problem analysis and justification for the project
Chapter 4	A description of the project including the project location, detailed description of project components including site conditions, site plans, implementation schedules, work methods, waste management and summary of inputs and outputs.
Chapter 5	A summary of the policy, planning and legal framework applicable to the project and a demonstration of how the project conforms to these aspects.
Chapter 6	Detailed description of the existing baseline environmental conditions on the site.
Chapter 7	Description of the economic and social environment
Chapter 8	Information regarding stakeholder consultations
Chapter 9	Information on the potential impacts and mitigation measures of the project.
Chapter 10	Assessment of best alternatives for the project or for certain project component.
Chapter 11	Details of the environmental monitoring program
Chapter 12	Conclusions

2 Project Description

2.1 Project Location

The project location is Gulhifalhu Reef located on the southern rim of North Male' Atoll at approximately 4.17971687° N latitude and 73.46668371° E longitude (see Figure 2.1). With a width of about 1.6 km and roughly 2.8 km in length, Gulhifalhu Reef is one of the largest reef system in the Male' Urban Region with a total surface area of approximately 365 ha. Gulhifalhu is in close proximity to Viligilli Island (400 m), Thilafushi Island (300 m) and Male' (2.5 km). The nearest resorts are Giraavaru Island Resort (5 km) and Kurumba Maldives (6.7 km).

2.1.1 Site Conditions

Maldives experiences two main seasons: the rainy SW monsoon and the dry NE monsoon. Winds are strongest during the SW monsoon and the project site will face the predominant wind and wave direction during this period. The project site will be largely protected from wind and wave activity during NE monsoon.

The proposed project site generally has shallow reef flat waters in the range of 1.0 to 1.7 m MSL. Reclamation will be done mainly in these shallow areas. It will be possible for dredge vessels to approach the project site. However, a reef entrance will have to be created. The central areas of the lagoon are deep, on average 8 m.

In addition, sand is proposed to be borrowed from the atoll lagoon approximately 1 km north of the reef system. The total boundary area during construction will include the borrow areas. This issue is addressed in more detail, later in this section.

This site experiences swell waves approaching from the SE Indian Ocean. However, direct exposure is limited due to refraction around the south Male Atoll, Male' and Viligilli Island. Swell waves approaching from the SW may have a reduced energy due to refraction around the western rim atolls of Maldives. However, SW swell waves may play a significant role in year round wave activity on the southern rim of the reef. Lagoonal currents will be strongest during the SW monsoon and force sediments on to the reef flat during tidal flows, unless protected by

adequate silt screens.

The phase I of the project has created a new 10 Ha island. The presence of the island will facilitate easier mobilization and provide some level of protection from wave activity.

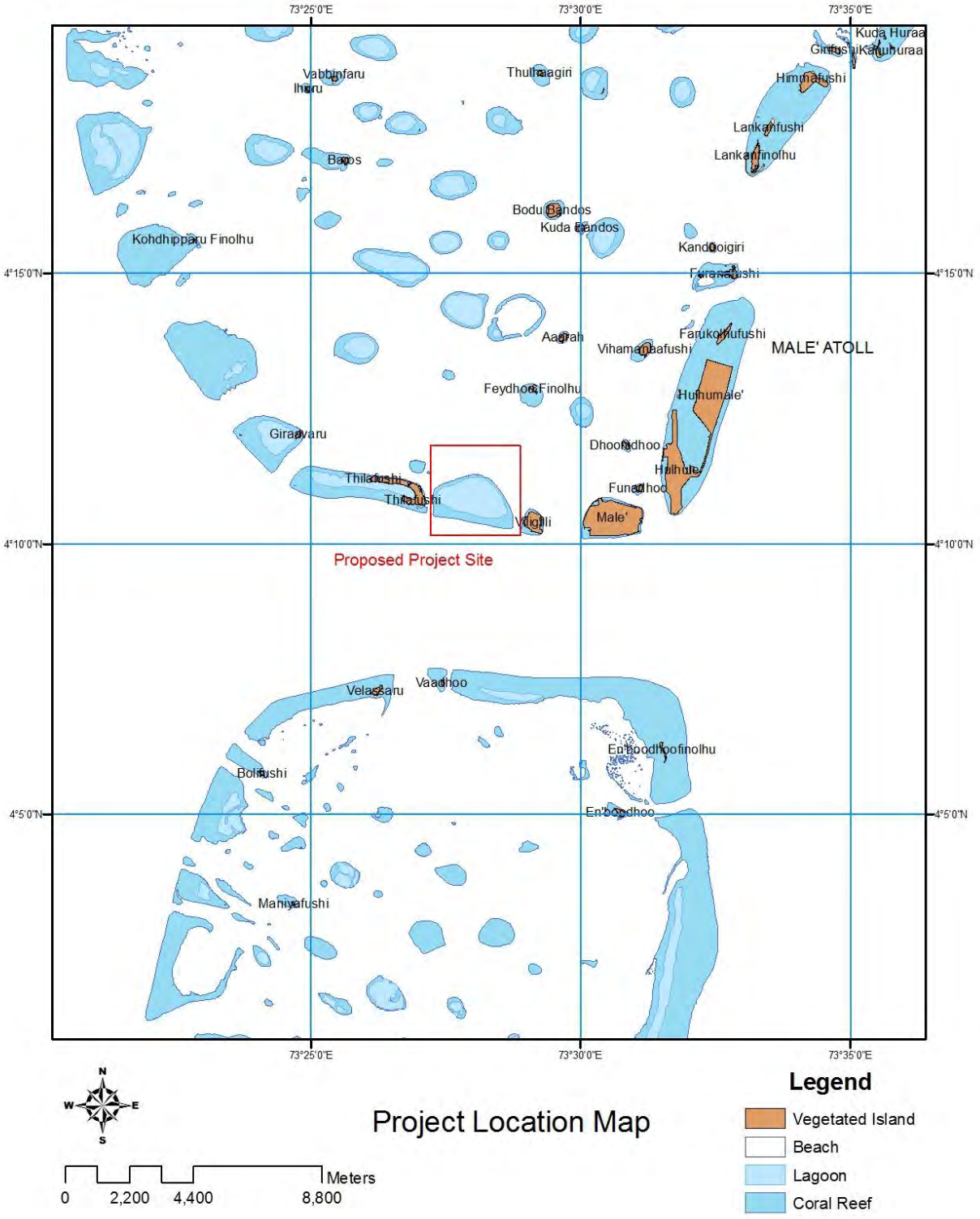


Figure 2-1 Location of proposed project site

2.1.2 Phased Development

At the time of writing of this Environmental Impact Assessment the Master Plan for the development of Gulhifalhu has dedicated the land created in Phase I mainly for warehousing and distribution and land created in Phase II and III mainly for housing (see also the Land Use Plan in Annex 3). During the development of the phases, the following facilities will also be developed:

The following phasing is proposed for the development of Gulhifalhu (see also Figure 2-2):

- Phase I: approximately 10 ha
- Phase II: approximately 30 ha
- Phase III: approximately 70 ha
- Phase IV: to be determined at a later stage

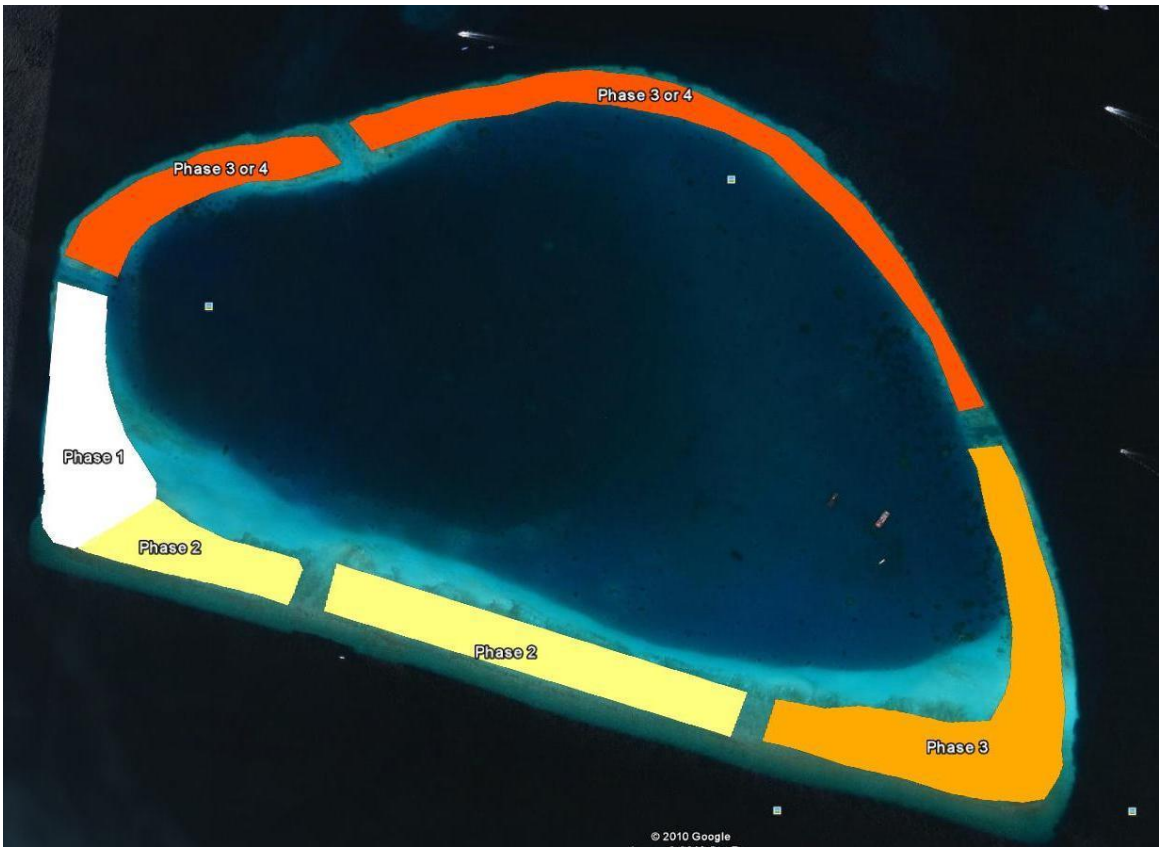


Figure 2-2 Gulhifalhu project phasing

2.1.3 Design Considerations

The design of the reclamation and shore protection works has been based on the following main concepts and considerations:

- To make maximum use of the topography / bathymetry as presently exists at Gulhifalhu on the one hand and using least-cost considerations on the other hand:
- The phase I and II reclamation takes as much as possible place in areas with present water depths of 1 to 2 meters.
- The phase III and further reclamation may take place in areas with present water depths of 1 to 10 meters.
- The newly reclaimed areas of the Gulhifalhu Island must be protected against flooding, wave action and erosion.
- The existing currents (mainly tidal) around the Gulhifalhu reef should be affected as little as possible by the project.
- The existing natural values on the outside of Gulhifalhu reef must be preserved as much as possible.

2.2 Project Outline

2.2.1 Overall Project

The proposed overall project involves the reclamation of over 110 ha over Gulhifalhu and the construction of revetments over a length of approximately 2500 m along the reclaimed land.

The main components of the project are:

- Dredging of approximately 300,000 m^3 of coral sand in Phase I; 800,000 m^3 of coral sand in Phase II and an amount to be determined in Phase III and Phase IV from a nearby borrow area and pumping the material into the reclamation area.
- Finishing the reclaimed area to the required levels.
- Construction of revetment along the reclaimed land.
- The project is expected to be carried out in four phases as shown in Table 2-1.

Table 2-1 Summary of four phases of development

Development phase	Reclamation Area	Material required (m^3)	Proposed borrow area	Dredging method	Planned land use
Phase I	10 ha	300,000 m^3	Within atoll lagoon just north of Gulhifalhu	Trailing Suction Hopper Dredger (TSHD)	Warehousing and distribution
Phase II	30ha	700,000 m^3	Within atoll lagoon just north of Gulhifalhu	TSHD	Housing
Phase III	70 ha	To be determined	To be determined (TBD)		TBD
Phase IV	TBD	TBD	TBD	TBD	TBD

2.2.2 Phase II

At present, this project is mainly concerned with the second phase (Phase II) of the development. The activities of Phase III and IV have not been scheduled yet and are not clear when it would be implemented. Detailed plans for the operations stage of the phase II has also not been finalized yet. Hence, for all practical purposes this report will have to mainly look into the construction stage activities of phase II. A separate assessment is required to assess the implications of the operations stage of phase II and remaining phases.

The key activities of the second phase of the development are:

- Dredging
- Land reclamation
- Coastal protection

2.2.2.1 Phase II Site Plan

The site plan for phase II reclamation activities are presented in Figure 2-3 below and in Annex 4.

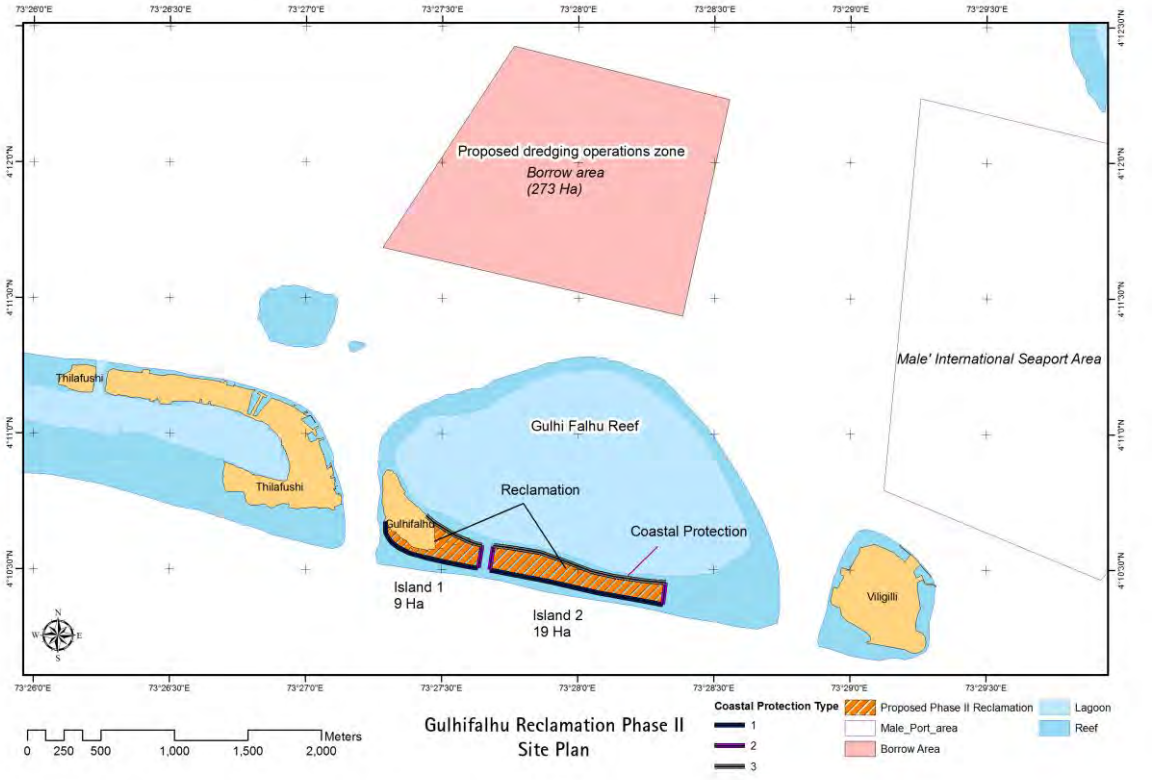


Figure 2-3 Gulhifalhu project phasing

2.2.2.2 Phase II Project Activity Zone and Project Boundary

Figure 2-4 shows the activity zone and the boundary of the proposed project. The project area comprise of a borrow area, reclamation zone and dredger activity zone. The borrow area and dredger activity zone will be used only during the dredging activities, namely for 2-3 weeks. Rest of the work will be undertaken in the reclamation site – a 30 ha area on the southern side of Gulhifalhu Reef.

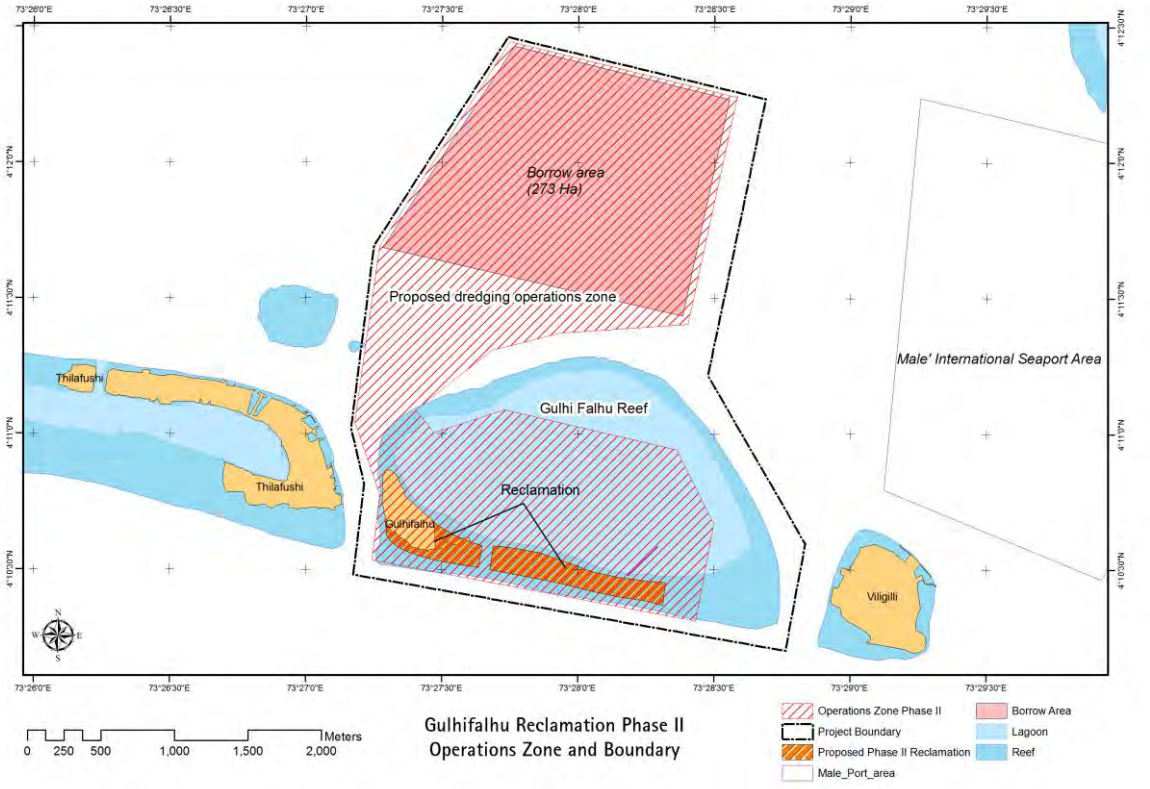


Figure 2-4 Proposed project activity zone for Gulhifalhu reclamation project Phase II

The subsequent sections provide detailed descriptions of the major components of the project.

2.3 Detailed Description: Dredging

2.3.1 Method and Equipment Used for Dredging

The method proposed is sourcing sand from the bed of the atoll lagoon using a Trailing Suction Hopper Dredger (TSHD).

A TSHD is a normal sea-going ship equipped with one or two suction pipes. At the end of each suction pipe is a drag head, which can be lowered onto the seabed while the TSHD navigates at a reduced speed. The material loosened by the drag head, together with some transport water, is sucked into the suction pipe by means of a centrifugal pump, and subsequently placed in the hopper of the dredger. The TSHD will transport the sediments to the reclamation where they will be brought to shore.

Most of the turbidity generated by a trailer suction hopper dredge is caused by the overflow of turbid water during the hopper filling operations. Overflow is the flowing overboard of excessive process water, together with a large part of the finest material. Overflow is used to

maximise the load of sand inside the hopper. When dredging pure sandy sediments the amount of overflow of particles is mainly determined by the grain size distribution of the dredged sediment. It is to be noted that the overflow process will not be a continuous activity, since its duration will be limited to operational dredging time, which is usually less than half the total cycle time.

The suspension of sediments and the effects on the coral reefs will mainly depend on the grain size distribution, the local currents and the distances to the coral reef areas.

2.3.2 Dredging Fleet and Equipment

1) One trailing suction hopper dredger

The proposed dredge vessel is the Gateway built by Merwede Shipyard B.V. The hopper capacity of this model is 12,000 m^3 and was built in 2010. Details of the dredge vessel are provided in Annex 7.

Figure 2-5 Proposed dredger - Gateway

2) One general purpose mechanized vessel for transport
3) Two wheel loaders
4) One excavator
5) Two trucks

2.3.3 Analysis of Options

The options including sources of fill material and type of dredger that can be used in the project are as follows:

Option 1 sand and coral material from the shallow reef flat and the lagoon area within the reef, to be dredged by cutter suction dredge (CSD);

A CSD is a stationary dredger, which dislodges the material with a rotating cutterhead mounted on a ladder. The cutterhead is equipped with cutting teeth. The loosened material is sucked into the suction mouth located in the cutter head by means of a centrifugal pump, which is installed on the dredge pontoon or on the ladder of the dredger. The amount of material not entering the suction mouth may be as much as 30% of the total dislodged material. Much of this material will fall immediately to the seabed and will be dredged on the next cut. Only the finer particles will stay in suspension and will be distributed throughout the water column by the local currents. With a CSD, the creation of turbidity is a more or less a continuous process.

Due to the fact that a rather deep basin will be created by the CSD of about 6 – 7 meters depth, the majority of the suspended sediments will stay within this created basin. As the cut material will be disposed by a discharge pipeline to the land reclamation site no additional turbidity will be created at the dredging site. To assess how the suspended sediments are spread over the coral reef areas, it is necessary to consider the local hydrodynamic conditions.

Option 2 sand from the bed of the lagoon of the atoll (away from islands), to be dredged by a trailing suction hopper dredge (TSHD);

Option 3 sand and coral material from a reef elsewhere in the atoll, to be dredged by a CSD;

Option 4 sand imported from overseas using a large scale TSHD or Jumbo barge.

Option 1 has simple logistics, the impacts on the environment are localised (limited to an area inside the lagoon where dredging and reclamation activities take place) and manageable, although deep water access to the islands is required.

Option 2 also has relatively simple logistics. The impacts on the environment are localised (limited to the borrow area and the island where reclamation activities take place) and manageable.

Option 3 involves more complicated logistics for transportation of the dredged material from the borrow area to the reclamation area. The impacts on the environment are also more severe, due to the fact that coral reefs will be exposed to dredging and reclamation activities at two different locations. Environmental impacts are therefore more difficult to manage. Hence, Option 3 is environmentally prohibitive.

Option 4 involves very long sailing distances for the TSHD and a very long execution time of the project. Hence, Option 4 is economically prohibitive.

With both types of dredgers a sediment-water mixture will be pumped to the reclamation site from where the excess of water will flow back (return flow) to the sea and most of the sediments stay behind. The potential issue of turbidity is basically the same for both dredging methods. The main differences between the methods are that:

- Impact of the re-suspension from the CSD at the borrow area can be better controlled than from the THSD at the atoll lagoon;
- During overflowing with the TSHD a large portion of the fines will be returned to the borrow area. The dredged material arriving at the reclamation area therefore contains less fines compared to the material from the CSD;
- Option 1 will have less negative impact on the ecology of the borrow area and nearby sensitive areas compared to option 2. Option 2 has less negative impact on sensitive receivers around the reclamation area compared to option 1. Since the reclamation area is located close to a marine Protected Area option 2 would be preferred above option 1.
- CSD takes more time in operation and therefore timeframe for impact is relatively more.

In addition, a TSHD is currently available to the proponent and will help reduce costs and save time. Therefore, **the chosen option is Option 2.**

2.3.4 Sand Borrow Area

The proposed location for the sand borrow area is within Kaafu atoll just to the north of Gulhifalhu. Location and size of sand borrow areas is given in Figure 2-3.

This location is preferred due to the use of a large TSH dredger and due to the presence of a protected dive site south of the reef system. The alternative available is deep areas of the Gulhifalhu Reef itself. This location is most suitable for a Cutter-suction dredger. In addition, the quantity of fill material required for Phase I and future Phases can be made available from within the atoll lagoon rather than Gulhifalhu lagoon.

2.3.5 Quantity, quality and characteristics of fill material

The quantity of fill material for phase II is 700,000m^3 as indicated in the table above. This figure is based on the reclamation parameters defined in the next section below.

The dredge depth is generally up 2.0 m and on average 1-1.5m from the sea bed. However, the actual depth will depend on the quality of material at any given location.

As an indication of guarantees for sufficient availability of fill material, the proponent has carried out a survey of the proposed borrow area. The proposed borrow area is selected based on this survey. However, the contractor of the survey does not wish to disclose the details of the survey in a public document due to possible disadvantages to the business from competitors. This clause has been included in the contract between the contractor and the proponent.

In general, the fill material is expected to be moderately coarse to fine sand. The presence of large coral pieces is expected to be minimal.

All available details of the fill material characteristics are provided in the existing environment section.

2.3.6 Duration of dredging activity

Phase II is expected to take six to 3 months including preliminary work and demobilisation. Given that the hopper capacity is 12,000 m^3 and approximately five trips can be made by the TSHD daily, Table 2-3 provides an estimated duration of dredging activity for Phase II. A detailed work plan is provided at the end of the chapter.

Table 2-3 Estimated duration of dredging activity for Phase 1 and Phase 2

Phase	Volume of material	No. of trips required	Duration of actual dredging activity[1]
Phase II	700,000 m^3	59	11-12 days (maximum 4 weeks)

1 Additional trips may be required in each phase depending on site conditions at the time of dredging.

2.3.7 Labour Requirements and Availability

The tentative list of labour requirements is given in Table 2-4.

Table 2-4 List of labour requirements for dredging and reclamation

Activity or work group	Specialists	Labourers
Dredge fleet	5	6
Dry fill	4	5
Special equipment	4	8
Workshop	2	4
Administration	2	5
Total	**19**	**28**

Specialist labour will be required to undertake specific tasks. A total of 47 jobs may be available for the locals from the project. However, no specific quota for local or foreigners have been established. It is unlikely that the required specialists may be available from the atolls hence, the use of foreign labour at least for some jobs is inevitable. Most of these workers are currently the staff of the specialised dredge vessel. Only land based loading and profiling activities will be undertaken by workers outside the ship.

2.3.8 Housing of Temporary Labour

Majority of the workforce will be accommodated on board the dredge vessel and the rest will be housed in Temporary accommodations built on existing Gulhifalhu Island. Temporary houses will be built from prefabricated units imported from overseas.

2.3.9 Emergency Plan for Spills

Royal Boskalis Westminster NV has ISO 9001, ISO 14001 and OHSAS certifications. The requirements of these certifications are met through company-wide Safety, Health, Environment and Quality system (SHE-Q), which provides clear procedures for safety, health and environmental management both at offices and project sites around the world.

Boskalis applies the same SHE-Q standards at all its projects around the world and to all its employees and subcontractors. These standards meet Dutch and international OHSA and environmental requirements, and are adjusted if a client has even more stringent requirements. Dredging vessels are IMS certified and have to meet international standards for waste, hazardous materials and sewage management, and fire, oil spill and other emergency

response and prevention. Annex 8 contains the framework that is used to make a specific Environmental Management Plan for each individual project that Royal Boskalis Westminster undertakes. Similar frameworks are applied for project specific Safety and Health Management Plans.

2.4 Detailed Description: Land Reclamation by Filling

2.4.1 Reclamation Design Levels

Taking into account the presently occurring water levels, the predicted sea-level rise, and the relatively high-value industries and services that Gulhifalhu land-development will potentially cater for, the finished level of the reclaimed land will be +2.0 m MSL. The initial reclamation will be made at 3.0 m to allow for settlement.

It is noted that most of Malé and the other inhabited islands in the Maldives are at +1.0 m MSL to +1.4 m MSL; so called "Safe Islands" are presently constructed at +1.4 m MSL.

2.4.2 Sediment Containment

As for the design of sediment containment measures area there are 3 options. These are:

Option 1: Enclosed reclamation area with bunds

Option 2: Open reclamation area without bunds

Option 3: Reclamation area with no bunds in phase 2 and with bunds for phases 3 and 4

Option 4: Silt screens around the reclamation area

Option 5: Sand bunds on the oceanward side and silt screens on the lagoonward side.

Option 1 involves more complicated logistics since Gulhifalhu reef is completely submerged and there is no material to create bunds with at the start of the development. Material needs to be imported to create the bunds. Additionally there needs to be land reclaimed before excavators or bulldozers will be able to prepare the bunds for the revetments. Another option is to build the bunds from the water. For this, cranes on pontoons, barges or a hopper with sand will be required. The impacts on the environment are localised (limited to an area around the island and inside the lagoon where the construction of the revetment takes place) and manageable. The revetment will reduce the size of the impact area during reclamation activities by keeping the excess water containing fine sediment within the bunded area. Release of this water is

manageable. The import of sand from overseas, the equipment and the long execution time make this option economically prohibitive.

Option 2 has simple logistics since no preparations need to be made prior to the reclamation. The impacts on the environment are temporary increased turbidity levels, a relatively high load of sediment which is potentially difficult to control, due to the fact that excess water will be released on all sides of the reclamation and during each phase. Environmental impacts are therefore more difficult to manage. This makes this option environmentally prohibitive.

Option 3 has moderately easy logistics. Phase I and II will be executed according to option 2. Before phase III and IV will commence bunds can be set up with material stored on the reclamations from phase I and II. The bunds can be set up with excavators and bulldozers from the now existing land. The impacts for the creation of the bunds on the environment are localised (limited to the area of the revetment) and manageable. The impacts of the reclamation of phase I and II such as increased turbidity and a high sediment load will however be short term. The increase in turbidity and the sediment load during the reclamation of phase III and IV will be reduced, more local and much more manageable.

Option 4, placing silt screens on the eastern and the southern side of the reclamation area will contain the sediment in the area and is economically feasible.

Preferred option

Option 1 will have the least impact on the ecology of the area around the reclamation area and nearby sensitive areas. However this option is economically not feasible. Option 2 is environmentally prohibitive. Option 3 is economically feasible with the strongest impact mainly focused on phase I and II. Option 4 is both economically feasible and environmentally favourable, therefore the preferred option is Option 4 i.e. to place silt screens in the reclamation area to contain the sediment.

The Figure 2-6 below shows the sediment containment deployment map.

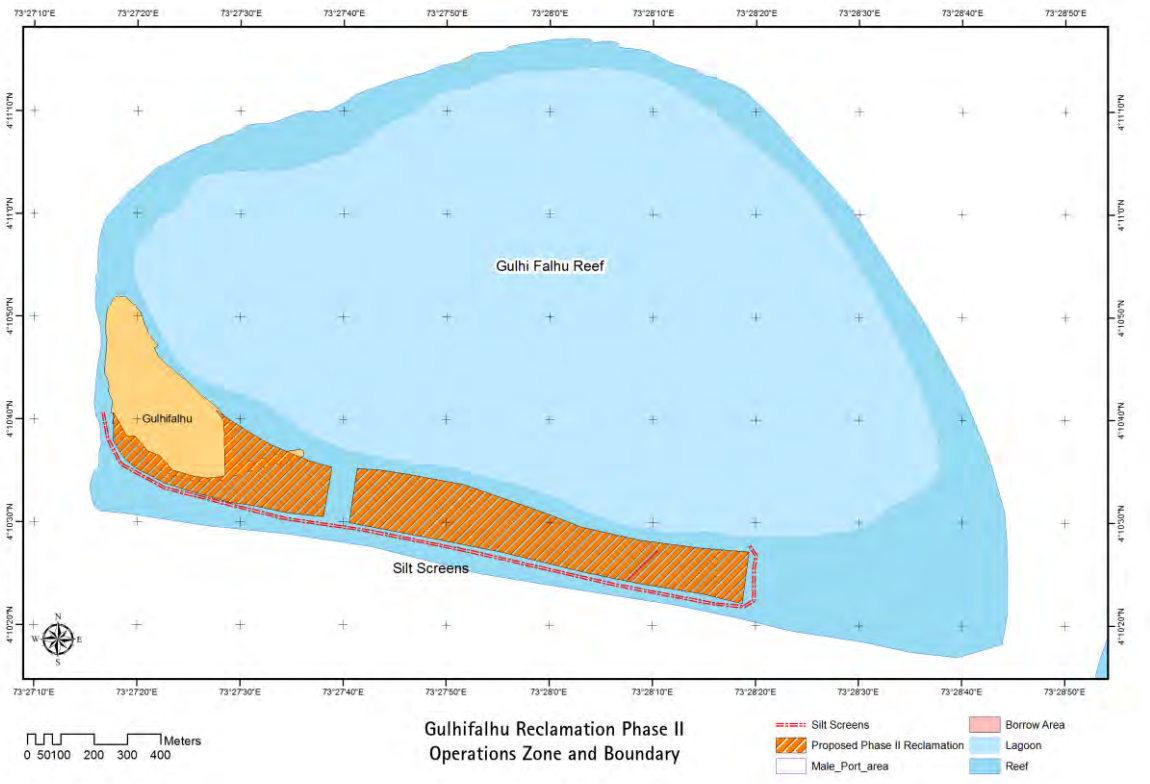


Figure 2-6 Map showing of sediment containment deployment

2.4.3 Planning and Timing

A detailed work plan is provided at the end of the chapter.

