

**ENVIRONMENT IMPACT ASSESSMENT**

**FOR THE PROPOSED**

**WATER SUPPLY SYSTEM IN EYDHAFUSHI, BAA**

**ATOLL**

July 2016

*Prepared for*

Ministry of Environment and Energy

*Consultant*

CDE Consulting, Maldives





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## **List of Abbreviations**

COADS	Comprehensive Ocean-Atmosphere Data Set
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
GPS	Global Positioning System
IPCC	Intergovernmental Panel on Climate Change
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
MEE	Ministry of Environment and Energy
MHI	Ministry of Housing and Infrastructure
MoTAC	Ministry of Tourism, Arts and Culture
MoTCA	Ministry of Tourism and Civil Aviation
MSL	Mean Sea Level
MWSC	Maldives Water and Sewerage Company
NAPA	National Adaptation Programme of Action
NE	North East
NEAP II	National Environmental Action Plan II
NW	North West
SAP	Strategic Action Plan
SE	South East
SW	South West
TDS	Total Suspended Solids
ToR	Term of Reference
UNFCCC	United Nations Framework Convention on Climate Change and the Kyoto Protocol

## **Acknowledgements**

The lead author of this report is Dr. Ahmed Shaig.

Additional assessments were undertaken by the following team members.

Mr. Ahmed Faizan (Marine Environment Specialist)

Ms. Shahdha (Socioeconomic impact assessment)

Ms. Hana Saeed (Stakeholder consultations)

Mr. Ali Nishaman Nizar (Terrestrial Environment)

Field assistance was provided by the following members

Mr. Ali Moosa Didi (Marine Assessments and Social Assessments)

Mr. Mohamed Ali (Marine surveying Social Assessments)

Mr. Ahmed Haiman Rasheed (Field Assistance)

The curriculum vitae's of the EIA consultants are attached in Appendix H of this report.

## **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 Ahmed Shaig

## **Proponent's Declaration**

As the proponent of the proposed project, I guarantee that I have read the report thoroughly and that to the best of my knowledge all information provided here is accurate and complete.

Please refer to Appendix H

## **Executive Summary**

The purpose of this document is to fulfil the requirements to get necessary environmental clearance from the Environmental Protection Agency to install the proposed Water Production Supply System at Eydhafushi, Baa. Atoll. The proponent of this project is Ministry of Environment and Energy.

The main rationale for the project is to improve the health condition and quality of life of residents of B. Eydhafushi by establishing a proper potable water supply system that will provide clean and safe water for the residents of Eydhafushi. The project is intended at providing an integrated water supply system covering rainwater and desalinated water production and supply.

The proposed project involves installation and establishment of two 8,000 litres/hour reverse osmosis plant systems that consist of construction of tube well to supply raw water for the RO plants, construction of elevated water storage tanks, construction of brine discharge outfall and house connections. Furthermore, the project aims at laying of separate pipe networks for water distribution, rainwater collection and rainwater treatment system. Duration of the project is approximately 18 months.

Currently the island population sources water from shallow wells constructed at individual households or in public areas. This is supplemented by collection of rainwater. These methods provide inadequate quantity and unacceptable quality due to the over abstraction and the unreliability of rainwater harvesting.

All project activities will be in conformance to the laws and regulations of the Maldives, and relevant international conventions that Maldives is party to. The key laws and regulations applicable to this project are: Environmental Protection and Preservation Act, Environmental Impact Assessment Regulation 2012, Desalination Systems Regulations, and Waste Management Regulation 2013.

The existing condition of the island and the proposed RO plant site was assessed for this report. Assessments conducted include marine assessments at the proposed brine outfall and alternative outfall locations. Groundwater quality and baseline noise level measurements were also taken. The assessments showed that there is no marine protected or environmentally sensitive site in the area and locations proposed for brine outfall showed mostly dead rock and rubble.

The assessment shows that the RO systems can be developed on the island with limited implications on the environment. The assessment shows that the proposed developments involve moderately significant impacts on the marine environment due to brine outfall construction,

brine discharge, ground excavation and operation of vehicles and machinery. The project also involves moderately significant health and safety risks due to equipment handling and pollution. However, the predicted impacts can be minimized considerably with the proposed mitigation measures. Significant impacts of operation stage include marine degradation due to brine discharge, ground water salinization and increased GHG emissions due to RO plant and operation of pumps stations, and increased cost of living due to additional cost in purchasing water. The assessment shows that the proposed project has many positive impacts including improved quality and accessibility to potable water, protection of groundwater aquifer, reduction of water related disaster risk, and increased employment and business opportunities.

The alternatives evaluated for the project is the alternative brine outfall location. The “No Project” option has also been explored and this option is not deemed preferable, given the current condition of portable water. An alternative site for brine outfall was also explored, but given the advantages associated with the proposed outfall, it is the preferred option.

Monitoring plan is designed to assess any changes to the coral reef environment of the island, ground and marine water quality as these are the key areas that will be impacted from this project. Monitoring costs is estimated at around Rf100,000 per annum, most of which involves water quality tests.

The management plan for this project is designed to produce a framework for anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions. In addition, it will provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.

Stakeholder consultations were held with Eydhafushi Island council, FENAKA, Eydhafushi public and Ministry of Housing and Infrastructure. A willingness-to-pay survey was also conducted during field assessments. Both Eydhafushi Island Council and public highlighted the need for a potable water supply system on the island. Majority of Eydhafushi public is also willing to pay for the service. Ministry of Housing and Infrastructure recommended the proponent to coordinate with them on project timings and components.

In conclusion, this project has been designed in conformance to the relevant laws and regulations of Maldives but requires final approval from EPA for the detailed drawings. MEE has requested the council to increase the allocated land area, as the desired plot size does not match the plot size issued by the Island Council. The most significant impacts are expected to be short-term impacts for the construction phase. Operational stage impacts are mainly limited to brine outfall location and emission due to power generation. However, mitigation measures have been proposed to adequately minimise these significant impacts.







## **1 INTRODUCTION**

### **1.1 Purpose of the EIA**

This Environment Impact Assessment (EIA) report is an evaluation of the potential environmental, socio-economic and natural impacts of the proposed EIA for the proposed installation and operation of RO Water Supply System, and water distribution network at Eydhafushi, Baa Atoll.

This document is submitted by the proponent to EPA to fulfil the requirements for an EIA under Article 5 of the Environment Protection and Preservation Act (4/93). The EIA Regulations 2012 has been used as the basis for preparing this document.

This report provides the background to the proposed project components as well as an assessment of their likely environmental and social impacts, both beneficial and adverse. The proposed enhancement and mitigation measures are outlined where necessary together with an environment management plan and a monitoring programme.

### **1.2 Project Title**

The project title is the “Installation of a water supply system in B.Eydhafushi”.

### **1.3 Project Proponent**

The proponent of this project is Ministry of Environment and Energy (MEE). MEE is the Government agency responsible for planning and implementing water and sanitation systems in islands of Maldives. The Ministry is currently implementing a number of water and sanitation projects across Maldives.

Contact details for the proponent are:

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*Green Building, Handhuvaree Hingun, Maafannu, Male', 20392,*

*Republic of Maldives.*

*Tel: +(960) 301 8300, Fax: +(960) 301 8301*

*Email: secretariat@environment.gov.mv*

## **1.4 Project Scope Summary**

The main components of the project are:

- Construction of 2 tube wells to supply raw water for the RO plants
- Construction of RO plant building
- Installation of 2 reverse osmosis desalination plants with output capacity of 8,000 Litre per hour for each plant
- Construction of water tanks for 7-day storage requirement
- Construction of brine discharge outfall
- Preparation of catchment areas
- Laying water distribution pipe
- Laying rainwater collection and transport network
- Connection to households

See next chapter for more details.

## **1.5 Project tasks completed**

No physical developments have been undertaken. However a number of studies including topography survey, bathymetry survey, marine assessments and social consultations have been undertaken. The concept design has been completed and approved.

## **1.6 Project Location**

The island of Eydhafushi is located on the eastern rim of the reef periphery of Baa Atoll and it is the capital island of Baa Atoll. The island has been recently reclaimed to almost twice of its original size. The island already has a sewerage system with treatment plant with the network serving the post reclamation plots on the island.

Site location map and satellite image is presented in Figure 1.1 and Figure 1.2 respectively. The table below summarizes some key information about the island.

**Table 1.1: Summary of key information about the proposed Island**

<b>Island Name</b>	<i>B.Eydhafushi</i>
<b>Island Status</b>	<i>Inhabited, Atoll Capital</i>
<b>Location</b>	<i>73°5'14.27"E; 5°7'13.08"N</i>
<b>Land Area</b>	<i>53 Ha</i>
<b>Length</b>	<i>About 874 m</i>
<b>Width at the widest point</b>	<i>About 448 m</i>
<b>Distance to Male' City</b>	<i>About 112.79 km</i>
<b>Nearest Airport</b>	<i>Dharavandhoo Airport (About 9.19 km)</i>
<b>Nearest Inhabited Island</b>	<i>Maalhos (About 4.85 km)</i>
<b>Nearest Resort</b>	<i>Soneva Fushi Resort (About 900 m)</i>
<b>Population</b>	<i>3266</i>
<b>Households</b>	<i>566</i>
<b>Key facilities on island</b>	<i>Atoll Hospital, Atoll School,</i>

***Environmentally sensitive sites in the vicinity***

There are no environmentally protected sites listed within 3 km of Eydhafushi. Nearest environmentally sensitive site is Maaddoo (within 1 km) and Nelivaru Finolhu (within 3 km).

**1.7 Legal status of Land**

Land has been allocated for this project by the Island Council and the site has been approved by Ministry of Housing and Infrastructure (See Appendix B). The plot has been given on leasehold to the Ministry of Environment and Energy to establish public service. The authority to develop and use the plot may be handed over to the operator once construction is completed. The details of the land allocated is as follows:

Plot Number: 320/2011/15

Plot Size: 2500 sq ft (50 ft x 50 ft)

Location: Northern side of the island, west of the harbour.

The site already has the existing water facility with desalination plants. The site consist of a small building and houses the desalination plant.

It has to be noted that the plot size given on the map issued in the approval does not match the size proposed in this project (98.5 x 115 ft; 11,302 sq ft). MEE has requested the Council to revise and increase the size of the land to 10,000 sq ft.

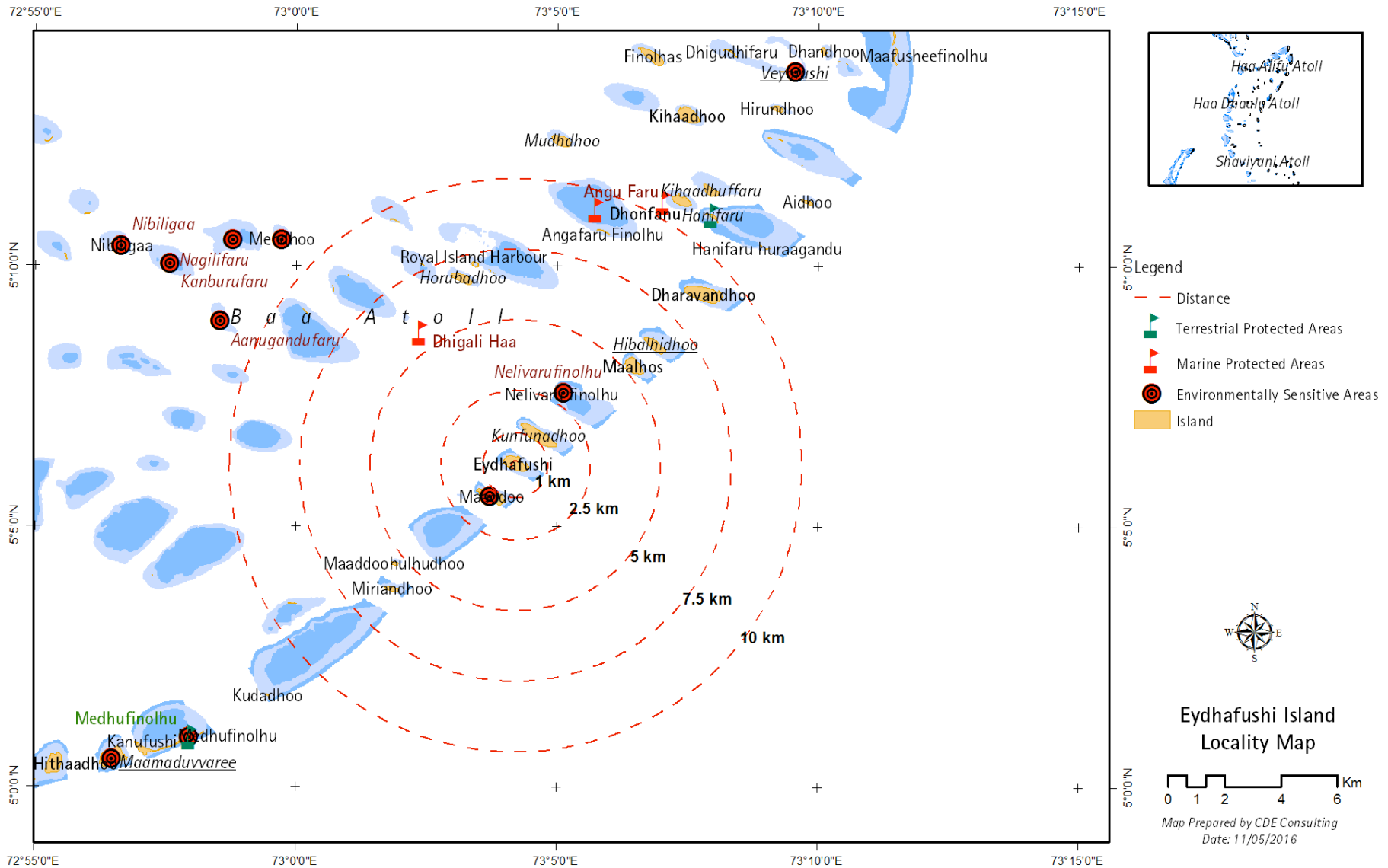


Figure 1.1: Location and locality map of Eydhafushi Island



Figure 1.2: Satellite image of Eydhafushi Island

## **1.8 Project Rationale**

Access to fresh water is a major issue in the Maldives. Except for a few wetlands or freshwater lakes there are no rivers or streams in any of the islands of Maldives. Freshwater resources occur only as groundwater in basal aquifers, mostly unconfined in nature and extending below sea level in the form of thin fresh water lenses that are vulnerable to saline intrusion owing to the freshwater- seawater interaction, making fresh water a scarce resource.

Fresh water scarcity is a serious concern in most of the inhabited islands of the Maldives. The unavailability of proper water not only cause inhibition to economic growth, social development and human health but also causes severe ecosystem damage due to water abstraction rates exceeding natural renewal rates. Furthermore, the lack of proper sewerage systems or sanitation, highly permeable soils, over extraction and high population densities in these communities cause contamination of the existing underground water lenses, making it foul smelling, undesirable and unhealthy for human consumption, limiting its usefulness as a resource.

To cope with this water paucity many islanders in the Maldives turn to rainwater harvesting. However the rain water harvested from the local roofs and the storage mechanism do not prove to be of the best practice as the catchment area are open for numerous types of contaminations causing rapid deterioration of water quality. These include addition of impurities from bird droppings, cats, rats other mobile organism's faecal matter. Moreover, there are no means of testing the quality of the harvested water or treating the water further. Hence it has become impossible to rely totally on natural resources and therefore it has become inevitable not to go for the alternative of desalination to supplement good quality water for human intake in the Maldives

In the recent past government acquired a policy towards ensuring all inhabited islands have water supplies that meet basic requirements and supply safe water for drinking and cooking purposes. Efforts are being sorted out to improve the water supply in the atolls through the simultaneous enhancement of community rainwater collection and storage facilities and construction of desalinated water supply systems.

In a similar manner, to cater for the basic water requirement of the population of B.Eydhafushi the Ministry of Environment & Energy have signed an agreement with Al Habshi Consultants for Design and Build basis for water supply network, ground storage tanks and reverse osmosis plant, allied works based on integrated water resources approach on 9<sup>th</sup> April 2015.

## 1.9 Aim and Objectives

The overall aim of this project is to enhance the quality of services and quality of life of residents of B.Eydhafushi by establishing a proper potable water supply system.

The specific objectives are to:

1. Ensure attainment of safe potable water for the people of B.Eydhafushi
2. Utilise harvested rainwater, save energy and reduce the operational cost of desalination.
3. Develop the infrastructure and facilities necessary to operate a potable water system based on reverse osmosis desalination technology.
4. Develop storage and pipe network to distribute water within B.Eydhafushi

## 1.10 Consultants, Contractors and Government Institutions

All the EIA related work is undertaken by consultants from CDE Consulting. Design criteria and technical specifications have been developed by Al Habshi Consultants from Kuwait.

The cost of the EIA and design work is borne by the government. Civil work is funded by OPEC Fund for Development (OFID).

## 1.11 Project Financing

The project financed by the Government of the Maldives and OPEC Fund for Development (OFID).

## 1.12 Scope and Terms of Reference of EIA

The scope of this EIA is broadly based on the Environmental Impact Assessment Regulations 2012. The assessment more specifically adheres to the Terms of Reference (ToR) issued by the Environmental Protection Agency on 30 May 2016. The ToR is based on scoping meetings held between the stakeholders at the EPA. A copy of the ToR is attached in Appendix A.