2.4.4 Method and Equipment for Transport of Fill Material

The transport of fill material for hydraulic filling will be undertaken directly by the dredge vessel. In a TSH Dredger the fill material collected from the borrow area is placed on the ship and transported to the reclamation area. The transportation route is shown in Figure 2-7 below.

Once at the reclamation site the pipes from the ships hold is connected to floating pipe deployed near the reclamation area which transports the sediment from the ship to the designated reclamation zone. The connection of the pipes will be undertaken using a small boat.

The following equipment will be used to transport of fill material for dryfill.

- Two excavator
- Four Dumpers
- Four Trucks
- Four wheel loaders.

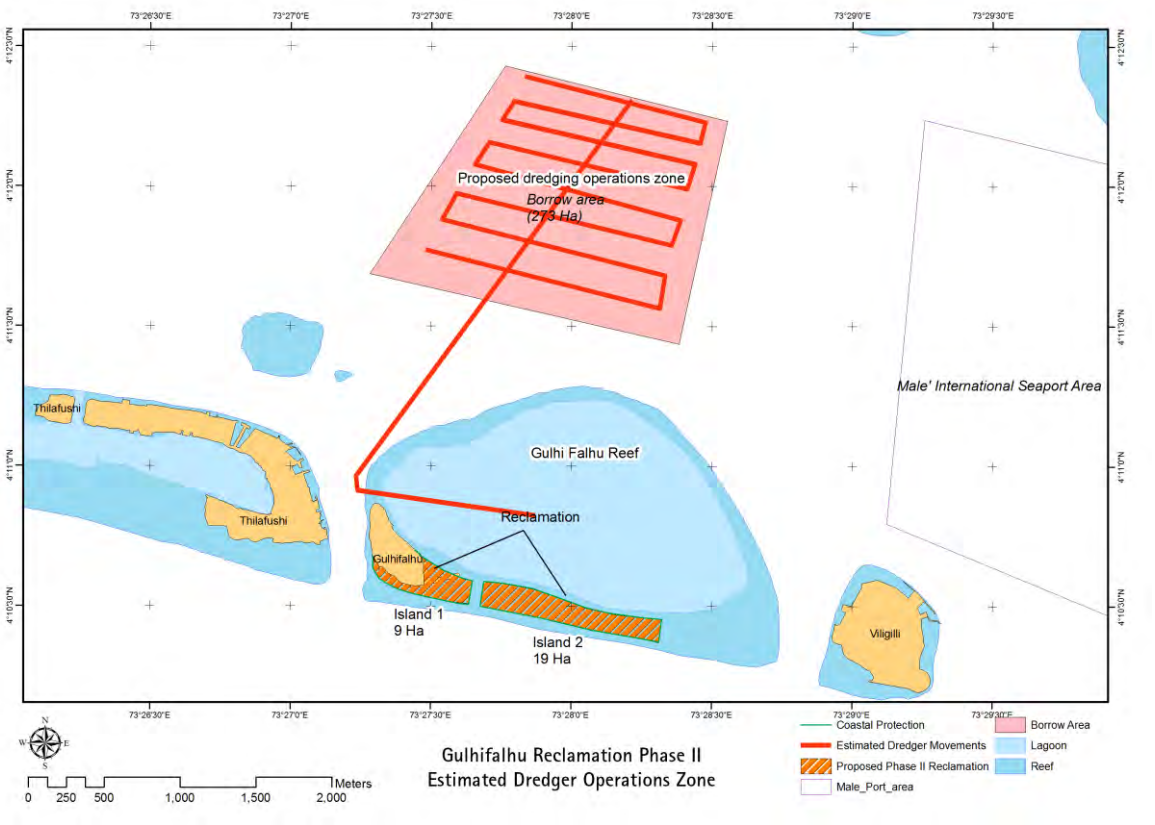


Figure 2-6 Map showing transport routes for dredger

Once sand has been pumped into the designated site, loaders will level the reclaimed area. Material from the designated pump site will also be transported to the fringes of the reclamation zone using loaders and trucks.

2.4.5 Distance of Transport

Distance of transport of fill material is approximately 2.9 km to 4.5 km.

2.4.6 Need for and Location of Temporary Stockpiles

TSHD stores the material on board the ship. The dredge material is deposited through bottom flaps or doors, or by rain bowing. In the proposed reclamation, the material is pumped on to the location through a pipeline.

2.4.7 Stability of Reclamation

Rate and volume of pumping sediment will be faster than the rate of erosion. Sediment will be highly mobile within the first 10 m from the shoreline and erosion will be prevalent in the zone. However, the rest of the island is expected to be stable. Erosion is predicted to be severe in the short-term and dominant on the eastern end and northern side of the island between March

and May.

2.4.8 Safety Measures during Construction

The contractor would ensure that Health and Safety procedures are complied with at all times. Construction activities would be carried out under the supervision of a suitably experienced person. All reasonable precautions will be taken for the safety of employees, and equipment will be operated by competent persons. Warning signs, barricades or warning devices will be provided and used. Necessary safety gear will be worn at all times.

2.4.9 Labour Requirements and Availability

See detailed description for dredging above.

2.5 Detailed Description: Shore Protection Works

2.5.1 Shore Protection Types

Figure 2-7 shows the location and types of coastal protection measures proposed and Table 2-5 provides the details of the structures.

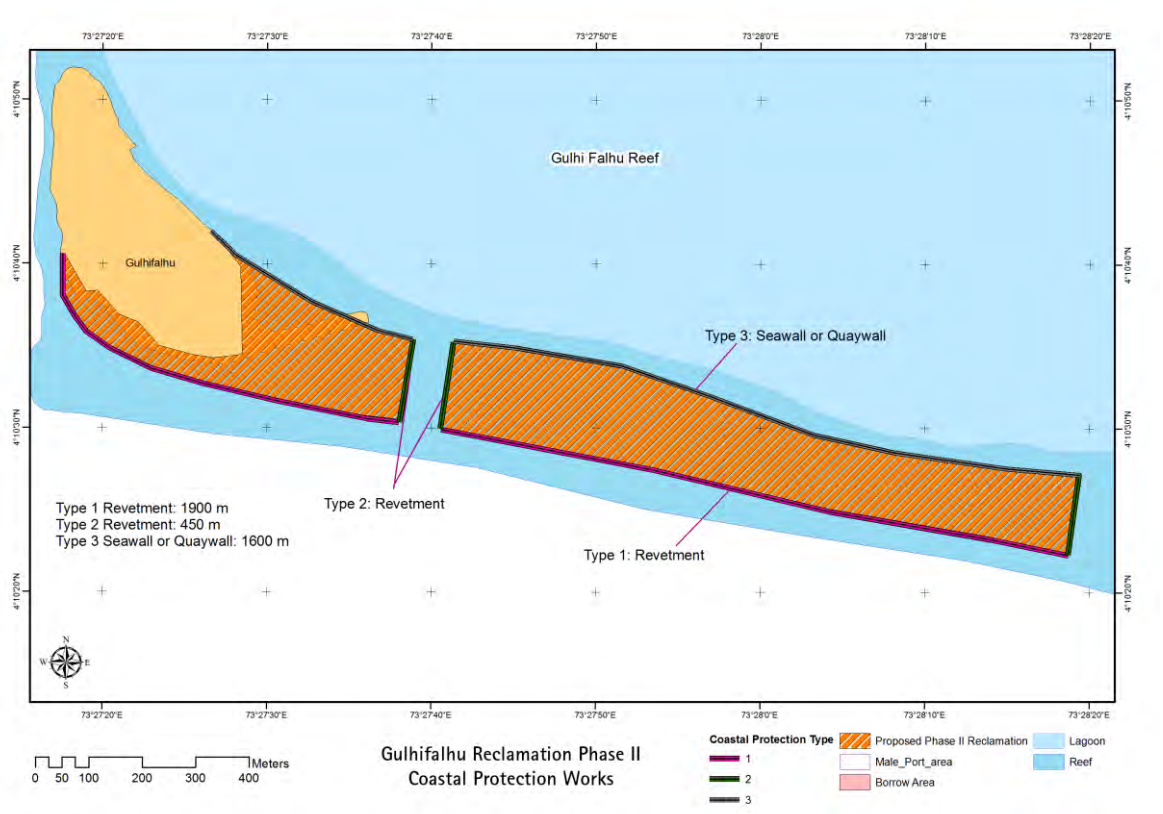


Figure 2-7 Location of coastal protection types

Table 2-5 Location and length of revetment

Type	Location	Impact of waves/ current	Length of revetment (m)
1: Revetment	Seaside (south side)	Strong (waves)	1900
2: Revetment	Between channels	Strong (current)	450
3: Seawall or quay wall	Lagoon side (inner slopes)	Moderate	1600

2.5.2 Type 1 Revetment

For the south side revetment an optimization has shown that a 50-70 meter wide strip of reef area will be left untouched in order to allow wave energy dissipation and a resulting reduction of cost of the revetment; a wider strip would result in cheaper revetment but also in a loss of easily reclaimed reef area.

All shore protection works have been designed in rock placed on geo-textile; at some locations Geobags, S-Blocks (see figure 2-10) or Sand-cement bags (see figure 2-9) may be considered as an alternative. Alternatives wil be determined based on costs once contractors submit their bids. Rock is imported from India or Sri Lanka. Figure 2-8 shows the cross-section of a typical revetment.

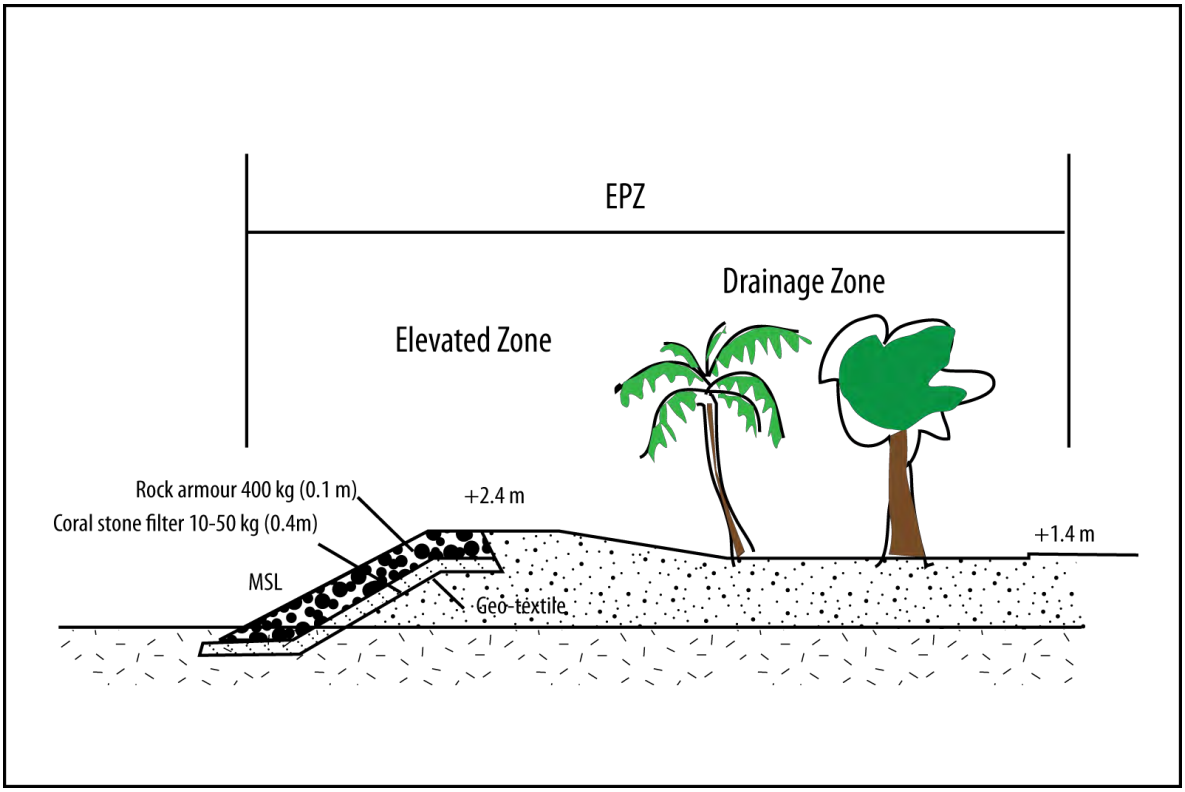


Figure 2-8 Cross-section of a typical revetment

2.5.2.1 Methods and Equipment

Breakwater will be constructed using a crane and two excavators. Cranes will be placed on land and boulders will be placed in batches. The excavators will be used profile the structure and make finer adjustments.

Boulders will be transported to Gulhifalhu on barges. The newly constructed harbor and quay walls will be used to unload the boulders using cranes. Transportation to the southern side will be undertaken on trucks.

2.5.3 Type 2 Revetment

Type Two Revetment will be mainly placed between the channels. The current flow is estimated to be high by the direct impact of the waves are expected to be minimal. Sand cement bags placed on a layer of geotextile has been proposed as the main method. The generic design of the Type 2 revetment is shown in Figure 2-9. Alternatively, concrete S-blocks (see figure 2-10) have also been considered for Type 2 revetment and the final option will depend on the costs proposed by contractors.

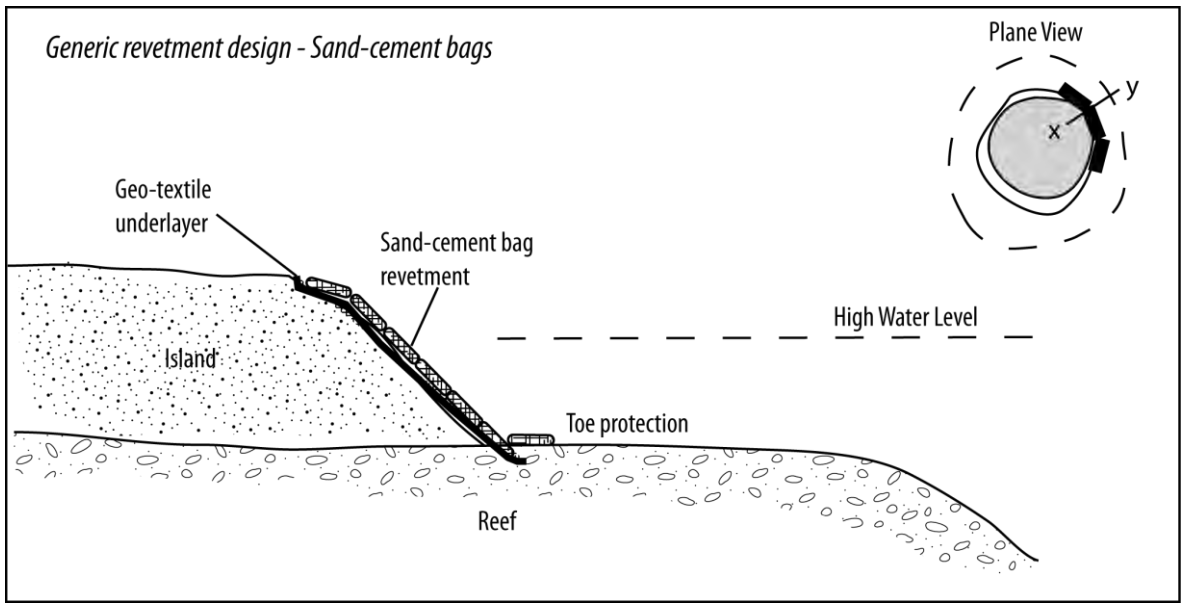


Figure 2-9 Cross-section of a proposed sand-cement bag revetment

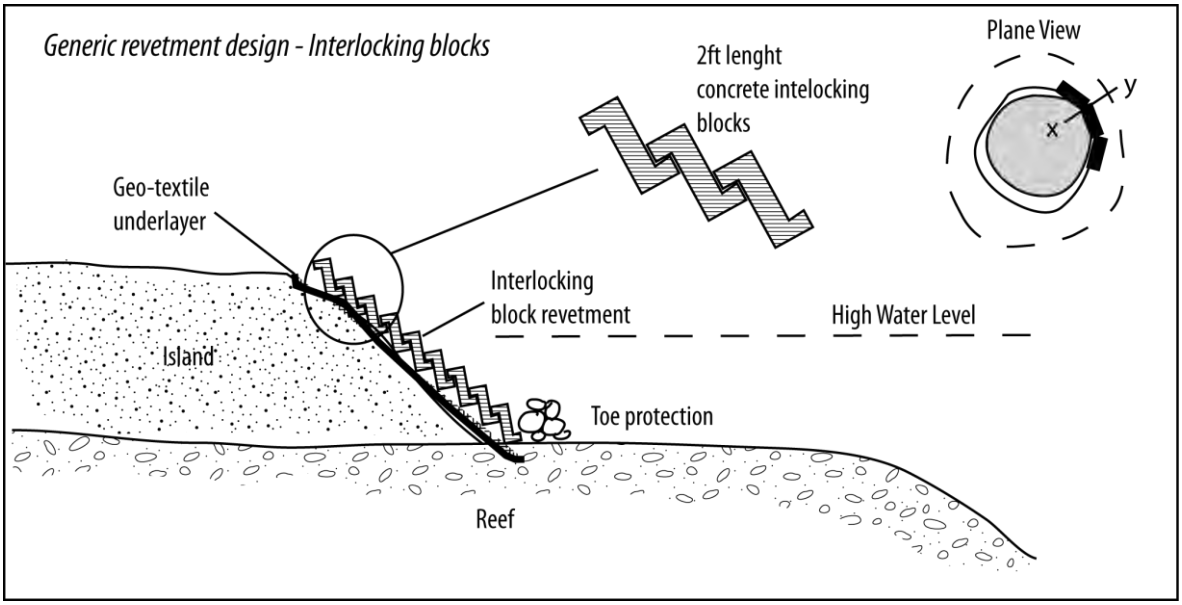


Figure 2-10 Cross-section of proposed S-block revetment

2.5.3.1 Methods and Equipment

Construction will mainly be manual, given the small distance involved. The sand-cement bag mixing will be done on site using portable cement mixers. Profiling will be dune with the assistance of excavators.

Material will be transported to Gulhifalhu on Dhoni's and barges. The newly constructed harbor and quay walls will be used to unload the material using cranes. Transportation to the southern side will be undertaken on trucks.

2.5.4 Quay Wall

Quay wall length in phase II will be between 500-1000 meters and will be located at the northern side of Gulhifalhu. The design vessel for the ocean-going berths has the following main characteristics:

- Length 150 m
- Beam 30 m
- Draft 10 m
- Carrying capacity 7000-10000 BRT.

The most common vessel for transport to and from the outer islands is the second generation 50- foot Dhoni with the following specifications:

- LOA 15.5m
- Beam 4.4m

- Depth 1.75m
- Draught 1.05m
- Engine power 75 hp.

Another vessel, the so called "2000 bag Dhoni" (carrying capacity 100 tons), is at present the largest transport vessel carrying food and other goods from Malé to the outer atolls.

In order to allow these vessels easy access at all times and all tides, the depth along the quay wall has been chosen at -3.6 m MSL. The crest level of the capping beam of the quay wall is +1.4 m MSL. It is proposed to construct 500-1000 m of quay wall for alongside or head-on mooring.

The final decision of quay wall length will be based on costs proposed by contractors.

The material considered for quay wall is concrete piles or concrete spun piles (see figure 2-11). These are prefabricated units placed at the edge of the reclaimed area with part of the structure anchored to land. This is the most commonly used quay wall type in current harbour construction projects in Maldives. Alternatives considered for quay walls is sheet piles and in the worst case sand cement bags.

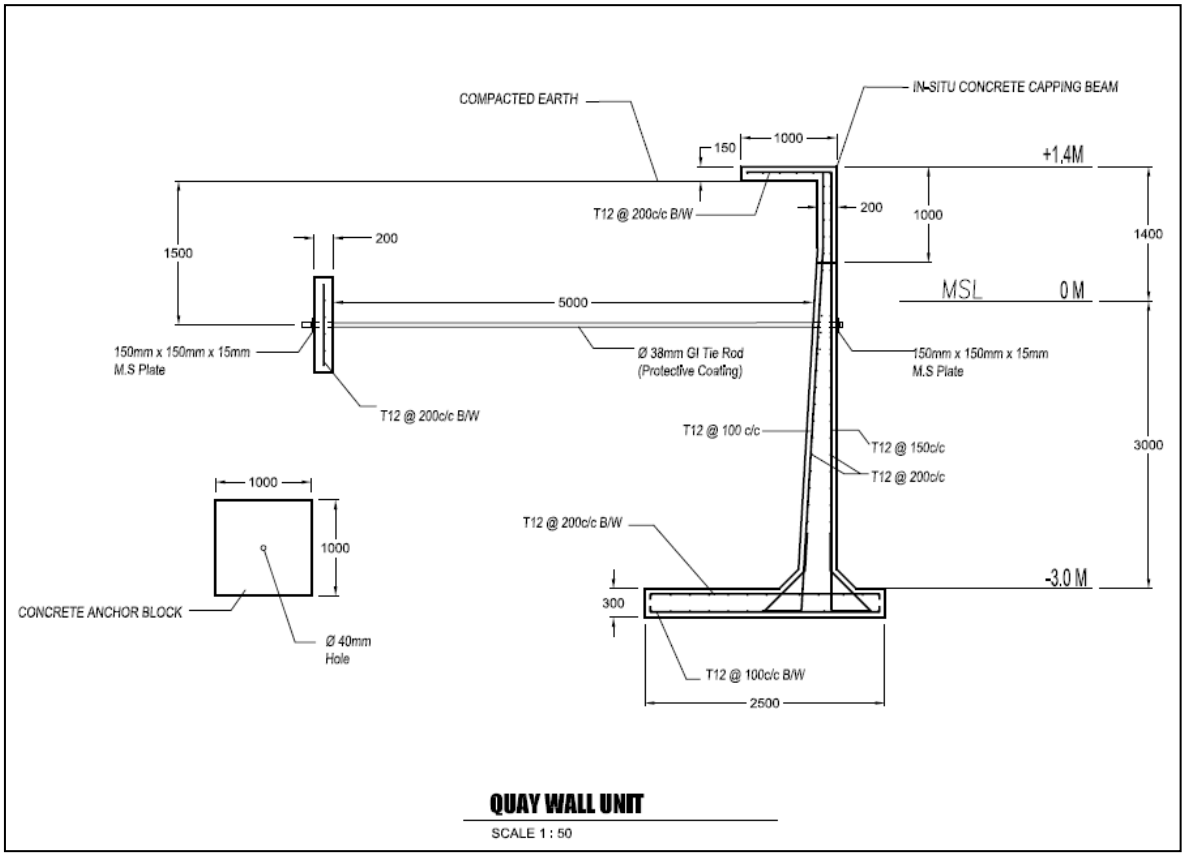


Figure 2-11 Design details for the proposed quaywall design

2.5.5 Design Criteria

- Top of quay shall be the higher of the following
  - 1.3 m above MSL
  - 0.15m above ground level.
- Access stairs shall be incorporated into the quay wall (3 sets of stairs).
- Mooring Hooks at intervals not less than 5m shall be provided.
- Unless substantiated with relevant data, soil properties shall be assumed as below.
- Angle of friction of sand not greater than 32°.
- Bearing capacity of sand not greater than 100 KN/m²
- All reinforced concrete shall be a minimum of grade C30 and a minimum concrete cover of 50mm shall be provided to all steel reinforcement.
- The specifications are given for different option for the material and workmanship for breakwater and quay wall. Contractor is to follow the respective specification, based on his detail design.

2.5.6 Methods and Equipment

Special equipment for construction of revetment and quay wall are:

- Concreting machines; truck and dumper and excavator

2.5.7 Sea Wall

Sea walls have been considered for all areas except to an area which may be designated as beach zone along the northern coastline. This option will be used in conjunction with the quay wall option and will depend on the final costs proposed by contractors. The generic design for the sea wall is shown in figure 2-12.

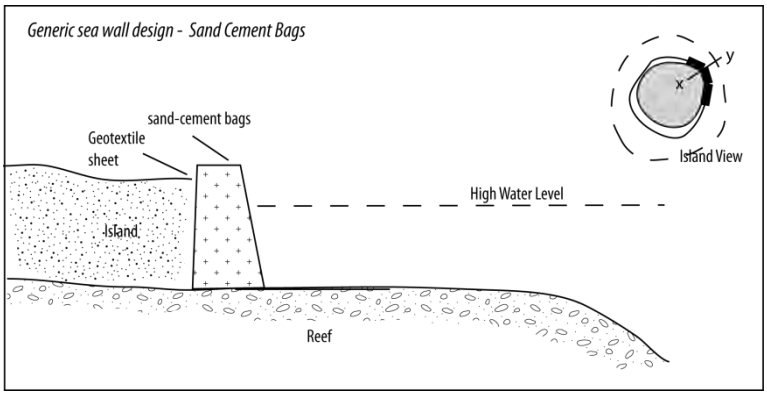


Figure 2-12 Generic designs for the proposed sea wall

2.6 Work Plan

The project is planned to be carried out in four phases. Phase II are expected to take 8-9 months each phase. Table 2-6 shows the work plan for phase II. The preparatory work is expected to take one month. The dredging activity is expected to take two weeks. Reclamation works is expected to take two months, primarily for profiling the reclaimed parts and coastline. Construction of revetment and quay walls is expected to take 4-5 months.

Table 2-6 Work plan for Phase II

No	Activity Description/Months	1	2	3	4	5	6	7	8
	Preliminaries								
	Detailed design	X							
	Mobilisation	X							
	Dredging and reclamation works								
	Preparation of mitigation measures		X						
	Preparation of borrow area		X						
	Dredging		X						
	Reclamation works		X	X					
	Profiling		X	X					
	Construction activities								
	Revetment				X	X	X	X	
	Quay walls				X	X	X		
	Finalizing								
	All other works							X	X
	Demobilisation								X

2.7 Summary of Inputs and Outputs

The types of materials that will go into the development and from where and how this will be obtained are given in Table 2-7 and the type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 2-8.

Table 2-7 Major inputs during construction – Phase II reclamation, dredging and coastal protection

Input resource(s)	Source/Type	How to obtain resources
Construction workers	Local and foreign, mainly foreign	Recruiting agencies, etc.
Engineers and Site supervisors	Local and foreign	Advertise in local papers, social networks, etc.
Construction material	electrical cables and wires, PVC pipes, light weight concrete blocks, reinforcement steel bars, sand, cement, aggregates, boulders 400-800kg, etc	Import and purchase where locally available at competitive prices – Main Contractor's responsibility.
Maintenance material	Similar to above	Import or purchase locally where available
Water supply (during construction)	Desalinated water	50 m^3/day desalination plant existing on the dredger
Electricity/Energy (during construction)	Diesel	Generator existing on the vessel; 50 Kva portable generator on the project site
Machinery	Dredger, Excavators, cranes, loaders, trucks, concrete mixers, dredger, dredge pipes	Import or hire locally where available
Food and Beverage	Mainly imported sources except a few locally available products.	Import and purchase locally
Fire fighting equipment	Fire Pumps, Fire Protection System, Smoke Detectors, Carbon Dioxide and Foam Fire Extinguishers, etc.	Local suppliers
Fuel, Kerosene and LPG	Light Diesel, LPG Gas, Petrol, Lubricants	Local suppliers

Table 2-8 Waste output management during construction stage – Phase II reclamation, dredging and coastal protection

Products and waste materials	Anticipated quantities	Method of disposal
Construction waste (general)	Small quantities	Combustibles: Burnt/incinerated Others: Sent to Thilafushi
Dredge waste	moderate quantity	Construction and as base fill for coastal protection zones
Waste oil	Small quantities	incinerated
Hazardous waste (diesel)	Small quantities	Barrelled and sent to designated Thilafushi

3 Policy, Planning and Legal Framework

3.1 Introduction

This Chapter will provide a summary of the legal instruments applicable to the project and demonstrate how the project conforms to these aspects.

The main legal instruments of concern are the Environmental Protection and Preservation Act (EPPA) 1993, the Environmental Impact Assessment Regulations 2007.

3.2 The Environmental Protection and Preservation Act (EPPA) 1993

The Environmental Protection and Preservation Act (EPPA) of the Maldives (Law No. 4/93) is an umbrella law that provides wide statutory powers to the Environment Ministry regarding environmental regulation and enforcement.

The EPP Act 1993 states that the natural environment and its resources are a national heritage that needs to be protected and preserved for the benefit of future generations and that the protection and preservation of the country's land and water resources, flora and fauna as well as the beaches, reefs, lagoons and all natural habitats are important for the sustainable development of the country.

The primary components of the EPP Act 1993 are:

3.2.1 Environmental Guidance

Guidelines and advice on environmental protection shall be provided by the concerned government authorities in accordance with the prevailing conditions and needs of the country. Hence, all concerned parties shall take due consideration of the guidelines provided by the government authorities.

3.2.2 Environmental Protection and Conservation

Formulating policies, rules and regulations for protection and conservation of the environment

in areas that do not already have a designated government authority already carrying out such functions shall be carried out by the Environment Ministry.

3.2.3 Protected Areas and Natural Reserves

The Environment Ministry shall be responsible for identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.

Kiki Reef which is located south of Gulhifalhu reef is a declared marine protected area.

3.2.4 Environmental Impact Assessment

An EIA shall be submitted to the Environment Ministry before implementing any developing project that may have a potential impact on the environment.

3.2.5 Termination of Projects

Projects that have any undesirable impact on the environment can be terminated without compensation.

3.2.6 Waste Disposal Oil and Poisonous Substances

Disposal of waste, oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purpose by the government. If such waste is to be incinerated, appropriate precaution should be undertaken to avoid any harm to the health of the population.

3.2.7 Hazardous/Toxic or Nuclear Waste

Hazardous / Toxic or Nuclear Wastes shall not be disposed anywhere within the territory of the country. Permission should be obtained for any transboundary movement of such wastes through the territory of Maldives.

3.2.8 The Penalty for Breaking the Law and Damaging the Environment

The penalty for minor offenses in breach of the EPP Act 1993 or any regulations made under this Act, shall be a fine ranging between Rf. 5.00 (Five Rufiyaa) and Rf. 500.00 (Five Hundred Rufiyaa) and for all major offences a fine not exceeding Rf. 100,000,000.00 (One Hundred Million Rufiyaa). The fine shall be levied by the Environment Ministry or by any other government authority designated by that ministry and shall depend on the seriousness of the offence.

3.2.9 Compensation

The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

This EIA report will comply with the EPP Act 1993.

3.3 Environmental Impact Assessment Regulation 2007

The Environment Ministry issued the EIA Regulation in May 2007, which guides the process of undertaking the Environmental Impact Assessment in the Maldives. This Regulation provides a comprehensive outline of the EIA process, including the application to undertake an EIA, details on the contents, format of the IEE/EIA report, the roles and responsibilities of the consultants and the proponents as well as minimum requirements for consultants undertaking the EIA.

This EIA has been undertaken in accordance with the EIA Regulations 2007 of the Maldives.

3.3.1 Post EIA Monitoring, Auditing and Evaluation

The EIA Regulations 2007 provides a guideline of the environmental monitoring programme that should be included in EIA reports as monitoring is a crucial aspect of the EIA process.