The EIA report contains the following main aspects.

A description of the project including the need for the project, how the project will be undertaken, full description of the relevant parts of the project, implementation schedules, site plans and summary of project inputs and outputs (*Chapter 1&2*).

A description of the pertinent national and international legislation, regulations and policies that are relevant and applicable to the project and a demonstration of how the project conforms to these aspects (*Chapter 3*)

Information on the baseline environmental condition of the project site; this includes information on marine flora and fauna, marine water quality, marine environment near the project site (*Chapter 4*).

An assessment of the potential impacts during both construction and operational stages of the project as well as identification and cost of the potential mitigation measures to prevent or reduce significant negative impacts during both construction and operation stages of the project (*Chapter 5, 6 & 7*).

Assessment of alternatives for the proposed project (*Chapter 8*)

Details of the environmental management and monitoring plan (*Chapter 9 and 10*).

Stakeholder Consultations (*Chapter 11*)

Potential gaps in information (*Chapter 12*)

Main conclusions (*Chapter 13*)

### **1.13 Summary of Assessment Methodology**

The process followed in the preparation of this EIA report consists of five parts. These are: scoping consultations; literature review; field surveys; analysis of results; and compilation of the assessment in the form of a report.

The first step of the process covered consultations with client and government agencies to determine the scope of the impact assessment. During this stage the client clearly outlined their development needs and assessment was geared to match the development plan and environmental assessment needs. The environmental assessment needs was determined based on the EIA Regulations 2012 and the issues brought forward by the Environmental Protection Agency in the scoping meeting.

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 similar developments in island settings. In this context, the EIA Regulations 2012, best practices from similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The third stage involved field assessment on the island and areas covered by the EIA scope. Conditions of the existing environment were analysed using established scientific methods. The fourth stage involved in house analysis using scientific analysis methods to identify, predict and assess the impacts and alternatives. These methods will be explained in detail in later sections.

The final stage involved compilation of individual consultants' findings.

The methods used in field assessments and impact prediction are summarised in their respective chapters.

### **1.13.1 The Study Area**

The area impacted by projects like these can be quite wide particularly when the socio-economic impacts are considered. The study area of this project considers that the entire island and some areas of the reef system of the island will be affected by the development and that Eydhafushi Island will experience the bulk of the socio-economic change.

Based on the results of the initial scoping of potential environmental impacts and the identification of sensitive aspects of the environment we have identified the following geographical areas likely to be affected at the various stages of the Project:

- During construction temporary and permanent impacts will occur primarily within a 100-200 m radius of the project site. The most direct physical impact will be on-site in the area of the actual physical interventions; particularly the borehole drilling and construction of RO plant facility.
- Secondary impacts are likely within a 100 m radius, particularly from noise, air quality reduction due to cement works.
- Secondary impacts during installation of pipes for water network
- During operation most impacts will be confined to the area that will be affected by construction impacts.
- There will also be induced development impacts due to the project, mainly in the form of positive socio-economic benefits to Eydhafushi island in general.

Study area boundary is presented in Figure 1.3 and survey locations map for the project is attached in Appendix D.



Figure 1.3: Study Area boundary

### 1.13.2 Field Observations

Field assessments were undertaken in Eydhafushi between 13<sup>th</sup> and 14<sup>th</sup> June 2016. Field visits mainly covered water quality, noise measurements around project site, assessment of marine environment and lagoon condition of the proposed project sites. In addition, stakeholder consultations and public consultation were carried out in Eydhafushi during the trip.

#### *Marine Assessments*

##### *Fish Census*

Fish and invertebrates species assemblages and abundance was surveyed using 50 m line transects, whereby the monitor swam along transect and recorded the number and the different species of fish and invertebrates observed within 2.5 m either side of the transect line.

A category-based methodology was adopted to estimate fish abundance and the mean number of fish per category and observation was extracted to estimate species and family abundance. The categories used to estimate abundance is displayed in table 1.2

**Table 1.2 Fish abundance categories**

Category	Number of fish
1	1
2	2 - 4
3	5 - 16
4	17 - 64
5	65 - 256

*Photo Quadrat Survey*

The composition of the substrate was assessed by taking twenty high-resolution images every 5 m (pictures covering 0.5 m<sup>2</sup> of the seabed) along the same transect line used for the fish surveys. These were later analysed using CPCe. CPCe, or Coral Point Count with excel extension, developed by the National Coral Reef Institute, is software designed to determine coral community coverage and diversity using transect photographs. Underwater photographic frames are overlaid by a matrix of randomly generated points, and the fauna/flora of species or substrate type lying beneath each point is identified. 20 random points per picture were analysed to characterize the substrate composition (sample size: 200 points per transect).

*Visual Snorkelling Survey*

Visual snorkelling surveys were carried out at select locations of the lagoon. General status of these sites were recorded, special attention was given to types of corals and fishes present at these sites and the environmental conditions that could affect growth such as suspended solids, depth, and other threats to coral life.

*Terrestrial Assessments*

Terrestrial assessments were carried out on 13<sup>th</sup> – 14<sup>th</sup> June 2016, and the weather conditions during this period is shown in Table 1.3 below.

Factors	13/06/2016	14/06/2016
<b>General:</b>	Clear	Drizzle
<b>Temperature:</b>	31 °C	30 °C
<b>Wind (Direction):</b>	W	W
<b>Wind (Speed):</b>	11 mph	16 mph
<b>Humidity:</b>	75%	75%

### *Flora*

The vegetation of the site was studied using ground observations. Vegetation types along the observation walks were recorded for their abundance, types of species and successional patterns.

### *Fauna*

Terrestrial fauna was not surveyed in detail as the occurrence of fauna was found to be minimal during the brief survey period. However, based on similar conditions found elsewhere in the Maldives, and local accounts on species found at the location, an approximate list of the faunal species have been compiled.

### ***Water Quality***

Water quality was assessed from MWSC laboratory. Marine water quality samples were taken at two locations (proposed and alternative outfall). Parameters measured include electrical conductivity, total dissolved solids (TDS), salinity, pH, temperature, dissolved oxygen (DO), Biological Oxygen Demand, Total Coliform and Faecal Coliform. Groundwater samples were taken from two locations around the proposed site for tubewells.. Parameters measured include temperature, pH, salinity, conductivity and Total Petroleum Hydrocarbon. Samples were collected in clean 1.5L PET bottles, sterile glass bottles and sterilized bags.

### **1.13.3 Desk Study Review**

A literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2012, best practices from similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The literature review comprised of, but is not limited to, the following:

- EIA for Water Production and Supply System in M.Dhiggaru
- EIA for Water and Sewerage Project in Fuvahmulah
- EIA for Water and Sewerage Project at S.Hithadhoo
- Island development plans of B.Eydhafushi
- Atoll Development Strategic Plan for Baa Atoll

- Relevant regulations, including Environmental Protection and Preservation Act, Environmental Impact Assessment Regulation and Desalination Regulation.

#### **1.13.4 Public and Key Stakeholder Consultation**

Stakeholder consultations were undertaken with the following stakeholders:

- Eydhafushi Island Council
- Eydhafuhsi FENAKA Office
- Eydhafushi public
- Ministry of Housing and Infrastructure

#### **1.13.5 Data Analysis**

The EIA experts used their experience and knowledge in their respective fields to analyse the data from the previous studies and field visits in order to determine the potential impacts of the proposed projects, the severity of effects arising from these impacts and how any adverse impacts can be best mitigated and positive impacts enhanced. This analysis provides the framework for the recommendations on corrective actions and remedial measures and provides the basis for the formulation of the environmental management plan which forms part of this report EIA

#### **1.13.6 Report Format**

The report format and structure presented here follows the report formatting guidelines issued by EPA.

### **1.14 Study Team Members**

The team members of this EIA are;

Dr. Ahmed Shaig (Lead Author and Coastal Environment Consultant)

Mr. Ahmed Faizan (Marine Environment Specialist)

Ms. Shahdha (Socioeconomic impact assessment)

Ms. Hana Saeed (Stakeholder consultations)

Mr. Ali Nishaman Nizar (Terrestrial Environment)

Mr. Ali Moosa Didi (Marine Assessments and Social Assessments)

Mr. Mohamed Ali (Marine surveying Social Assessments)

Mr. Ahmed Haiman Rasheed (Field Assistance)

The curriculum vitae's of the EIA consultants are attached in Appendix G of this report.

## 2 PROJECT DESCRIPTION

### 2.1 Project Outline and Project Site Plan

The proposed site plan and required land use permits are presented in Appendix B. A Reduced version of the site plan is provided in Figure 2.1 below.

This project involves the construction and operation of:

1: Construction and installation of Reverse Osmosis water systems.

*Key activities include:*

- Construction of tube wells to supply raw water for the RO plants
- Construction of plant building
- Installation of 2 x 8,000 litres/hour reverse osmosis desalination plant
- Installation of 62 m<sup>3</sup> filtered rainwater GRP tank
- Installation of 1295 m<sup>3</sup> groundwater feed tank
- Installation of 62 m<sup>3</sup> mixing tank
- Installation of 185 m<sup>3</sup> desalinated water tank
- Construction of brine discharge outfall
- Connection to households

2: Rainwater harvesting and distribution

*Key activities include:*

- Preparation of catchment areas
- Establishment of rain water treatment system
- Installation of 493m<sup>3</sup> rainwater tank
- Laying of separate pipe networks for water distribution and rain water collection

The main components of the project are:

1. Procurement of materials
2. Mobilization
3. Site preparation (equipment setup and storage facilities)
4. Civil works
5. Water pipeline networking for both desalination plant and harvested water
6. Construction works

7. Mechanical and electrical work
8. Finishing
9. Testing and commissioning
10. Demobilization

The next section provides the details of the project components

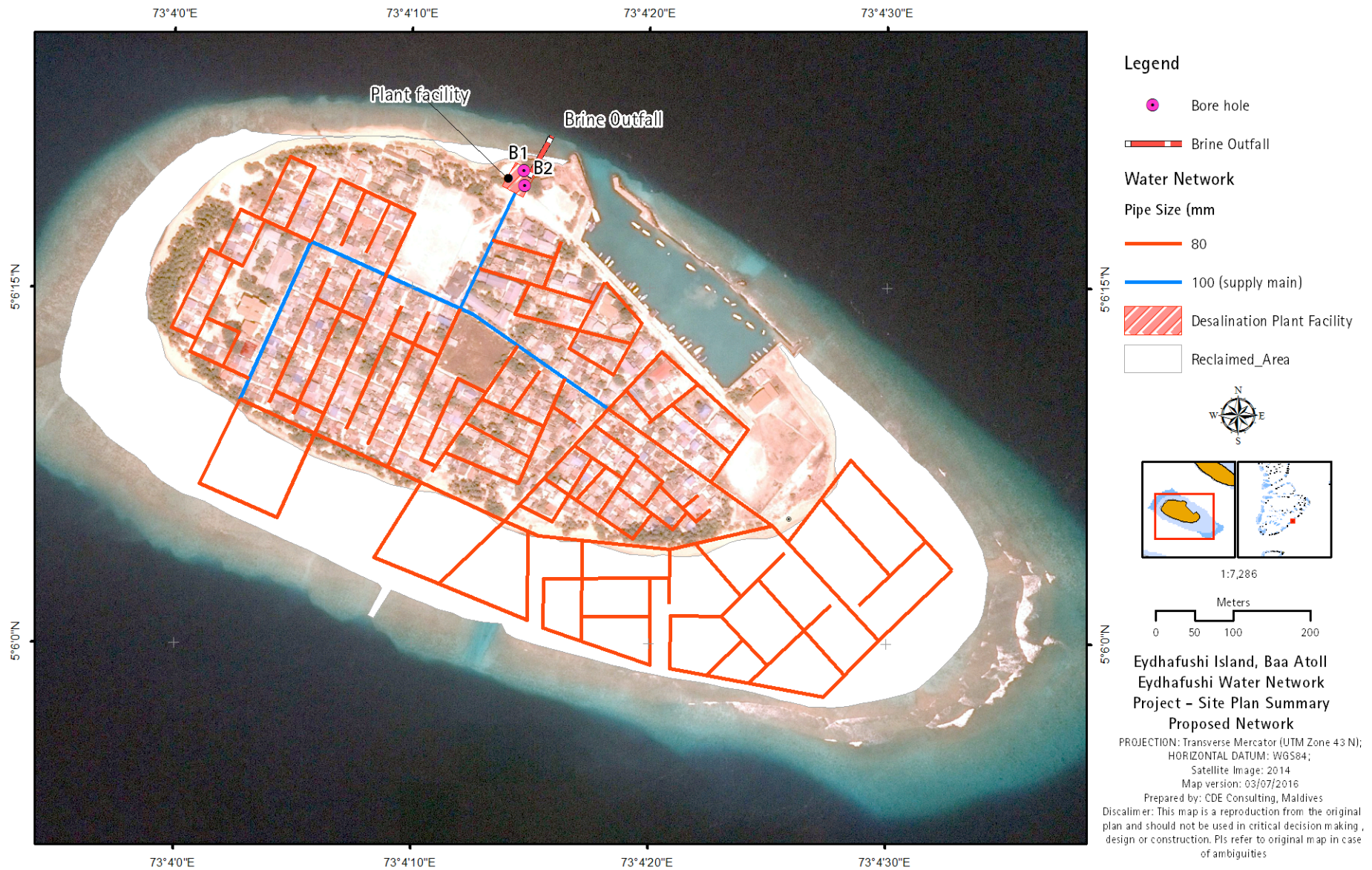


Figure 2.1: Project water supply network site plan summary



Figure 2.2: Project rainwater network site plan summary

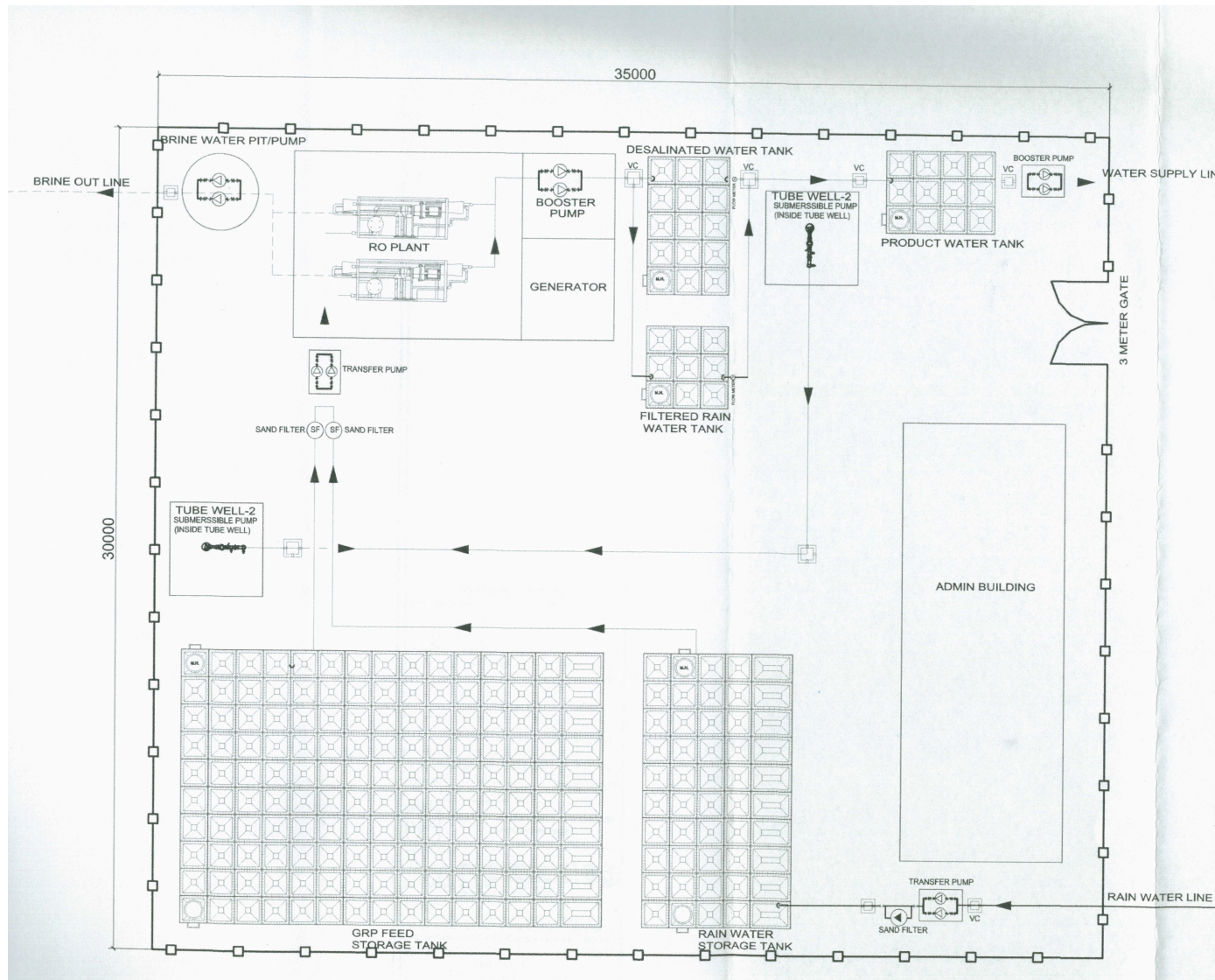


Figure 2.3: Desalination facility layout

## **2.2 Detailed Project Outline and Work Methodology**

### **2.2.1 Scope of Works**

This project is being undertaken on a Design and Build basis. As noted above, the project mainly involves installation of an integrated water production and supply system covering an RO plant and associated infrastructure, and rainwater harvesting facilities.