Accordingly, the monitoring programme shall outline the objectives of monitoring, the specific information to be collected, the data collection program and managing the monitoring programme. Managing the monitoring programme requires assigning institutional responsibility, enforcement capability, requirements for reporting and ensuring that adequate resources are provided in terms of funds, skilled staff and the like.

The monitoring programme outlined in the EIA report will comply with the EIA Regulations 2007.

3.4 'Aneh Dhivehi Rajje' – The Strategic Action Plan (SAP)

The Strategic Action Plan (SAP) provides the National Development Framework for the period 2009-2013. It has been compiled through consultation with multiple sectors and by reviewing development trends, emerging issues, goals, policies and interventions relevant to the five main pledges and key themes of the MDP Alliance Manifesto.

The five pledges listed below represent the vision on which the people elected this government.

3.4.1 The establishment of a nationwide transport system

Due to the lack of a public transport system in the Maldives residents of many islands are unable to travel or are forced to pay for limited and over-priced private transport services. A sustainable maritime transport network will increase accessibility and mobility of the people and will increase economic regeneration at all levels through revitalization of the urban setting and land use.

3.4.2 Ensuring affordable living costs

As the country is heavily dependent on imports (especially food and energy) and highly susceptible to external shocks, achieving price stability is a major challenge. The government therefore has initiated efforts to control inflationary pressures through prudent fiscal policies and plans including the shift to direct taxation and the introduction of expenditure reduction measures.

3.4.3 Provision of affordable housing

Over a third of the country's population resides in Malé making it one of the most densely populated cities in the world. The government aims to address the housing situation in the capital Male' and other urban centres through increasing housing delivery through public-private partnership schemes and improving affordability through housing finance schemes. It is also believed that decentralisation and improved connectivity in the provinces will support de-congestion in the capital and other urban centres.

3.4.4 Providing quality healthcare for all

In the past most Maldivians have not had any insurance plan to pay for their medical expenses. This has created a heavy burden for the government and resulted in an out of control welfare situation. Therefore, the government plans to introduce and implement a basic health insurance scheme accessible to all citizens.

3.4.5 Prevention of narcotics abuse and trafficking

The Maldives over the years has seen rampant increase in substance abuse among the youth. One study suggests that over 30% of the youth are dependent on heroin and the study found out the youngest age to use drugs was nine years. The government is taking a firm stance to reduce the supply of narcotics into the Maldives. The policies also address elimination of demand for

narcotics and other illegal substances and ensure access to appropriate treatment and rehabilitation services for addicts. More broadly, it will establish a comprehensive and coordinated national response to combat narcotics and trafficking.

The project has a direct relevance to the Policy 4 of SAP which is establishing additional housing units to enable affordable housing, as this project will ease out the current congestion in Male' and enhance the economic potential of Male'. It is noteworthy that there are some contradicting policies, however, detail assessment of these policies are outside the scope of this report.

3.5 Third National Environmental Action Plan (NEAP III)

The Third National Environment Action Plan (NEAP III) of the Government of Maldives sets out the agenda for environmental protection and management for the period 2009 till 2013. NEAP III provides the basis for environmental planning, budgeting, performance measurement and accountability. The key target of NEAP III is to achieve measurable environmental results that matter to the people of the Maldives.

NEAP III provides the following principles to be adhered to in environment protection and environmental management.

1. Environmental protection is the responsibility of every individual. Protection of the natural environment and practicing environment friendly lifestyles is a responsibility of every Maldivian.

2. Achieve results. The actions, activities, regulations, supervision, reporting, incentives, information and advice for environmental management shall be directed and well co-ordinated to achieve the results the citizens want.

3. Promote and practice sustainable development. In environmental management the principle of sustainable development shall be followed. Conditions shall be created to give equal distribution of environmental goods and services both geographically and between generations including future generations. Special attention shall be given to address the concerns of the most vulnerable groups in the population.

4. Ensure local democracy. In environmental management the actions and decisions shall be taken and authority exercised at the most appropriate level.

5. Inter-sectoral co-ordination and co-operation. Co-ordination and co-operation is essential

from all sectors. For environmental management all should work informatively and co-operatively toward the goal of integrating environmental aspects into the goals and actions of all sectors.

6. Informed decision making. Actions for environmental management should be based on documented facts to as great extent as possible and not to pursue self interest or short term gains.

7. Precaution first. Where there is threat of irreversible damage and when the factual basis is inadequate or uncertain, the precautionary principle shall apply.

8. Continuous learning and improvement. Favourable conditions shall be created for continuous learning and improvement in the work with environment management at the national, regional and local level

9. Right to information and participation. The citizens have a right to information about status of the environment as well as the right to participate in decisions affecting their environment. They also have the right to actively participate in protecting the environment.

10. Environmental protection complements development. Environmental protection efforts shall not be portrayed as competing with the development needs and aspirations of the present people. Healthy debate about values as they relate to ecological and social sustainability shall be encouraged.

More importantly, NEAP III consists of the following six strategic results that shall be attained during the period 2009-2013:

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

The proponent is aware of NEAP III and is committed to work with the 10 guiding policies and towards achieving the strategic results of NEAP III.

3.6 National Strategy for Sustainable Development

The National Strategy for Sustainable Development is a new policy developed by the new government. Its aim is to unite all existing policies regarding environmental, social and economic development, and to provide a framework for future policies addressing these issues

3.7 Waste Management Policy

The aim of the waste management policy is to formulate and implement guidelines and means for solid waste management in order to maintain a healthy environment. Accordingly, the key elements of the policy include:

Ensure safe disposal of solid waste and encourage recycling and reduction of waste generated;
Develop guidelines on waste management and disposal and advocate to enforce such guidelines through inter-sectoral collaboration;
Ensure safe disposal of chemical, hazardous and industrial waste.

3.8 Regulation on Sand and Aggregate Mining

The Regulation on Sand and Aggregate Mining was issued by the Ministry of Fisheries, Agriculture and Marine Resources on 13th March 2000. This Regulation addresses sand and aggregate mining from uninhabited islands that has been leased and from the coastal zone of other uninhabited islands. Under this Regulation, it is an offence to mine sand or aggregate from the beach, lagoon or reef of any island leased for the purpose of building a tourist resort.

Mining of aggregate or sand for the construction of resorts and associated facilities is discouraged and utilization of alternative construction material is encouraged under the policy of the Tourism Ministry of the Maldives. As an incentive, import duty is exempted for the import of cement, iron, steel, roofing sheets and timber for the construction of tourist resorts. However, sand mining is allowed for reclamation and beach replenishment projects, primarily from the immediate lagoon of the island and in the case of a lack of sand on the island, from an area that is decided by the Ministry of Fisheries, Agriculture and Marine Resources.

3.9 Ban on Coral Mining

Coral mining from the house reef and the atoll rim has been banned from 26th September 1990 through a directive from the President's Office.

3.10 Population Policy

The primary objective of the population policy of Maldives is to contribute to improve the standard of living and quality of life of each individual through socio-economic development that is sustainable and ensures a balance between population and development.

3.11 Land Act

The Land Act provides for allocation and releasing of land for different needs as well as releasing of public land for housing. The Act also states the conditions that govern the using of, owning, selling, renting and transferring of ownership of public and private land.

3.12 Fisheries Act

The Fisheries Act provides for:

- Formulation of Fisheries Regulations and Fisheries Management and Development
- Fishing Grounds most Commonly used by Maldivians
- Information and Research on Fisheries in the Maldives
- Conservation of Living Marine Resources for a Special Purpose
- Licensing
- Cancellation of License
- Fishing by Foreigners in the Exclusive Economic Zone (EEZ) of the Maldives
- Procedure for Entering the EEZ of the Maldives by Fishing Vessels without a License
- Steps to be taken in case of suspected illegal activities
- Penalties

3.13 Relevant International Conventions, Treaties and Protocols

3.13.1 United Nations Convention on Climate Change (UNFCCC) and the Kyoto Protocol

The UNFCCC is an "overall framework for the intergovernmental efforts to achieve stabilization of greenhouse gas concentrations in the atmosphere at a low level enough to prevent dangerous anthropogenic interference with the climate system, recognizing that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases."

The Clean Development Mechanism (CDM) of the Kyoto Protocol allows implementing

project activities that reduce emissions in non-Annex I Parties, in return for certified emission reductions (CERs). Accordingly, the CERs generated by such project activities can be used by Annex I Parties to help meet their emission targets under the Kyoto Protocol.

3.13.2 United Nations Convention on Biological Diversity (UNCBD)

The objective of the 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."

Maldives was one of the first nations to ratify the UNCBD. In 2002, Maldives developed the National Biodiversity Strategy and Action Plan (NBSAP) through wide consultation and extensive stakeholder participation.

3.13.3 United Nations Conference on Desertification (UNCCD)

The objective of UNCCD is "to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach which is consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in affected areas."

The Convention calls for improved productivity of land and the rehabilitation, conservation and sustainable management of land and water resources in order to improve the living conditions particularly at the community level.

3.13.4 United Nations Convention on the Law of the Sea (UNCLOS)

The UNCLOS provides a legal order for the seas and oceans to facilitate international communication, promote the peaceful uses of the seas and oceans, the equitable and efficient utilization of their resources, the conservation of their living resources and the study, protection and preservation of the marine environment.

Under UNCLOS, the Maldives is an archipelagic state and UNCLOS provides important provisions for the utilization of fishery resources within the territory of the Maldives and ensure that there is no serious pollution or dumping of waste by vessels that use the territory of the Maldives.

3.13.5 International Convention for the Prevention of Pollution from Ships (MARPOL)

The MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978. MARPOL includes regulations aimed at preventing and minimising pollution from ships either by accidental or from routine operations.

The Convention 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 Ship,
- Prevention of Pollution by Garbage from Ships, and
- Prevention of Air Pollution from Ships

3.13.6 Male Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia

The objectives of Male' Declaration includes:

- Assessing and analysing the origin and causes, nature, extent and effects of local and regional air pollution,
- Developing and/or adopting strategies to prevent and minimise air pollution
- Setting up monitoring arrangements beginning with the study of sulphur and nitrogen and volatile organic compounds emissions, concentrations and deposition.

3.14 Responsible Ministries and Institutions in the Maldives

The main governmental institutions, involved in the development of Gulhifalhu are described below.

The act 4/93 names the (then) Ministry of Planning and Environment as the main responsible ministry for safeguarding the environment. Some years later this responsibility went to the (then) Ministry of Home Affairs, Housing and Environment; whereas in 2004 the responsibility went to the Ministry of Environment and Construction (MEC), and more recently to a new Ministry of Environment, Energy and Water. Under the new government of President Nasheed, who was elected president in 2008, the Ministry of Housing and Environment (MHE) is responsible for safeguarding the environment.

At present, the MHE is the authoritative and responsible body for the effective implementation of the Environmental Protection and Preservation Act in the Country and has the statutory power over various issues related to the environment. The MHE plays the main role within the government system with regard to environmental matters. It has the central control over environmental protection, conservation, management and related matters. This is mainly manifested at the policy level. The ministry is also responsible for developing, advising and undertaking environmental policies and government positions in national and international context as well as undertaking monitoring and research related to the environment.

In May 2004 the Environment Section of the (at that time) MEC published the so-called "Information Handbook for Proponents for EIA" (draft), which describes and clarifies the EIA process to be followed. In 2007,an updated version, Environmental Impact Assessment Regulations 2007, was published by the Ministry of Environment, Energy and Water.

The MHE will, in case of project approvals, normally seek the advice of the National Commission for the Protection of the Environment (NCPE). The NCPE was appointed by the President in 1989 and restructured in 1993 at the time of the Environmental Act (Law No 4/93). The Commission was again restructured in 1999 to broaden the consultative process on environmental protection among the Government concerned agencies. The new government that took place in 2008 formed an agency to regulate and enforce the Environmental Act (4/93). Environmental Protection Agency (EPA) has to advice the Minister of Environment on environmental matters such as environmental assessment, planning and management and political decisions with regard to protection of the environment. A number of government agencies and ministries (Ministry of Tourism, Arts and Culture, Ministry of Fisheries and Agriculture) have environment-related mandates, sometimes these overlap with the mandate of the MHE.

In the case of the development of Gulhifalhu Industrial Zone Limited is the project proponent and client (employer) for the construction contract execution. The Ministry of Housing, Transport and Environment will act as Licensing Agency.

A Concession Agreement was signed with Gulhifalhu Industrial Zone Limited (State owned company in Maldives) followed by a Foreign Investment agreement with the Ministry of Economic Development. The project has been approved by the Ministry of Finance and Treasury. In the former government the project was also approved by Presidential Decree in 2007. Both approval letters can be found in annex 2.

4 Description of the Natural Environment

4.1 Introduction

This section assembles, evaluates and presents baseline data on the relevant environmental characteristics of the study area and includes the following subsections:

- Study Methodologies
- Physical Environment
    - Climate
        - *General climatic patterns, wind, rainfall*
    - Coastal Environment
        - *Waves, currents, tides, bathymetry, coastal geomorphology, beaches*
    - Coastal environment of the existing island from Phase 1
        - *Beach profiles, description of beach conditions*
    - Lagoon and reef flat
        - *Lagoon bottom conditions, marine water quality, sediment levels*
- Natural and Biological Environment
    - Terrestrial Environment
        - *Flora and fauna including coastal vegetation, groundwater aquifer*
    - Coral Reefs
        - *Marine life including coral reef and other marine organisms*
- Socio-economic Environment
    - Social setup of Gulhifalhu and Kaafu atoll
    - Economic setup

4.2 Methodologies

Baseline environment of the study area were analysed by using standard scientific methods. The environmental components of the study area were divided into marine, terrestrial, coastal and aquatic resources. The marine environment of the island covered the lagoon habitats including coral patches, marine water quality and the house reef of Gulhifalhu. The coastal environment

covered the beaches, the beach rock formations and coastal processes including longshore sediment transport, nearshore currents, tides and wave climate. The terrestrial environment covered the flora and fauna inland including and habitats within them, groundwater quality.

Particular attention was placed in detailed surveys on the marine environment life, as these components are likely to involve the most significant environmental Impacts from the proposed project. The different methods used in assessing and presenting the conditions of the existing environment of the island are given in the following subsections.

4.2.1 Study area and Survey Locations

Figure 4-1 below shows the specific study area and Figure 4-2 shows the survey locations. GPS co-ordinates for the survey locations are provided in Annex 5.

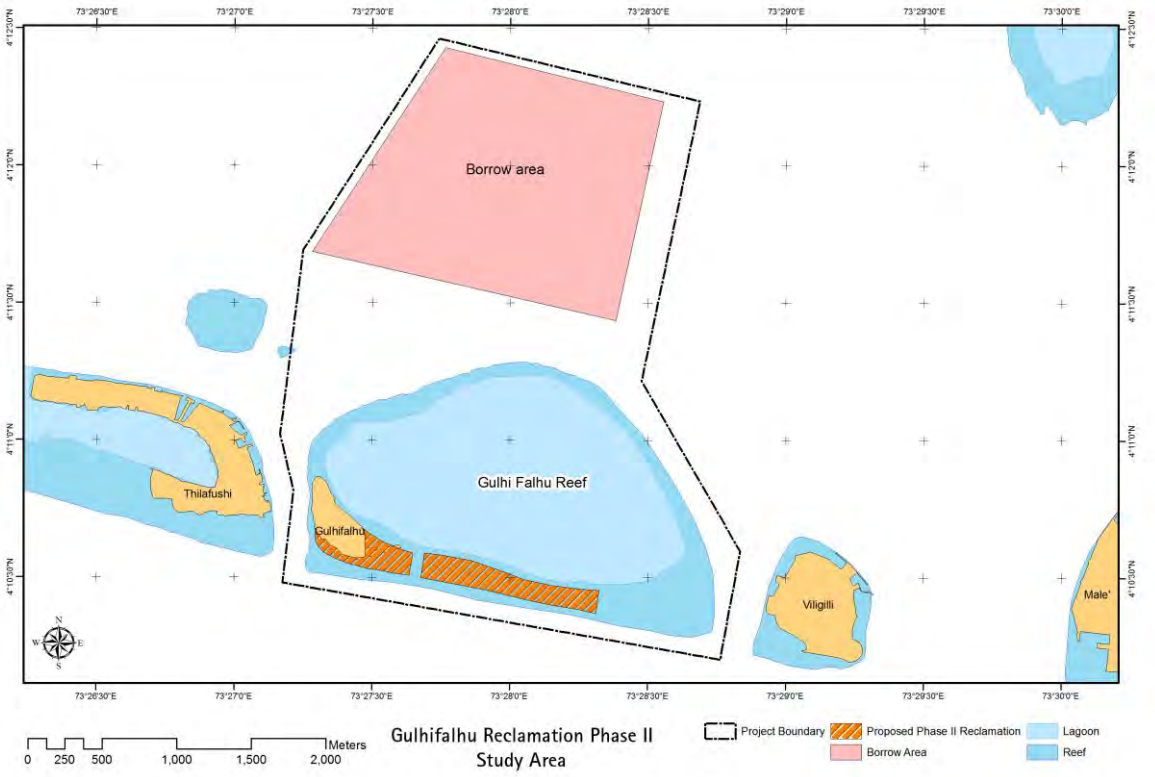


Figure 4-1 Study areas for the proposed project

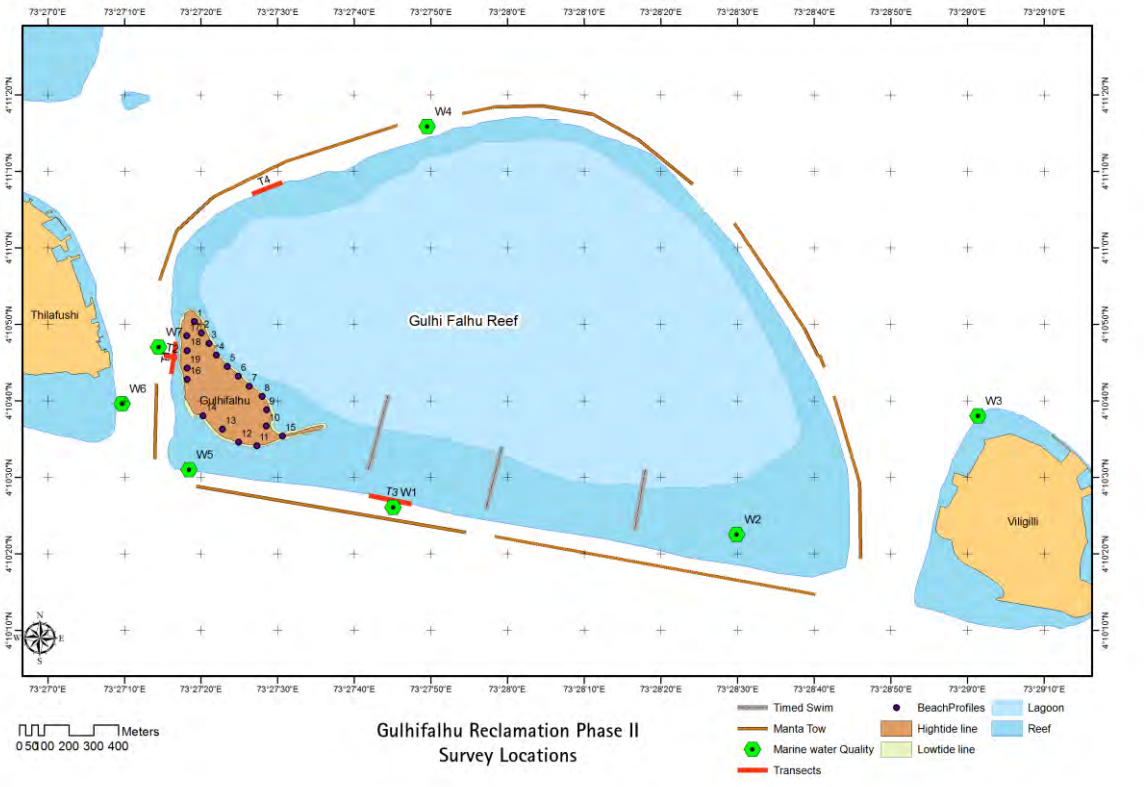


Figure 4-2 Survey locations

4.2.2 Aquatic Resources

One of the main environmental components that would be affected by implementing the project would be water quality. Water quality was assessed at different locations during monitoring surveys in December and January 2011. Samples were collected in clean 500ml PET bottles after washing them with water to be sampled. Also to test for biological content (faecal coliform), samples were collected in sterilized 100ml glass bottles provided by the National Health Laboratory. Parameters tested for sea water quality assessment were Biological Oxygen Demand (BOD5), Dissolved Oxygen (DO), Salinity, Total Dissolved Solids (TDS), pH, Nitrate, Nitrite and Faecal coliform and for ground water quality assessment parameters tested were Total Coliform, Faecal Coliform, Electrical Conductivity, Chlorine, Nitrates, Nitrites, pH, TDS and Ammonia. All parameters were analysed at the National Health Laboratory

4.2.3 Coastal processes

Nineteen beach profiles were taken from designated locations around existing Gulhifalhu Island using standard levelling techniques. These profile locations are marked in Annex 5 and figure 4-2 above. The measurement of beach profiles involves standard practice of surveying with a staff

and a dumpy level. Measurements were taken along the beach profile line at different intervals wherever there occured a distinctive morphological feature such as beach ridge, high water mark, an erosion scarp, dip, rise, or other significant break in the beach slope up to a minimum distance of 30m from the Benchmark. Shoreline maping was undertaken using a differential GPS.

4.3 Physical environment

4.3.1 Geologic setting

Gulhifalhu is located on the southern rim of the North Male' Atoll. The reef is fairly large with about 365 Ha. The reef flat is wider on the south side of the reef system (300 m) and very narrow (90 m) on north, east and west side of the reef system. The water depth over the reef flat varies between 1.0 and 2.0m. Apart from a natural reef entrance on the eastern side, a reef entrance was made on the western side with the width of about 38 m. The inner lagoon is deep with around 8-9 m. The inner lagoon occupies about 63% of the total surface area of the reef system.

About 10 ha of land that has been reclaimed in the phase I of Gulhifalhu development at south western corner of the reef system is the only land seen on Gulhifalhu, above sea level. The elevation of this recently reclaimed land is +2.5 m above MSL. Figure 4-3 shows a satellite image of Gulhifalhu taken after the reclamation. The island has been created from coral material from the atoll lagoon bottom. Please refer to phase I EIA for more details. The new island is barren with no vegetation and poorly established ground water system. There are not topographic variations on the island as it has been levelled.

4.3.1.1 Borrow area

Based on similar projects and proponent's experience, the material of the borrow area can in general terms be described as "loosely packed, silty, coral sand and shells". The grain size envelope is expected to be as in figure 4-4.

One vibro-core sample was taken in the area north of Gulhifalhu in June 2009. The results of the analysis of this sample are shown in Table 4-1 Characteristics of vibro-core sample taken near Gulhifalhu.

Figure 4-3 Satellite image of Gulhifalhu taken on 19 October 2010

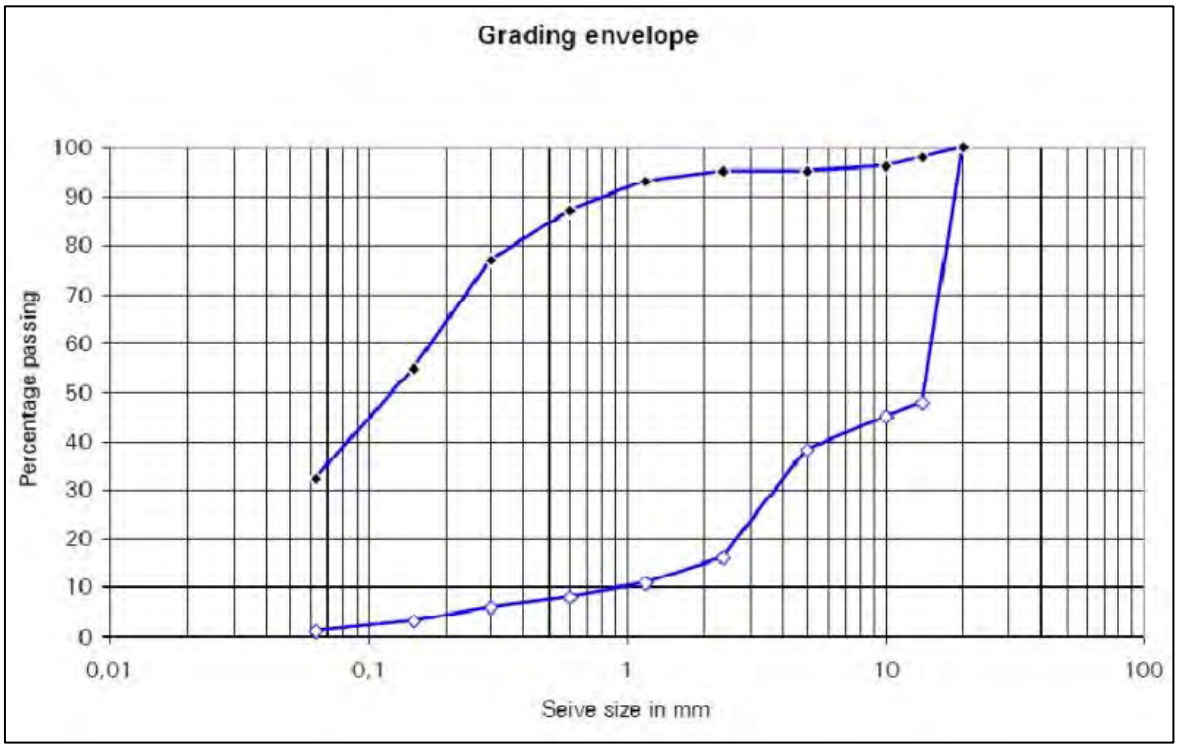


Figure 4.4 Gulhifalhu assumed grading envelop.

Water depth	25-50m
Type of environment	Inside atoll lagoon, sandy seabed, coral reef formations such as farus, thilas and giris are located outside the perimeter of this area
Typical D50	625
Typical D10	60
Typical D90	1900
Percentage fines	11
Percentage coarse material	40
Percentage sand	49

Table 4.1 Characteristics of vibro-core sample taken near Gulhifalhu

4.3.2 Climatic setting

The Maldives, in general, has a warm and humid tropical climate with average temperatures ranging between 25°C to 30°C (MHAHE, 2001) and relative humidity ranging from 73 per cent to 85 per cent. The country receives an annual average rainfall of 1,948.4mm. There is considerable variation of climate between northern and southern atolls. Table 4.2 provides a summary of key meteorological findings for Maldives.

Table 4.2 Key Meteorological Information

Parameter	Data
Average Rainfall	9.1mm/day in May, November; 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973; 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973; 17.2 C in April 1978
Average wind speed	3.7 m/s in March; 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December; 1010 mb in April

4.3.2.1 Monsoons

Monsoons of Indian Ocean govern the climatology of the Maldives. Monsoon wind reversal plays a significant role in weather patterns. Two monsoon seasons are observed: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. Monsoons can be best characterized by wind and rainfall patterns. The southwest monsoon is the rainy season which lasts from May to September and the northeast monsoon is the dry season that occurs from December to

February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

4.3.2.2 Wind

The monsoons are relatively mild due to the country's location near the equator and strong winds and gales are infrequent in the Maldives. However, storms and line squalls can occur, typically in the period May to July. The winds usually get stronger in the southwest monsoon especially during June and July. During storms the impact is greater on the northern atolls than on the southern atolls. The northeast and southwest monsoons have a dominant influence on the winds experienced in the Kaafu atoll. The southwest monsoon, with winds predominantly between SW and NW, lasts from May to October. In May and June, winds are mainly from WSW to WNW, and in July to October, winds between W and N W predominate . The northeast monsoon, with winds predominantly from NE to E, lasts from December to February. During March and April, winds are variable. During November, winds are W, becoming variable. soon, winds can occasionally exceed 30 knots (force 7 Bf) from the NE sector. During the southwest monsoon, winds have on one occasion during the period described above exceeded 40 knots (force 8-9 Bf) from the W sector. Generally, however, winds during the northeast and southwest monsoons are around 10-15 knots (force 5 Bf).

Season	Month	Wind
NE - Monsoon	December	- Predominantly from NW-NE.
	January	- High Speeds from NE
	February	
Transition Period 1	March	- From all directions. Mainly W.
		- High Speeds from W.
	April	
SW - Monsoon	May	- Mainly from W.
	June	- High Speeds from W.
	July	
	August	
	September	
Transition Period 2	October	- Mainly from W.
	November	- High Speeds from W

Figure 4.5 Summary of General Wind Conditions for National Meteorological Centre

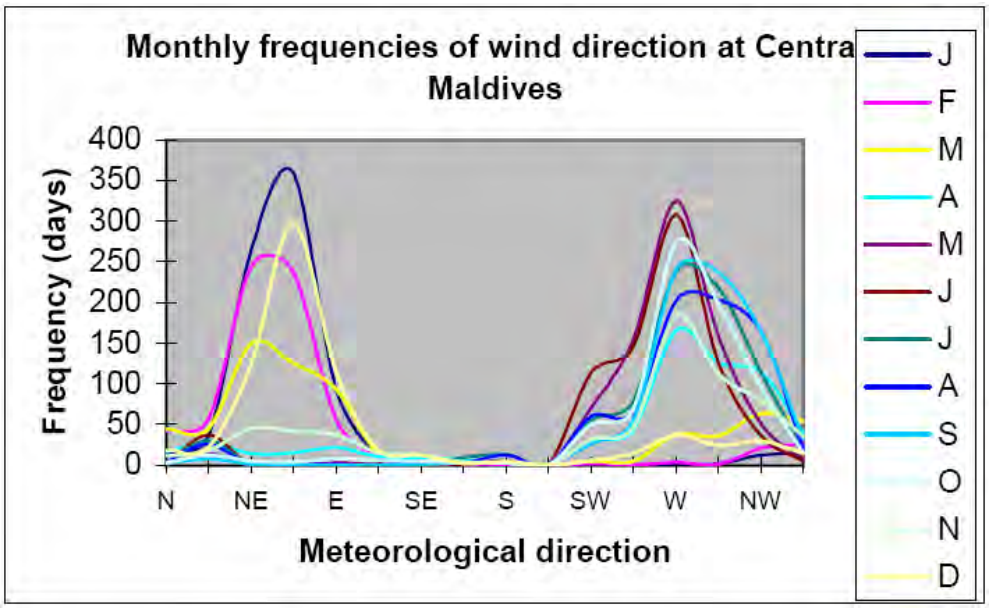


Figure 4.6 Monthly Frequencies of Wind Direction in Central Maldives based on National Meteorological Centre

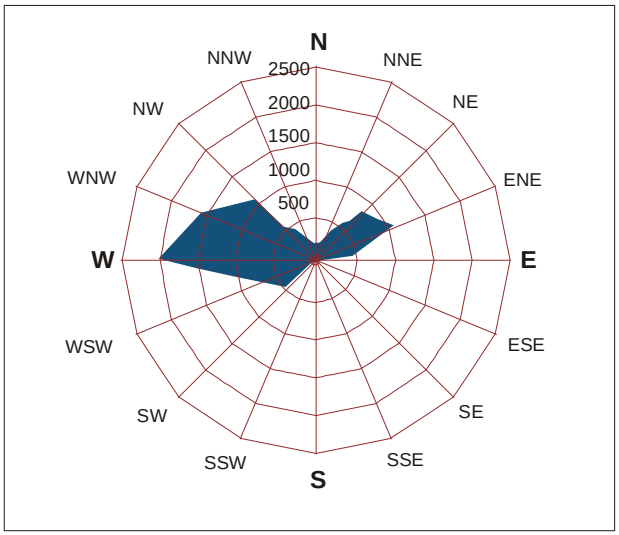


Figure 4.7: 5 Year Wind Frequencies Recorded at Hulhule Meteorological Centre

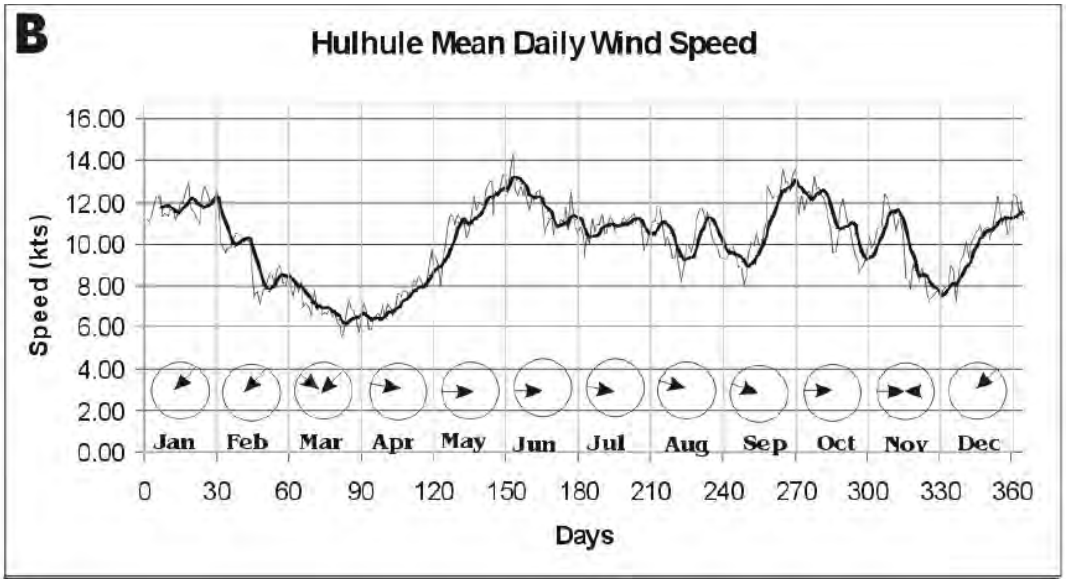


Figure 4.8 Mean Daily Wind Speed and Direction Recorded at National Meterological Center.

4.3.2.3 Tides, Currents and Waves

Tides

During spring tides, the tidal range is between about 90-110 cm and during neap tides the range can be as little as a few centimeters. The height of the tide is also affected by the weather. Winds from different directions influence the raising and lowering of the water level and situations of high sea levels on the outside of the atolls are caused by storm surges and wave set-up. The water also stands higher with a low barometer, to what extent is uncertain. Maximum water levels are estimated to be in order of MSL+1m. The tides observed in the country are twice daily (semidiurnal), and typical spring and neap tidal ranges are approximately 1.0m and 0.3m respectively. Maximum spring tidal range in the central and southern atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February – April and decrease of 0.1m during September – November. Table 4-3 shows tidal variations for Malé Airport.

Tide level	Reference to Mean Sea Level
Highest Astronomical Tide (HAT)	0.64m
Mean Highest High Water (MHHW)	0.34m
Mean Lower High Water (MLHW)	0.14
Mean Sea Level (MSL)	0.00m
Mean Higher Low water (MHLW)	-0.16m
Mean Lower Low water (MLLW)	-0.36m
Lowest Astronomical Tide (LAT)	-0.56m

Table 4.3 Water Levels

Currents

Currents which affect the sea area around the Maldives and within the Thaa atoll are caused by one or more of the following systems: oceanic currents, tidal currents, wind-induced currents, and wave-induced currents.

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. In the Arabian Sea, as you get closer to the equator, the prevailing winds become more and more indicative of the oceanic surface current. Thus, wind (especially during monsoons) can be a major factor affecting current velocity and direction, and currents can be of great strength (wind-induced currents). For example: currents in the channels near Malé have been recorded at 4 knots or more. Inside an atoll, current speeds are more settled. Oceanographic currents are driven by two monsoonal winds, namely the westerly and easterly wind. The westerly flowing currents tend to dominate from January to March while the easterly currents dominate from May to November. The changes in current flow patterns occur in April and December. The current velocities are about 0.5 m/s, only in May values may increase to 0.8 m/s.

The vertical water movements associated with the rise and fall of the tide are accompanied by horizontal water motion termed tidal currents. These tidal currents have the same periodicities as the vertical oscillations, but tend to follow an elliptical path and do not normally involve simple to- and-from motion. Generally the tidal currents are eastward in flood and westward in ebb. Tidal currents, which flow according to the height of the tide, are generally not strong. There is a strong diurnal influence which governs the tides in the Maldives, but in general the tidal range is less than 1m.

On a more local scale, especially on the reef flats, wave-induced currents (cross-shore and/or long-shore) also form an important factor affecting the current regime.

Waves

The swell and wind waves experienced on the Maldives are governed mainly by the two monsoon periods. Swell caused by cyclonic storms in the area west of Australia

may also reach the southern atolls of the Maldives on occasion.

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically strongest during April – July in the south-west monsoon period. During this season, swells generated north of the equator with heights of2-3m with periods of 18-20 seconds have been reported in the region.

The Maldives also experiences swells originating from cyclones and storm events occurring well south of the equator. It is reported that the swell waves from southeast to south-south-east occur due to strong storms in the southern hemisphere in the area west of Australia with direction towards the Maldives.

The swell waves that reached Malé and Hulhule in 1987 had significant wave heights in the order of 3 meters. Local wave periods are generally in the range 2-4 seconds and are easily distinguished from the swell waves. Due to the shallow depths on the reef flat, significant wave breaking (energy dissipation) will take place at the reef's edge, reducing the wave height of waves which pass over the reef flat.

Tsunami and Waves

Although records are inexact, it would appear that earthquake-generated tsunamis of greater than 1.0m in height have occurred on three occasions in the Indian Ocean since 1883. A tsunami of the magnitude experienced on 26th December 2004, which was approximately 4.0m in height, is an extremely rare event. In the morning of 26th December, three hours and 18 minutes after the Sumatran earthquake, the tsunami reached the shores of Maldives islands. Sea-level station records show a southward decrease in the amplitude of the tsunami tidal-record signal from ~1.8m above mean sea level (MSL) at Hanimaadho in the north, ~1.5m for Hulhule, Malé in the central region, and ~0.8m for Gan in the south. The sea-level station data are filtered and do not show absolute heights of the tsunami. Uncorrected tsunami water levels measured by UNEP showed a range from barely measurable to 3.25m, with most measurements in the 2.0 to 2.6m range. Tsunami inundation heights ranged from 0.65m in south Malé to 3.20m in L. Fonadhoo. The tsunami's height typically decreased from east to west as it travelled across islands. Many islands reported the tsunami approaching from the west, quite probably because it refracted around the ends of the islands. Eyewitness accounts often referred to several (usually three) waves approaching in rapid succession (30 seconds to minutes) with minimal draining of

water between waves. Wave effects were most pronounced on eastern shores, but flooding and damage to coastal infrastructure was widespread among the islands. The tsunami arrived in Maldives during daylight hours near low tide.

4.3.2.4 Rainfall

Annual average rainfall in Maldives is about 1900mm. There is a marked variation in rainfall across Maldives with an increasing trend towards south. The annual average rainfall in north is 1977mm and for south is 2470mm.

The southwest monsoon is known as the wet season with monthly average rainfall ranging from 125-250mm. The northeast monsoon is known as the dry season with average monthly rainfall of 50-75mm.

On average, the NE monsoon months have 5 days a month with rainfall exceeding 1mm. The southwest monsoon is the wet season, with monthly average rainfall ranging from 125mm to 250mm. During the SW monsoon months, each month will on average have 10 to 15days with rainfall exceeding 1mm. Open water evaporation rates are in the range of 6mm per day and transpiration from plants is also high. The relative humidity generally ranges between 75 to 80%.

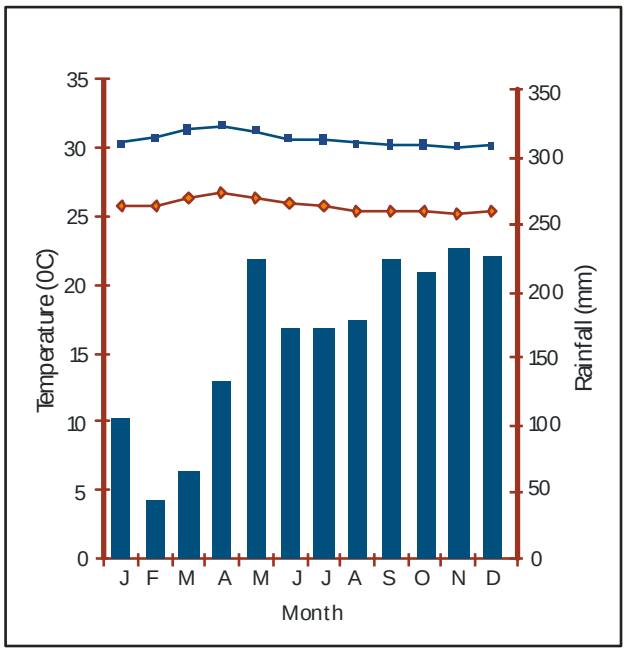


Figure 4.9 Summary of mean rainfall and temperature values recorded at Male' International Airport.

4.3.2.5 Temperature

Daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. The annual mean maximum temperature recorded for Male' during the period 1967-1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C. The highest recorded temperature for Male' was 34.1°C on 16th and 28th of April 1973. The hottest month recorded was April 1975 with a maximum monthly average temperature of 32.7°C, the next highest being 32.6°C in April 1998. The lowest minimum average temperature of 23.7°C was recorded in July 1992.

4.3.3 Coastal Environment of Existing Island from Phase 1

The only island on the reef system is the newly reclaimed 'Gulhifalhu Island' on the southwest corner of the island. The island is created from atoll lagoon bottom sediments, primarily containing fine to moderately coarse sediments. The initial reclamation activities were followed by severe erosion on the southern side reaching 30 m inland from the reclaimed shoreline. Large chucks of these materials are deposited on the northern and eastern ends of the island. Figure 4.10 below shows a comparison of design template, actual reclamation and changes after 4 months. The elevation of the island is 3.0 m and has been compensated for future natural settlement and wind erosion. The island has grown on the northern eastern and north western side. These changes were generally predicted for the Southwest monsoon. A slight reversal of sediment transport patterns is expected during the NE monsoon with erosion on the northern and eastern end of the island accretion in the previously eroded areas. The volume of change may not be dramatic since coastal protection measures are being constructed on the western and northern side of the island. Coastal protection on the southern and eastern end of the island has been halted since these areas are planned to be reclaimed in phase II.

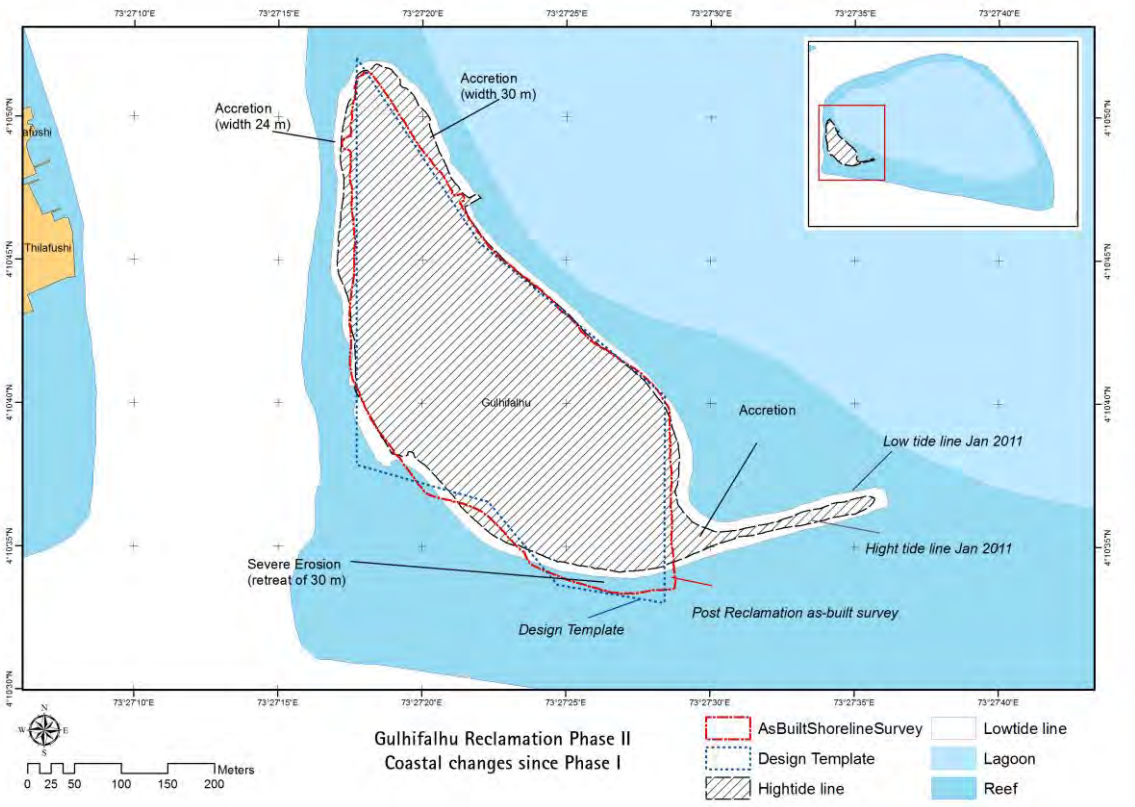


Figure 4.10 Coastal changes to phase I reclamation

There have also been significant changes to the beach profile with the construction profile naturally adapting wave and current conditions. Detailed beach profile surveys were undertaken in 19 locations around the island. Beach profile data is attached as Annex 9.

Figure 4.11 and 4.12 below shows the dramatic changes to beach profile on the northern side and southern side of the island, following erosion. The changes in the northern areas in modest (3 m) compared to a 30 m erosion on the southern side. In the northern side, the sections of the profiles eroded form the top half of the shore face has been deposited back in the lower half below low tide line. The material lost from the southern side has been reworked to other parts of the island.

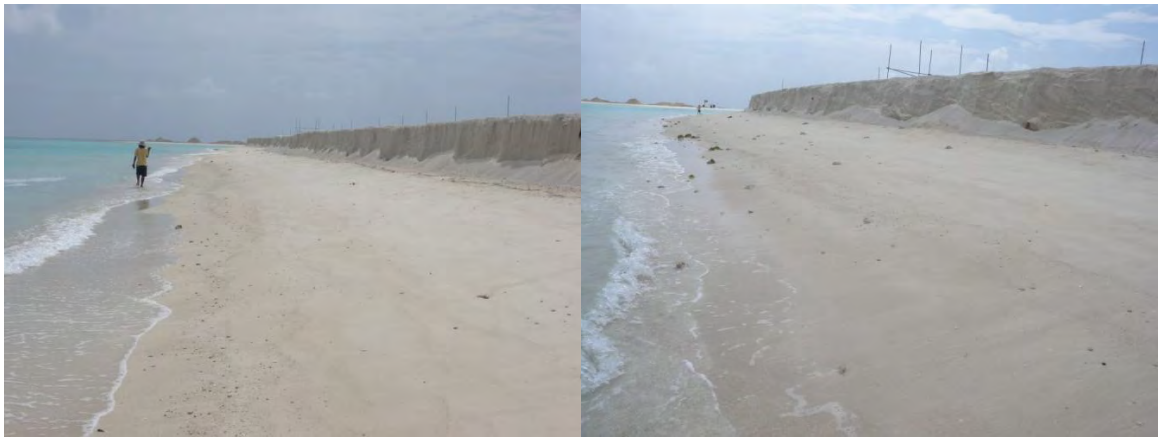


Figure 4.11 Beach profile changes on the north eastern side of the island

Figure 4.12 Beach profile changes on the southern side of the island – severe erosion and exposed rubble

Figure 4.13 Coastal protection activities being carried out on the south western and western side.

4.3.4 Lagoon Water quality

Quality of coastal water is not only important for the ecological functioning of organisms living in the habitat but also important for aesthetic and health reasons such as swimming in unpolluted waters.

The primary objective of the lagoon water quality sampling was to determine the baseline conditions of the marine water in around Gulhifalhu, and monitor any changes to the baseline conditions. Water quality tests were done at the National Health Laboratory (NHL).

The following table shows the results of the marine water samples collected on 25th November 2010 and 11th January 2011. Main parameters tested were salinity, suspended solids, turbidity, and Iron content of the samples.

		Sample ID					
	Parameters Tested	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**
25th November 2010	Physical Appearance	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles
	Salinity	16500mg/L	16000 mg/L	16400mg/L	16200 mg/L	15800 mg/L	15200mg/L
	Suspended Solids	-	-	-	-	-	-
	Turbidity	0 NTU	0 NTU	0 NTU	0 NTU	0 NTU	0 NTU
	Iron (Total)	0.00mg/L	0.00mg/L	0.00mg/L	0.00mg/L	0.00mg/L	0.00mg/L
11th January 2011	Physical Appearance	Clear	Clear	Clear	Clear	Clear	Clear
	Salinity	8400mg/L	7600 mg/L	9600 mg/L	9500 mg/L	9800 mg/L	9800mg/L
	Suspended Solids	0mg/L	0mg/L	2mg/L	1mg/L	0mg/L	0mg/L
	Turbidity	0 NTU	0 NTU	0 NTU	0 NTU	0 NTU	0 NTU
	Iron (Total)	0.00mg/L	0.00mg/L	0.01mg/L	0.00mg/L	0.00mg/L	0.04mg/L

Table 4.4 lagoon water test results from January 2011

From December 2010 to January 2011 it can be observed that the salinity levels have reduced at all sampling locations. At site 1 and 2 salinity levels have reduced by half, while at site 3 and 4 the levels have reduced by approximately 40 percent and in site 5 and 6 the levels have decreased by 35 percent. This reduction in salinity could be due to an error during the test.

Suspended solids present in almost all samples are nil, except for site 3 and 4: but these levels at 3 and 4 are negligible. There is no change to turbidity levels in for both months at all sites.

Iron content of samples taken on November 2010 is 0 mg/L for all sites, but in the samples collected in January 2011 it can be observed trace amounts of Iron at site 3 and 6: levels which

are negligible.

4.3.5 Natural disaster risk

The primary sources of natural hazard risks in Maldives are strong winds during monsoons or freak storms, earthquakes, island interior flooding caused by heavy rain, coastal flooding caused by high surf, storm surge, prolonged strong monsoonal wind, high astronomical tides or tsunamis, and sea level rise (Pernetta and Sestini, 1989; Woodroffe, 1989; Severe weather events in 2002 2003 and 2004(2005); UNDP 2005). Coastal flooding and wind damage can be considered as the most frequent natural hazards that occur in Maldives (see Maniku (1990), Luthfy (1994)). Most of these risk factors (apart from earthquake, wind damage and rainfall flooding), stems from the extremely low elevation of all Maldivian islands: the average elevation is 0.8 m above sea level. Despite the occasional natural hazards, Maldives in general is relatively safe from high risk natural disasters.

Spatial variations in hazards are evident across Maldives (Maniku, 1990; Shaig, 2005). Northern atolls are more exposed to intense storm systems, increasing the risk of wind damage in these atolls. In comparison, southern atolls experience less storms systems, but are more exposed to flooding events, probably as a result of exposure to intense South Indian Ocean storm surges and wind-waves during south west monsoons.

4.4 Natural and biological environment

4.4.1 Abiotic marine environment

4.4.1.1 Lagoon system

Reclaimed area of Gulhifalhu during phase 1 is on the south western corner of the Gulhifalhu reef system. The marine environment associated with this island is composed of an intertidal reef flat, a shallow lagoon area, a reef edge and a steep reef slope. Figure 4.14 is a diagrammatic representation of the offshore geomorphology of the reef system associated with this island.

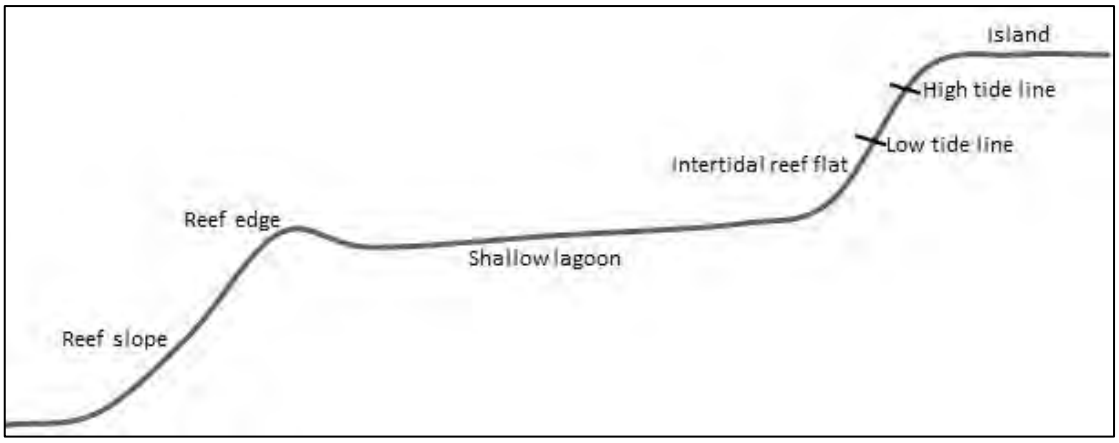


Figure 4.14 Cross-section of the reef system associated with the reclaimed (not to scale)

4.4.1.2 Intertidal reef flat

The intertidal reef flat extends approximately 5 m away from the islands low tide line, with a depth ranging approximately between 0.1 m to 0.5 m. The benthic cover of this area is dominated by sand and small broken off pieces of coral rubble (Figure 4.15).

Figure 4.15 Benthic cover of the intertidal reef flat

4.4.1.3 Shallow lagoon

The shallow lagoon area extends approximately 15 m, from the intertidal reef flat till the reef edge. The depth at the lagoon area ranges of 0.5 m to 1 m. The benthic cover is similar to the reef flat; dominated by coral rubble and sand (Figure 4.16).

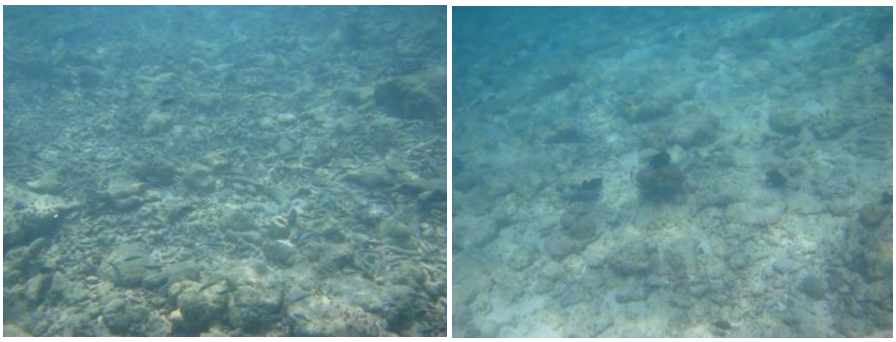


Figure 4.16Benthic cover of the shallow lagoon

4.4.1.4 Reef edge

The reef edge is approximately 3 m to 5 m in width from the shallow lagoon area till the reef slope. The depth varies between 2 m to 3 m at this location. The benthic cover of this area is dominated by large boulder shaped rocks, and large Porites (massive) (Figure 4.17).

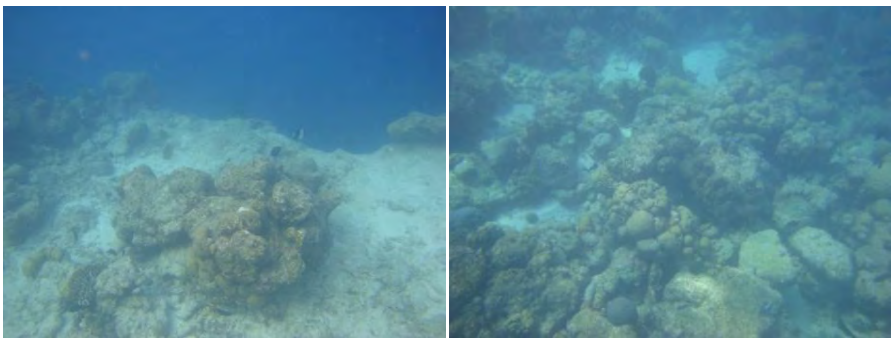


Figure 4.17Benthic cover of reef edge

4.4.1.5 Reef slope

The reef slope steep and extends approximately 30 m from the reef edge. Depth at the reef slope ranges between 3 to 30 m. The benthic cover is dominated by sand, rocks and dead hard corals (Figure 4.18). Small colonies of Pocillopra, Acropora and massive Porites were observed along the reef slope.

Figure 4.18Benthic cover of the reef slope

4.4.2 Biotic marine environment

The baseline condition of the marine environment of Gulhifalhu is derived from the marine surveys conducted by Hydrodynamics BV in June 2010, for an EIA (Development of Gulhifalhu, Kaafu Atoll Maldives - prepared in August 2010). GPS coordinates of the survey locations are given in the Table 4.5 below.

Site	Location	Geographical Coordinates	
		N	E
Site 1	North West Side	04º 11.21″	73º 27.67″
Site 2	Middle North Side	04º 11.27″	73º 27.99″
Site 3	North East Side	04º 11.21″	73º 28.32″
Site 4	Centre Han Hass	04º 10.45″	73º 27.68″
Site 5	Middle South side	04º 10.35″	73º 28.00″
Site 6	South East side	04º 10.32″	73º 28.32″

Table 4.5 GPS locations of survey locations - baseline survey

For the baseline survey the following methodology was adopted: two transects were laid at each site; one on the reef top near the edge at approximately 5 m depth and another at 10 m depth. An additional transect was laid on site 4 to characterize the top of the rocky platform. 5 high resolution photographs were selected to assess the benthic cover of each site. These were analyzed using 25 point grids to characterize the substrate composition, with a sample of 125 points per transect.

In addition to the baseline survey; two more marine assessments were conducted at three locations around Gulhifalhu on 25th November 2010 and 11th January 2011 to monitor the reef conditions around Gulhifalhu.

Snorkeling visual surveys were conducted on November 2010, along the reef tops of the locations mentioned in Table . Line transect surveys were conducted on January 2011, at 5 m depth at sites 2, 4 and 7 (Table 4.6). In addition a vertical transect was laid at site 7 along the reef slope. The results of these surveys are presented in the following sections.

Site	Location	Geographical Coordinates	
		N	E
Site 2	Middle North side	04° 11.27″	73° 27.99″
Site 4	Centre Han Hass	04° 10.45″	73° 27.68″
Site 7	South West Corner	04° 10.38″	73° 27.17″

Table 4.6 GPS locations of survey locations – monitoring surveys

Figure 4.19 shows the marine survey locations for both to establish the baseline and

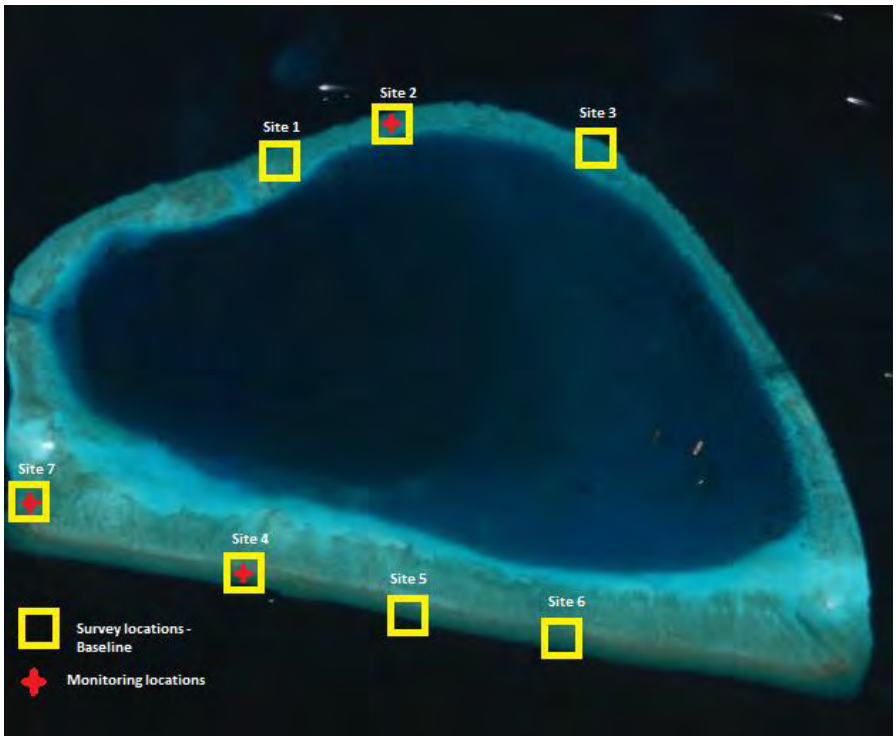


Figure 4.19 Marine survey locations

4.4.2.1 Site 1

Reef top: The area is flat, and relatively deep for a reef edge at a depth of 2.5 to 3 m. The substrate is composed of loose stones which may move when wave action is strong. Coral cover is virtually nil, living substrate (17%) is comprised of turf algae (13%) and ascidians (4%).

Reef slope: Live coral is mostly comprised of small colonies of acroporidae, with the digitate and tabular forms totaling 53% of the coral cover. Total benthic area covered with coral is 24%, 34% algae and 24% rubble pavement.

4.4.2.2 Site 2

Reef top: During the baseline survey it was recorded that 22% of the benthic area was covered with hard coral, while 34% covered with an algal turf, and 24% with pavement and 14% with rubble. Corals belonging to species Tubastrea micrantha were recorded among live corals observed at this site.

Results of the snorkeling visual survey conducted on 25th November 2010; indicate that approximately 50% of the benthic area at the reef top is covered in coral rubble, 30% in sand, 12% with algae covered rocks, and less than 6% of the survey area comprised of live hard corals. Even these hard corals were isolated small colonies as shown in Figure 4.20. Coral colonies observed here belonged to the genera Pocillopora, Acropora and Tubastrea.

A list of main fish species observed during the snorkelling survey is listed in the Table 4.7 below.

Genera	Species	Common name
Amphirion	clarkii	Clarks anemone fish
Chilidichthys	inornatus	Yellow dotty back
Chromis	atripectoralis	Blue green puller
	weberi	Webers puller
Chrysiptera	biocellata	White saddled damsel
Dascyllus	trimaculatus	Three spot humbug
Gnatholepis	cf adjerensis	Silty sand gobty
Odonus	niger	Blue trigger fish
Paraluteres	prionurus	Mimic file fish
Pseudanthias	squamipinnis	Orange basslet
Spratelloides	gracilis	Silver sprat

Table 4.7 List of fish species observed at site 2 (25 November 2010)

Pocillopora sp

Acropora sp

Tubastrea sp

Figure 4.20 Types of corals observed on the reef top of site 2

Reef slope: Transect survey along the reef slop during the baseline study indicates that the area had a steep wall heavily colonized with coralline algae. In addition it was suggested that the reef wall might have been subjected to collapse as the reef edge appears jiggered. Main fishes recorded were blue trigger fishes, sea basslets, moon wrasses and a number of Morey eels.
Line transect survey done, on 11th January 2011 indicates; large portion of the reef slope is coved with rocks covered in a coating algae (45%). The benthic composition is presented in Figure . Main types of hard corals observed in this area belong to genera Tubustrea, Acropora (branching), and Pocillopora. Few soft corals belonging to the genera Sarcophytons were also observed.

Typical benthic cover of this site is displayed by the photographs below (Figure 4.21).

Figure 4.21 Selected photographs of benthic cover along transect at site 2 (11th Jan 2011)

The following bar graph (Figure 4.22) summarizes the benthic cover along this transect; live coral cover is makes up 14% of the total transect length and is composed of 10% hard corals and 4% soft corals.