### **2.2.2 Site Preparation**

Proposed sites for RO plant is a reclaimed area, hence the site is already cleared and no additional work is required for site clearance.

All pipelines will be laid along the roads and no large trees will need to be removed for this purpose.

### **2.2.3 Mobilization of equipment**

No special equipment or materials are planned to be used for construction. Standard building and construction material will be used.

All site mobilisation and construction related activities will be undertaken in a planned manner. A temporary site office and the necessary facilities for preparatory works will be constructed at the initial phase of the project.

The materials used will include main line pipes and branch pipes made of PE, fittings and necessary valves, water storage tanks, interconnecting pipes, transfer pumps, power supply, wiring accessories and RO plant.

#### ***Construction Equipment and Fleet***

The likely construction fleet will consist of the following:

- Compactor
- Excavator
- De-watering pump
- Concrete mixing machine
- Backhoe loader
- Truck
- Pick-up
- Crane Lorry

- Mobile Generator
- Petrol Pump
- Butt Welding machine
- Electro Fusion Machine
- Total Station Survey Equipment
- Pressure testing equipment
- Dumpy level
- Tractor

Heavy machinery is unlikely to be required for this component, except during transportation of RO plant.

### **2.2.1 Design Considerations**

After considering various options in the context of availability of source water, an integrated rainwater collection system and water desalination system through RO plant is considered as the best option for providing a sustainable source of freshwater in Eydhafushi.

#### **2.2.1.1 Existing Water Sources and Quality**

##### ***Groundwater***

Currently water is obtained from shallow wells constructed in the facilities or in public areas (e.g. a mosque). The freshwater lens is quite thin, and can therefore become saline quite rapidly if abstractions exceed the sustainable yield. For these reasons, rainwater has become the main source of drinking water for the vast majority of islands. These methods provide inadequate quantity and unacceptable quality due to the over abstraction and the unreliability of rainwater harvesting. Details of the existing levels of pollution are presented in the Existing Environment.

##### ***Rainwater***

Rain water harvesting is traditionally practiced in the islands as a major source of water used for drinking. However, exceptional care in collection is needed to ensure that the surfaces from which the water is collected are kept clean and free from detritus which can pollute the water. However based on the present practice, even with the utmost care water supplied from this method cannot be considered totally safe for potable use.

### **2.2.1.2 Water Demand**

Determination of design capacity is a prerequisite to begin the design of water supply facilities. Accordingly, the design period, estimated population, commercial and industrial growth, estimation of the unit water use, and estimation of the variability of the demand were taken into account when designing the capacity of the proposed water production and distribution project.

The design consideration for the proposed water supply was based on the following:

- Current population
- Growth ratio
- Projected population for 35 years
- Per Capita Consumption (PCC)
- Daily Operation duration of RO plant
- Total water required

### **2.2.1.3 Plant Sizing Criteria**

Factors taken into account in determining the size and layout of the plant are:

- Number and size of process units
- Number and size of ancillary structures include administration building, pumping facilities and storage
- Provision for expansion
- Connection to the water distribution system, and
- Residuals handling system.

### **2.2.1.4 Site Location Criteria**

Criteria for site selection include:

- Land availability
- Potential for expansion
- Proximity to lagoon
- Proximity to rainwater catchment area

Other issues considered include:

- Waste disposal options
- Public acceptance
- Security

## 2.2.2 Concept of RO plant and Rainwater Harvesting System

### 2.2.2.1 Operation of RO Plant

#### *Intake Design and Method*

Water intake will be through two tube wells located in the vicinity of the RO plant building. The benefit of using tube wells is that it allows certain amount of filtration and it also eliminates difficult engineering design to establish intake structure in the sea. Tube well will be designed for a 15-year sustainability period.

Two tube wells will be drilled to a depth of 32 m and will have a diameter of 50 cm. Figure 2.1 and 2.3 shows the location of the tube wells that will be installed. Two submersible raw water pumps will be installed inside the tube well with the capacity to pump 17 m<sup>3</sup> of water per hour can raise water up to a height of 61.09 m. Table below summarises key design features of the tube well.

*Table 2.1: Summary of key features of tube well*

<b>Total input for RO plant</b>	32,800 Litres / hour
<b>Safe yield</b>	4.5 Litres / second
<b>No. of tube wells</b>	2
<b>Capacity of tube well pump</b>	17 m <sup>3</sup> / hour
<b>Depth of tube well</b>	32 m
<b>Diameter of tube well</b>	30 cm
<b>Thickness of housing pipe (steel)</b>	9 mm
<b>Diameter of housing pipe</b>	30 cm
<b>Length of Housing</b>	51.5 m
<b>Length of blind pipe</b>	10 m
<b>Diameter of blind pipe</b>	25 cm

#### *Method of constructing tube well:*

- Temporary light post will be fixed to illuminating working area. Land survey will be conducted with accuracy to find out the exact location of the borehole as per engineering drawing.
- Location of the tube well will be worked out from the approved drawing and marked on the top of the existing ground profile. Drilling will be carried out at these marked locations. An area surrounding the drilling location will be cleaned before set up of drilling machine.

- Two mud pit will be made by using shovel and spade in front of drilling location and connected to each other by a drain and canvas lining, to prevent fluid loss.
- Drilling mud will be prepared by mixing of bentonite with water. Thickness of the mud will be controlled as per the strata encountered during drilling. As far as possible the least amount of bentonite will be used to retain the natural condition of aquifer. Commercial bentonite, fine grained, impervious with at least 50% bentonite and 0.5 mm maximum size of remaining portion will be used.
- Reverse circulation will be employed to drill the holes of the required size and depth.
- Samples of no less than 500 grams will be taken from stratum at every 3 m or often where the stratum changes. At least 1 kg of samples of all aquifer materials in proper sample boxes or bags will be handed over to Engineer for mechanical analysis.
- The well be developed by compressed air, surge block or pump and it will be done in a manner that does not cause undue settlement and disturbances of the strata. The well will be developed either by surging and agitating or by over pumping and backwashing with an airlift and high velocity jetting. This development will be continued until the stabilization of sand and gravel pack has taken place.
- Contractors will ensure that the slotted pipe strainers are lowered in the well at the places indicated in the design. The contractor will check that the joints in pipes are rigid, water tight and free from kinks. Immediately after lowering the well assembly, a chart will be made displaying aquifer positions in the bore and the location where both slotted pipes or strainers have been placed.
- A temporary surface casing will be furnished and installed to support the walls of the larger well bore where the grout surface seal is to be placed.
- Where submersible pumps are to be installed for plumbness and ailment of wells, axis of well will not deviate from vertical position and alignment will be such that a 20 foot plummet will pass all sections of the well easily. Where line shaft turbines are to be installed, axis of well will not deviate from vertical position by more than half of the casing inside diameter for each 100 feet of depth. The casing alignment will be such that a 40 plummet will pass all sections of the well easily.
- Portland cement with a maximum of 6 gallons of water per sack of cement, Bentonite clay up to 5% will be used to shut off unsatisfactory water horizons or to stabilise caving formations. Grout will be placed using a grout pump and tremie.
- Permanent casing of the well will not extend more than 18 feet below the ground surface. Centring guides will be used to keep the permanent well casing centred in the oversize drill hole.
- The grout surface seal will be constructed in the presence of an engineer. Annular space between permanent well casing and drill hole will be completely filled and sealed with

cement grout to comply with applicable state regulations. Annular space will be drilled a minimum of 4 inches in diameter larger than the nominal diameter of the permanent well casing and at least 18 feet below ground surface.

- All temporary surface casing will be removed as the annular space is filled with grout. Alternatively, the temporary surface casing will be removed immediately after the grout has been placed but no later than ½ hours after initial introduction of grout into the hole.
- Grout surface seal will be completed by topping off the fresh grout after settlement occurs and within ½ hours after initial placement of the grout surface seal.
- Permanent casing will be installed using joints where joining segments together using arc welder. Casings will be welded to form continuous, watertight casings.
- Well screen will be installed using the pull back method.
- The well is developed either by surging or air jetting after the well screen has been installed or the casing has been perforated.
- Development will be carried out with raw hiding method for 18 hours using turbine pump till water is cleared of sand in six steps each of three hours. A multi step test will follow development of 12 hours in six steps with each step at 2 hours.
- Professionals will supervise drilling and testing of tube well throughout the process. The results of the drilling and testing will be recorded and completed by the contractor and submitted in the form of a report which will include daily job record details, drilling record, geological time log and casing program.
- Pumping test will be conducted and water samples will be tested for parameters pH, EC, temperature, taste, odour, color and sand contents.
- Upon completion of well, a 3/6 inch steel plate will be welded, approximately ½ inch larger in diameter than casing over the cut off casing top. The steel plate will be welded in four places around the casing.
- The well be cleaned upon completion by removing foreign substances and if required swabbed with alkali to remove oil and grease. The well will also be disinfected with chlorine solution of sufficient strength to provide a 50mg/L chlorine residual in all parts of the well.

### ***Feed Water Storage Tank***

Water drawn from the tube well will be transferred to a 1,295 m<sup>3</sup> GRP storage tank. The storage tank is designed for a period of 15 years. The tank will be 6 m above ground level and measures 22 m by 10 m.

### **RO Plant Design**

The location of the RO plant was identified following consultations with island community and officials of the island office. The final location approved by Ministry of Environment and Energy consists of 1,500 sqm area located on the north western side of the island next to the harbour. The building housing RO plants also includes facilities such as office space, laboratory, generator room, equipment storage, vehicle parking space and electrical mechanical instruments repair workshop. See Figure 2.3 for site plan.

Desalination plant will consist of one building that house the pumping station, the pre-treatment and post-treatment line and desalination unit. Additional facilities include product water tanks, elevated tanks, office buildings, fence and gate. Two RO plant systems will be installed with a capacity of 8,000 litres/hour. Table below summarizes key features of one RO plant.

**Table 2.2: Summary of key features RO Plant**

<b>Input capacity</b>	19,500 Litres / hour
<b>Output capacity</b>	8,000 Litres / hour
<b>Brine output</b>	11,500 Litres / hour
<b>Working hours</b>	12 hours

The site plan of the proposed RO building is presented in Figure 2.3.

RO plant system consists of primary treatment unit, a pump to apply pressure, tubular units fitted with semi-permeable membrane for separation and a fresh water collection tank for onward distribution network. Following primary treatment water is subjected to RO treatment plant where salt water is pumped with high pressure through semi-permeable membranes. These membranes are made of synthetic materials that only allow water to pass through leaving salts and contaminants behind in a solution called brine. After one stage of reverse osmosis process, a post treatment process further refines product water. The post treatment processes include disinfection, media filtration, UV filtration and cartridge filtration. Disinfection of the product water will be by chlorination prior to distribution. Chlorine is added to control biological activity in the product water storage, transmission, and distribution systems. Product water from RO plant will be pumped to the desalinated water tank after post treatment. Product water quality can also be improved by adding a second pass of membranes, whereby product water from the first pass is fed to second pass.

The desalinated water tank is a 185 m<sup>3</sup> GRP tank measuring 13 m by 3 m. The tank will be elevated 5 m above ground level. The RO plant is also fed with rainwater during the wet seasons and water from tube well during dry seasons.

### **Brine Water Collection and Disposal**

An optional brine storage tank is proposed in the concept design of the RO plant. The capacity of the storage tank will be 46 m<sup>3</sup>.

The RO plant will operate on an estimated 40% product water recovery; hence with 60% brine output. A total volume of 23,000 Litres of brine will be produced from the two RO plants per hour. The pumping machinery has the capacity to pump 35 m<sup>3</sup> of brine water per hour and total length of brine water pumping line will be 180 m. The brine outfall is proposed to be located on the northern side of the island at a distance of 70 m from the site. An HDPE pipe will be used for brine outfall with a diameter of 80 mm.

#### **2.2.2.2 Rainwater Harvesting System**

##### **Catchment Areas**

The total roof area for the community buildings in Eydhafushi is 627 m<sup>3</sup> and storage is 100 m<sup>3</sup> as per assessment conducted by Ministry of Housing and Environment and Water Sanitation Department in 2011. Assuming no increase in the catchment area for the community buildings as per the new Land Use Plan, the expected catchment area remains the same, 627 m<sup>3</sup>. Currently, Eydhafushi has two buildings where roof are being used for rainwater harvesting and which can be used for this project. Details of the buildings and rainwater harvesting capacity are listed in the Table below.

**Table 2.3: Community buildings with rainwater tanks**

<b>Location</b>	<b>No. Of tanks</b>	<b>Volume (m3)</b>
Masjid Mueenuhdheen	7	35
Masjid Yoosuf	2	5

The total rainwater storage available from these buildings is 40 m<sup>3</sup>.

There are a number of other public/government buildings in the island which can be used for rainwater harvesting under this project. Table 2.4 below is a list of these buildings.

**Table 2.4: List of public/government buildings in Eydhafushi**

<b>No.</b>	<b>Location</b>	<b>No.</b>	<b>Location</b>	<b>No.</b>	<b>Location</b>
1	Eydhafushi Council Office	13	Medhu Avashu Anhenunge Miskiy	25	Dhiraagu Building
2	Baa Atoll Council Office	14	Irumathee Avashu Anhenunge Miskiy	26	Bank of Maldives Building
3	Baa Atoll Thauleemee Markaz	15	Baa Atoll House	27	Media Centre
4	Baa Atoll Hospital	16	Theyoge (Oil Building)	28	Police Station
5	Bahiyaa Pre-School	17	Roashan Hiya (Council Guest House)	29	STO Shop
6	Villa College Eydhafushi Campus	18	Eydhafushi Power House	30	Dhandhiffaru
7	Vafaa Jamuiyya	19	Existing Water Plant House	31	Kulunu vehi (TRC)
8	Eydhafushi Magistrate Court	20	Stage House	32	Dhanaalu (Boarding House)
9	Eydhafushi Family and Children's Service Centre	21	Youth Centre	33	Biosphere Reserve Office
10	Mariyaadhuge	22	Ooredoo Building	34	Prosecutor General's Office
11	Maarana 1 – Post Office	23	Maarana 2 - Bank of Maldives	35	Multi-purpose Building

**Rainwater Collection Network**

Rainwater from catchment areas and roofs are collected from gutters by downpipes (PVC) 75mm. Leaf screen filters installed in the gutters will prevent the debris from entering the system.

A first flush device will be installed on the conduit of the down pipe before it is connected to the rainwater collection network. It is a critical feature of the rainwater harvesting system to improve rainwater quality and help prevent pollution of tank water. When fitted upstream of a First flush device, the rain heads will prevent leaves, debris and other organic matter away from the flow of water. The First Flush Diverter then ensures that heavy sediments and other finer pollutants are captured in the diverter chamber. A manual/semi-automatic first flush device will be provided on the down pipe as per requirements. See Figure 2.4 for a First flush device.

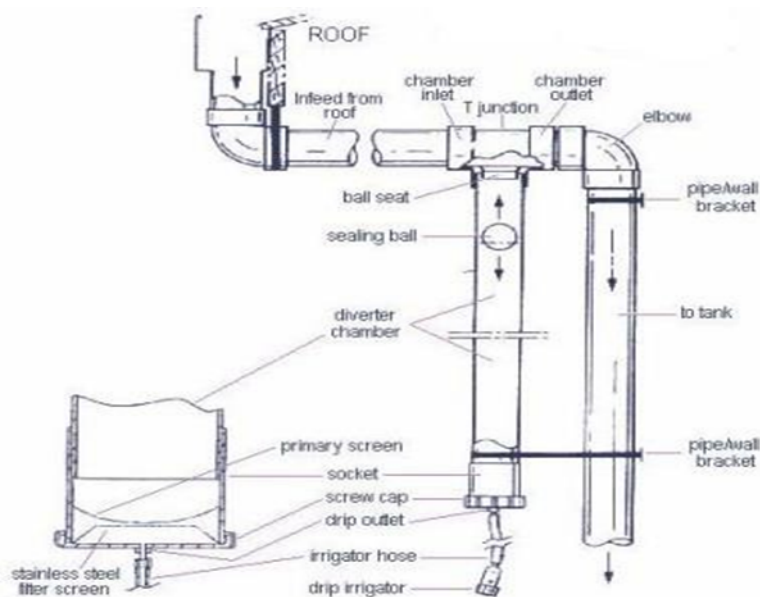


Figure 2.4: First Flush Device

The piping network consists of 75 mm size HDPE pipes according to ASTM standard. The total network is designed such as it should be able to collect rainwater from all the public catchment areas through gravity.

The rainwater collected from catchment areas will be first pumped to a 493 m<sup>3</sup> GRP tank measuring 8 m by 10 m. The collected rainwater will then be filtered via filter feed pump and media filter before entering the filtered rainwater tank in the RO plant house. The filtered rainwater tank is a 62 m<sup>3</sup> GRP tank measuring 6 m by 3 m. The tank will be positioned 6 m above ground level. The water in this tank will be chlorinated to make it safer for drinking purpose.