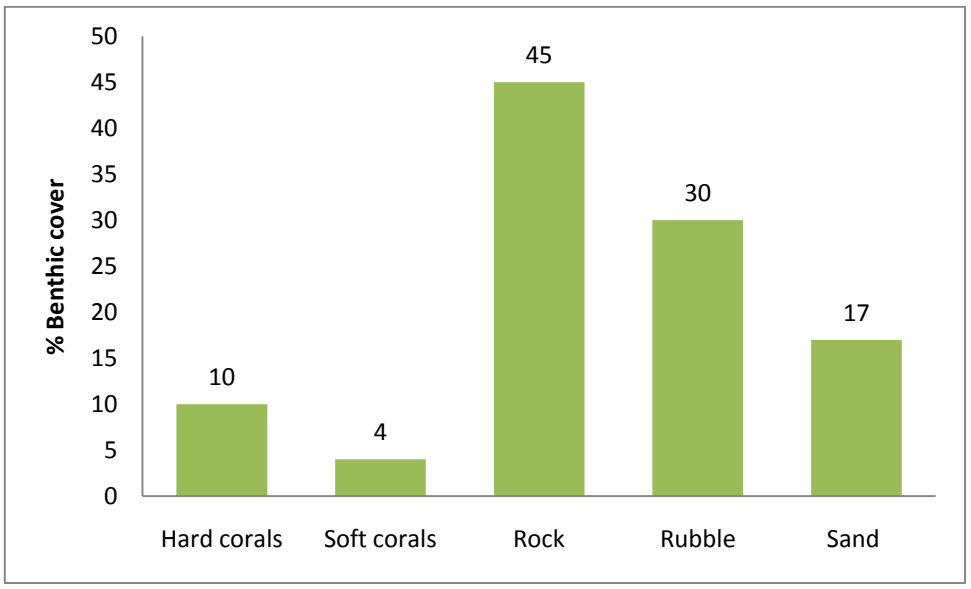


Figure 4.22 Percentage benthic cover along transect at site 2 (11th Jan 2011)

The dominant fish species observed along this transect are Powderblue surgeonfish (Acanthurus leucosternon), Spotted UnicornFish (Naso brevirostris) and Redtooth triggerfish (Odonus niger).

In addition the following fishes were observed at this transect:

- Long-barbel Goatfish – Parupeneus macronema
- Black Pyramid butterflyfish – Hemitaurichthys zoster
- Orange-lined triggerfish – Balistapus undulates
- Lined brsitletooth – Ctenochaetus striatus
- Head-band Butterflyfish – Chaetodon collare
- Clown Triggerfish – Balistoides conspicillum
- Reef Bannerfish – Heniochus acuminatus

4.4.2.3 Site 3

Reef top: This site was recorded as similar to site 2, with lower coral cover; few hard slabs were recorded which could enable some colonies to settle at this site.

Reef slope: Transect was laid out at a depth of 5 m, on the upper part of the reef slope. In this area, the erosion and breaking off of the reef crest is even more important than at site 2, and the slope is even more uneven, with steep walls alternating with gullies. The composition of the substrate is given in Figure 6-17.

4.4.2.4 Site 4

This is a popular dive site; "Hans Hass Place", consists in a reef slope exposed to Vaadhoo kandu. The reef edge has collapsed on a distance over 150 m, and consists of number of caves. The reef is steep past the reef edge, but evolves into a slope at around 15 m depth. This is continuous until it meets another terrace at around 40 m.

Reef top: Coral cover at this site especially at the reef edge is good and covers 23% of the benthic area. Most coral species at this site belongs to massive species with a few encrusting and sub massive live forms. In addition almost 28% of the benthic area is covered in algal turf.

The result of the snorkeling visual survey indicates that the large portion of the reef top area is was covered with rubble (90%), sand (9%) and large rocks (1%). However diverse range of small fishes was recorded at this location (Table 4.8). It should be noted here that the reef top areas closer to the reef edge was not observed during this survey, thus could be the reason for the large variation in records with the baseline conditions.

Genera	Species	Common name
Abudefduf	vaigeinsis	Sergeant major
Acanthurus	leucosternun	Powder blue surgeon
Caesio	xanthonota	Yellow back fusilier
Chaetodon	collare	Head banded butterfly fish
	lunula	Raccoon butterfly fish
Chromis	weberi	Webers puller
	atripectoralis	Blue green puller
Hamitaurichthys	zoster	Black pyramid butterfly fish
Naso	hexacanthus	Sleek unicorn fish
	brevirostris	Spotted unicorn fish
Odonus	niger	Blue trigger fish
Pterocaesio	tile	Blue banded fusilier
	sp 1	Yellow banded fusiler
Spratelloides	gracilis	Silver sprat
Zanclus	cornutus	Moorish idol

Table 4.8 List of fishes observed at site 4 (25th Nov 2010)

Reef slope: Coral cover is almost 16% at this location, the abiotic substrate remains dominant and coralline algae (16%) also occupies a large proportion of the substrate.

Line transect survey done, on 11th January 2011 indicates the amount of sand found at this site is very low, and the hard coral cover is considerably high. However, this area is also dominated by dead rocks. Coral diversity is higher than the other locations, corals belonging to the genera; Acropora, Montipora, Pocillopora, Porite and Favia were observed along the transect line.

Typical benthic cover of this site is displayed by the photographs below (Figure 4.23).

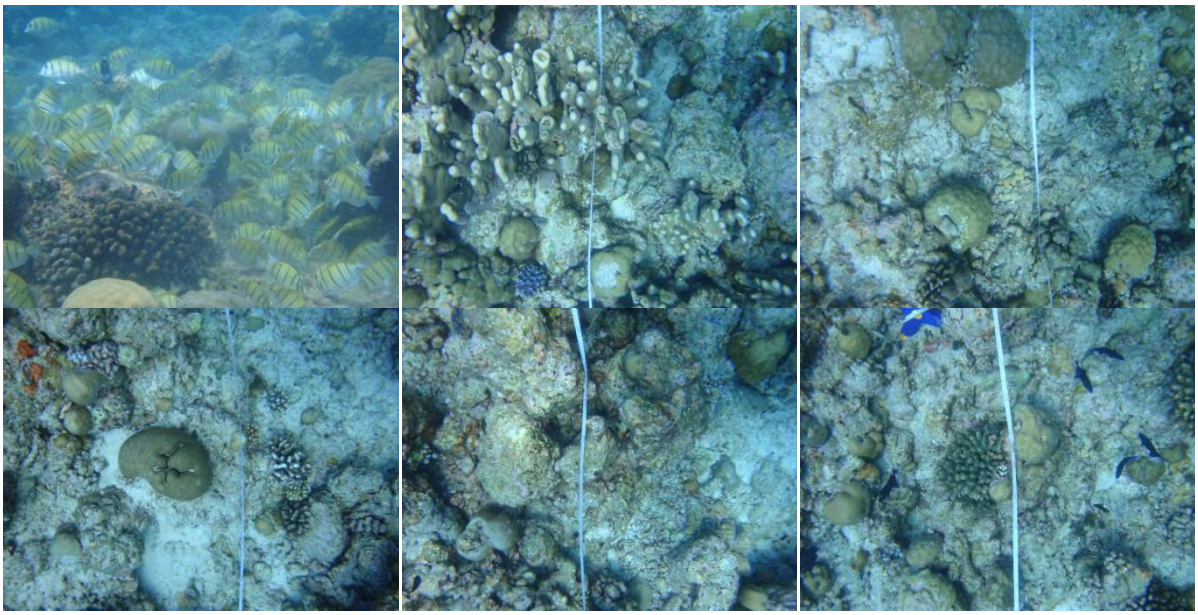


Figure 4.23Selected photographs along the transect line of control site

The following bar graph (Figure 4.24) summarizes the benthic cover along this area; as it is shown hard coral cover at this transect is 35%, however no soft corals were observed.

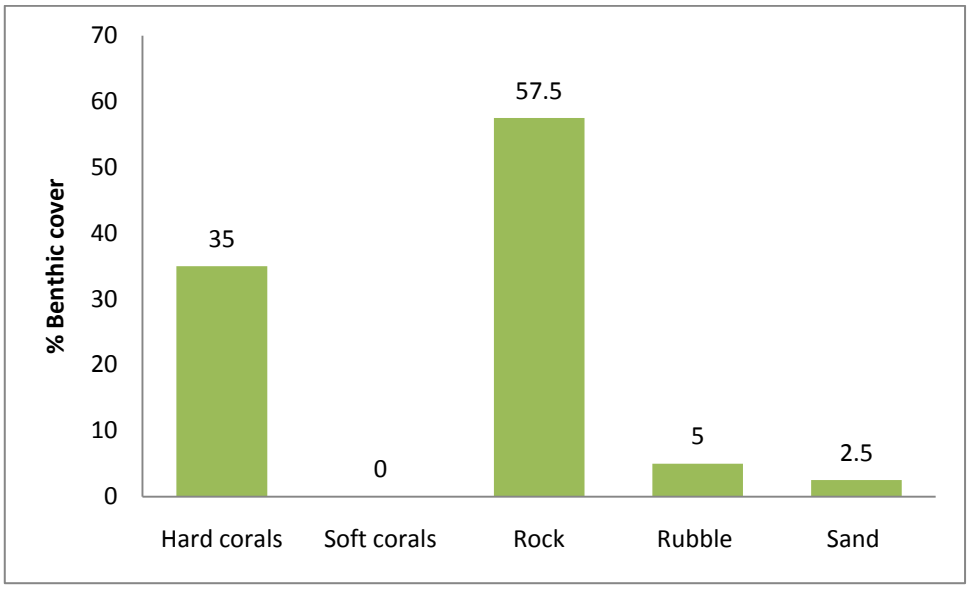


Figure 4.24 Percentage benthic cover along transect at site 4 (11th Jan 2011)

The dominant fish species observed along this transect are Convict Surgeonfish (Acanthurus triostegus), Powderblu surgeonfish (Acanthurus leucosternon) and Redtooth triggerfish (Odonus niger).

In addition the following fishes were observed at this transect:

- Black Pyramid butterflyfish – Hemitaurichthys zoster
- Orange-lined triggerfish – Balistapus undulates
- Lined brsitletooth – Ctenochaetus striatus
- Head-band Butterflyfish – Chaetodon collare
- Clown Triggerfish – Balistoides conspicillum

4.4.2.5 Site 5

The reef slope differs in that it is more regular and do not show the so many ledges and caves as at site 4. The gradation from a reef edge with good coral cover, mostly consists massive corals, to the shallower platform with Pocillopora is a common feature with site 4 and site 6.

Reef top: There is little loose material on the reef top and coralline algae are more important than at site 4 (16 %), probably cementing the structure more efficiently. The coral cover is high, and mostly comprised of massives and encrusting.

Reef slope: The coral cover is still good and mostly comprises of massive species (15 %). Coralline algae dominate over the turf algae and consolidate the structure. Some of the sand and rubble originating from the reef top trickles down the slope.

4.4.2.6 Site 6

Reef top at this site is very similar in all respects to site 5, with an even healthier reef edge. With a live coral cover of 34 %, the site has the highest coral cover among all the sites surveyed. Again coralline algae dominate over turf and there is little loose sediment. Fish life is abundant with a large number of grazers such as the surgeon fishes and planctonivores such as sergeant fishes.

Reef slope: The coral cover diminishes and many ascidians are present, accounting for 13%. The surface is quite rugged causing a lot of shadows to increase the unidentifiable points in the survey. Similarly as at site 5, rubbles and sand falls down the slope.

4.4.2.7 Site 7

Transect 1

Benthic cover of this area was dominated by dead rocks covered in a thin layer of sand. Only a few hard coral were observed along this transect; and all belonged to the genera Favia. Large number of Asidians; Diadenum molle (Commonly known as Sea quirts), were observed on the rocks. Figure 4.25 shows the typical benthic cover along this transect.

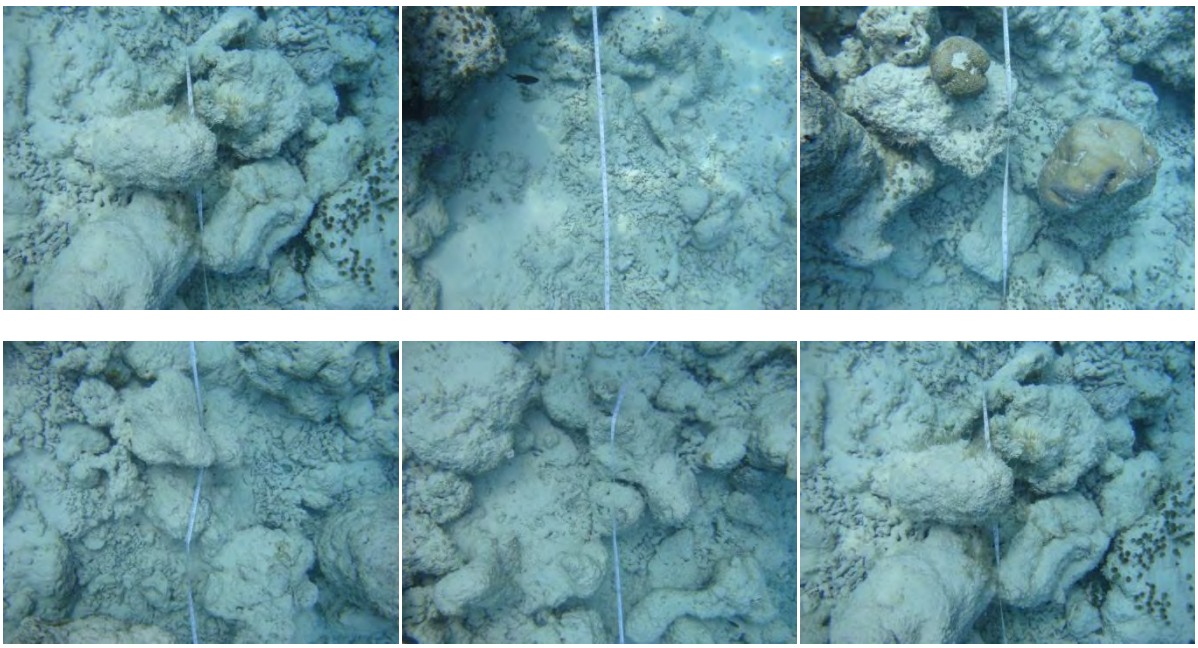


Figure 4.25 Selected photographs of the benthic cover along transect 1

The following bar graph (Figure 4.26) summarizes the benthic cover along the transect line. The live coral cover at this area is very low, only 7.5% of transect is covered with live hard coral.

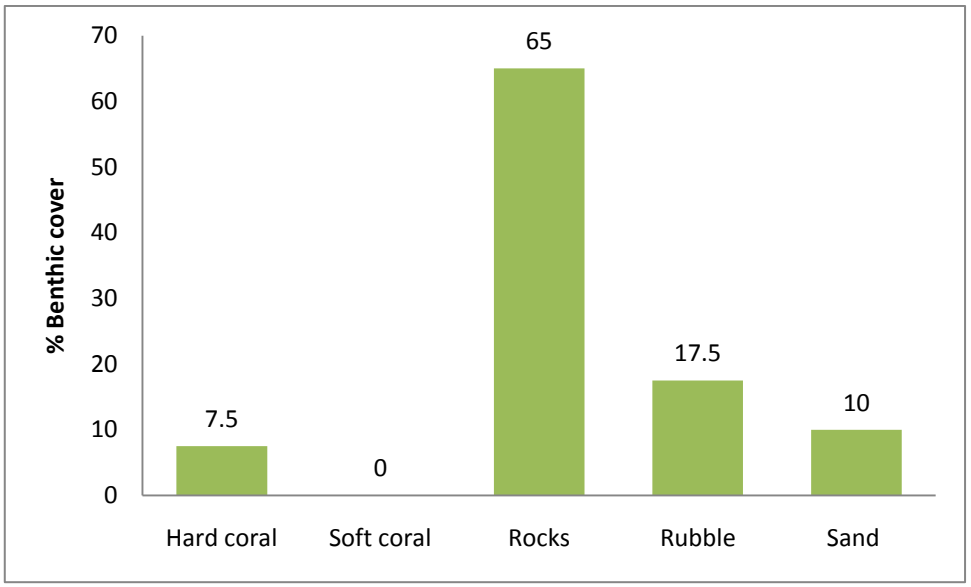


Figure 4.26Percentage benthic cover of transect 1 (11/1/2011)

Dominant fish species observed along the transect line are; Indian triggerfishes and Powderblue surgeonfishes. The following is a list of fish species observed along this transect line.

- Brown Butterflyfish – Chaetodon kleinni
- Spotted Unicornfish – Naso brevirostris
- Six bar wrasse - Thalassoma Hardwicke
- Indian triggerfish - Melichthys indicus
- Twotone chromis – Chromis dimidiate
- Bicolor chromis – Chromis margaritifer
- Powderblue surgeonfish – Acanthurus leucosternon
- Orange-lined triggerfish – Balistapus undulates

Transect 2

GPS location: 4° 10' 47.91"N, 73° 27' 16.56"E. Benthic cover of this area was dominated by sand, rocks and rubble. Live hard coral cover along this transect is also very low; and composed mainly of small colonies of Tubastraea micrantha, and Pocillopora. In addition to hard corals few soft corals were also observed along this transect that belonged to genera Sinularia and Sarcophyton. The photographs (Figure 4.27) below shows typical benthic composition along this transect line

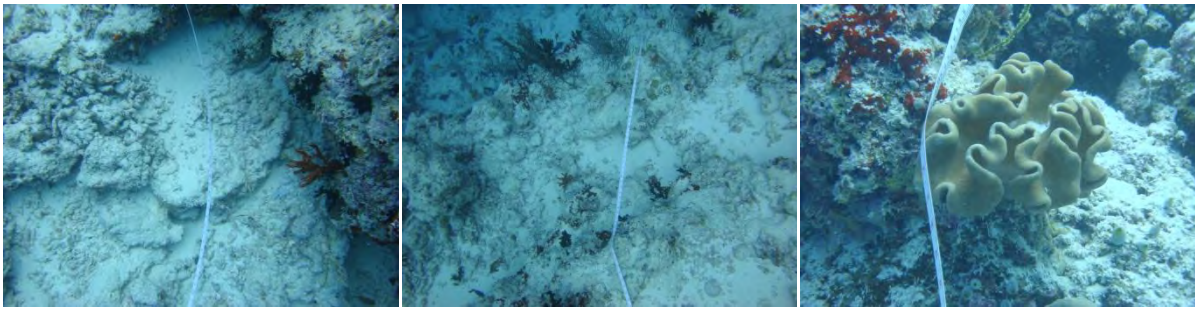


Figure 4.27 Selected photographs along transect 2

The following bar graph (Figure 4.28) summarizes the benthic cover along this area, it can be observed that the live coral cover along this transect line is also very low.

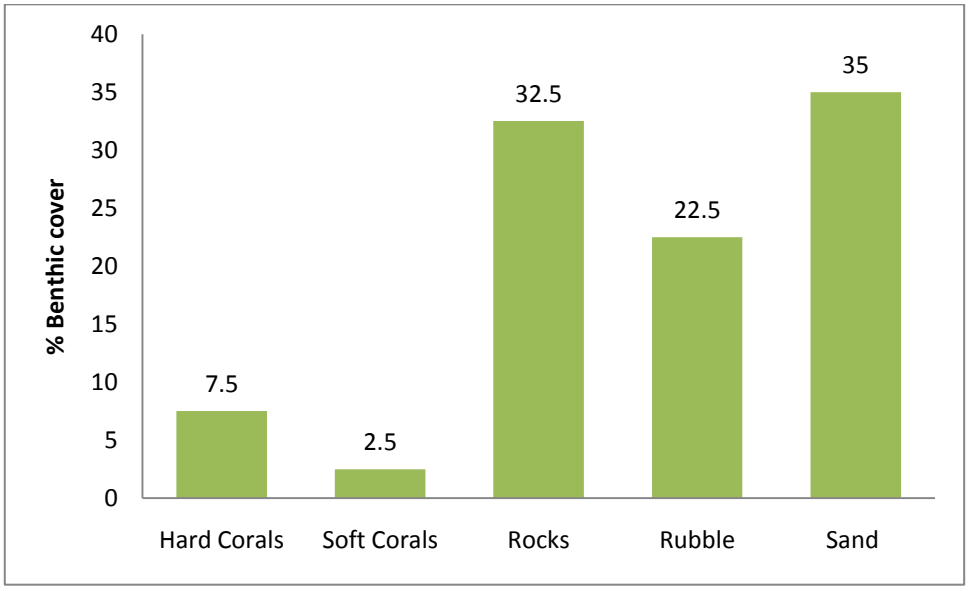


Figure 4.28 Percentage benthic cover at transect 2

Dominant fish species observed along this transect were Redtooth triggerfish (Odonus niger), The following is a list of fishes observed near the transect line.

- Spotted Unicornfish – Naso brevirostris
- Black Pyramid butterflyfish – Hemitaurichthys zoster
- Lined bristletooth – Ctenochaetus striatus
- Sergent major – Abudefduf vaigiensis
- Regal angelfish – Pygoplites diacanthus

4.5 Protected areas and species

In the Maldives there are 33 Marine Protected Areas (MPAs) of which 8 are located in the North Male' Atoll and 2 in the South Male atoll. The closest marine protected area to Gulhifalhu is Hans Hass place (04°10.5‟ N 73°28‟ E) located just south of the Gulhifalhu reef (Figure 4.29).

Figure 4.29 Location of Hans Hass Place

The MPAs in the North and South Male atoll are:

North

- Gulhifalhu Medhuga / Hans Hass Place
- Dhekunu Thilafalhuge Miyaru vani / Lions Head
- Giravaru Kuda Haa
- Gaathugiri / Banana reef
- Lankan Thila/ Nassimo Thila

- Thamburudhoo Thila / Girufushi Thila / HP Reef
- Rasfari Island
- Makunudhoo kandu
- Huraa Mangrove Area

South

- Embudhoo kandu
- Guraidhoo kandu

The areas have been chosen for a number of reasons such as their underwater beauty, fragility and their unique biodiversity.

A number of species have been protected in relation to the biological diversity convention. The marine protected species are:

- Napoleon wrasse (Cheilinus undulates)
- Lobsters (of the family Palinuridae)
- All marine sea turtles: Hawksbill (Eretmochelys imbricate) and Green turtles (Cheloniamydas) are the most common species in the Maldives.
- Conch (triton) shell (Charonia spp.)
- Black coral (Antipathes aperta)
- Giant clams (of the family Triacnidae)
- Whale shark (Rhincodon typus)
- Dolphins (of the family Delphinidae)
- Whales (of the order Cetacean)

Some of the protected species were observed in the waters around Gulhifalhu reef. This was the Napoleon wrasse, giant clams and conchs. Spinner dolphins were observed south of the Gulhifalhu reef.

In addition, 70 bird species (including5 species which are native to the Maldives) are protected under the Environment Protection and Preservation Act (Act 4/93 of the Maldives). These include Noddy‟s, Terns, Shearwaters, Frigate Birds, and the White-tailed tropic bird. The bird species living in the Maldives are Herons, Maldivian water hen and the Asian Koel.

Gulhifalhu is currently completely submerged and has therefore no beaches and no function as a turtle nesting area. Annex 6 gives an overview of the turtle nesting areas in the Maldives. The nearest location with recorded nesting sites lies in the Baa atoll.

4.6 Gaps in baseline information

4.6.1 Gaps in Information

The environment of Maldives is generally poorly understood. This may be due to the lack of detailed studies in the Maldives. Much of the literatures on coral islands are derived from studies done in the pacific which unfortunately has very different and climatic and geologic settings.

Detailed environmental analysis for an EIA is often required to be undertaken in a relatively short period of time. Give the seasonal climatic variations in Maldives and the differences in local geomorphologic and climate settings in individual reefs and islands such a short time frame is often too little to assess selected aspects of the environment. This problem is compounded by the absence of long-term studies in other parts of Maldives. Hence, most EIA's end up being based on an environmental snapshot of specific point in time. However, experienced EIA specialists can deliver a close match to reality based on a number of similar assessments.

In this regard, the following gaps could be identified in information.

- Absence of long-term site specific or even regional data (at least 2 years). Most critical data include current and wave history.
- Absence of historical and long-term records on reef and lagoon environment.
- Lack of detailed data on geology of the reef structure due to time limitation in EIA submission.

These gaps are seriously considered in the assessment and care has been taken to address the issue in designing mitigation measures and the monitoring programme.

4.6.2 Uncertainties in impact prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. As noted earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. However, the level of uncertainty is partially minimised due to the experience of land reclamation activities in similar settings in the Maldives. For example, Hulhumale', Maamigil, Vilufushi and GA. Viligilli. Nevertheless, it is important to consider that there will be uncertainties hence voluntary monitoring of natural processes as described in

the monitoring programme is absolutely essential.

4.6.3 Additional Studies

A detailed study of the currents around Gulhifalhu has not been executed during this ecological survey. A better understanding of the complex current system is needed in order to:

- predict plume dispersion during the dredging and reclamation works
- create an optimal design for the revetments and the need for groynes

Hence, a systematic monitoring programme for currents as outlined in the monitoring programme is required in the future. These data should be used for the preparation of the EIAs for remaining phases.

5 Description of Economic and Social Environment

The present socio-economic environment of Gulhifalhu is outlined in relation to Male', Villingili, Thilafushi and nearby resorts assuming their maybe implications from the project. Socio-economic changes caused by the establishment of Gulhifalhu Island cannot be evaluated at this stage because details of land leasing, types of industries and such information are unknown. Following sections provide a summary of the proximate socio-economic environment.

5.1 Villingili

Villingili is situated west of Malé, and east of Gulhifalhu, separated by narrow channels. Villingili, once a resort, is now a residential area with about 500 houses, catering for the increasing demand for space on Malé itself.

As for the number of inhabitants, the official figure is about 15.000, however the real figure is probably something like 9000/10.000; as the island is administratively a ward of Malé municipality, detailed statistics for the Island as such are not available.

As for the economy, the government (in the broad sense including services such as electricity) employs up to 250 people; a further 200 people are employed or have business in Malé, and shop keeping on Villingili with 3 bigger shops and about 40 small general purpose shops and other such activities as sewing, employs another 100 people. Three fishing dhonis provide for the local market.

The island has a complete range of services comparable to Malé with electricity (local generation) and desalination water plant, a school up to 7th grade with some 600 pupils, and medical facilities and the like. There are two restaurants that cater for residents.

5.1.1 Public Consultation at Villingili

See public consultations chapter.

5.2 Male'

Male' being the capital has a population of over 100,000 representing one third of the population of the country. This increase in population is Male' is due to heavy migration from the atolls. Male' is considered as the main gateway of the country. All the service related industries within the community include civil service, construction activities, retail and whole sale trade and cargo transport to other major international hubs. The main economic infrastructure include Male' International Airport and the Male' port. The key social infrastructure are 19 schools including two international schools, one power house operated by state-owned STELCO, and two hospitals, one government and one private. Two Schools teach up to grade-12. There are health clinics in the island operating privately. Male' also has the major dive schools of Maldives with the exception of dive schools in resorts.

5.3 Thilafushi

Thilafushi is located approximately 400 m from Gulhifalhu and 6.85 km from Male'. Although originally Thilafushi was a lagoon of about 3.5 km in length, currently it has a landmass of approximately 0.5 km^2. The primary purpose of reclaiming Thilafushi was to resolve the issue of waste on Male' and has been in use for landfilling for the last 18 years or so. Since 1997 the reclaimed land of Thilafushi is being utilized for industrial purposes. Current land use of Thilafushi includes cement packing, LPG bottling, boat manufacturing and warehousing.

As part of the waste management operations, the barge carrying waste travels between Male' and Thilafushi five times a day on average. During dredging and reclamation the transportation route of the barge will have to be detoured (see Public Consultations chapter). This will have cost implications to the waste management operations of Thilafushi.

5.4 Resorts

There are two resorts located in close proximity to Gulhifalhu. Kurumba Village is located 6.5 km north east of Gulhifalhu and Giravaru Island Resort is 5 km to the west of Gulhifalhu. Giraavaru has a bed capacity of 132 while Kurumba has a bed capacity of 362.

5.5 Potential for Development at Gulhifalhu

Gulhifalhu's future role follows from the above-mentioned economic conditions, in particular as related to Malé's congestion. Following is a per sector overview of activities with their relation and importance to the future Gulhifalhu development.

Table 5-1 GDP development per sector in the Maldives period 1998 - 2004.

Table A.1: Gross Domestic Product by Industrial Origin in Constant 1995 Prices
(Rf million)

Sector	1998	1999	2000	2001	2002	2003	2004[a]
Primary Sector	**578.8**	**599.1**	**595.2**	**625.5**	**724.8**	**740.0**	**765.3**
Agriculture	165.5	168.8	174.7	181.4	188.6	196.3	204.6
Fisheries	373.8	388.1	381.2	402.4	494.7	498.0	512.9
Coral and Sand Mining	39.5	42.2	39.3	41.7	41.5	45.7	47.8
Secondary Sector	**801.2**	**900.5**	**914.8**	**989.0**	**1,091.7**	**1,177.7**	**1,251.5**
Manufacturing	435.4	483.3	505.1	532.4	615.1	629.8	660.9
Electricity and Water Supply	156.4	178.5	203.9	226.3	247.6	273.0	290.6
Construction	209.4	238.7	205.8	230.3	229.0	274.9	300.0
Tertiary Sector	**4,493.4**	**4,798.6**	**5,084.5**	**5,205.4**	**5,448.8**	**5,988.9**	**6,298.4**
Wholesale and Retail Trade	270.4	278.9	287.8	288.9	295.6	308.3	323.1
Tourism	1,854.2	1,982.3	2,094.0	2,093.5	2,162.6	2,482.5	2,600.1
Transport and Communication	825.4	854.2	919.1	934.2	998.0	1,078.8	1,156.5
Financial Services	194.3	208.6	215.1	220.4	235.1	259.5	273.7
Real Estate	460.6	483.9	496.7	507.4	530.7	566.9	589.3
Business Services	166.1	178.3	183.9	188.4	201.0	221.9	233.9
Government Administration	590.5	677.8	750.7	833.0	883.9	906.8	975.4
Education, Health and Social Services	131.9	134.6	137.2	139.6	141.9	144.2	146.4
FISIM	(225.2)	(241.8)	(249.3)	(255.5)	(272.5)	(300.8)	
GDP in Constant 1995 Prices	**5,648.2**	**6,056.6**	**6,345.5**	**6,564.4**	**6,992.8**	**7,585.8**	**7,997.9**
GDP at Current Prices	**6,356.9**	**6,935.4**	**7,348.4**	**7,650.8**	**8,201.0**	**9,156.7**	**9,529.6**
GDP at Current Prices ($ million)	**540.1**	**589.2**	**624.3**	**625.1**	**640.7**	**715.4**	**744.5**

FISIM = Financial services indirectly measured, GDP = gross domestic product, Rf = rufiyaa.
[a] Projection.
Source: Ministry of Planning and National Development.

As for the role of the **Primary Sector** on the GF-island to be:

Agriculture has no role, apart from some fruit trees such as coconut and mango along the roads or in the residential area.
Fisheries, important as it may be on the national level, has no particular and certainly no direct business on GF-to-be.

As for the Secondary Sector:

Light manufacturing primarily for the internal (Maldives) market, will have an important place on GF island. This will include probably (but is not limited to): assembly of computer hardware, laboratory activities, other research, materials testing, other assembly activities, etc. Electricity supply: the State Electricity Company – Stelco - is to install further capacity to meet a growing demand; the Malé Power Plant presently has total capacity of 21.5 MW. With the construction of energy-intensive high-rise buildings and growing ownership of household equipment, the consumption of energy has been growing rapidly, the demand for electricity in Malé has been growing at a rate of 12% per year. Stelco is interested to relocate part of its current activities to Gulhifalhu and to set up new activities.

The **Tertiary Sector** provides the main reason and drive for the GF land development with transport and communication, in order to relieve the congestion at Malé port. The various projects include:

As for business services, a location for wharehouses is planned;
Services such as an international school, a shopping mall and a hospital have to be set up;
A luxury shop, to attract both tourists and residents, together with a 7-star hotel and a golf course;
Social housing and labourers quarters. Additionally luxury housing and accommodation for support staff, as far as those are not commuting from Malé is planned.

6 Stakeholder Consultation

6.1 Introduction

Stakeholder consultations were undertaken with the key stakeholders identified in the EIA for Phase I reclamation and those required by the ToR. One of the difficulties during consultations was the lack of information regarding the phases 3-4 of the project and the operations of phase 2. The consultations particularly focused on stakeholders that raised major concerns regarding the project during consultations for phase 1. The findings are presented below.

1.1 Key Stakeholders

The stakeholder consultation for this EIA was undertaken during the month of February 2011. The stakeholder consultation was undertaken through phone interviews, emails and meetings.

The major stakeholders consulted are as follows:

- Project beneficiaries
- Inhabitants of Villingili
- Divers Association
- Nearby Resorts: Giravaru, Laguna and Vaadoo
- National, provincial and atoll level government agencies

1.1.1 Project Beneficiaries

Phase 2 reclaimed land is planned to be for social housing and city block that provides amenities for residents. General public was interviewed on any major concerns that they may have. Opinions expressed are presented below.

- Overall the project is seen beneficial although most are not aware of the details of the project.
- None of those interviewed expressed concerned regarding reclamation of Gulhifalhu.
- People are keen on housing availability, some are interested in the option of land acquisition while others are interested in built housing units. However, preference seems to depend on offered financing schemes.

1.1.2 Inhabitants of Villingili

Consultation with the inhabitants of Villingili was conducted by both phone interviews and personal interviews. Altogether 10 interviews were conducted. The questions used in the interview followed the phase 1 consultation questions. The first questions were whether they knew about the project, what in general was their opinion and whether there were any issues - positive of negative - to be taken into account. The views expressed are presented below.

- About half of the people interviewed were not aware what the project was about. However, upon explanation most feel that the project is beneficial.
- One person expressed that the project is beneficial to citizen however the activities will cause damage to the reef and the environment in general. In addition, one person identified that the EIA will assess the damages and benefits.
- Among benefits the most highlighted was employment opportunities for Villingili inhabitants.
- One respondent also stated that some houses reported cracks on walls. This could have been during the development of the reef entrance channel.

1.1.3 Divers Association

The Vice President of the Divers' Association of Maldives (DAM), Mr. Azim Musthag was consulted as he participated in phase 1 consultations as well.

- DAM indicated that they have visited Gulhifalhu twice since phase 1 reclamation was completed. Observations show that reef in the area is overall good although some turbidity has occurred. They are not able to conclude whether the turbidity is as a result of the reclamation activities or whether due to current patterns. It is likely that both the project activities and the current patterns are causing the turbidity.
- The inner lagoon of Gulhifalhu is still being used for training purposes. Once phase 3 reclamation starts alternative sites will have to be seeked.
- Discharge of sewage in Thilafushi and Gulhifalhu channel is not seen as a major concern because the current in the channel is quite strong. However as the channel is quite narrow either Thilafushi or Gulhifalhu may experience problems of odour. Therefore it is important to pay attention to the design of the pipeline particularly the depth and length.

- DAM also advised that Phase 2 reclamation should implement use of silt screens to minimize sedimentation impacts on the reef.

1.1.4 Nearby Resorts

Giraavaru, Laguna and Vadoo was contacted to assess any major concerns that they may have regarding the project. Giraavaru is closed down for renovation. Management from Laguna and Vadoo was unavailable for discussions and emails were sent in order to provide them an opportunity to respond. Any major concerns expressed will be communicated to EPA should there be a response.

A summary of main concerns raised during phase 1 consultation is presented below so that these may be taken into account during phase 2 reclamation.

Dive sites & coral reefs

It was informed during the phase 1 consultations that MPA Hans Hass Place is not used more than once a year by nearby resorts. The reason stated for not using the Hans Hass is the travel distance and the quality of the dive site. Hans Hass Place is expected to be out of bounds with the reclamation of phase 3 and 4.

Waste & pollution

During phase 1 consultations, Giravaru Island resort was found to be facing a lot of problems from the presence of Thilafushi Island. Waste, bad odour, water pollution and flies were the main problems mentioned.

Giravaru is at present closed for renovation and therefore the resort management is not available to communicate any concerns.

Currents

Concerns regarding a shift in the currents resulting from the reclamation were expressed during consultation of phase 1. Although this was not viewed particularly as damaging, possibility for the need for coastal protection measures was discussed.

1.1.5 Government Agencies

Province Office

Mr. Ahmed Asheed, Deputy State Minister of Medhu Uthuru Province was consulted regarding the views of the Province Office on Gulhifalhu project. The Deputy State Minister's

views are stated below.

- The Province Office is aware of the project but not on the progress of the project.
- The Province will benefit from the project if some of the services provided within Male' can be given from Gulhifalhu so that not everyone has to travel to Male' for all types of services. However, these services were not specified by the Deputy State Minister.
- Main concern regarding the project is the incentive to migrate to Male' region. The Province Office does not encourage the migration of the Province Population to Male'. Since Gulhifalhu project involves housing this might encourage people living in other islands to migrate to Gulhifalhu. The concern is that migration to Male' region might hinder development in other areas of the Province.
- Province Office is not aware of any residents of the Province leasing land from Gulhifalhu. However, Province Office is of the view that people involved in industrial activities will be interested in learning about the opportunities at Gulhifalhu.
- The Province has many ongoing industrial activities being undertaken by businessmen. The Province Office would like to receive more information from the developer on the leasing of land for industrial activities.

Atoll Office

Mr. Hussein Abdul Rahman, Head of Atoll Office was consulted regarding the views of the Province Office on Gulhifalhu project.

- Male' Atoll Office is aware of the project and on the progress of the project. Information is mostly from media. There has not been any direct communication from the developer. The reason may be that Gulhifalhu is being developed as part of Male' region therefore it is under the jurisdiction of Male' Municipality.
- Given that Gulhifalhu is planned to provide land for industrial activities, it is expected that this will benefit the whole atoll.
- Overall the project is seen as a good project with socio-economic benefits for the atoll. There have not been any concerns raised regarding project activities by any of the inhabited islands.
- The project is expected to create employment opportunities especially for the Kaafu atoll population.

Ministry of Tourism, Arts and Culture

Ministry of Tourism was consulted in order identify any concerns that nearby resorts may have raised regarding the project. Miss Fathimath Jimzeena Musthafa, Environment Anaylyst, stated that no resorts have contacted the Ministry regarding any issues such as waste, erosion since the commencement of the Gulhifalhu project.

It is noted that during the phase one reclamation Mr. Moosa Zameer Hassan (Director – Ministry of Tourism) stated that the developer should make nearby resorts aware of this project. Further he mentioned that it is advisable to allocate some budgeted amount of money for site management or waste management.

1.1.6 Conclusion

It may be concluded from the consultations that the project is generally viewed as beneficial. There are expectations for employment opportunities from the project. Most stakeholders are resigned to the fact that the project will take place. There is a need for developer to communicate progress of project activities to key stakeholders.

7 Potential Impacts and Mitigation Measures

7.1 Introduction

The proposed development of Gulhifalhu is anticipated to cause significant detrimental as well as beneficial impacts. Impact identification (environmental/social/economic impacts) and mitigation measures were primarily based on literature reviews, professional judgment and past experience from similar projects.

For the purpose of this EIA, the chain of events linking activities to specific impacts and knock-on effects are represented in flowcharts to allow for easier interpretation. This is because the cause-effect relationship between a specific activity and its potential impacts are rarely linear and in most cases, a series of casual factors linked to different activities create the conditions that cause an impact. Two separate flowcharts were developed and organized to display logically the following sequence of events:

Activity → Casual Factor → Potential Impacts → Short Term Effects → Long Term Effects

Accordingly, Figure 7.1 and 7.2 below illustrates the flowcharts. The first chart will show the potential negative impacts of the proposed development activities during construction stage (dredging and reclamation stage) and the second chart will show the potential positive impacts expected to arise once the project is complete (operation stage). It should be noted that no potential positive impacts could be identified for the construction stage of the proposed development activities.

7.2 Uncertainties in Impact Prediction

In the EIA process of the Maldives, uncertainties in impact prediction generally arise due to the lack of long term data, limited timeframes to complete EIAs and lack of standard procedures to collect data leading to inconsistent methodologies used by the various EIA consultants. Such issues are mainly linked to the lack of importance given to the EIA process in strategic planning and initial stages of development projects. Typically in the Maldives, EIAs for major

development projects are only done after development activities and project locations are finalised. This gives the EIA consultants limited time frames to conduct a comprehensive impact assessment.

Accordingly, the uncertainties in impact prediction for this particular EIA are due to the time constraints in data collection and due to the limited amount and type of data available for measuring or predicting impacts.

Potential negative Impacts from Dredging and Reclamation of Gulhi Falhu

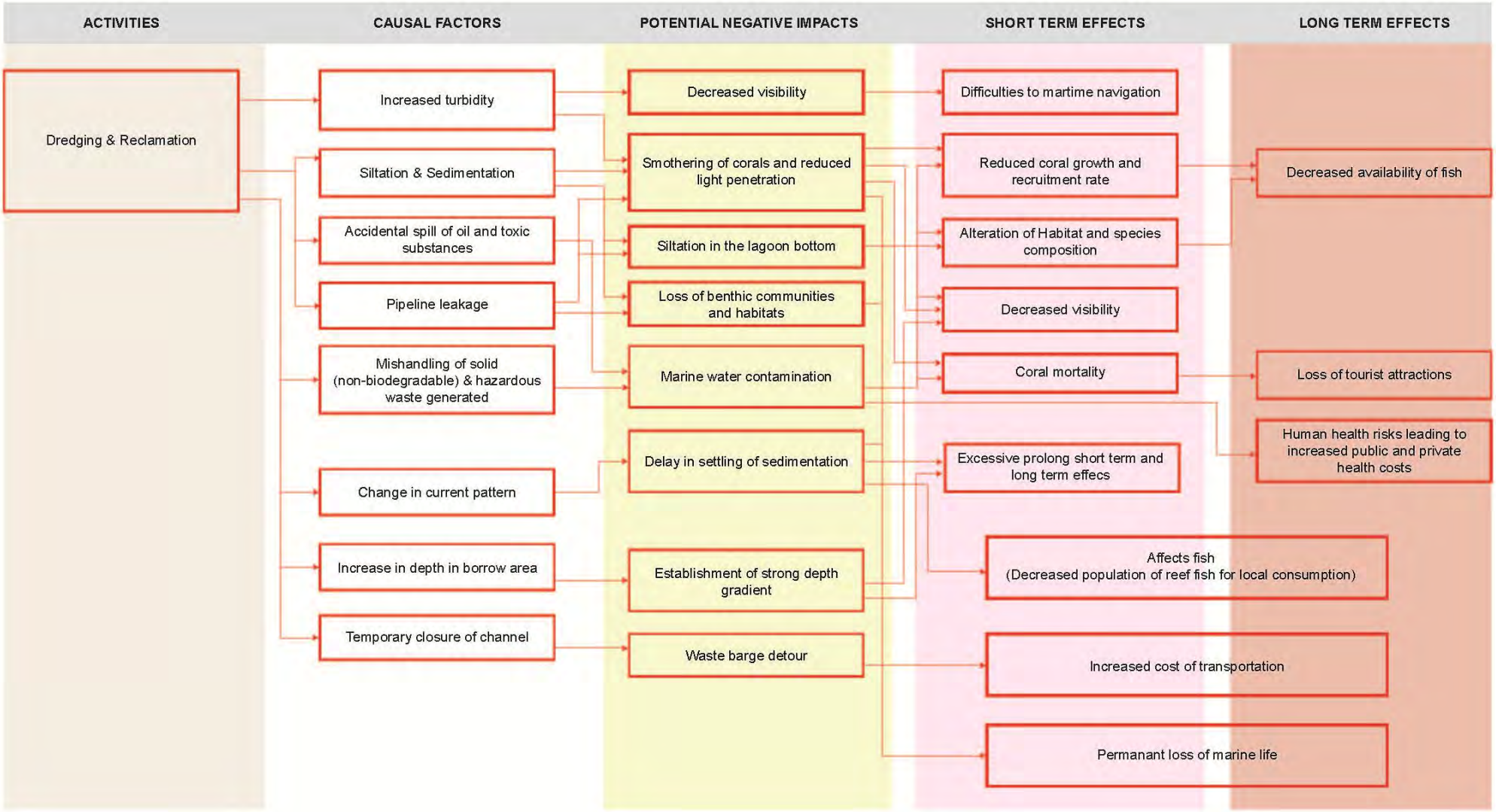


Figure 7-1 Potential negative impacts during construction stage

Prepared by: CDE Consultancy

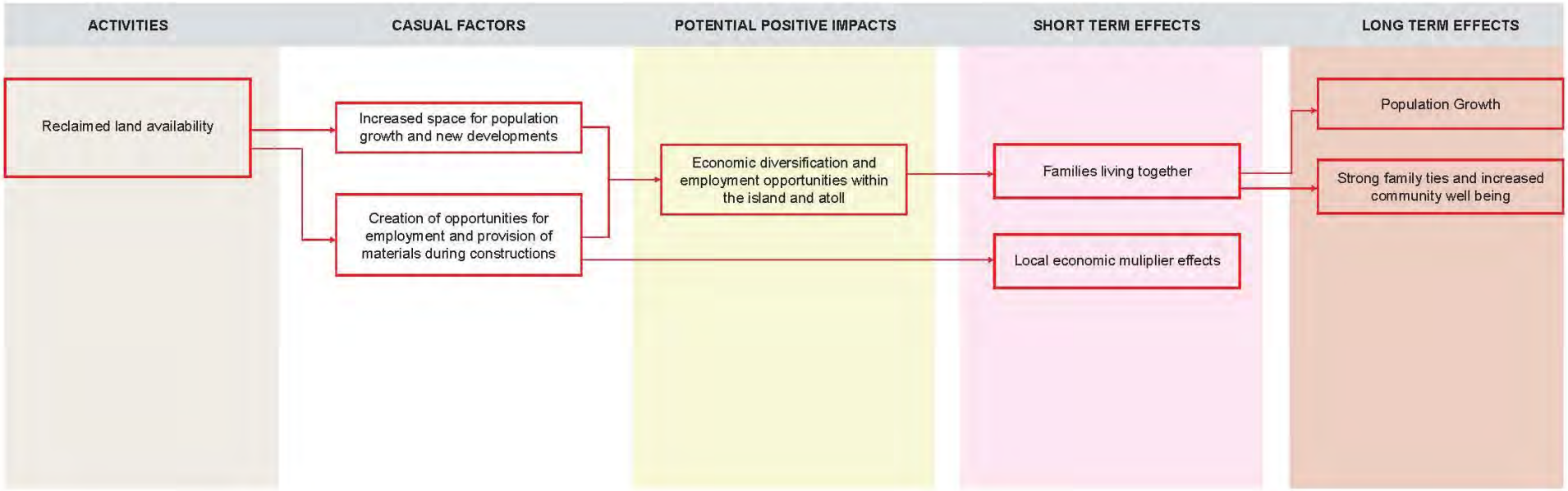


Figure 7-2 Potential positive impacts during construction stage

7.3 Brief Description of Potential Impacts and Suggested Mitigation Measures for All Adverse Impacts

This section will provide a brief description of each of the potential impacts illustrated in the flowcharts of Figure 7.1 and suggest appropriate mitigation measures for all potential adverse impacts. Similar to the flowcharts, firstly potential negative impacts and mitigation measures during the construction stage will be described. This will be followed by descriptions of the potential negative impacts during the operation stage. Finally all potential positive impacts will be discussed.

7.3.1 Potential Adverse Impacts on Natural Environment

The potential significant impacts from the project are summarized below:

- Potential damage to lagoon benthos and fish population due to turbidity and sedimentation from reclamation activities
- Potential water contamination (Marine Water and/or Ground Water)
- Noise and air pollution
- Potential impacts to the existing land form (10 hac)
- Cumulative impacts to natural habitats
- Alteration of current flow and patterns, visual amenity and navigational patterns

7.3.1.1 Sedimentation

During dredging and reclamation works as well as construction of revetments, a significant amount of siltation and sedimentation of the water column is anticipated. Also increased turbidity of the water column is expected.

These factors will cause adverse impacts such as smothering of corals and reduced light penetration to the coral and benthic communities. As corals have a self cleansing mechanism and can withstand a certain rate of sedimentation, detrimental impacts such as reduced coral growth and recruitment rate and decreased visibility can be short term effects. However if the sedimentation exceeds the rate at which corals can self clean, then it may lead to serious detrimental impacts such as coral mortality and alteration of habitat and species composition within the Gulhifalhu reef and the surrounding area. Figure 7.3 illustrates the possible area of direct impact of the proposed project.

The suspension of sediments and the effects on the coral reefs will mainly depend on the grain size distribution, the local currents and the distances to the coral reef areas.

The proposed borrow area is located just north of Gulhifalhu, on the side of the reef with the lowest percentages live coral cover. The closest reef structures to the north, east and west are located more than 2.5km away. To the southeast, Villingili is 1.5km away, and to the southwest, Thilafushi is 1.25km away. The nearest resorts are more than 5km away, well outside the potential area of influence.

Depending on the monsoon season, the reef structures to the north and northeast may, under severe conditions during the southwest monsoon, be impacted by the suspended sediments generated at the TSHD borrow area. During the northeast monsoon, Villingili and Thilafushi are likely to experience some increase in suspended sediments. These impacts are temporary, and will disappear within a few days after the dredging works have ended.

The suspended fine sediments may get caught up in the Southern currents occurring in the area. These currents would tend to carry any suspended sediments over coral reefs at the northern section of the atoll. It should be noted that the reef in this area is in a relatively poor condition when compared to the reef in the southern side of the atoll and, therefore, the possible impacts of sedimentation and turbidity would not be as severe as it would be in the case of healthier reefs.

It must be taken into account here that the current status of the coral on Gulhifalhu reef is not significantly healthy and the trend in the last few years has shown a decline in quantity and diversity. According to the Divers Association Maldives, nearby resorts and local dive centers this declining autonomous trend in species abundance and biodiversity is due to the impact of Thilafushi and fishing.

Fish population is often affected when their gills are stuck by suspended sediments. There will be loss of habitat for a large portion of the juvenile species. Most species will stay out of the harm's way by moving to safer areas of the lagoon. However, the juveniles may lose their habitats and this may affect the fish population in the short term.

Given that the existing environment had been intensely modified by previous reclamation activity of Phase I, the sedimentation impacts of the proposed reclamation in phase II will have cumulative impacts. Areas that are recovering from sedimentation related damages both in the borrow and reclamation area will affected again with potentially terminal effects on some micro habitats.

Therefore, it is vital to take proper mitigation measures to avoid siltation, sedimentation and turbidity as much as possible.

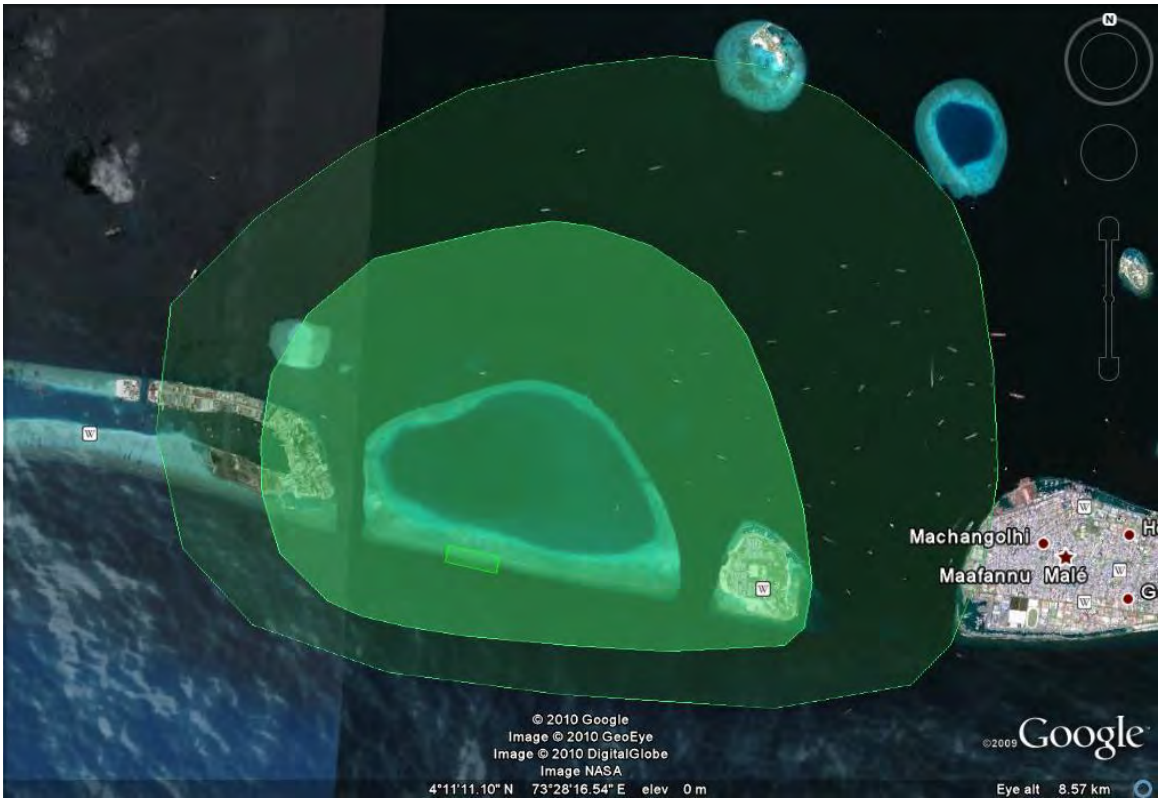


Figure 7-3 Possible area of impact due to sedimentation

Possible area of direct influence (bright green, temporary increase in suspended sediment concentration during dredging and reclamation works) and less direct influence (darker green, short term reduction of visibility during storm events) of suspended solids released from the proposed borrow area and the reclamation area under worst case conditions.

Mitigation measures

- The methodology adopted by the contractor is TSHD. This method involves reduced sedimentation in the receiving area as the dredged material will have less fine sediments. As a result there will be no significant impacts to the coral patched near the receiving area.
- Use silt screen on the southern side of the reef system to contain sediments from flowing on to the outer reef slope. This measure is particularly critical in the NE monsoon. On the northern side, sand bund wall shall be used to contain sediments.
- The projects should be completed in as short period as possible and the work should be carried out during outward drift of current so that sediment settling on the reef would be minimised. It is best to carry out the work during low tide and in calm weather conditions

to minimise spread of any sediment plume.

- Choice of location of the TSHD borrow area away from coral reef, coral patches, marine protected areas, dive sites and resorts
- Use of TSHD as a dredging method avoids dredging an entrance channel for the dredger to be able to reach the reef lagoon.
- The project manager, and the work force involved during the operation of the work should be briefed of environment friendly practices.
- The work should be properly supervised and monitored to minimise any adverse effect on the environment.
- The marine environment should be monitored for sedimentation and siltation stress and possible impacts on the biological aspects such as bottom benthos. This is further outlined in the monitoring programme given in this EIA report

7.3.1.2 Water Contamination (Marine Water and/or Ground Water)

- During the reclamation of Phase II at Gulhifalhu, any accidental spill of oil and toxic substances will contaminate the marine and/or groundwater.
- Waste water, oily waste water and solid waste that will be produced during the construction stage will contaminate the marine and /or ground water if they are not managed properly.
- The ground water is the newly reclaimed area is completely saline. And it is not known when the ground water will reach to an acceptable quality. However vehicles will be used in these processes and some of these vehicles will be located, on the existing land form. This may lead to accidental oil spillage and may lead to contamination of the ground water.
- In the Maldives, groundwater contamination is an irreversible impact due to the absence of impermeable layers to separate the freshwater lens in independent reservoirs. Accordingly, any point sources of pollution would cause the contamination of the entire island groundwater resources. If human consume such contaminated groundwater, it may lead to serious health risks leading to increased public and private health costs. Therefore, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Mitigation measures

- All the vessels used in construction will be equipped with waste water and solid waste handling facilities to collect and handle the waste water and the solid waste generated by each vessel.
- No waste or waste water will be disposed into the sea.

- Oily wastewater, oily contaminated material generated from the construction machinery during the construction activities and solid construction waste generated during offshore construction works will be collected and transferred back to on shore for treatment/disposal, to avoid any adverse impact on the marine environment.
- Construction activities will be carried out under the supervision of a suitably experienced person.
- Vessels and machinery used for the work should be properly maintained at all times during the operation to prevent leaks.

7.3.1.3 Loss of marine bottom organisms and habitats

The potential impacts due to the actual dredging procedure are considered to be of high significance at borrow area. Lagoon bottom is a habitat for certain organisms such as worms, mollusks, amphipod etc. which are important food sources for bottom feeders such as certain species of fishes. For the reclamation, sand will be mined in the seabed in the atoll lagoon to a depth of 1 meter or less by a TSHD. It is estimated that an area of 2,000,000 m^2 will be affected in the first phase of the dredging through direct removal of benthic communities and habitats and disturbing habitats of lagoon bottom organisms. However, it has been found elsewhere that lagoon bottom dwelling organisms re-establish within few months after such disturbances. Direct removal of hard bottom substrate for dredging can result in loss of habitats for fish, and other benthos.

The land reclamation to enlarge the island will result in a permanent loss of marine habitats and resources. However, the land reclamation is limited to the shallow reef area and will not destroy the coral reef areas at the reef slopes at the lagoon side and the ocean side. The reef flat itself is of low ecological value.

7.3.1.4 Noise, Vibrations and Air Pollution

- Dredging and reclamation works will continue 24 hours per day.
- Experience from the projects at Viligili and Vilufushi has shown that the dredge (in those cases a CSD) cannot be heard on the island while it is working. Distance from the island to the dredge varied from 500m to 1500 m. A TSHD generates a similar amount of noise while pumping material ashore as a CSD, so no noise impacts are expected from the dredges.
- At the reclamation area, bulldozers, excavators etc will be working non-stop. This will generate some noise, but it is unlikely that this noise will be heard on Villingili during NE monsoon. During north eastern and eastern winds, some noise may be heard on the east side of Thilafushi when reclamation takes place at the west site of Gulhifalhu.
- Due to the open nature of the working areas, air pollution is assumed to be minimal.

Since the dredging activities take place entirely in a wet environment dust problems will not be encountered during dredging and reclamation.

- With proper mitigation measures, it is unlikely that noise and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs. Nevertheless, mitigation measures will be undertaken to ensure that air pollution and noise will be minimised.

Mitigation measures

- All construction works will be carried out during day time to minimise nuisance to the local community and disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.
- All vehicles and machinery will be tuned and well maintained to minimise air pollution
- To minimise dust from land mass, it will be kept damp.

7.3.1.5 Impact on Unique Habitats

The proposed dredging and reclamation works is anticipated to cause significant detrimental impacts on the dive site Hans Hass Place (Kiki reef) which is located just south of the Gulhifalhu reef. This dive site, which is a declared marine protected area, is well known for the presence of a large variety of fish species. It is reported that the dive sites around Maamigili were significantly affected due to dredging and reclamation activities carried out in Maamigili. Since Gulhifalhu area is a similar setting, it is expected that behavior of some of the fish species will be significantly affected and might move away from the dive site and most turbid zone around the reclamation area permanently.

Phase 2 reclamation is expected to cause irreversible detrimental effects to Hans Hass Place. Therefore, a more detailed impact assessment needs to be undertaken as part of the EIA for Phase 2.

The impact on corals on the steep slopes is considered relatively small due to their orientation. The amount of live and healthy corals on this dive site is also relatively limited compared to other dive sites and has decreased significantly over the last years.

The Divers Association of the Maldives has been consulted on the subject.

Mitigation measures

- As mentioned in the earlier section, it is recommended to study whether it is technically possible to place silt screens between the reclamation area and the Hans Hass Place and if

this will have an added value to the protection of the coral reef by studying the local current pattern in the area.

- If it is technically possible, silt screen will be used between the reclamation area and the dive site during phase 1 and 2.
- Suspended sediment levels at the Hans Hass Place MPA and nearby dive sites will be monitored as part of the water quality monitoring program described in chapter 9.
- It is proposed that a new area is declared as a Marine Protected Area by Environmental Protection Agency to compensate for the decline of Hans Hass protected area.
- Coral transplantation on a pilot scale to compensate for coral loss as a result of the Gulhifalhu project could be considered as a compensation measure after completion of the project. The transplantation has to add value to the location of the reception area and not cause any loss to the donor area. The transplantation pilot will be a small scale project and will have to be financially feasible.

7.3.1.6 Potential impact to the existing land

- The phase I reclamation was done in fourth quarter in 2010. The area that was reclaimed was 10 ha. The characteristic of this land mass was described in existing environment. The reclamation and construction work of Phase II would lead to some changes in the Phase I land.
- Phase II area is adjacent to the existing land and it would be continued from south eastern side of the existing land. This would modify the coastline of the existing land. There may be extensive erosion in the unprotected sections of the southern and northern side of the existing island.
- This will alter the recently established coastal dynamics around the island.
- The potential impacts to Phase I reclaimed area are unavoidable. However, necessary mitigation measures would be taken to reduce the impacts of erosion and other significant geological changes.

Mitigation measures

- Plantation of the tree species like kuredhi, magoo and other coastal vegetation in the area prone to extensive erosion. Impacts from this landscaping and coastal vegetation should be covered in a separate EIA for development, construction and landscaping in Phase II land.
- Creation of bund walls along the coastline where there is extensive erosion. This makes sure that the beach is retained and reduces the erosion process during and after the completion of reclamation in Phase II.
- The projects should be completed in as short period as possible, to reduce extensive

changes or modification in the existing land mass.

- The project manager, and the work force involved during the operation of the work should be briefed of environment friendly practices.
- The work should be properly supervised and monitored to minimise any adverse effect on the environment.
- The beach/or coastline environment should be monitored for erosion level. This is further outlined in the monitoring programme given in this EIA report.
- The replanting activities on the newly reclaimed land should consider natural profiling of vegetation. Coastal vegetation should comprise of species such as kuredhi and magoo and the larger trees should be placed inland rather than on the coastline.

7.3.1.7 Impact on Current Patterns

No study has been done on the impact of dredging and reclamation on the local current patterns in the Maldives. However, experience from similar dredging and reclamation projects in the Maldives, such as Hulhumale', suggest that such activities may result in stronger current pattern in the impacted area. Based on this, it is anticipated that the local current patterns around the Gulhifalhu area is likely to get stronger. Due to lack of baseline data of the area, the extent of this impact is not known.

Mitigation measures

As mentioned in the previous section, it is recommended to study the local current pattern in the area to gather sufficient baseline information and undertake further studies to test the impacts of dredging and reclamation on the current pattern in the area before the second phase of the proposed dredging and reclamation commences.

7.3.1.8 Impact on Visual Amenity

The natural character of the vicinity of the proposed development has been already affected by the presence of the waste management site in Thilafushi. The proposed project will affect the amenity value of this area by developing a natural reef area to some extent. It is considered that any adverse effects of the proposed development on natural character and visual amenity of the area are likely to be minor.

Mitigation measures

- Complete the dredging works in the shortest time possible.
- Landscape the reclaimed land to provide a feel of a coral island of Maldives

7.3.2 Impacts on the Socio-economic Environment

7.3.2.1 Impact on Fishing Activities

- No significant economic impact on commercial fisheries sector in Male' Atoll is anticipated from the proposed development.
- Gulhifalhu reef is known to be a recreational reef fishing area for nearby islands (Vilingili and Male'). However, fishing is not allowed in the marine protected area Kiki Reef.
- Dredging and reclamation will restrict fishing activities from the area temporarily for about one week. In addition, fishing will also be affected in the short term as fish population is expected be decreased due to sedimentation and habitat loss. These effects may also continue medium term on a lesser degree of significance. The effects of increased suspended sediments will mainly be limited to within 500-1000 m from the reclamation run off point and the borrow area. Fishing for bait fish will still be possible at islands and reefs located 5 km or more away.

Mitigation measures

See mitigation measures for sediment control.

7.3.2.2 Impact on Navigation of Boats

- Gulhifalhu reef passes are used as a direct route by the barge transferring waste from Male' to Thilafushi. During the dredging and reclamation of Phase II, vessels transferring waste will need to take an alternative route which increases travel time by ten minutes each way. The current transport route through Gulhifalhu may not be available in the long term when Phase 3 and 4 are developed.
- The waste transfer barge makes ten trips daily requiring additional two barrels (400 litres) of fuel per day for the addition travel time. This is estimated to cost an additional 5000 Rufiyaa per day. This cost will be borne by the Government as it is a municipal service.
- Marine traffic might be affected by the dredging and reclamation activities. Dredging activities in the borrow area can temporarily increase the turbidity in the water making visual navigation around the shallow reefs difficult. However, the effects will be temporary and alternate routes can be taken by vessels without significant additional costs.

Mitigation measures

- Use of navigation aids around shallow reefs when visual navigation is temporary impossible in order to prevent groundings.
- Announcements on radio and news papers giving information on temporary navigational

disruptions.

7.3.2.3 Impact on Tourism

As discussed in the previous sections, a marine protected area Kiki Reef, located less than half a kilometre from the proposed reclamation area of Phase 1, will be significantly affected during the construction activities due to sedimentation. This will be a significant impact on tourism industry as many divers use Kiki Reef dive site. Most significant impact will be short term, however, this impact is likely to continue long term on a lesser degree of severity.