### 2.2.2.3 Integrated Water Supply System

#### Product Water Tank

Product water from RO plant will be filtered and discharged into desalinated water tank and rainwater from main rainwater storage tanks will be discharged into filtered rainwater tank. A mixing tank or product water tank of capacity 62 m<sup>3</sup> will be installed in the RO plant house where incoming water from desalinated water tank and rainwater tank will be mixed. Flow meters are installed on the lines leading to the mixing tank where the water mix ratio of 3:1 (RO water to Rain water) will be maintained.

### ***Booster Pump***

Product water from integrated water supply system will be pumped from the product water tank to the main water supply line via a booster pump. Two booster pumps will be installed with one acting as a back-up. Each booster pump will have the capacity to pump 31 m<sup>3</sup> of water per hour and can raise water up to a height of 39 m.

### ***Pipe Network***

Water supply pipeline network is designed in loop. The main supply network loop will be 100mm HDPE pipes and sub lines of 80mm diameter HDPE pipes. Each household connection in Eydhafushi will be provided with a piped connection to the boundary wall and will include a water meter at all drawing points. Household connections will be using 18 mm pipes. The pipelines of the water distribution network are proposed to be buried to a depth of 600 mm requiring a maximum excavation depth of 1 m approximately.

The total network is designed such as it should be able to deliver constant flow, with minimum head of 25 m at the furthest point at all times. Valve chambers are provided at each junction of main line and sub lines to ease service and maintenance. The pipeline network is designed to cover the whole island including houses and institutional buildings according to land use plan. Hence, authorities can make individual connections easily as per future demand.

The system developed for Eydhafushi is designed in accordance with international standards and for a flow of 35 years projected population.

### Integrated Water Supply Network

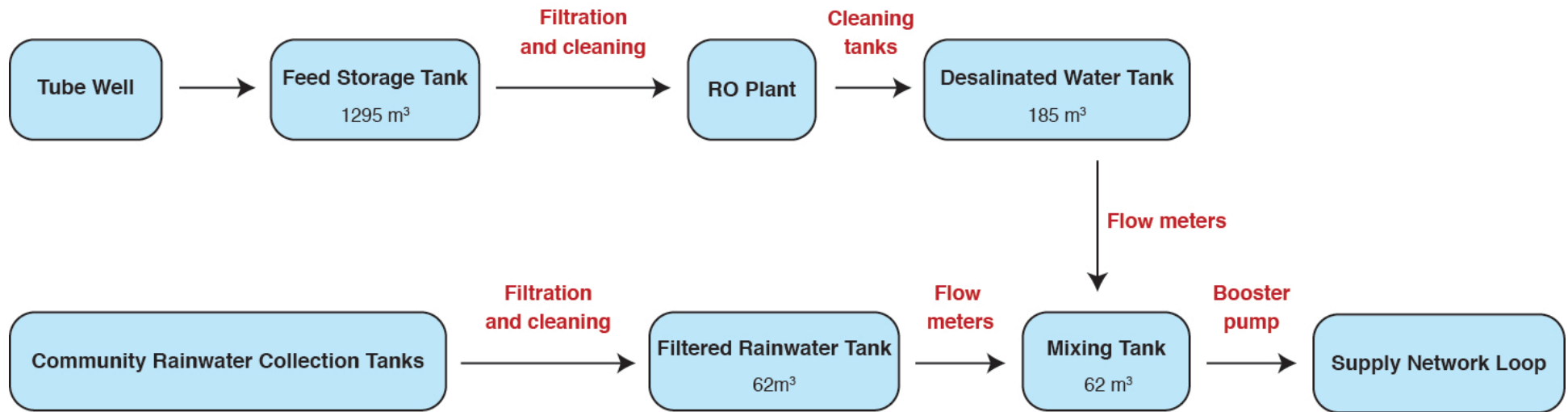
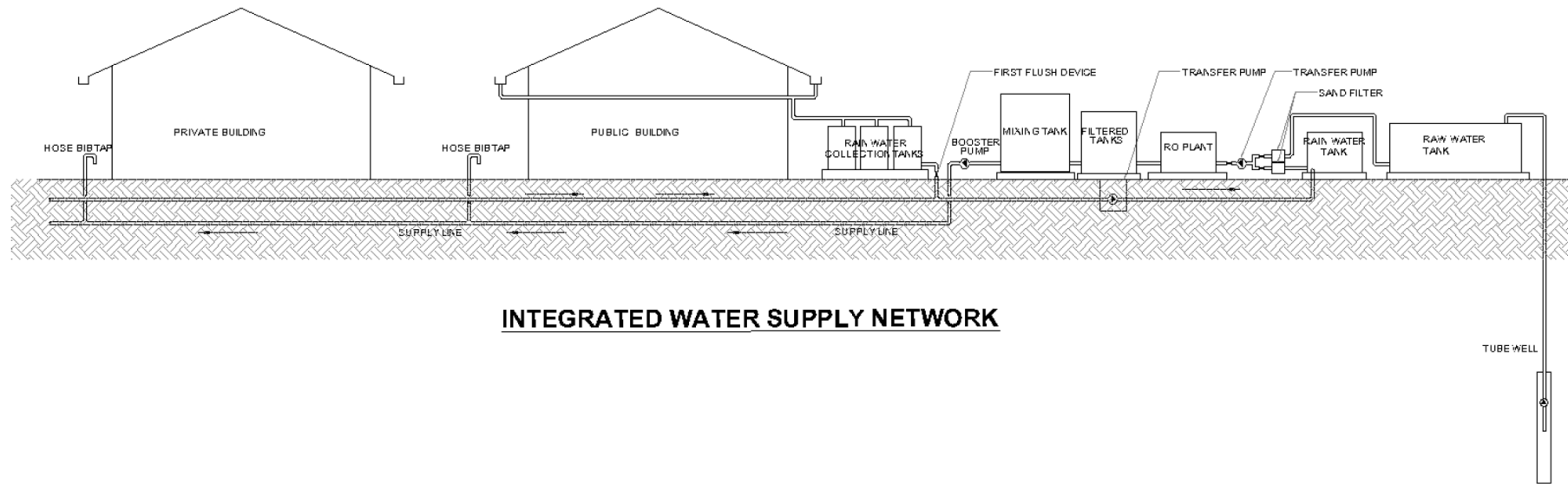


Figure 2.5: Flow chart of water supply network



**INTEGRATED WATER SUPPLY NETWORK**

*Figure 2.6: Proposed integrated water supply network for Eydhafushi*

### 2.2.2.4 Water Quality

The product water will be according to standards defined by EPA Maldives. The design of the RO plant will be based on the conditions specified in the table below.

*Table 2.5: Treatment level of RO plant*

Ions	Feed water to RO plant	Product water from RO plant
Ca	448	0.6
Mg	1330	1.78
Na	11400	89.15
K	383	3.88
NH <sub>4</sub>	0	0
Sr	0.1	0
Ba	5.8	0.01
Fe	0	0
Mn	0	0
CO <sub>3</sub>	0.5	0
HCO <sub>3</sub>	132	1.88
SO <sub>4</sub>	2940	3.5
Cl	20600	143.6
NO <sub>3</sub>	0	0
SiO <sub>2</sub>	1	1.01
CO <sub>2</sub>	2.66	2.63
TDS	37240	244.41
pH	7.5	6.5
Hardness	6595.82	8.83

The proposed desalination plants can produce fresh water from salt water with TDS of 37,000 ppm. The water produced from the plants will have a quality TDS <300 ppm.

### 2.2.2.5 Excavation, Dewatering and Pipeline Installation

Pipeline for the proposed water supply distribution network will be installed at 600 mm from ground level. Dewatering depends on the water table levels. It is expected that only minor dewatering will be required in low areas during construction and installation of distribution pipe. The water tables lie on average between 0.5 m below ground levels.

All water removed during dewatering will be discharged back into the water table as outlined in the EPA guidelines.

Leakage test will be conducted on the whole network after installing the network prior to commission of water supply services.

### 2.2.2.6 Water Quality Management

The quality of product water will be monitored regularly on site and from the MWSC Laboratory according to the requirements of the Maldives Desalination Regulation. These are further elaborated in the Monitoring Programme given in this EIA.

### 2.2.2.7 Projected Water Demand

The water supply network for the proposed project has been designed for a projected population of 35 years. Current population of Eydhafushi is 3217 and at a growth rate of 1.3% per annum and another 10% added for migration, projected population for 35 years is 5561. Assuming water consumption rate at 20 Litres per day per person, average water demand will be 111, 220 litres per day. Total maximum daily requirement is calculated based on the following.

*Table 2.6: Projected water demand calculation for 35 years*

<b>Projected population for 35 years</b>	5561
<b>Water consumption</b>	20 litres per day per person
<b>Average day demand</b>	111,220
<b>Average institutional, commercial and industrial demands</b>	117,925 litres per day
<b>Peak daily demand</b>	25,0245 litres per day
<b>Total daily demand</b>	368,170 litres per day

As per the calculations, total daily demand for a 35 year period will be 368,170 litres per day. Assuming that the RO plant will be operating for 8 hours a day, total demand pre hour will be 46,021 litres.

Storage system for freshwater produced from the system is designed for a 15-year period. Accordingly, a total of 185.1m<sup>3</sup> of freshwater and 61.7 m<sup>3</sup> of rainwater is required in Eydhafushi per day. To facilitate this and as per the requirement of EPA, 7 day storage tanks for both freshwater and rainwater will be installed. The 7-day storage system is also designed to reduce supply disruption.

### 2.2.2.8 Renewable Energy Source

Renewable energy sources are considered for the operation of the water supply system in Eydhafushi. Accordingly, roof area of the administrative building and RO plant building are considered for installation of Photo Voltaic (PV) Panels. Area of the roofs assessed for the installation of Photo Voltaic Panels was 176.24 m<sup>2</sup>. The total power requirement for the water

supply system is 1,079 KWhr/day. With an area of 176 m<sup>2</sup>, output for PV system is estimated as 558.2 KWhr/day which is 51.7%.

### 2.3 Project Schedule and Life Span

Mobilisation for the project will begin after the EIA is approved. It is anticipated that the completion of the whole project will take approximately 18 months.

Preliminary schedule is given in Appendix E and a summary is given in Table 2.7 below.

*Table 2.7 Summary of schedule for water component*

Project Activity	Est. Starting Date	Est. Duration (Days)
Site Mobilization for construction	15 <sup>th</sup> November 2016	30
Civil works	15 <sup>th</sup> December 2016	524
Testing, commissioning and handover	15 <sup>th</sup> May 2018	16

### 2.4 Labour Requirements

On average, 35 people will be involved in construction every month for the project period of 18 months.

### 2.5 Waste Management, Logistics and Safety Measures

#### 2.5.1 Construction Waste Management and Disposal

Waste will be generated from construction activities and from material consumption by construction workforce, green waste from site clearance, excavated material and construction debris. All excavated material will be used while laying out water connection pipe network. Dredge material will be used to fill the trenches once the pipeline is installed. Both unusable green waste and general domestic waste will be disposed at Eydhafushi Waste Management Centre as designate by Eydhafushi island Council. All substantial packaging and construction waste will be transferred to Vandhoo waste management centre by the contractor.

Small amounts of waste oil may be generated from the operation and maintenance of vehicles. All waste oil will be disposed as per the approved standards of the Environment Ministry.

#### 2.5.2 Pollution and Emission Control Measures

The following measures will be taken to ensure minimal pollution during construction stage.

- Machinery will be properly tuned and maintained to reduce emissions and minimize risk of spills/leaks.

- All paints, lubricants, and other chemicals used on site will be stored in secure and banded location to minimize risk of spill.

### **2.5.3 Sediment Containment and Turbidity Control Measures**

The proponent is committed to prevent any sedimentation of the reef system from this proposed project. The following specific measures will be undertaken during the project.

- Undertake dredging work for brine discharge outfall during calm weather conditions.

### **2.5.4 Health and Safety Measures**

- 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.
- Fire extinguishing equipment would be readily available and employees will be trained in its use. In general, water-based fire extinguishers would be used.
- Oxygen, acetylene or LPG bottles will not be left free-standing. All welding and cutting will be done in accordance to high safety regulations by experienced personnel.

### **2.5.5 Utilities**

Water, Electricity and sanitation facilities will be provided for construction workers from the existing facilities on the island. A generator is also installed in the RO plant house as a back-up. Approximately 50% of the power for the operation of RO plant will be sourced from photovoltaic system.

### 2.5.6 Labour Camps

Accommodations for the construction workforce will be provided on existing accommodation facilities on the island. Approximately 12 rooms will be required for worker's accommodation.

### 2.5.7 Equipment and Materials Storage

Equipment and materials will be stored either on-site or a site identified by the island council. Chemicals required for operation of RO plant will be stored in the Administrative building or RO building premises.

## 2.6 Summary of Project 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 2.8 and the type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 2.9

*Table 2.8 Major Project Inputs*

<b>Input resource(s)</b>	<b>Source/Type</b>	<b>How to obtain resources</b>
Construction workers	Local and foreign	Recruiting agencies, etc.
Engineers and Site supervisors	Local and foreign	Contractor's employees or by announcement
Construction material	Electrical cables and wires, DBs and MCBs, PVC pipes, light weight concrete blocks, reinforcement steel bars, sand, cement, aggregates, PVC conduits, floor and wall tiles, gypsum boards, zinc coated corrugated metal roof, paint, varnish, lacquer, thinner...etc	Import and purchase where locally available at competitive prices – Main Contractor's responsibility.
Water supply (during construction)	Bottled water, ground water and rain water	Purchased from local businesses; contractor equipment
Machinery	Excavators, trucks, concrete mixers, etc	Contractor's machinery or hire locally where available
Maintenance material	Maintenance parts and fluids required for the machinery and piping.	Import or purchase locally where available
Food and Accommodation	Existing houses or purpose built accommodation	Contractor's equipment or hire locally
Firefighting equipment	Fire Extinguishers...etc.	Contractor's equipment
Fuel	Light Diesel, Petrol, Lubricants	Local suppliers
Food and beverage bottles	PET bottles, glass bottles, packaging waste, plastic bags	Contractor's equipment

Input resource(s)	Source/Type	How to obtain resources
<b>Operation</b>		
Electricity supply	Diesel	Local power supply system and generator set in the RO plant house
Operational staff	Local	Contractor's employees or by announcement
Raw water	Saline underground water and harvested rain water	From tube well and from local roofs

**Table 2.9: Major Project Outputs**

Products and waste materials	Anticipated quantities	Method of disposal
Excavated earth	Moderate quantity	Used while laying out water distribution pipe network.
Waste oil	Small quantities	Barrelled and sent to Vandhoo waste management site during demobilisation.
Hazardous waste (diesel)	Small quantities	Barrelled and sent to Vandhoo waste management site during demobilisation.
Noise	Only localised	Excavator and truck operation will be noisy. No option available.
Food waste	Small quantities	Managed under existing waste management system of the island
Plastic and packaging wastes	Small quantities	Managed under existing waste management system of the island
<b>Operation</b>		
Brine	Large quantities	Discharged through the ocean outfall

## 2.7 Demobilization

The proponent advocates a phased demobilization plan to commence in the last week of the contract. Machinery transported from Male' will have to be demobilized on one specific date.

## 2.8 Maintenance during Operation Phase

During the first operational year, the facility and all contributing components will be maintained by the contractor. However, after the first year of operations, the facility will be handed over to Ministry of Environment and Energy. Then on the ministry would take the decisions on whom to run the facility. During the construction period and the first year of operations, the contractor would train locals from the island for various jobs associated with the facility.

### **3 POLICY AND LEGAL FRAMEWORK**

These legal and policy provisions have to be fully respected in carrying out the proposed development. All contractors and sub-contractors will be informed of these requirements. This project conforms to all relevant laws and regulations of the Maldives.

#### **3.1 Relevant Environment Legislation**

##### **3.1.1 Environment Protection and Preservation Act (Act no. 4/93)**

The Environmental Protection and Preservation Act (4/93) enacted on 19 March 1993 is the framework law related to environment protection in the Maldives. The authority responsible for the Environment Act is the Ministry of Environment and Energy.

Articles 2, 4, 5, 6, 7, and 8 of the law are relevant to the Eydhafushi water supply system Project.

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

*The project developers and contractors shall abide by any guidelines or advice given by the concerned Government authorities for the project.*

Article 4 states that the Ministry of Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protections and preservation.

*The project developers and contractors shall ensure that there is no negative impact from the proposed project on sensitive environments in the vicinity or protected species.*

According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment.

According to Article 5 (b), The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

*This report is prepared to fulfil this clause.*

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

*All project developer and contractors shall be aware of this provision and contractors shall take all practical measures to ensure there is no irreversible and significant negative impact of the projects on the environment*

Article 7 of the EPPA (4/93) states that any type of waste, oil, poisonous gases or any substances that may have harmful effects on the environment shall not be disposed within the territory of the Maldives. In cases where the disposal of the substances becomes absolutely necessary, they shall be disposed only within the areas designated for the purpose by the government. If such waste is to be incinerated, appropriate precaution should be taken to avoid any harm to the health of the population.

*All project contractors shall comply with the Environmental Management Plan presented in this report, which specifies how the wastes, oil and gases generated by the project will be disposed.*

Article 8 of the EPPA (4/93) states that Hazardous/ Toxic or Nuclear Wastes that is harmful to human health and the environment shall not be disposed anywhere within the territory of the country.