There are two resorts located in the vicinity of Gulhifalhu within north Kaafu atoll. Giraavaru is located approximately 5 km north west of Gulhifalhu while Kurumba Maldives is located about 6.7 kilometres on the north east of Gulhifalhu. In addition, Vaadhoo (5.58 km) and Velassaru (6.32km) are located to the south of Gulhifalhu across Vaadhoo Kandu in south Kaafu atoll.

The proposed construction works may affect aesthetics of the area which will be seen when landing aircrafts at Male' International airport and during transfer to the resort. However, the construction activities of Phase 1 will last for approximately one week.

As discussed in the previous section, aesthetics of the area will also be affected in the long term from the developments. This impact is not likely to be significant since the urban centres of the country are already located in the close vicinity of the project site.

Mitigation measures

See mitigation measures in visual amenity.

7.3.2.4 Impacts on Employment and Income, Potential for Local to have Temporary Job Opportunities

It is expected that approximately 30-50 jobs will be available for interested locals with relevant skills. These jobs will be for a period of 7months.

7.3.2.5 Level of Protection against Natural Hazards

Taking into account the presently occurring water levels, the predicted sea-level rise, and the relatively high-value industries and services that Gulhifalhu land-development will potentially cater for, the finished level of the reclaimed land will be +1.5 m MSL.

It is noted that most of Malé and the other inhabited islands in the Maldives are at +1.0 m MSL to +1.4 m MSL; so called "Safe Islands" are presently constructed at +1.4 m MSL

7.3.2.6 Impacts on Housing, Conflicting Policies, Demographics and Transportation in the Male Urban Area

There is not enough information on the operational stage of Phase II and the remaining phases to determine the socio-economic impacts. This EIA deals only with the construction stage impacts of Phase II. Additional EIAs are required for the operational stage of Phase II and the remaining phases of the project, once detailed project designs are available.

7.3.2.7 Impact of Noise, Risks and Pollution on Workers and Local Population

The contractor, Royal Boskalis Westminster nv, has ISO 9001, ISO 14001 and OHSAS certifications. The requirements of these certifications are met through company-wide Safety, Health, Environment and Quality system (SHE-Q), which provides clear procedures for safety, health and environmental management both at offices and project sites around the world.

Boskalis applies the same SHE-Q standards at all its projects around the world and to all its employees and subcontractors. These standards meet Dutch and international OHSA and environmental requirements, and are adjusted if a client has even more stringent requirements.

Dredging vessels used for the project are IMS certified and will meet international standards for waste, hazardous materials and sewage management, and fire, oil spill and other emergency response and prevention. Hence, the impact of noise, accidents and pollution on workers is expected to be minor.

Experience from the projects at Vilingili and Vilufushi has shown that the dredge (in those cases a CSD) cannot be heard on the island while it is working. Distance from the island to the dredge varied from 100m to 500m. A TSHD generates a similar amount of noise while pumping material ashore as a CSD, so no noise impacts are expected from the dredges.

At the reclamation area, bulldozers, excavators etc will be working non-stop. This will generate some noise, but it is unlikely that this noise will be heard on Villingili. During north eastern and eastern winds, some noise may be heard on the east side of Thilafushi when reclamation takes place at the west site of Gulhifalhu. Therefore the impact of noise on local population is temporary and is likely to be minor.

7.3.2.8 Impact on Local Population (Social Values, Norms and Beliefs) due to Presence of Workers of Dredging Company

It is not anticipated that the social values, norms and beliefs of local population will be affected due to the presence of workers of dredging company since majority of the workers will be onboard the TSHD vessel while the rest will be housed in existing land on Gulhifalhu.

7.4 Brief Description of Potential Positive Impacts

The proposed reclamation has its positive impacts even though it has some environmental impacts. However, as mention above the environmental impacts could be minimized by adopting appropriate mitigation measures.

The major positive impacts from the project include availability of land area near Male'. This reduces the pressure on the land prices, thereby reducing the land value in the capital city thus elevating poverty within the region and at broader level with the country. The availability of land would trigger the population to migrate from the highly populated Male' for more space and quality life. The Gulhifalhu project has an objective of allocating land zones to lighter and heavy industries. This will lead to transfer of existing light and heavy industries in Male' to Gulhifalhu, resulting in relive to the ethical and social problems in the capital city.

The project also increases the Government revenue thus achieving government target to be more sustainable. Meanwhile project creates numerous economic activities to prosper the development of Maldives as country. This is closely related to the revenue that government generate by leasing out the shallow lagoon area to develop as Gulhifalhu. This allows employment opportunities for the unemployed people of the country, particularly the ones who travel across the nation to hunt for jobs with better rewarding jobs.

This creates a liveable environment that ensures strong social ties and wellbeing of the community. Moreover the whole project has close links to the current government Strategic Action Plan and its five major pledges. This project will have direct positive impacts to affordable housing, affordable living cost.

7.4.1 Affordable Housing

Over a third of the country's population resides in Malé making it one of the most densely populated cities in the world. The Government aims to address the housing situation in the capital Male' and other urban centres through increasing housing delivery through public-private partnership schemes and improving affordability through housing finance schemes.

This project will contribute to this pledge of the as the project involves allocating zone for housing plots, flats, apartment, condominiums.

7.4.2 Affordable Living cost

As the country is heavily dependent on imports (especially food and energy) and highly susceptible to external shocks, achieving price stability is a major challenge. The government therefore has initiated efforts to control inflationary pressures through prudent fiscal policies and plans including the shift to direct taxation and the introduction of expenditure reduction measures.

This pelage of the Government will be also taken care and will have positive results. This is mainly because the island allocates land for the light and heavy industries and also zone out land for storage facilities. When the storage of goods within the Maldives is adequate, will guarantee the supplies of goods are safe hence cost of living will come at affordable level.

7.5 Cost of mitigation measures

Table 7-1 Costs of mitigation measures

mitigation measure	Costs
Use of TSHD to avoid making of entrance channel	Project cost
TSHD borrow areas away from coral reefs, coral patches, Marine Protected Areas, resorts and dive sites	NA
Conduct reclamation work during low tide and in calm conditions to minimize spread of sediment plumes.	NA
All machinery will be properly tuned and maintained to minimize pollution (both air and marine environment)	US$5000
Use of limited overflowing when dredging sand from the atoll seabed by TSHD	Project Cost
Use of navigation aids around shallow reefs to prevent grounding	Project Cost
Place silt screens between the reclamation area and the Hans Hass Place	US$ 15,000
Technical studies on impacts of current patterns due to dredging and reclamation process	US$ 8,000
Coral transplantation on a pilot scale for compensate for coral loss as a result of Gulhifalhu project.	US$ 6,000
Appointment of a new Marine Protected Area by Environmental Protection Agency (EPA) to compensate for the decline of Hans Hass ecosystem	US$8,000

8 Alternatives

8.1 Introduction

This section looks at alternative ways of undertaking the proposed project. Firstly, at the broad level there are two main options to undertake the project: (1) undertake the phase II of the project or (2) not undertake phase II of the project. The environmental evaluation above has been conducted in view of the latter and this section will explore the no project option.

8.2 No Project Option

The no project option for phase II takes the following into account.

- The existing reef remains with no additional damage from reclamation activities other than those from phase I activities.
- No further coastal impacts are felt on phase I reclamation site
- Housing congestion in Male' will remain as it is.
- The reclamation will not be relocated in any other reef flat or any other island in the atoll and the project will be abandoned.

The advantages and disadvantages of the no project option are discussed in Table 8-1 below.

Table 8-1 Advantages and Disadvantages of the No Project Option

Advantages	Disadvantages
– Environmental problems related to development can be avoided. Absence of reclamation activities keeps the lagoon and reef in good health; – Ensure the protect reef Ki ki Reef not further disturbed and damaged from project activities – No development costs to the Proponent	– The location remains economically stagnant and the opportunity cost on Maldivian economy is very high. – Loss of business to the Proponent – Loss of government revenue – Political and social problems due to lack

Advantages	Disadvantages
– The proponent avoids a high probability of bearing costs associated with highly probable future erosion and flooding – No economical losses to the Waste Management Centre to run Thilafushi barge – Reduces the possibility of over-supply of land in Male' region with the proposed reclamation in Thilafushi	of employment and economic development opportunities – Increase of ethical and social problems within the Male' and greater Male' area due to congestion. – Increase in high land cost for Male' and grater Male' region – Rise in cost of the living – Negative impacts from dredging and reclamation activities in Thilafushi will continue to affect Gulhifalhu regardless of the abandonment of Gulhifalhu project.

Despite the environmental disadvantages of the no project option, the socio-economic benefits are too numerous for this project to be undertaken. The modern day mitigation technologies if followed properly as prescribed in this document will ensure negative impacts are managed efficiently, when implemented properly.

8.3 Alternate Location

The project involves reclamation Phase II in Gulhifalhu. There is an alternative to transfer the reclamation activities to other areas designated for phase II of Hulhumale' reclamation or another reef system. However, investments have already been made in Gulhifalhu project, including reclamation of a 10 Ha area and sale of land. All the necessary logistics have also been arranged to go ahead with the project. Hence, alternative location is not an option because the contractor has already invested money to develop the entire Gulhifalhu and necessary paper work is also completed for the investment.

8.4 Alternate dredging options

The project requires up to 1 million m^3 of suitable fill sand for phase 1 and 2. The possible sources of fill material are the following:

- Option 1: Sand from the reef lagoon area to be dredged by a CSD (Cutter Suction Dredger) with a pipeline system; this option is an attractive alternative both from an economic and an environmental point of view, provided there is enough sand of sufficient quality available in the reef lagoon.
- Option 2: Sand from the seabed of the atoll lagoon just north of Gulhifalhu, to be dredged by a TSHD (Trailing Suction Hopper Dredger); this is a realistic alternative depending on the water depth of the seabed in the atoll lagoon, and the available quantity of sand within the atoll lagoon. Sand mining in the atoll lagoon can be done by a Trailing suction hopper dredger. As the water depth is between 20 – 80m, a large TSHD is required. This option has already been used in phase I.
- Option 3: Sand and coral material from a coral reef elsewhere in the Kaafu atoll to be dredged by a CSD; will cause considerable damage to the environment.
- Option 4: Sand imported from overseas by a jumbo trailer (very large trailer); will result in very high costs.

Dredging with a CSD at the reef lagoon area means that an access channel into the Gulhifalhu reef lagoon needs to be dredged. Where this channel is dredged, most likely on the atoll (north, east or west) side of Gulhifalhu where live coral cover percentage are low (between 0-10%), coral reef communities will be destroyed. On the other hand, the total area of seabed directly impacted by dredging is smaller when using a CSD than when using a TSHD.

Working with a TSHD in the atoll will generate a source of suspended sediments in a location further away from Gulhifalhu. This will cause temporary impacts on both the environment as well as on navigation. Although the TSHD will dredge away from coral reefs and patches, the benthic fauna living on and in the seabed at the borrow area will be affected. The benthic fauna will, over time, recolonise the seabed at the borrow area. In addition, this method has been successfully used in Phase I.

Working with a CSD elsewhere in the atoll will cause damages to the life organisms at a second reef and coral patches.

The costs of dredging overseas with a jumbo trailer will be very high.

The possible alternate methods and locations for acquiring suitable fill material for reclamation are as follows:

Options	**Pros**	**Cons**
1: Sand from the reef lagoon area to be dredged by a CSD (Cutter Suction Dredger) with a pipeline system	Environmental impacts will be limited to the already shallow and sediment	All impacts related to reclamation on reef flats
2: Sand from the seabed of the atoll lagoon just north of Gulhifalhu, to be dredged by a TSHD (Trailing Suction Hopper Dredger).	Environmental impacts related to dredging will be minimal on the lagoon and reef	All impacts related to reclamation on reef flats The affected area in an open lagoon will be 5-10 times higher than a shallow reef flat Cumulative impacts on borrow area with limited time to recover
3: Sand and coral material from a coral reef elsewhere in the Kaafu atoll to be dredged by a CSD	Environmental impacts on the dredged reef Other impacts associated with the transport, loading and unloading of sediments. Cumulative effects high as two reef systems are disturbed.	All impacts related to reclamation on reef flats High costs Social conflicts associated with other island objections
4: Sand imported from overseas by a jumbo trailer (very large trailer)	Environmental impacts related to dredging will be minimal on the lagoon and reef	All impacts related to reclamation on reef flats Very high costs Potential to introduce foreign species and diseases.

Based on these results, dredging sand from a borrow area in the atoll lagoon by TSHD is the preferred option. Dredging sand in the reef lagoon by CSD is a viable alternative option, provided the location of the access channel is chosen properly (i.e. at a location where live coral cover is lowest)

In sum, the proposed option 2 appears to be the preferable option for this project. It has lower cumulative environmental impacts, is the least costly option and has been tested in phase I. This assessment only looks into the impacts of dredging. Impacts from reclamation are expected to remain constant for all four options.

8.5 Alternatives for borrow areas

There are three major alternative locations for the mining of sand for the development of Gulhifalhu.

- Mining sand by trailer dredger (TSHD) from the seabed in the atoll lagoon. In this case it is most likely that the dredging dept will be 1 meter or less; in that case the affected area will be some 2,000,000 m^2 during phase 2.
- Dredging sand (by cutter dredger/ CSD) within Gulhifalhu's lagoon area. The area affected, will be between 750,000 and 1,300,000 m^2.
- Dredging sand (by cutter dredger/ CSD) within a shallow reef or reef lagoon area nearby.

Dredging within the reef lagoon area by a CSD (option 1) will affect an area of about 750,000 – 1,500,000 m^2. The created depth within the dredging area will be about 15-20 meter inside the reef lagoon, which is 8-15m deep. In case dredging is carried out within the atoll lagoon by a TSHD (option 2), it is most likely that the dredging depth will be less than 1m. In that case the affected area will be at least 2,000,000 m^2, which is 2-3 times larger than in case of dredging within the reef lagoon.

For this project, the depth of the borrow area is directly related to the dredging method used. When a Cutter Suction Dredger (CSD) is employed, a relatively small but deep borrow area will be created in the reef lagoon. A Trailer Suction Hopper Dredger (TSHD) will create a relatively large and shallow borrow area in the seabed of the atoll lagoon at greater water depths.

Working with a TSHD in the atoll will generate a source of suspended sediments in a location outside the Gulhifalhu reef. Although the TSHD will dredge away from coral reefs and patches, the benthic fauna living on and in the seabed at the borrow area will be affected. The process of

filling the reclamation area by TSHD however will allow for more control over the release of suspended sediments from the reclamation area.

Working with a CSD elsewhere in the atoll will cause damages to the life organisms at a second reef and coral patches and is therefore not seen as a viable alternative.

Since benthic organisms live in the top 30 – 40 cm of the seabed and on the seabed, the damage to the benthic communities at the reef flat area will be much smaller compared to dredging the atoll lagoon area. It is expected that on the sandy reef flat area, limited benthic communities are present, due to the limited water depth and the high water temperatures. On the sandy seabed areas in the atoll lagoon, it is likely that more benthic communities will be present, due to the conditions being less extreme. However, in areas where high current speeds occur, the presence of benthic fauna will also be limited. Additionally, benthic fauna communities have the capacity to recolonize areas with disturbed seabed fairly quickly. Recovery in highly dynamic systems is quick, taking anywhere from as little as a few months up to a few years. However, since the sea bed was disturbed only a few months ago, a new project may not provide enough time for the area to recover. This is avoided by using areas within the designated borrow area which hasn't been used yet.

Based on the above alternatives options and from an ecological point of view regarding the benthic communities, dredging at a reef lagoon or reef flat area would be preferred over dredging in the atoll lagoon area. However, given the availability of suitable dredging material in the atoll lagoon, this area is preferred above Gulhifalhu's reef lagoon. Dredging in the atoll lagoon is also the preferred option with respect to the impact on nearby coral reefs.

8.6 Alternatives for Design of the Reclamation Area

As for the design of the reclamation area there are five options

- Option 1: Enclosed reclamation area with bunds all around in all phases of the reclamation
- Option 2: Open reclamation area without bunds in all phases
- Option 3: Reclamation area with no bunds in phase 2 and with bunds for phases 3 and 4
- Option 4: Reclamation with single or multiple settlement basins
- Option 5: Use of silt screens to filter sediment

Option 1: involves complicated logistics since Gulhifalhu reef is completely submerged and there is no material to create bunds with at the start of the development. Material needs to be imported to create the bunds. Another option is to build the bunds from the water. For this cranes on pontoons, barges or a hopper with sand. The impacts on the environment are localised (limited to an area around the island and inside the lagoon where the construction of the revetment takes place) and manageable. The revetment will reduce the size of the impact area during reclamation activities by keeping the excess water containing fine sediment within the bunded area. Release of this water is manageable. The import of sand from overseas, the equipment and the long execution time make this option economically prohibitive. An excavator may also be used to dredge and create a sand bund wall but the process of excavation itself close to a marine protected area is a concern.

Option 2: has simple logistics since no preparations need to be made prior to the reclamation. The impacts on the environment are temporary increased turbidity levels, a relatively high load of sediment which is potentially difficult to control, due to the fact that excess water will be released on all sides of the reclamation and during each phase. Environmental impacts are therefore more difficult to manage. This makes this option environmentally prohibitive.

Option 3: has moderately easy logistics. Phase 1 and 2 will be executed according to option 2. Before phase 3 and 4 will commence bunds can be set up with material stored on the reclamations from phase 1 and 2. The bunds can be set up with excavators and bulldozers from the now existing land. The impacts for the creation of the bunds on the environment are localised (limited to the area of the revetment) and manageable. The impacts of the reclamation of phase 1 and 2 such as increased turbidity and a high sediment load will however be short term. The turbidity increase and the sediment load during the reclamation of phase 3 and 4 will be reduced, more local and much more manageable.

Option 4: involves additional dredging to create basins and will need to be supported by some sort

of bund. Hence, this option is more suitable if used with enclosed reclamation. Moreover, there is not enough rom to create additional basins in the reef flat area.

Option 5: uses a simple method of lining a silt screen around the project area to prevent finer sediments from flowing into the reef system. It's effectiveness is debatable in a large project such as this and involves some logistical issues for its place. However, if the protection of marine life is a priority, siltscreens provide a best possible option.

Table 8-2 below summarises the impacts for these five options.

Table 8-2 Comparison of impacts from reclamation options

Alternatives / Environmental impacts	**Open Reclamation**	**Closed Reclamation**	**Closed reclamation with one settling basin**	**Closed area with multiple settling basins**	**Silt screens**
Turbidity and sedimentation	Very High	High	Moderate	Low	Low
Lagoon benthos impacts (whole lagoon)	High	Low	Low	Low	Low
Lagoon benthos impacts (work area)	Very High	Very high	High	High	High
Lagoon Fish population	High	High	High	High	Moderate
Reef areas (whole reef system)	High	Low	Low	Negligible	Negligible
Reef areas (near work area)	Very High	Low	Low	Very Low	Low
Reef Fish population	High	Moderate	Low	Low	Low

Based on the analysis of the above discussed alternatives the preferred option is Option 1 will have the least impact on the ecology of the area around the reclamation area and nearby sensitive areas. However this option is economically not feasible and does not fit in the Master Plan of the development of the Gulhifalhu project. Option 2 is environmentally prohibitive and will therefore

not considered as an option. Option 3 is economically feasible with the strongest impact mainly focused on phase 1 and 2. Option 4 involves additional dredging and therefore additional costs. Option 5 is simplest most cost effective method mitigate the immediate effects on marine life. In combination with mitigating measures in order to try and reduce the influence area of the impact this is considered as the preferred option.

8.7 Alternative coastal protection technologies

A number of alternatives could be used for coastal protection both to improve the effectiveness and reduce the costs of development. The key alternatives are sand-cement bag revetments, concrete s-block revetments, concrete tetra pods or geo-bags for the southern side. For the northern side, key alternatives are to use sheet piles, sand-cement bags or leave open as a beach. Comparison of these alternatives is provided below.

Table 8-3 Comparison of coastal protection options – south side

Alternatives / Environmental impacts	**Armour rock (present option)**	**Concrete tetrapods**	**Sand-cement bag revetment**	**Concrete S-block revetment**	**Geobags**
Strength against strong waves	Very High	Very High	Moderate	Moderate	High
Applicability to current conditions	High	High	High	High	Moderate
Construction material	Rock	Concrete and aggregate	Sand and cement	Concrete and aggregate	Sand, geo textile
Maintenance requirement	Low	Very Low	High	Moderate	Moderate
Durability	Very High	Very High	Moderate	Moderate	High
Environmental Impacts during construction	Moderate	Moderate	High	Moderate	High
Aesthetic Impacts	High	High	Moderate	High	Low
Cost	High	Very High	Low	Moderate	High

In general, the applicability of all options studies is high for the proposed conditions on the oceanward side, albeit with the appropriate designs. In terms, so environmental impacts during construction, all methods requiring sand as a material have had impacts on sand resources in the past. The proponent has decided that durability, low maintenance and low cost are key requirements due to the nature of this investment. Hence, the preferred method by the proponent is armour rock followed by geobags. A final decision has not been taken on the material yet.

Comparison of the alternatives for north side is provided below. Again, for durability and practical purposes the proponent has chosen concrete piles.

Table 8-4 Comparison of coastal protection options – north side

Alternatives / Environmental impacts	**Prefab concrete piles (present option)**	**Steel sheet piles**	**Sand-cement bag revetment**	**Leave as beach**	**Geobags**
Applicability to current conditions	High	High	High	Low	Low
Usability as a quay wall	High	High	High	None	Low
Construction material	Concrete and aggregate	Steel sheet piles; Concrete and aggregate	Sand and cement	Concrete and aggregate	Sand, geo textile
Maintenance requirement	Low	Low	High	Moderate	Moderate
Durability	High	High	Low	none	High
Environmental Impacts during construction	Moderate	Moderate	High	Moderate	High
Aesthetic Impacts	Moderate	Moderate	Moderate	none	Low
Cost	High	Very High	Low	Low	High

9 Environmental Monitoring Plan

The monitoring program and its equipment, monitoring locations and frequencies and reporting requirements, is based on the information needs for the project. The monitoring program includes three sections:

- information needs
- the monitoring program including the equipment, the locations and frequencies
- the monitoring reports

9.1 Information needs

In this monitoring plan, which includes the construction phase and the long term (both of which will be the responsibility of the project proponent), the most relevant information needs are:

- water quality aspects, including suspended sediments and sedimentation;
- ecological aspects related to coral;
- the re-colonization of the borrow area;
- erosion around the borrow area.
- erosion around the reclaimed island
- changes to currents and waves in proximity to Gulhifalhu reef

9.1.1 Water quality aspects

One of the most important potential marine environmental impacts associated with dredging and reclamation works is the deterioration of water quality due to increased levels of suspended sediments and possible reduced oxygen levels.

Due to the re-suspension of the fine fraction of the coral sand, dispersion and resettling of the sediments during the dredging and the reclamation activities, a wide range of effects can be caused, including damage to coral and other organisms that cannot leave the area to escape the increased suspended solids concentrations. If the turbidity level is continuously high for a period of 3 months or more, significant damage can occur to coral.

Significant sedimentation will also cause damage to coral and other sessile organisms. In the EIA a range of mitigating measures has been selected to minimize the re-suspension and dispersion and sedimentation of suspended sediments from the borrow area and the reclamation areas.

However, because the exact effects of the dredging and reclamation works at Gulhifalhu cannot be predicted in detail, it is necessary to monitor the actual effects of the works on water quality. In this way the scale of the impacts as well as the duration of the impacts and the influence of the weather conditions will become clearer. The monitoring will have two purposes:

To evaluate the effectiveness of mitigating measures already in place, such as the silt screen and in later phases the bund closing off the reclamation area from the ocean, and the settling basin to signal the need for additional mitigating measures, such as adjustments in the dredging and reclamation processes.

The effects of dredging and reclamation on water quality are directly related to the working activities and the local physical characteristics, like the currents and waves. It is recommended to periodically monitor the currents along the reef to get more information on where the suspended sediments released at the borrow and reclamation areas may be transported to by the local currents.

During the construction of the reclamations at Vilufushi and Viligili, the suspended sediment plume did not disperse further than 2.5km away from the source under storm conditions. Suspended sediments settled within 2-5 days.

The proposed water quality measurements will take into account the cumulative effects from phase I as well as future phase III and IV reclamation activities. The present baseline is based on the conditions that exist after the reclamation works of phase I.

9.1.2 Ecological aspects related to coral

At the shallow reef area around the island there is hardly any coral. After the surveys at the shallow reef areas it is estimated that the life coral is less than 1%. Even at the reef edges there is practically no live coral coverage. This is mainly due to the coral bleaching in 1998 and the tsunami in December 2004. Consequently at the shallow reef no monitoring of coral is required. At the line transects that were surveyed on the slopes around the shallow reef area, the live coral coverage varies from less than 5% to 15% at the ocean side and from 0% to more than 10% at the atoll side.

The coral cover of the Gulhifalhu reef and, in general, the whole reef system of Gulhifalhu is under

significant pressure. The monitoring activities that are been carried out of the Phase I EIA will be acting as a baseline for this monitoring. This will allow for cumulative impacts to be monitored effectively.

9.1.3 Turbidity and sedimentation

If turbidity levels are significant for several months, the light available to the coral is reduced and consequently coral colonies may die. The Sedimentation on coral is quite different. Soft corals and branching corals are less vulnerable than massive and table corals. Most coral species have a mechanism to clean very fine sediments off of their surface, but they have difficulty cleaning off coarse sediments.

9.1.4 The re-colonization of the borrow area created by a CSD

Re-colonisation of microbenthos (<1mm) is a much faster process than the recovery of the macrobenthos (>1mm). Complete restoration of the nematodes community can take place within some days. The restoration of the macrobenthos community after the sand extraction depends on the degree in which the new substrate is arranged for re-colonisation and establishment of larvae. The biological period of recovery can take place within some months to 2 or 3 years.

9.1.5 Erosion around the borrow area

The borrow area created by a TSHD will be located at relatively large depth (20-50m). At these depths, waves will not hit the seabed to stir up sediments.

It is expected that currents will barely influence these borrow areas, since the fastest currents run through the channels between islands and reefs where no dredging of sand will take place.

9.1.6 Erosion around the reclaimed island

The reclaimed island will undergo rapid erosion in the short to medium-term. Patterns and rates of erosion and changes to currents around the island needs to be determined to understand the adjustment patterns around the areas where the coastline is left unprotected, namely the southern side.

9.1.7 Changes to currents in proximity to Gulhifalhu

Anecdotal evidence from Hulhumale' island reclamation project suggests changes to currents and wave activity in the near vicinity due to the blockage created by a new land mass. Currents will need to be monitored between Gulhifalhu, Viligilli and Thilafushi, and immediately inside the atoll.

9.2 The monitoring program

In this section, the requirements, methodology, equipment and monitoring locations and frequency for the monitoring components are presented. Included in this section are:

- water quality monitoring;
- sedimentation monitoring;
- erosion around the borrow area;
- erosion around reclaimed land
- changes to currents in close proximity to Gulhifalhu reef.

The proposed monitoring activities below should be combined with phase I monitoring. In fact, the programme below has been aligned with the parameters identified in the First Phase EIA.

9.2.1 Water quality monitoring

Water quality monitoring shall be carried out by an environmental monitoring team to ensure that any deteriorating water quality is readily detected and that timely action is taken to rectify the situation. The objective of the water quality monitoring program is to determine the effectiveness of the operational controls and mitigation measures employed, and the need for supplementary mitigation measures to protect the coral.

General parameters to be recorded during sampling and measurements

- Location;
- time and date;
- weather conditions;
- sea conditions;
- tide;
- monitoring / sampling depth.

Parameters to be measured *in situ*

- dissolved oxygen (DO) (% saturation);
- dissolved oxygen (DO) (in mg/l);
- temperature (°C);
- turbidity (NTU);
- salinity (ppt);
- water depth (m).

Additionally, water samples will be taken periodically in conjunction with turbidity readings to determine Suspended Solids Concentration (SSC) and establish a relationship between Suspended Solids Concentration (mg/l) and turbidity (NTU). This relationship will help translate the turbidity readings that are taken at the monitoring locations into SSC so that comparison with the maximum allowed value is possible.

Parameters to be measured in the laboratory

- suspended solids (mg/l)
- heavy metals

9.2.1.1 Methodology

For marine water quality monitoring the following equipment is required:

- a survey vessel with DGPS positioning equipment;
- dissolved Oxygen and temperature measuring equipment;
- turbidity measurement equipment;
- water depth gauge;
- water sampling equipment.

9.2.1.2 Locations and frequency

A total of 8 sampling and monitoring locations (2 of these are background stations) for the water quality have been selected (see *Figure 9-1*). Prior to the start of dredging activities a baseline survey will be done.

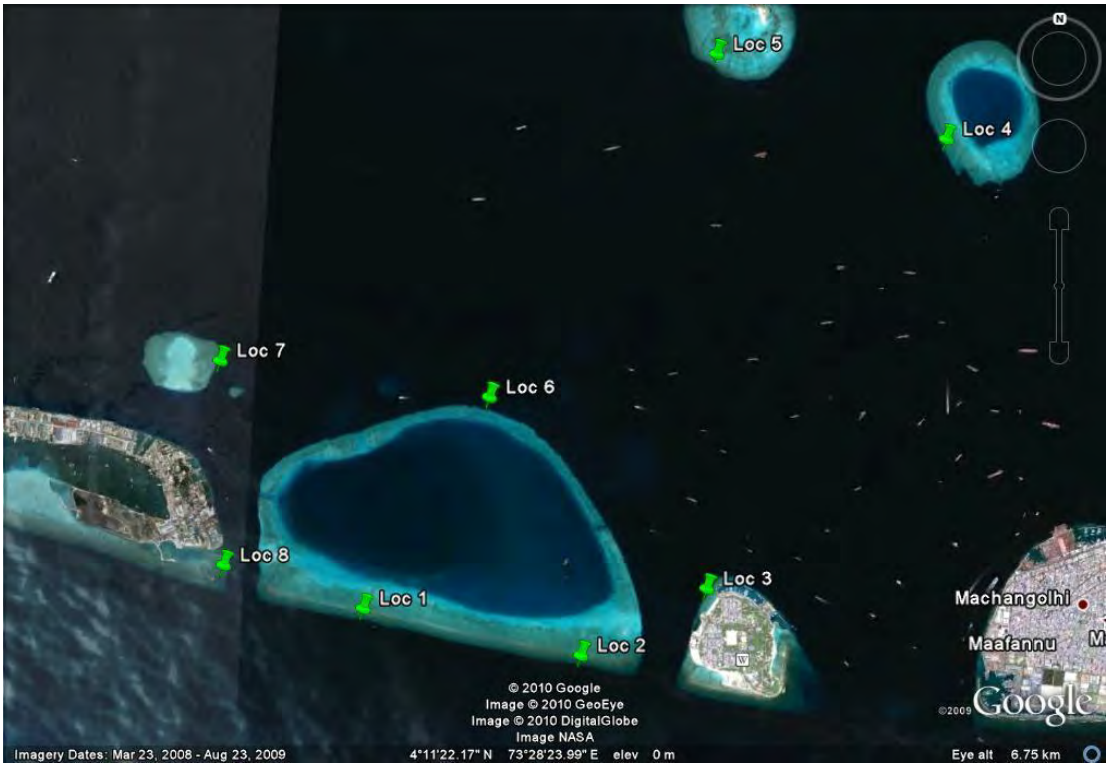


Figure 9-1 Monitoring locations around Gulhifalhu

It is recommended that the following parameters will be monitored at the indicated frequencies:

Table 9-1 water quality sampling and monitoring

Type	Parameters	Locations	Frequency
In situ monitoring 1m below surface middle of water column 1m above seabed	Dissolved oxygen (% saturation) Dissolved oxygen (in mg/l) Temperature (°C) Turbidity (NTU); Water depth (m).	All locations	2 times per week during dredging and reclamation works + once per day during one week before the start of dredging and during the first week after the start of dredging and reclamation works and during 1 week after completion of the works
Water sampling for laboratory investigations anywhere in the water column			Covering a sufficient range of suspended solids concentration to establish a satisfactory correlation + monthly to update the established correlation Once before the start of the works, once a month during the execution of the works and once at completion of the works

9.2.2 Monitoring the marine environment

Ecological change often occurs gradually over time. Therefore, long term monitoring and research programs are necessary to accurately assess environmental change. This is particularly true when the change is due to small but chronic perturbations to the environment which have a cumulative effect. It should be kept in mind that (1) many ecological processes are slow occurring over a number of years, (2) inter-annual variability is often high, (3) short term studies miss rare but important events, and (4) monitoring only reveals recent historical events. It should be noted, however, that the proposed activities involve high level turbidity and sedimentation and therefore may have faster rate of environmental change.