*Any hazardous wastes that may be generated from this project shall be transferred to the designated waste site in Thilafushi or Vandhoo for disposal according to Government regulations and standards. It should not be disposed on the Island, as it does not have the necessary facility.*

### **3.1.2 Maldivian Land Act (Law no. 1/2002)**

The Act governs the allocation of Maldivian land for different purposes and uses and other issues regarding the issuing of land, issuing of state dwellings for residential purposes, conduct regarding state dwellings or private dwellings constructed for residential purposes and the sale, transfer and lease of Maldivian Land.

It states that:

- All transactions concerning the issuing, receiving, owning, selling, lease, utilizing and using Maldivian land shall be conducted in compliance with this Act.
- Policies concerning Maldivian land shall be decided by the President of the Maldives on the advice of the discussions in the Ministers Cabinet.

In accordance with section 3 of this Act, land shall be allocated for the following purposes and uses.

- a. For the construction of households and buildings for residential purposes.
- b. For commercial use.
- c. For social use.
- d. For environmental protection.
- e. For government use.

Under the Maldivian Land Act several regulations had been formulated such regulations include:

- Issuing state dwellings regulation
- Regulation governing the transfer (of land) as a gift or by will
- Lease of buildings and dwellings regulation
- Mortgaging land, building and flats regulation
- Registration of state dwelling and building regulation
- Regulation on the Inheritance of Fixed Assets on State Dwelling / Intestate
- Transfer or transfer by will Regulations 2004
- Privatization of State Business Land Regulations 2006

*The project complies with the provisions of this Act.*

## **3.2 Relevant Regulations and Guidelines**

### **3.2.1 Environmental Impact Assessment Regulations 2012**

Environmental Impact Assessment regulations were issued by Environment Ministry on 8 May 2012. The first step in environmental assessment process involves screening of the project to be classified as one that requires an EIA or not. Based on this decision, the Ministry then decides the scope of the EIA, which is discussed with the proponent and the EIA consultants in a “scoping meeting”. The consultants then undertake the EIA starting with baseline studies, impact prediction and finally reporting the findings with impact mitigation and monitoring programme. This report follows the principles and procedures for EIA outlined in the EIA regulations.

The EIA report is reviewed by MEE following which an EIA Decision Note is given to the proponent who will have to implement the Decision Note accordingly. As a condition of approval, appropriate environmental monitoring may be required and the proponent shall have to report monitoring data at required intervals to the Ministry. The project proponent is committed

to implement all impact mitigation measures that are specified in this EIA report. Furthermore, the proponent is committed to environmental monitoring and shall fulfil environmental monitoring requirements that may be specified in the EIA decision note as a condition for project approval.

*This report complies with the EIA regulations.*

### **3.2.2 Desalination Systems Regulation**

Desalination System regulation requires the registration of desalination systems that will be operated for use by a population exceeding 200 or for large-scale agricultural or tourism activities or for the purpose of implementing project(s) that involves economic or industrial operations. Prior to the establishment of desalination system, an Environment Impact Assessment (EIA) must be carried out in accordance with guidelines provided by Environment Ministry.

*The desalination plants to be installed will have to be registered with EPA. For this, the Proponent will be required to submit the EIA Decision Note for this EIA report, completed application forms with all details of the plant to be registered. A copy of the relevant section of this EIA may be appended to the forms as justification for the desalination plants.*

### **3.2.3 Maldives Building Code**

The building code hand book of Maldives details the guidelines and standards that should be used for designing building in Maldives. All construction projects are required to meet the standards specified in the building code.

*The proponent and contractor shall ensure that all construction activities of the project will follow the Building code.*

### **3.2.4 Waste Management Regulation 2013**

Waste Management Regulation (WMR) was published on August 2013 and came into effect in February 2014. It will be implemented by EPA. The aim of WMR is to implement the national waste policy, which contains specific provisions to:

- Implement measures to minimize impacts on human health
- Formulate and implement waste management standards
- Implement an integrated framework for sustainable waste management
- Encourage waste minimisation, reuse and recycling
- Implement Polluter-Pays Principle

- Introduce Extended Producer Responsibility

WMR contains four main sections:

- Waste management standards: Defines standards for waste collection, transfer, treatment, storage, waste site management, landfills and managing hazardous waste.
- Waste management Permits: Defines approval procedures for waste sites
- Waste transfer: Standards and permits required for waste transport on land and sea, including trans-boundary movements.
- Reporting requirements: Defines reporting and monitoring requirements and procedures.
- Enforcement: Defines procedures to implement WRM and penalties for non-compliance.

*The proponent shall use registered vessels under this regulation for transporting waste to Thilafushi or Vandhoo.*

*The proponent should also ensure compliance from the subcontractors in handling and transport of waste from the island to the designated waste site.*

### **3.2.5 The Environmental Liability Regulation (Regulation 2011/R-9)**

This law is pursuant to Article 22 of national constitution that states that protection, preservation and maintenance of the Maldivian natural environment, the richness of the living species, the natural resources and the beauty of the Maldives for the present generations as well as for the future generations is a basic obligation of the Maldivian government. The government shall enforce that the activities conducted in order to gain economic and social development should be of sustainable nature that protect the environment and such activities shall not deteriorate the environment, endanger any species, damage the environment, and shall not waste any natural resources.

This regulation is also pursuant to Environment Protection and Preservation Act of Maldives (4/93). The regulation is aimed at maintaining equal standards for reprimanding and enforcing environmental liabilities, fines for those who violate the rules and regulations and give guidance to those who are involved in the implementation process of the regulations pursuant to Preservation Act of Maldives (4/93).

One of the key objectives of the environmental liability regulation is also to practice polluter-pay-principles in the Maldives.

*All project developer and contractors shall be aware of this provision and contractors shall take all practical measures to ensure that all relevant laws and regulations, and the EMP proposed in this EIA is followed.*

### **3.2.6 Guidelines and Manual for Rainwater Harvesting the Maldives 2009**

This guideline published by Ministry of Housing Transport and Environment in 2009 includes components for rainwater harvesting system that needs to be followed. Components included in the guideline are the following;

- Catchment Area
- Conveyance System
- Storage
- Filtering System
- Distribution
- Protecting Water Quality
- Rainwater Harvesting in Emergencies
- General Checklist

A detailed manual and standard guidelines are provided for each component.

*All project developer and contractors shall be aware of this guideline and contractors must ensure that the procedures outlined in the guideline are followed.*

### **3.2.7 Compliance**

In general, the proposed developments are in compliance with the laws and regulations described above. Where there is a special requirement to comply, the EMP identifies measures and mechanisms required to comply.

## **3.3 Environmental Permits Required for the Project**

### **3.3.1 Environmental Impact Assessment (EIA) Decision Note**

The most important environmental permit to initiate project work would be a decision regarding this EIA. The EIA Decision Note, as it is referred to, shall govern the manner in which the project activities must be undertaken. This EIA report assists decision makers in understanding the existing environment and potential impacts of the project. Therefore, the Decision Note may only be given to the Proponent after a review of this document following which the Ministry may request for further information or provide a decision if further information is not required. In some cases, where there are no major environmental impacts associated with the project, the Ministry may provide the Decision Note while at the same time requesting for further information.

### **3.3.2 Desalination plant registration permit**

The desalination plant cannot be operated unless EPA processes the desalination plant registry. Hence, the plant needs to be registered at EPA before operations begins.

### **3.4 Responsible Institutions**

The main government institutions that have roles and responsibilities relevant to this project are summarised below.

#### **3.4.1 Ministry of Environment and energy**

The Ministry of Environment and Energy (formed in 2012) formerly the Ministry of Housing and Environment is mandated for the effective implementation of the Environmental Protection Act of the country and has the statutory power over issues related to the environment. It has the central control over the environment protection, management, conservation and environmental emergencies. The Ministry operates mainly at a policy level and the more regulatory and technical assessment activities are mandated to the Environmental Protection Agency (EPA). In this respect EPA has now been mandated to manage all issues relating to Environmental Impact Assessment of individual projects.

The Ministry of Environment also seeks the advice of National Commission for the Protection of Environment (NCPE) on all significant environmental matters. The commission is appointed by the president and is mandated to advice the Minister of Environment on environmental matters such as environment assessment, planning and management, and political decisions with regard to the protection of environment.

#### **3.4.2 Ministry of Housing and Infrastructure**

The Ministry of Housing and Infrastructure (MHI) is responsible for the construction of infrastructure and allocation of land in Maldives.

#### **3.4.3 Atoll Council**

The Maldives is grouped into 20 administrative areas under a new local governance system Baa Atoll has an elected Atoll Council located in Eydhafushi. The Atoll Council Office is the main focal point of Government Ministries in Male' and they co-ordinate and liaise with government ministries and elected island councils on all issues relating to the Atoll.

*A copy of this EIA will be submitted to the Atoll Council.*

### **3.5 Guiding Policies and Documents**

#### **3.5.1 Guidelines and Manual for Rainwater Harvesting in the Maldives 2009**

This guideline published by Ministry of Housing Transport and Environment in 2009 includes components for rainwater harvesting system that needs to be followed. Components included in the guideline are the following;

- Catchment Area
- Conveyance System
- Storage
- Filtering System
- Distribution
- Protecting Water Quality
- Rainwater Harvesting in Emergencies
- General Checklist

A detailed manual and standard guidelines are provided for each component.

*All project developer and contractors shall be aware of this guideline and contractors must ensure that the procedures outlined in the guideline are followed.*

#### **3.5.2 National Environmental Action Plan II (NEAP II)**

The aim of NEAP II is to protect and preserve the environment of the Maldives and to sustainably manage the country's natural resources for the collective benefit and enjoyment of present and future generations.

Accordingly, the key strategies of the NEAP II are:

- Continuous assessment of the state of the environment in the Maldives, including impacts of human activities on land, atmosphere, freshwater, lagoons, reefs and the ocean; and the effects of these activities on human well-being
- Development and implementation of management methods suitable for the natural and social environment of the Maldives and maintain or enhance environmental quality and protect human health, while at the same time using resources on a sustainable basis
- Ensure stakeholder participation in the decision making process by consultation and collaboration with all relevant sectors of society

- Preparation and implementation of comprehensive national environmental legislation in order to provide for responsible and effective management of the environment
- Adhering to international and regional environmental conventions and agreements and implementation of commitments embodied in such conventions.

Furthermore, NEAP II specifies priority actions in the following areas:

- Climate change and sea level rise; coastal zone management;
- Biological diversity conservation; integrated reef resources management;
- Integrated water resources management;
- Management of solid waste and sewerage;
- Pollution control and management of hazardous waste;
- Sustainable tourism development;
- Land resources management and sustainable agriculture
- Human settlement and urbanization.

### **3.5.3 National Waste Management Policy 2015**

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.

*The proponents of this project must be aware of the policy and all solid and hazardous waste produced in this project should be disposed according to the Environmental Management Plan for the project, which reflects the principles of the Waste Management Policy.*

## 4 EXISTING ENVIRONMENT

### 4.1 Physical Environment

#### 4.1.1 Meteorology

##### 4.1.1.1 Climate

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 percent to 85 percent. The annual average rainfall is approximately 1,948 mm. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 4.1 provides a summary of key meteorological findings for Maldives.

*Table 4.1: Key Meteorological Information of the Maldives*

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

##### 4.1.1.2 Monsoons

The climate of Maldives is characterised by the monsoons of the Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is 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.

#### **4.1.1.3 Winds**

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Male’.

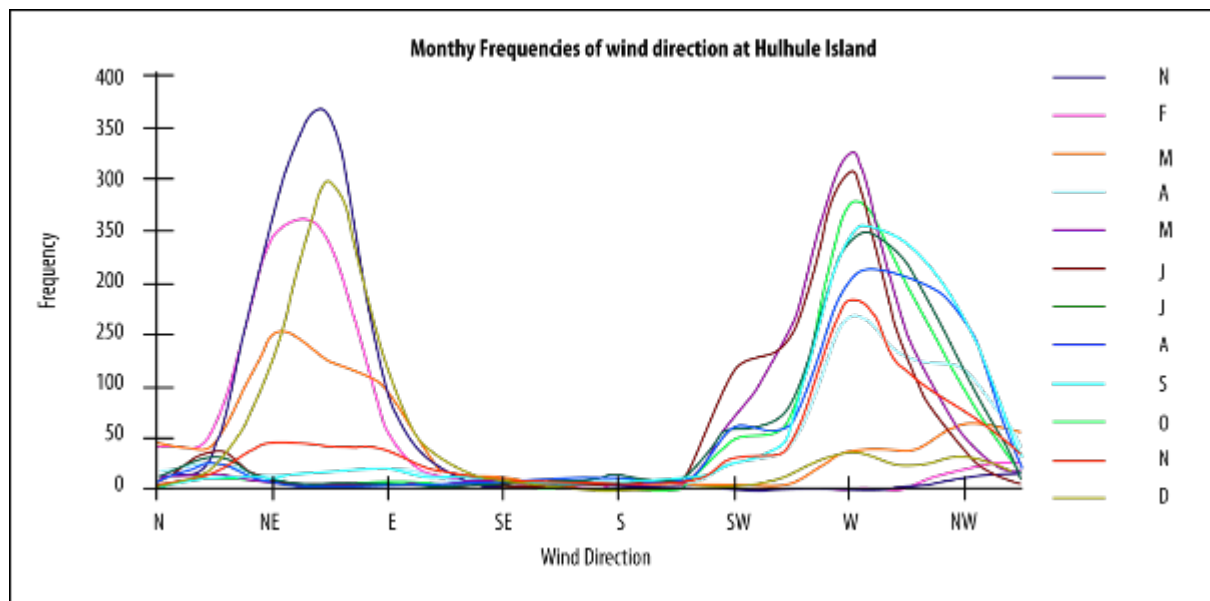
Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms<sup>-1</sup> for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003).

Besides the annual monsoonal wind variations there are occasional tropical climatic disturbances (tropical storms or low intensity tropical cyclones) in the central region which increases wind speeds up to 110 km/h, precipitation to 30 to 40 cm over a 24 hour period and storm surges up to 3 m in open ocean (UNDP, 2006).

Table 4.2 summarises the wind conditions in central Maldives throughout a year. Medium term meteorological data from Hulhule meteorological centre (see Figure 4.1, Figure 4.2 and Figure 4.3) and findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.

**Table 4.2: Summary of General Wind Conditions from National Meteorological Centre**

Season	Month	Wind
NE - Monsoon	December	Predominantly from NW-NE.
	January	High Speeds from W
	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	
Transition Period 2	September	
	October	Mainly from W.
	November	High Speeds from W



**Figure 4.1: Monthly Frequencies of Wind Direction in Central Maldives based on National Meteorological Center 10 year Data (adapted from Naseer, 2003).**

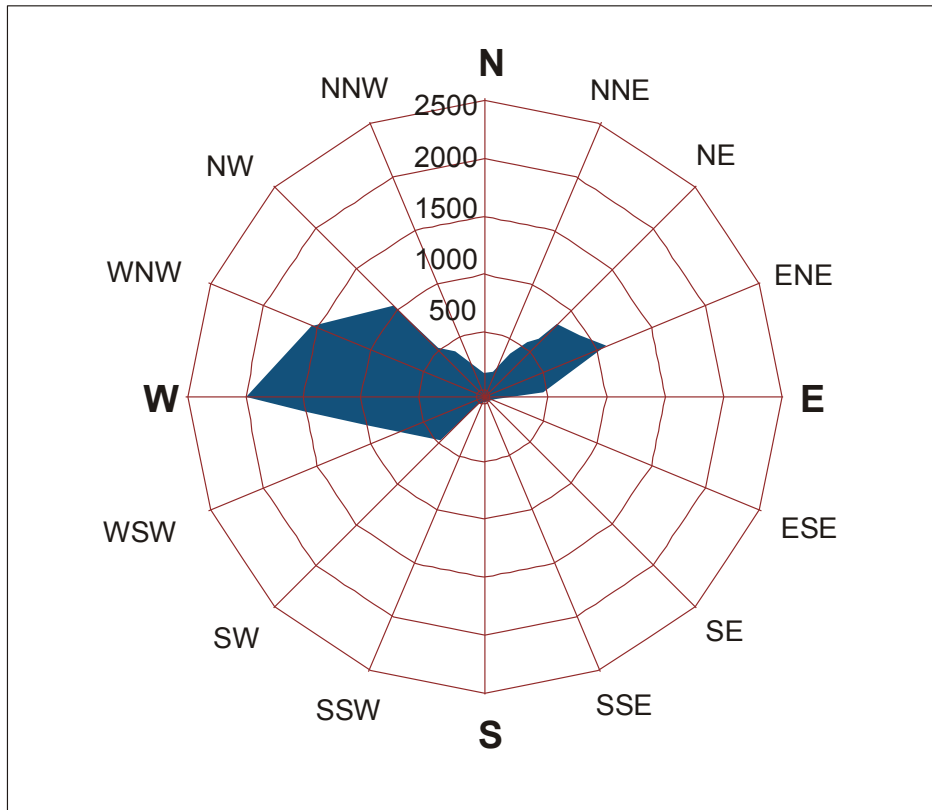


Figure 4.2: 24 Year Wind Frequency Recorded at National Meteorological Center.

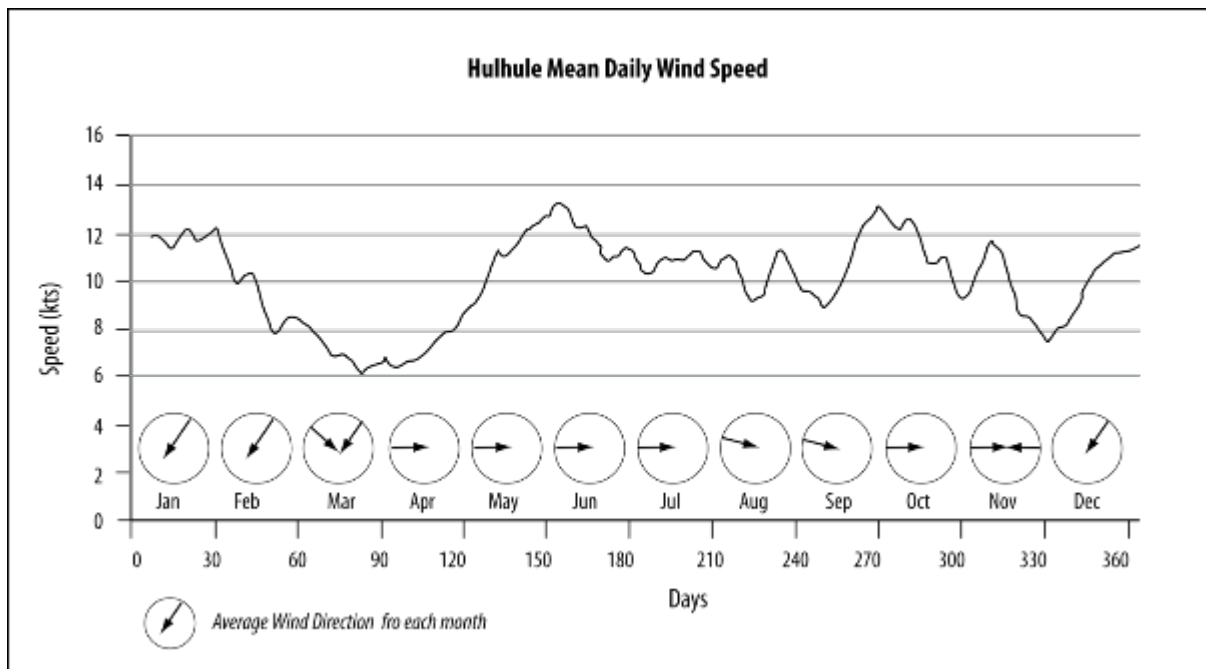


Figure 4.3: Mean Daily Wind Speed and Direction Recorded at National Meteorological Centre (1978 – 2004)

The Disaster Risk Profile of Maldives (UNDP, 1006) reports 11 cyclonic events over the Maldives in the last 128 years and only one event over the central Maldives. All of these events were of category 1 cyclones. There have been no cyclonic events since 1993.

Eydhafushi Island is located in a high risk cyclonic hazard zone which has the potential for a maximum probable cyclonic wind speed of 84.2 kts (UNDP, 2006).

The project site is expected to receive regular annual strong winds during the peak SW monsoon.

#### 4.1.1.4 Rainfall

The average annual rainfall for the archipelago is 2,124 mm. There are regional variations in average annual rainfall: southern atolls receive approximately 2,280 mm, and northern atolls receive approximately 1,790 mm annually (MEC, 2004). Mean monthly rainfall also varies substantially throughout the year with the dry season getting considerably less rainfall. This pattern is less prominent in the southern half, however. The proportions of flood and drought years are relatively small throughout the archipelago, and the southern half is less prone to drought (UNDP, 2006).

The nearest meteorological station to Eydhafushi is the National Meteorological Centre in Hulhule' Island. The mean annual rainfall in Hulhule' is 1991.5 mm with a Standard Deviation of 316.4 mm and the mean monthly rainfall is 191.6 mm. Rainfall varies throughout the year with mean highest rainfall during October, December and May and lowest between February and April (See Figure 4.4).

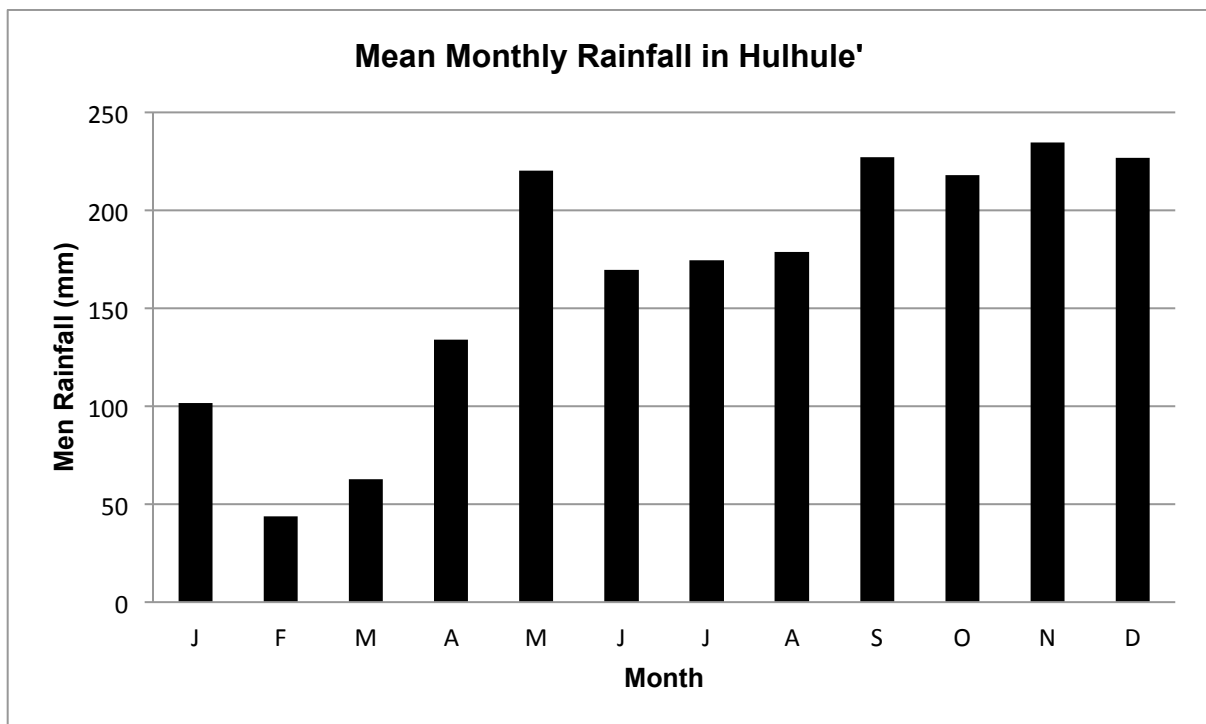


Figure 4.4: Mean Monthly Rainfall in Hulhule' (1975-2004)

Analysis of daily maximum annual rainfall data shows high variability, including extremes (see Figure 4.5 below). However, no significant long term trends are evident in the Hulhule data.

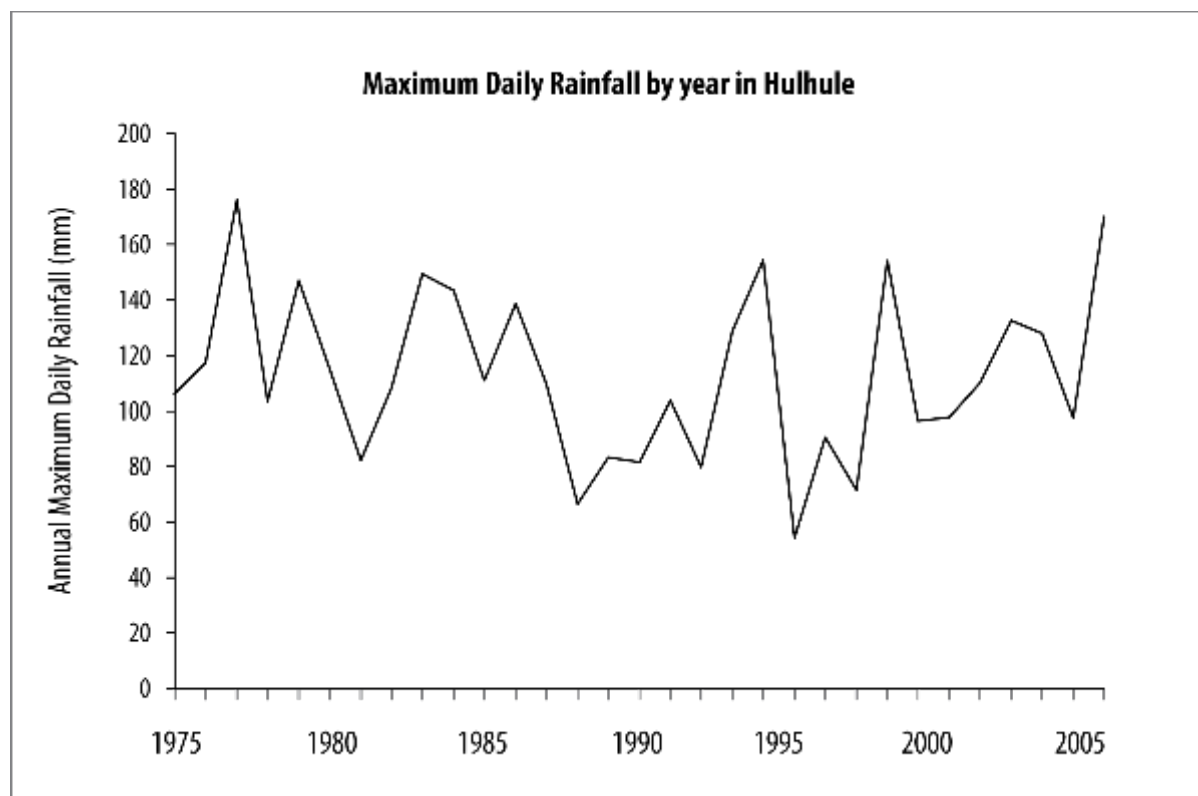


Figure 4.5: Maximum daily rainfall by year in Hulhule' (1975-2005) - (Source: Hay, 2006)

The probable maximum precipitations predicted for Hulhule' by UNDP (2006) are shown in Table 4.3.

Table 4.3 Probable Maximum Precipitation for various Return periods in Hulhule'

Station	Return Period			
	50 year	100 year	200 year	500 year
Hulhule'	187.4	203.6	219.8	241.1

Source (UNDP, 2006)

It would be possible to identify threshold levels for heavy rainfall for a 24 hour period in Eydhafushi, which could cause flooding or disruptions to operations. However, it does require observation of historic, daily rainfall data, which at present is unavailable.

#### 4.1.1.5 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.

There is considerable inter annual variability in extreme temperatures for Hulhule as shown in Figure 4.6. A maximum temperature of at least 33.5°C is rare at Hulhule and has a return period of 20 years (Hay, 2006).

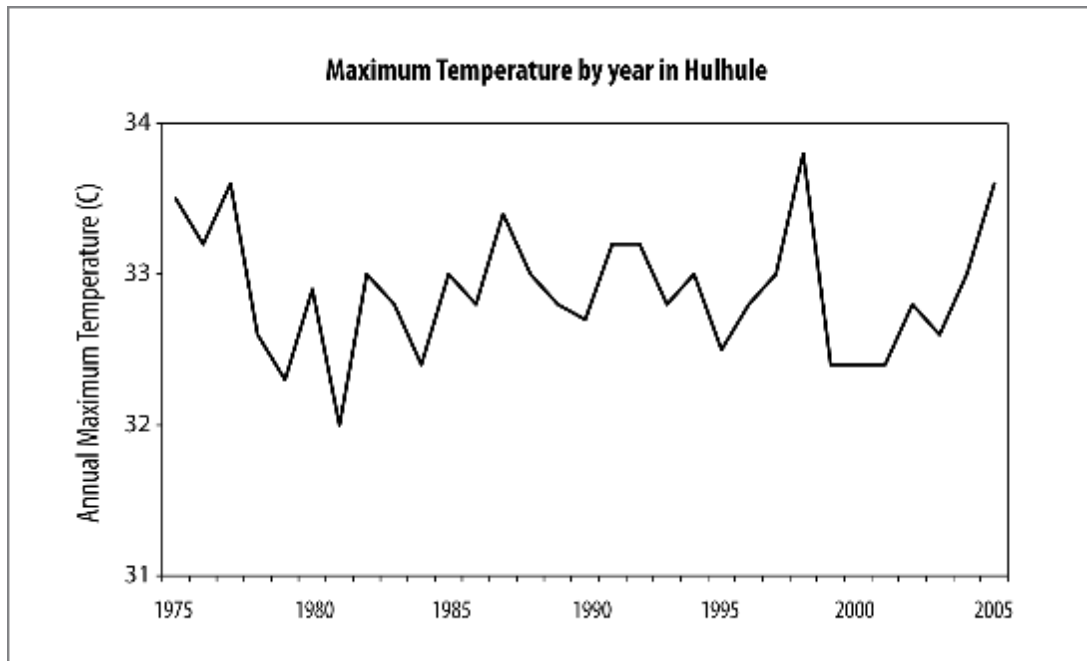


Figure 4.6: Maximum Temperature by year in Hulhule'- 1975-2005 (Source: Hay, 2006)

## 4.1.2 Hydrology

### 4.1.2.1 Tidal Pattern

Water levels at the site vary mainly in response to tides, storm surge or tsunamis. Tides in the Maldives are mixed and semi-diurnal/diurnal.

Tidal variations are referred to the standard station in at Hulhulé Island located approximately 111 km from the Eydhafushi Island. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively (MEC, 2004). Maximum spring tidal range in Hulhulé 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 to April and a decrease of 0.1m during September to November. Table 4.4 summarizes the tidal elevations reported at Hulhulé, which is representative of tidal conditions at the project site.

**Table 4.4: Tidal Variations at Hulhule International Airport**

<b>Tide Level</b>	<b>Referred to Mean Sea level</b>
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.00
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MHLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

#### **4.1.2.2 Waves**

There are two major types of waves observed along the islands of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds [Kench et. al (2006), DHI (1999), Binnie Black & Veatch (2000), Lanka Hydraulics (1988a & 1998b)]. The local monsoon predominantly generates wind waves, which are typically strongest during April-July in the southwest monsoon period. Wave data for Male and Hulhulé' between June 1988 and January 1990 (Lanka Hydraulics 1988a & 1998b) shows that the maximum significant wave height (Hs) recorded for June was 1.23 m with a mean period (Tm) of 7.53s. The maximum recorded Hs for July was 1.51 m with a Tm of 7.74s. The mean wave periods were 5.0 – 9.0s and the peak wave periods were within 8.0 – 13.0s.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 meters that flooded Male' and Hulhulé' in 1987 are said to have originated from a low pressure system off west coast of Australia (refer the next section for more detail). In addition, Maldives has recently been subject to an earthquake-generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable has been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003).

Eydhafushi Island is exposed to wind generated waves during both monsoons and during transition periods. The eastern and northern side receives the strongest waves during the peak NE monsoon (see figure 4.7) and during transition periods when wind blow from a northerly to north-easterly direction.

The southern and western side receives the strongest waves during the SW monsoon.

#### **4.1.2.3 Swell Waves and Storm Surges**

Waves studies around Maldives have identified the presence of swell waves approaching predominantly from a southwest to a southerly direction Kench et. al (2006), Young (1999), DHI(1999), Binnie Black & Veatch (2000) and Naseer (2003).

Being located inside the atoll's eastern rim, the reef system is exposed to predominant Indian Ocean swells approaching from the SW and the SE. Islands on the eastern rim are usually shielded from the SW swells but the orientation of Baa Atoll allows refracted swells to reach the eastern and southern shoreline of Eydhafushi. The strongest swells occur between May and July.

The Eastern side is also exposed to strong swells during the NE monsoon approaching from the east to northeast quadrant. The exposures of eastern reef line to these waves are evident from the algal rim and the presence of old rubble.

Waves generated from abnormal events could also travel against the predominant swell propagation patterns (Goda, 1998), causing flooding on the eastern and southern islands of Maldives (UNDP, 2009).

As noted in the previous section, Eydhafushi Island is located in a moderately high risk cyclonic hazard zone. It has the potential for a 2.30 m storm tide in a 500 year return period (UNDP, 2006, p45).

#### **4.1.2.4 Currents**

Currents that affect the reef system of Eydhafushi Island can be caused by tidal currents, wind-induced currents and wave-induced currents. It is presumed that generally current flow through the country is defined by the two-monsoon season winds. Westward flowing currents are dominant from January to March with the change in current flow pattern taking place in April and December (Kench et. al, 2006). In April the westward currents become weak while the eastward currents start to take over. In December the eastward currents are weak with the westward currents becoming more prominent. Hence, currents within the site are very likely to be heavily influenced by the monsoons.

Current measurements were undertaken on the island during field visits (SW monsoon) during day time high tide. Generally, long term studies are required to establish the prevailing site specific current patterns. However, due to time limitations of the present study a snapshot assessment was undertaken using drogue technique. The findings of the tide measurements are presented in Figure 4.8. Current measurements varied based on location. Current flow was generally in an easterly direction. Flow rate was generally slow at the time of the survey was between 0.2 and 0.3 m/s.