The objectives of this monitoring programme 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 phases of the project activities 2) evaluate the success of a particular management action, 3) to quantify the change in abundances of certain marine organisms, e.g. indicator species near a sewage outfall and elsewhere to compare.

Table 9-2 gives the coral reef monitoring schedule recommended for the long-term evaluation of reef system and ambient marine environment for impact assessment and mitigation of impacts.

Table 9-2 Reef monitoring schedule

Parameter/Method	Frequency of Monitoring	Purpose
Ambient Environmental Parameters Temperature, Salinity, Turbidity/light penetration, Currents	Twice a month in construction Once every month in operation	Important to the 'health' of living marine resources, reefs and fish populations and other benthos
General status of reef Manta Tow Technique	Once every year or following a significant natural event e.g. coral bleaching, COT infestation etc.	Broad scale qualitative and Semi-quantitative assessment of general status of the reef system / coral and other benthic recruitment
Marine Environmental Aesthetic Survey using Time Swim and Manta Tow Technique	Once a month in construction Once every 6 months in operation	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 population structure / Underwater Fish Census	Once in 3 months in construction Once every 6 months in operation	Quantitative assessment of fish population of selected species
Benthic cover of reef / Permanent Photo quadrats	Once every 3 months in construction Once every 6 months in operation	Quantitative assessment of temporal changes in the reef system e.g. coral

Parameter/Method	Frequency of Monitoring	Purpose
		growth rates
Sedimentation / Sediment traps deployment/collection	Twice a week in construction Once every 3 months in operation	Quantitative assessment of sediment loading on the reef benthos.
Impacts from Diving and Snorkelling activities / Comparison with control sites using Visual observation	Once every 3 months in operation	Quantitative assessment of damage from these activities.

9.2.3 Erosion around the borrow area

It is expected that the erosion around the borrow area will be rather limited due to the water depth at which the borrow area will be located. Bi-annual bathymetry surveys are recommended for the borrow site. No other monitoring actions are recommended at this stage.

9.2.4 Erosion around the reclaimed island

It is necessary to monitor beach profiles at monthly intervals immediately after the reclamation and quarterly thereafter.

Table 9-3 gives the monitoring requirements for the coastal zone to assess the effectiveness of the mitigation measures so that alternatives can be identified if the measures taken are in-effective.

Table 9-3 ***Environmental monitoring requirements for the coastal zone***

Monitoring Parameter	Indicators	Baseline / Reference values	Technique	Frequency
Shorelines (high tide and low tide)	Sediment distribution	Baseline to be collected immediately after the reclamation	Differential GPS	Quarterly
Beach Profiles	Rates of accretion and/or erosion	Baseline to be collected immediately after the reclamation	Beach profile surveys	Monthly for the first 6 months and Quarterly thereafter.
Currents	Nearshore currents	Baseline to be collected immediately after the reclamation	Drogue (spaghetti diagrams)	Quarterly

9.2.5 Changes to currents in close proximity to Gulhifalhu

Current surveys need to be undertaken between the Gulhifalhu and Viligilli, Gulhifalhu and Thilafushi and 1 km north of Gulhifalhu. A baseline measurement will be required before the commencement of the project and quarterly during and after reclamation.

9.2.6 Other monitoring needs

The following aspects will be monitored during the construction stage:

- Daily monitoring to ensure that the cleared areas and other construction processes are not creating any significant dust nuisance for the local environment.
- Daily monitoring of vehicle refuelling and repair to ensure that these exercises are carried out on hardstands and to ensure that they are done properly. This is to reduce the potential of soil contamination from spills. Spot checks will be conducted by the site supervisor.
- Monitor borrow areas to ensure only the designated areas are dredged.
- Regularly monitor bundwalls of silt screen lining to ensure they are intact.
- Monitor dredger activity activities to check for spills.

9.3 The monitoring reports

Weekly monitoring reports during construction.

The weekly reporting will be based on the monitoring results, site inspections and the evaluation/interpretation of the monitoring results.

Based on the weekly monitoring results the effectiveness of the operational controls, the mitigation measures employed and the need for supplementary mitigation measures will be discussed between the Engineer and the contractor on a weekly basis. In case of extreme urgent matters a meeting between the engineer and the contractor will be arranged within 24 hours. The weekly reports shall be submitted to the engineer, the employer and the contractor.

A detailed annual environmental monitoring report is required to be compiled and submitted to the Ministry of Transport, Housing and Environment yearly based on the data collected for monitoring the parameters included in the monitoring programme given in this Chapter. This report may be submitted to the relevant Government agencies in order to demonstrate compliance. If required, however, a monitoring report for the proposed work phase may be prepared and submitted to the Ministry of Transport, Housing and Environment. The report will include details of the site, strategy of data collection and analysis, quality control measures, sampling frequency

and monitoring analysis and details of methodologies and protocols followed. This report should be combined with the first phase EIA monitoring report. In addition to this more frequent reporting of environmental monitoring will be communicated among the environmental consultant, project proponent, the contractors and supervisors to ensure possible negative impacts are mitigated appropriately during and after the project.

9.4 Cost of monitoring

The cost of monitoring is estimated to be US$ 15,000 annually. CDE consulting has been contracted to carry out the monitoring activities for all developments in Gulhifalhu.

9.5 Commitment to monitoring

The proponent is fully committed to undertake the monitoring programme given in this Chapter. An arrangement has been made with a consultancy firm to conduct construction phase monitoring programme.

10 Conclusions

10.1 Environmental

The following conclusions are drawn, based on the gathered information:

- The reclamation of Gulhifalhu with proposed coastal protection measures can be done with medium impacts on the environment in phase 2 if preventative measures (silt screens, closed reclamation or use of siltation basins) are implemented during construction and further mitigating measures are implemented when necessary.
- A closed reclamation with siltation basins is not possible in phase 2 but partial protection could be provided and is the most suitable option for the time being.
- During the dredging and reclamation activities, good care should be taken to allow only a pre-determined minimum of suspended sediments to escape from the working areas.
- Preventative measures will be in place to ensure minimal loss of suspended sediments, and additional mitigating measures will be available for implementation should the need arise. Monitoring should concentrate upon these aspects.
- Some coral reef will be impacted at locations near dredging and reclamation works. All feasible measures will be taken to minimise the amount of coral damage by dredging the absolute minimum required volume of sand needed to fill the reclamation area.
- Monitoring activities are essential. In particular, monitoring of damage to coral reefs, their recovery, changes to currents and wave activity around the Gulhifalhu is essential.

10.2 Socio-economic

The socio-economic impacts from the construction stage of phase 2 of the project will mainly be on the following groups:

- Dive schools around the area: they anticipate a loss of dive sites around Gulhifalhu once the project is completed.
- Waste management services section: changes to travel routes and increase in time and costs for waste transfer is anticipated

- Recreational fishermen: temporary disruptions are anticipated.
- Impacts to these groups may not be fully mitigated and they understand that the socio-economic benefits outweigh the environmental costs associated with the development.
- There is not enough information on the operational stage of phase 2 and the remaining phases (phases 3 and 4) to determine the socio-economic impacts. This EIA deals only with the construction stage impacts of phase 2. Additional EIAs are required for the operational stage of phase 2 and the remaining phases of the project, once detailed project designs are available.

11 References

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Environmental Impact Assessment for the Three Islands Project – Hinnavaru, Lhaviyani Atoll, Hydronamic, 2009-2010

Annex 1 – Terms of Reference

Annex 2 – Presidential Decree (2007) and approval letter from Ministry of Finance and Treasury (May 2010)

Annex 3 – Gulhifalhu Land use Master Plan

Annex 4 – Gulhifalhu Phase II Site Plan

Annex 5 – Survey Locations

Annex 6 – Dive Sites and Resorts near project site

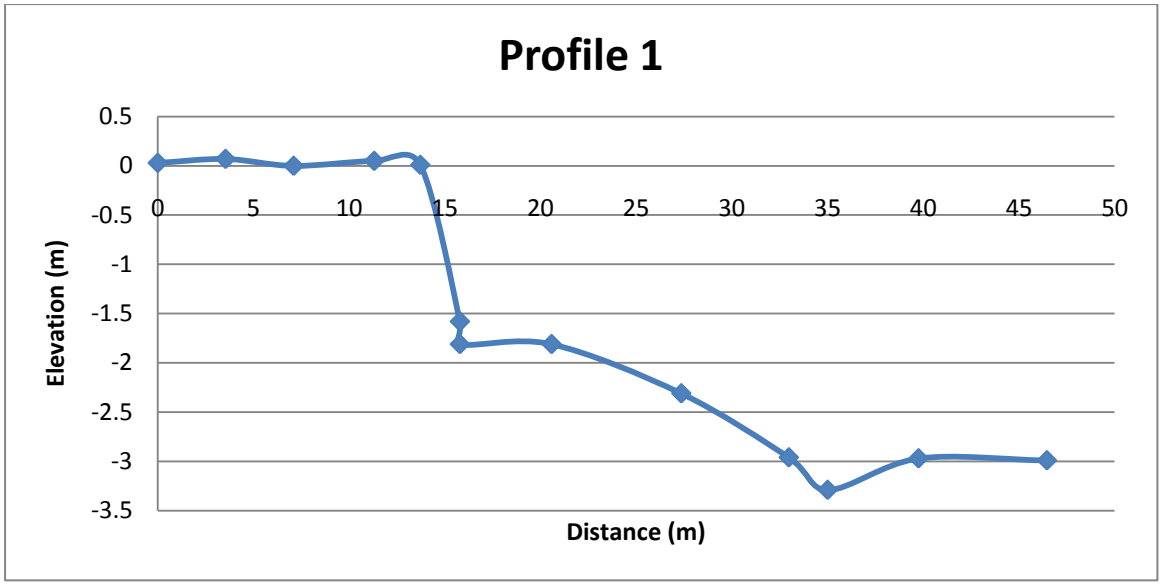
Annex 7 – Bathymetry

Annex 8 – Dredger Specifications

Annex 9 – Environmental Management Framework (Boskalis SHE-Q)

Annex 10 – Beach Profiles

Refer to Annex 5 for beach profile locations

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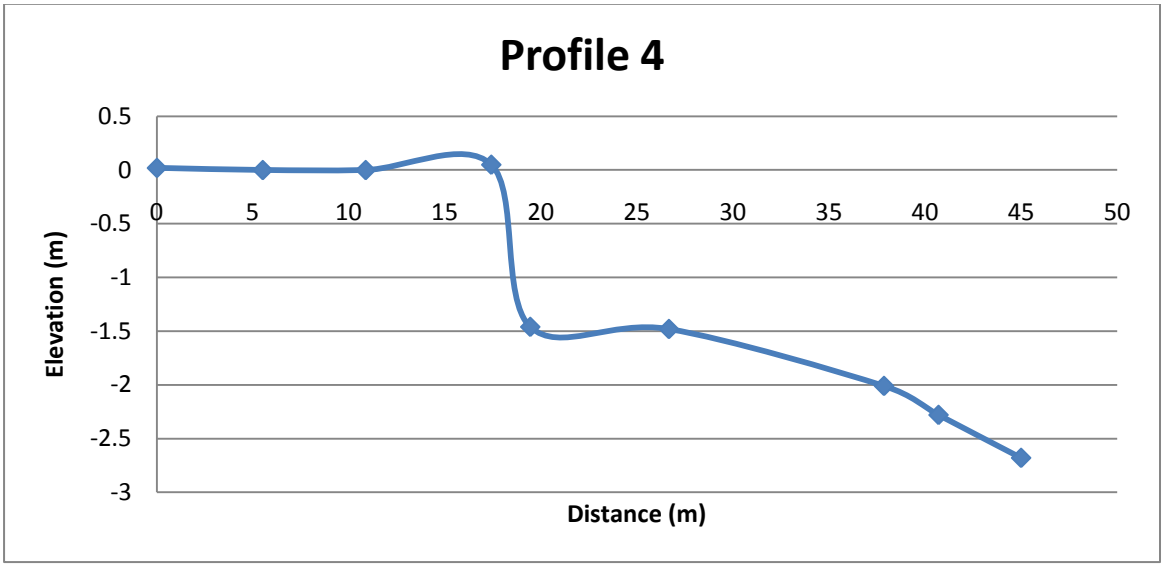
Distance (m)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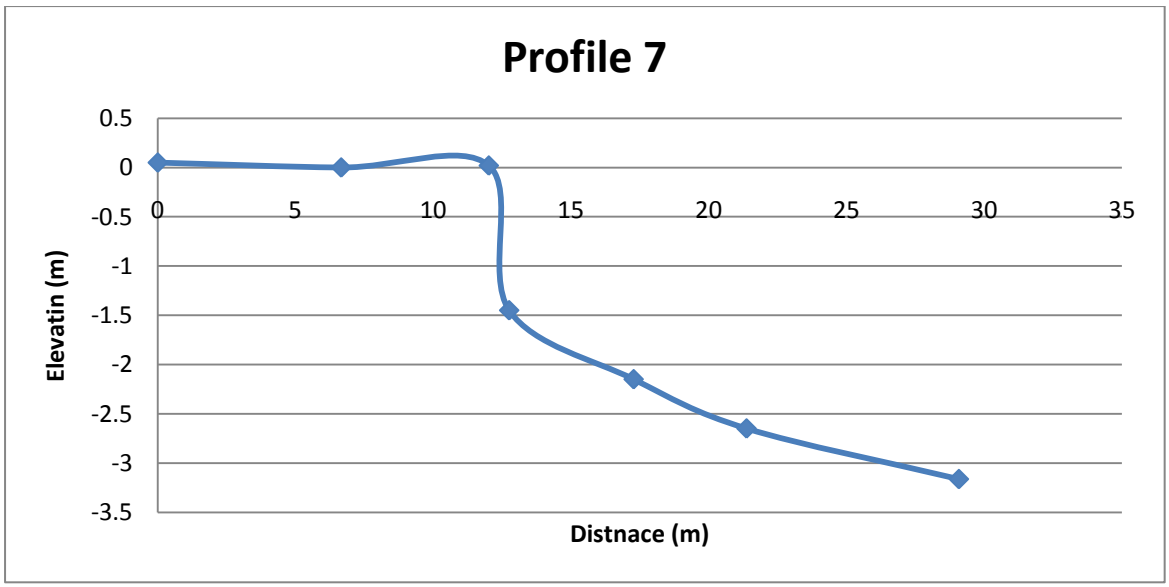
Distance (m)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Distnace (m)


Profile 8
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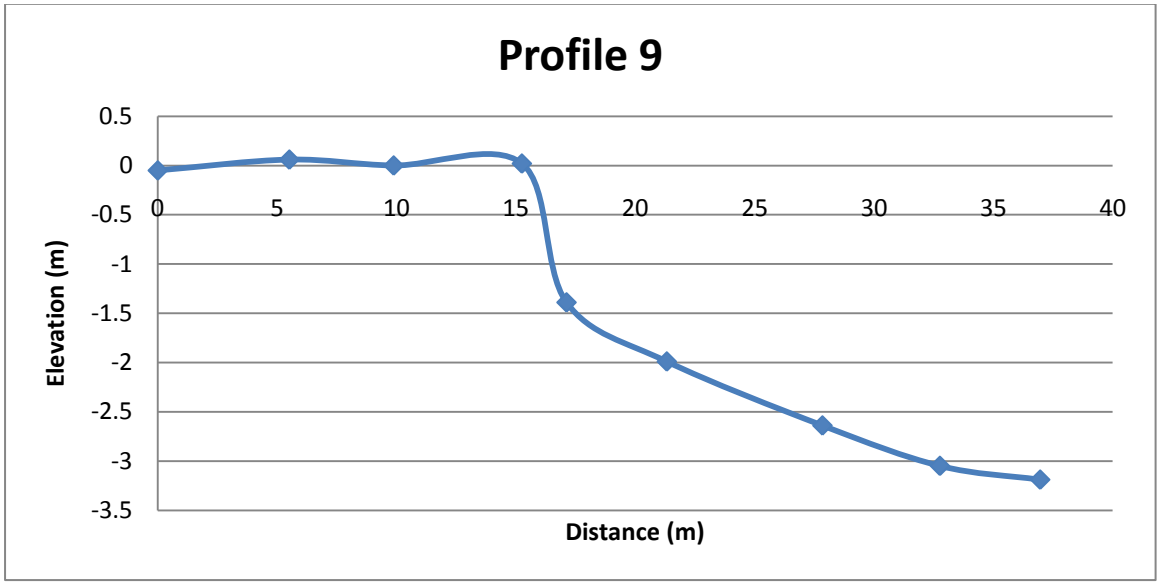
Distance (m)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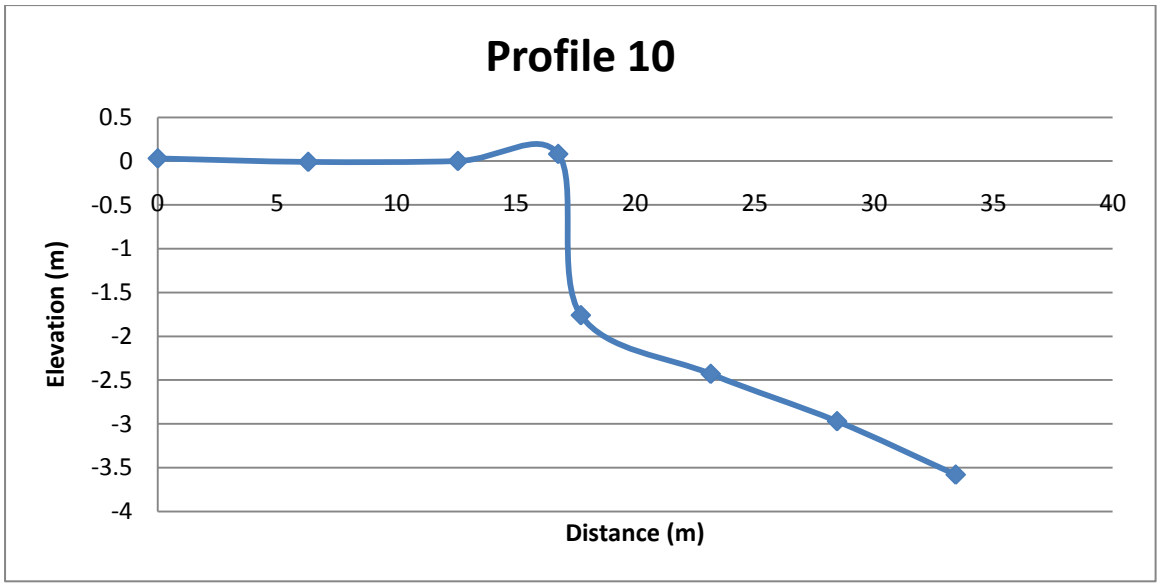
Distance (m)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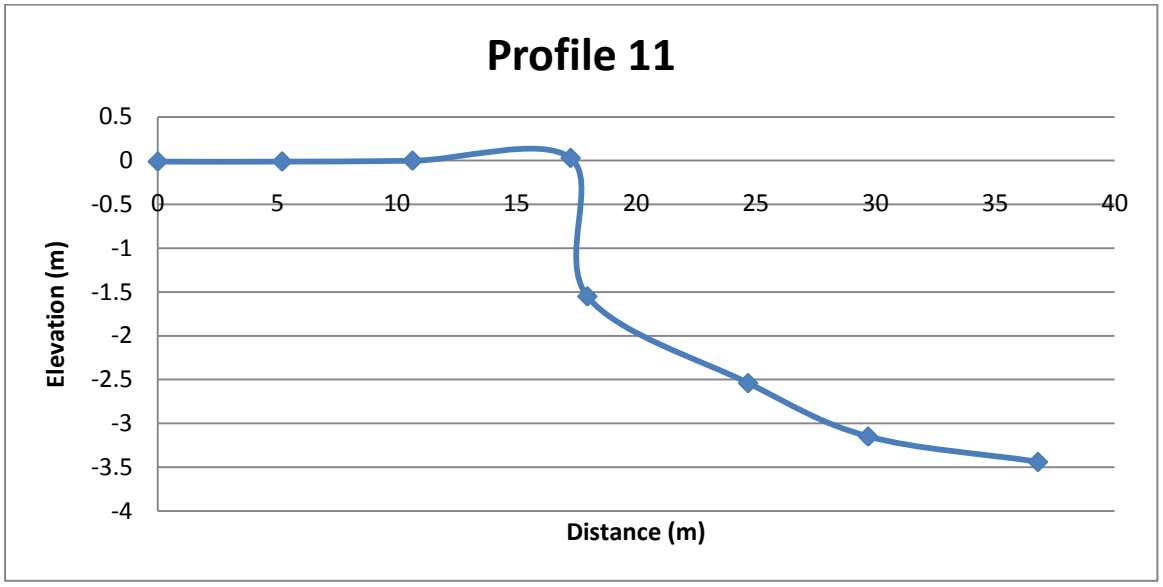
Distance (m)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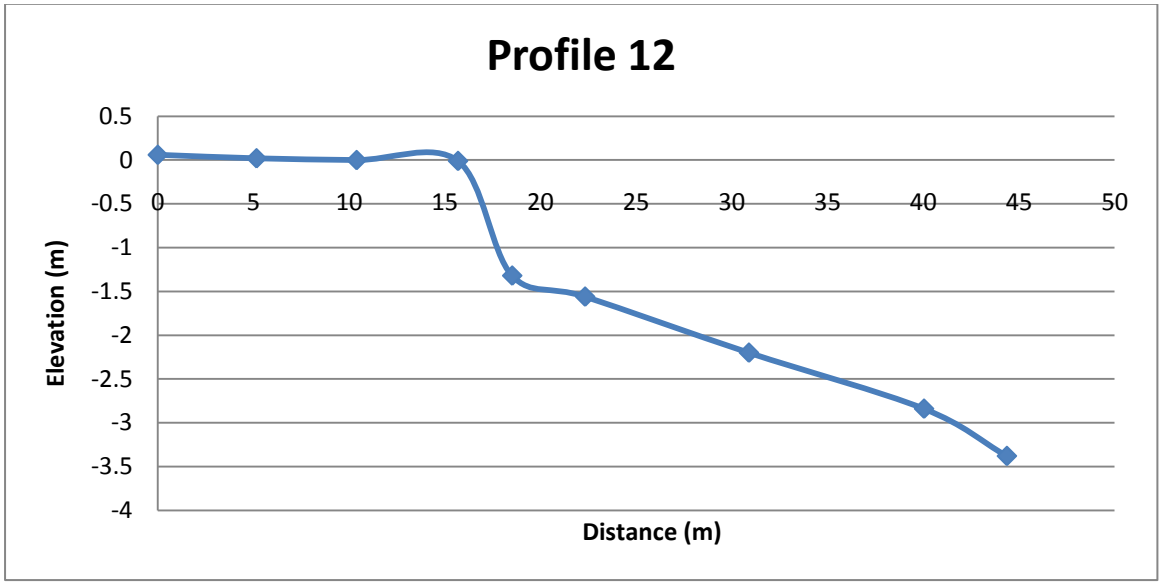
Distance (m)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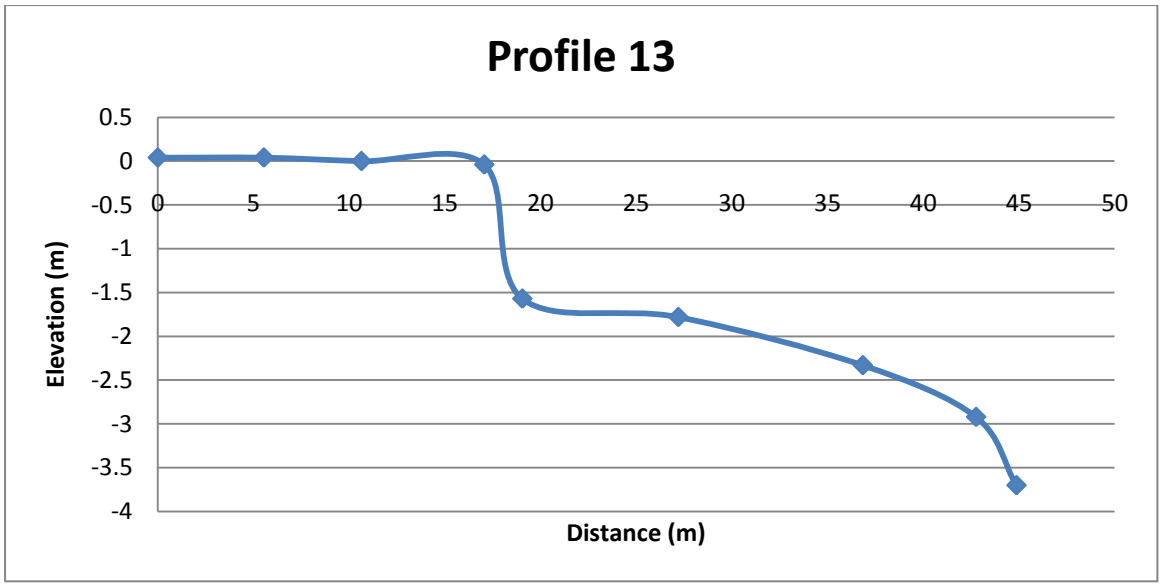
Distance (m)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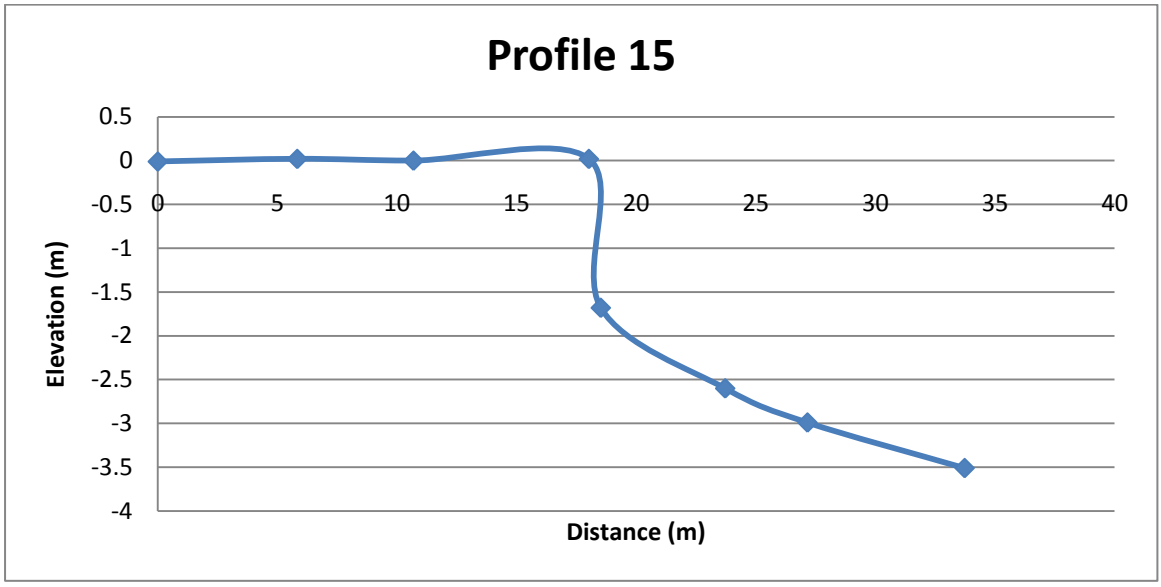
Distance (m)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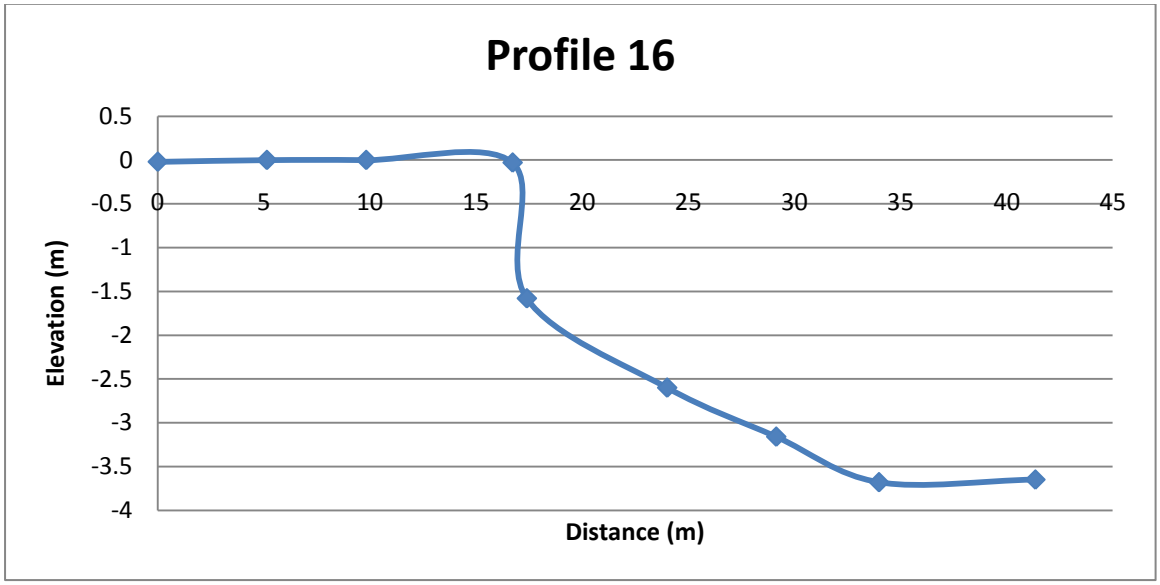
Elevation (m)
Distance (m)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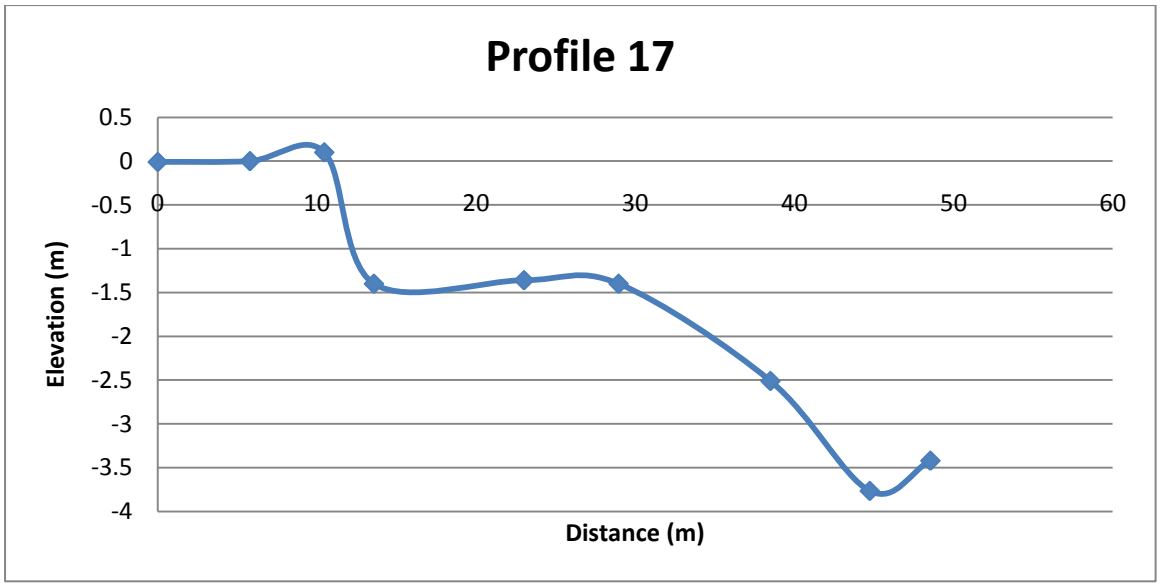
Distance (m)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Elevation (m)
Distance (m)

Annex 11 – CV's