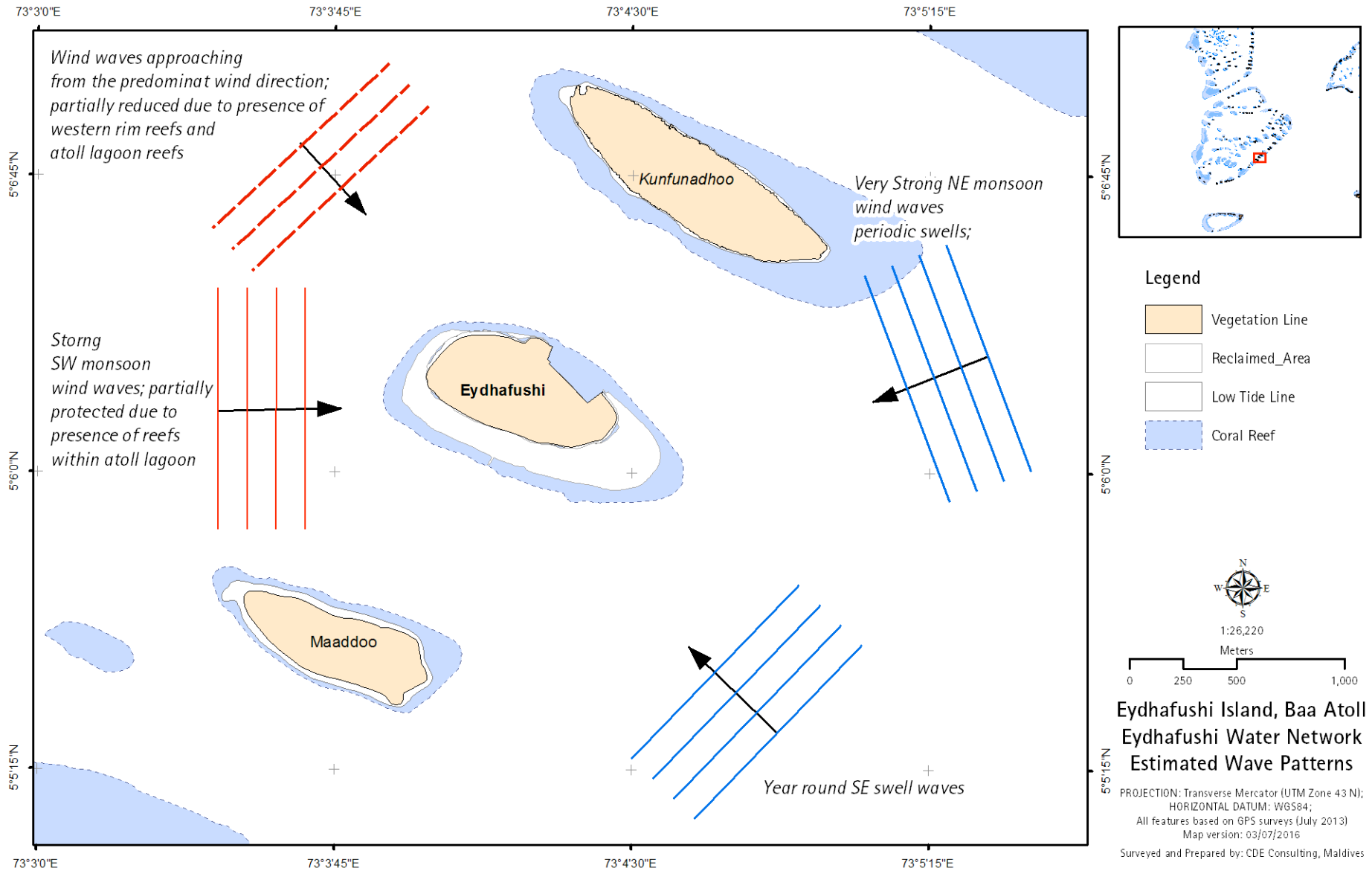


Figure 4.7: Estimated wave patterns around Eydhafushi Island

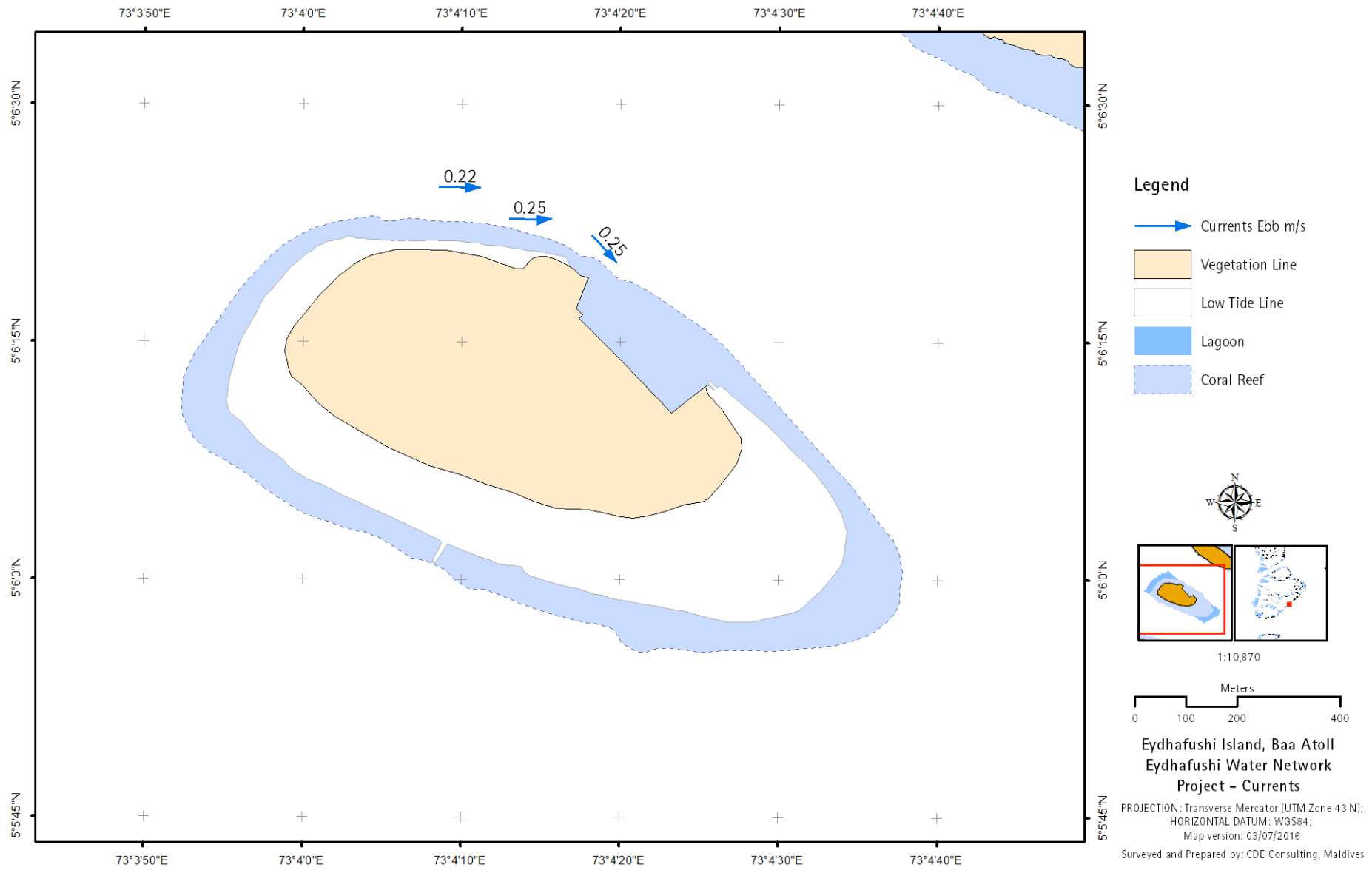


Figure 4.8: Results of current study

### 4.1.3 Ground Water Quality Assessment

The primary objective of the ground water quality sampling was to determine the baseline conditions of the ground water in Eydhafushi, especially at the proposed project site. Water samples were collected from two locations around project site using clean 1.5L PET bottles. All water quality tests were done at the Male' Water & Sewerage Company laboratory.

The following table shows the test results of the ground water samples collected on 14<sup>th</sup> June 2016. Laboratory results are attached in Appendix C

**Table 4.5 Results of water quality testing for groundwater**

Parameter	Optimal Range by EPA for product water	GW1	GW2
Physical appearance	Clear	Clear with particles	Clear with particles
Temperature °C	18 - 32	22.3	22.1
Conductivity	NE	3380	3330
pH	6.5 – 8.5	7.43	7.42
Total Petroleum Hydrocarbon	NE	1.26	2.28
Salinity ‰	NE	1.77	1.74

*(NE – not established, TNTC- too numerous to count)*

At present there are no established reference quality parameters for ground water in the Maldives. Nonetheless, EPA provides a standard that needs to be maintained by the desalination plants for product water, which is described in the above table. However, the standards may not be applicable to groundwater as the inherent characteristics of groundwater are different from desalinated seawater.

The investigations of groundwater quality revealed that most of the parameters are within the limits specified by EPA. Temperature and pH are well within acceptable limit. There is evidence of contamination by oil in the sites investigated, with TPH values at 1.26 and 2.28. This could be due to exposure of groundwater lens to point sources of pollution such as domestic and farming effluents.

#### 4.1.4 Marine Water Quality Assessment

The primary objective of the marine water quality sampling was to determine the baseline conditions of the marine water in Eydhafushi, especially at the proposed project site. Two sites were selected for marine water quality assessment, proposed outfall location and alternative outfall location. Water samples were collected using 1.5L PET bottles, sterile glass bottles and sterilised bags. All water quality tests were done at the Male' Water & Sewerage Company laboratory.

The following table shows the test results of the ground water samples collected on 14<sup>th</sup> June 2016. Laboratory results are attached in Appendix C

*Table 4.6 Marine water quality assessment results from MWSC laboratory*

Parameter	Optimal Range (EPA)	Results	
		SW1 (Proposed outfall)	SW2 (Alternative outfall)
Physical appearance	Clear	Clear	Clear
pH	8.0 – 8.3	8.09	8.10
Temperature (°C)	18 - 32	21.8	21.4
Salinity (‰)		34.13	33.75
Total Dissolved Solids (mg/l)	-	26000	25700
Biological Oxygen Demand (BOD)- (mg/l)	<2	1	<1 (LoQ 1mg/L)
Conductivity		5200	51500
Dissolved Oxygen		7.59	7.71
Total Coliforms (mg/L)	0	>2420	>2420
Faecal Coliforms (mg/L)	0	20	30

The investigations of marine water quality revealed that most of the parameters are within limits specified in the EPA guideline. Parameters, temperature, pH, Biological Oxygen Demand are well within acceptable limits. Total coliform and faecal coliform count is well above the specified limit. This indicates contamination of marine water.

#### **4.1.5 Soil**

In order to analyze the soil profile of the area, a borehole (5ft x 5ft) was made (See Appendix-F: survey location map) on the island. The soil conditions of the site were similar to soil conditions of other islands across the Maldives, consisting considerable quantities of un-weathered corals as parent materials, coral rocks and sand.

The site has a relatively young soil profile, especially at the location of the borehole due to the site being a reclaimed area so close to the shoreline. The only visible layer is a shallow layer of coarse fine white sand (30cm) before reaching the water table (See Figure 4.9).

The pH of the water sample taken at the site was 7.43. The soil is generally poor and deficient in nitrogenous nutrients, potassium and several other micronutrients; particularly iron, manganese and zinc.



*Figure 4.9 Baa Eydhafushi RO Plant Site Soil Profile*

#### 4.1.6 Noise

Baseline noise measurements at the proposed project site was recorded on 14<sup>th</sup> June 2016. In general, much of the noise during daytime is associated with background noise level of the settlement, including vehicle movements and other natural noises. On average the maximum noise level is at 81 dBA and minimum noise level is 67 dBA. Table 4.7 below displays the results of the noise measurements.

*Table 4.7 Baseline noise measurements*

<b>Location</b>	<b>Noise level (dBA)</b>
Proposed RO plant house	67
Residential houses within 5 m	77-78
Residential houses within 10 m	77-81

## 4.2 Biological Environment

### 4.2.1 Marine Environment

The aim of this assessment is to establish the baseline condition at the proposed project location. Marine assessments were carried out from 13<sup>th</sup> June 2016, the sea was rough and the sky was partially cloudy during the survey. The main objectives of this assessment were:

1. To determine the general status of the reef associated with the island
2. To assess the condition of the marine environment which will be directly impacted by the project
3. To determine the fish species abundance and composition of the reef system

The following sub-sections provide details site, the methodology adapted for this assessment and the results.

#### 4.2.1.1 Photo Quadrat Survey and Fish Census

##### *Proposed Brine Outfall*

This transect was deployed at 2.5 m depth, along the reef edge on the north side of the island near the harbor. This site was assessed as it is the nearest reef, to the proposed project activities.

Analysis of the photos shows that the dominant benthic substrate at this site is dead rock (44%) and coral rubble (42.5%). Coral cover at this site is very low making up about 2% of the surveyed area. Few live massive *Porites* were the only live corals observed.

A total of 32 fish species 13 fish families were recorded during the fish census. Highest number of fishes were recorded from families *Labridae* (5 species) and *Acanthuridae* (4 species).

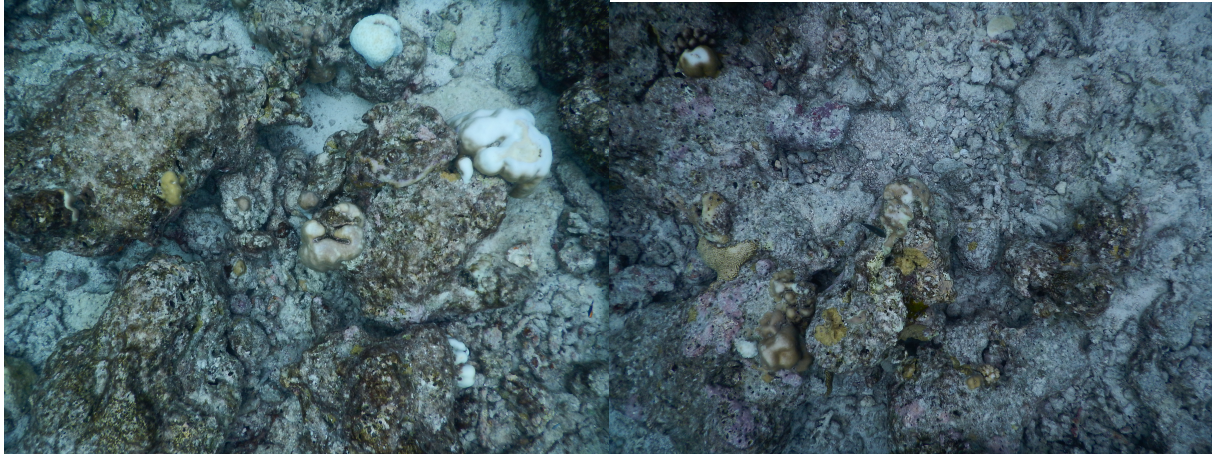


Figure 4.10 Select images showing variety of coral species along the proposed brine outfall

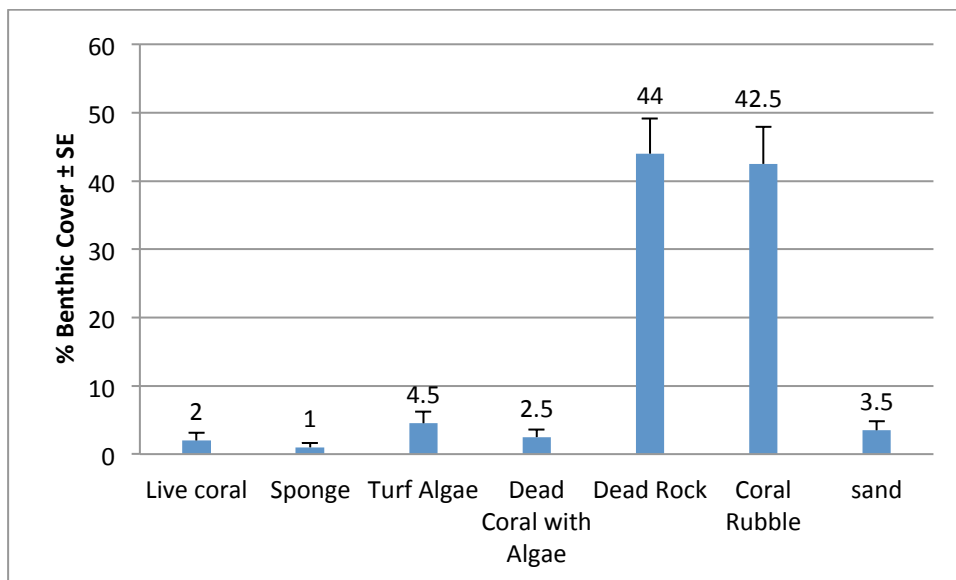


Figure 4.11 Benthic substrate composition along the proposed brine outfall

**Table 4.8 Summary of fish census data along the proposed brine outfall**

Family	Species	Diet	Abundance
Holocentridae	<i>Sargocentron caudimaculatum</i>	Small fishes; benthic invertebrates	2
	<i>Sargocentron spiniferum</i>	Benthic invertebrates	2
	<i>Neoniphon argenteus</i>		2
	<i>Myripristis pralinia</i>	Plankton	3
Serranidae (Groupers)	<i>Cephalopholis argus</i>	Small fishes; small crustaceans	2
Priacanthidae	<i>Priacanthus hamrur</i>	Large zooplankton; small fishes; benthic invertebrates	2
Lethrinidae	<i>Gnathodentex aurolineatus</i>	Small fishes; benthic invertebrates (crabs/snails)	4
Chaetodontidae	<i>Chaetodon trifasciatus</i>	Coral polyps	2
	<i>Chaetodon collare</i>	Coral polyps; gorgonians; tunicates; worms; crustaceans	2
	<i>Forcipiger flavissimus</i>	Coral polyps; worms; clams; tunicates; crustaceans	2
	<i>Heniochus pleurotaenia</i>	Plankton	3
Pomacanthidae	<i>Pygoplites diacanthus</i>	Crustaceans; sponges; tunicates; algae	2
Cirrhitidae	<i>Paracirrhites forsteri</i>	Benthic invertebrates; small fishes	2
Pomacentridae	<i>Dascyllus carneus</i>	Algae	2
	<i>Dascyllus trimaculatus</i>	Benthic invertebrates; zooplankton	3
	<i>Chromis viridis</i>	Zooplankton	3
	<i>Chromis dimidiata</i>	Zooplankton	3
Labridae	<i>Halichoeres hortulanus</i>	Benthic invertebrates	3
	<i>Labroides dimidiatus</i>	Skin parasites	2
	<i>Thalassoma amblycephalum</i>	Benthic invertebrates; zooplankton	3
	<i>Thalassoma lunare</i>	Benthic invertebrates; zooplankton	2
	<i>Hemigymnus melapterus</i>	Benthic invertebrates	2
Scaridae	<i>Cetoscarus bicolor</i>	Algae covered rock; coral branches/mounds	2
	<i>Scarus sordidus</i>		3
	<i>Scarus niger</i>	Algae covered rock; coral branches/mounds	2
Acanthuridae	<i>Acanthurus leucosternon</i>	Algae	3
	<i>Acanthurus lineatus</i>	Algae	2
	<i>Ctenochaetus striatus</i>	Film algae; detritus	3
	<i>Zebrasoma scopas</i>	Filamentous/macroalgae	2
Siganidae	<i>Siganus corallinus</i>	Algae; benthic invertebrates	2
Balistidae	<i>Pseudobalistes flavimarginatus</i>	Zooplankton; small fishes; benthic invertebrates	3
	<i>Odonus niger</i>	Small fishes; starfishes; crabs; shrimp; urchins	6

***Alternative Brine Outfall***

This transect was deployed at 2.5 m depth, along the reef edge to the eastern side of the island. Live coral made about 2% of the surveyed area. Large dead rocks dominated the area with 62 % cover.

A total 25 fish species belonging to 10 fish families were recorded during the fish census at this site. Highest numbers of fish species were recorded from families *Acanthuridae* (8 species) and *Chaetodontidae* (4 species).

***Figure 4.12 Select images showing benthic substrate cover along alternative brine outfall***

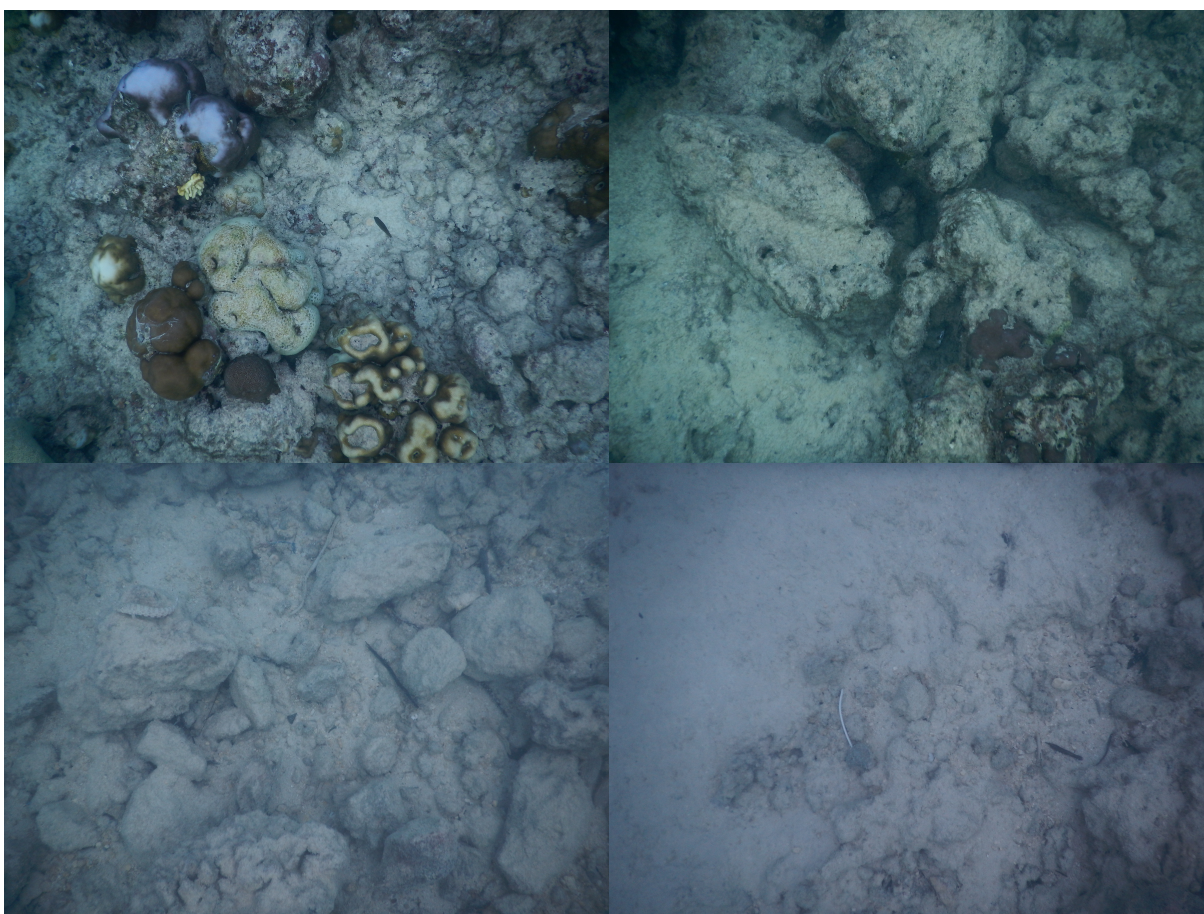


Figure 4.13 Benthic substrate composition along alternative brine outfall

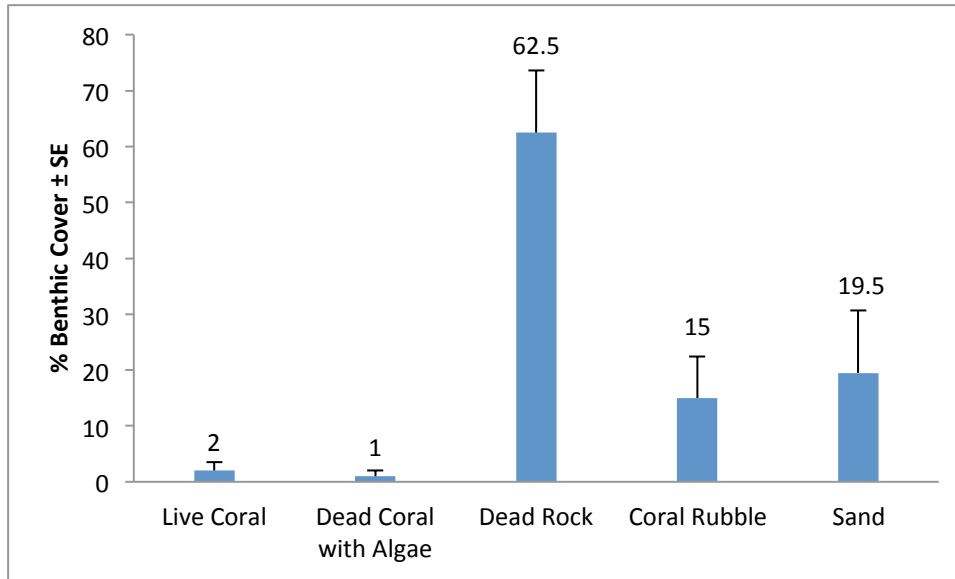


Table 4.9 Summary of fish census data along alternative brine outfall

Family	Species	Diet	Abundance
Holocentridae	<i>Sargocentron caudimaculatum</i>	Small fishes; benthic invertebrates	3
Serranidae (Groupers)	<i>Cephalopholis argus</i>	Small fishes; small crustaceans	2
	<i>Epinephelus spilotoceps</i>	Small fishes; crustaceans	2
Mullidae	<i>Parupeneus barberinus</i>	Benthic invertebrates	2
Chaetodontidae	<i>Hemitaurichthys zoster</i>	Plankton	3
	<i>Chaetodon lunula</i>	Coral polyps; worms; algae; clams; crustaceans	2
	<i>Chaetodon kleinii</i>	Coral polyps; worms; algae; crustaceans	2
	<i>Heniochus pleurotaenia</i>	Plankton	2
Cirrhitidae	<i>Paracirrhites forsteri</i>	Benthic invertebrates; small fishes	2
Pomacentridae	<i>Dascyllus trimaculatus</i>	Benthic invertebrates; zooplankton	2
	<i>Chromis xutha</i>		2
	<i>Abudefduf vaigiensis</i>	Algae; zooplankton	3
Labridae	<i>Labroides dimidiatus</i>	Skin parasites	3
Scaridae	<i>Cetoscarus bicolor</i>	Algae covered rock; coral branches/mounds	2
	<i>Scarus sordidus</i>		3
Zanclidae	<i>Zanclus cornutus</i>		2
Acanthuridae	<i>Acanthurus leucosternon</i>	Algae	3
	<i>Acanthurus nigricauda</i>	Zooplankton	2
	<i>Acanthurus lineatus</i>	Algae	2
	<i>Acanthurus triostegus</i>	Algae; zooplankton	4
	<i>Acanthurus blochii</i>	Film algae	3

Family	Species	Diet	Abundance
	<i>Ctenochaetus striatus</i>	Film algae; detritus	3
	<i>Zebrasoma scopas</i>	Filamentous/macroalgae	2
	<i>Naso lituratus</i>	Brown kelp	2
Tetraodontidae	<i>Canthigaster janthinoptera</i>	Benthic invertebrates; sponges; algae	2

#### 4.2.1.2 Marine Protected Areas and Environmentally Sensitive Sites

No marine protected areas or environmentally sensitive areas will be affected by this project.

#### 4.2.2 Terrestrial Environment

The aim of this assessment was to establish the baseline condition of the terrestrial environment at the proposed project location in Eydhafushi Island, Baa Atoll.

The sub-objectives of the assessments include determination of the present terrestrial fauna, flora, vegetation groups and soil conditions at the proposed location.

##### 4.2.2.1 Flora

###### *General Characteristics*

The proposed site is located on the northern side of Baa Eydhafushi Island, just 80m ~ north west of the harbour. There is an existing building on the site, and the area is proposed to be expanded for this project.

Due to its urban location, there are no natural vegetation groups found within the vicinity of this location, and the only vegetation found within the existing facility is a single Kaani (*Cordia subcordata*) Tree and a Nika (*Ficus benghalensis*) Tree which has been pruned up (See images in the next section).

The expanded area to the west of the existing facility is newly reclaimed land with no existing vegetation. The site is easily accessible and no unique trees or groups of vegetation were observed during the field visit.

The removal of the existing vegetation from the project area will be insignificant in terms of environmental impacts. No species of significant importance was identified on any of the roads where the proposed network is to be laid out on as well.

## Vegetation Types

Since the area of assessment is relatively small (compared to the size of an average island) and as it is located in an urban area, there are no specific vegetation groups that can be classified at this location.

**Table 4.10 Floral Inventory of proposed location**

#	Name				Ethnobotanical Aspects			IUCN Red List (Category)	Remarks
	Family	Scientific	English	Dhivehi	General Uses	Medicinal Uses	Potential Uses		
1	Boraginaceae	<i>Cordia subcordata</i>	Sea Trumpet	Kaani	Boat building, crafting, construction	-	Can be used as a coastal bioshield	Unlisted (proposed LC)	Single tree on site
2	Moraceae	<i>Ficus benghalensis</i>	Banyan Tree	Nika	Timber, shade	-	-	Unlisted (proposed LC)	Single tree on site (pruned)

IUCN: EX: Extinct; EW: Extinct in the wild; CR: Critically endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data deficient; NE: Not evaluated

### 4.2.2.2 Fauna

#### General Characteristics

The site is located in an urban area adjacent to a busy road and thus not much fauna was observed on the site or its vicinity. The only species recorded during the field visit was the common crow (*Corvus linnaeus*), and the common garden lizard (*Calotes versicolor*).

However, based on local accounts and experiences from similar conditions found in the Maldives, it can be said that some other common species such as the Rat (*Rattus sp.*), Fruit bats (*Pteropus giganteus ariel*) and other small fauna will be found in this area.

No species of significant importance was identified for the proposed RO plant site.

***Terrestrial Environment Photo Summary***



***Figure 4.14 The two trees found within the existing RO Plant facility***



***Figure 4.15 A small park located on the eastern side of the existing RO plant facility***



***Figure 4.16 Existing RO plant facility on the island***

### **4.3 Natural Hazard Assessment for the Site**

According to the UNDP Disaster Risk Assessment Report of Maldives in 2006, proposed site is located in an area exposed tsunami, wind storms, storm surges and flooding. The island of Eydhafushi has a tsunami risk index of 5 and is among the top 20 islands with multi-hazard physical vulnerability risk. The following parameters can be deduced for the Eydhafushi Region based on Disaster Assessment Report and the Detailed Island Risk Assessment Reports (UNDP, 2009).

**Tsunami:** Maximum probable wave height range 3.2-4.5m

**Cyclone or storm (wind):** Probable maximum wind speed 84.2 knots

**Storm surge:** predicted storm surge height – 0.99 m; predicted storm tide height 0.98 m

**Rainfall:** probable maximum daily rainfall for Hulhule' for a 500 year return period 241.1 mm

Based on these parameters, field surveys and planned design parameters of the island, the methodology for risk assessment identified in the Detailed Island Risk Assessment Reports (UNDP, 2009) and findings from Ali (2005) was used to assess the hazard risks on the site. However, the results should be treated with caution as this is a preliminary risk assessment. A more comprehensive assessment will require a longer time frame and more data, which is beyond the scope of this study.

## 4.4 Island Social Socio-Economic Setting

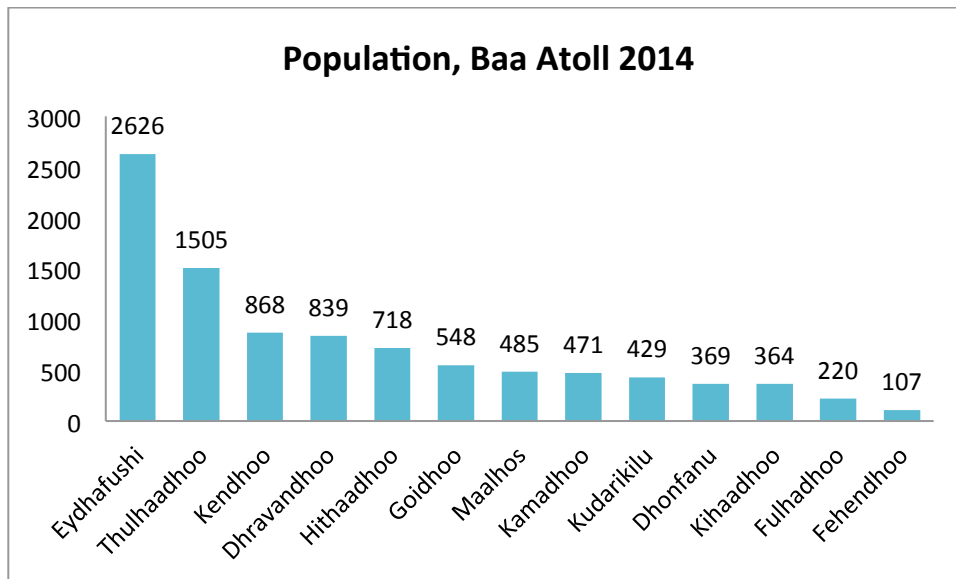
### 4.4.1 B. Eydhafushi

#### 4.4.1.1 Population Characteristics

##### **Total Population**

According to Preliminary results of Census 2014, Eydhafushi had a total population of 2,626. Out of the total enumerated population in 2014, 1,255 were males and 1,371 were females. The population in 2014 was comprised of 2,513 Maldivians (1,165 males and 1,348 females) and 113 foreigners (90 males and 23 females). Eydhafushi has the highest population in South Maalhosmadulu Atoll and makes up 28 per cent of the atoll population. Figure 4.17 below represents population sizes for the all administered islands in the atoll.

Figure 4.17: Population Size by locality, B Atoll, Census 2014



Source: National Bureau of Statistics, 2014

##### **Sex Ratio**

According to census 2006, there were more females than males in Eydhafushi with a sex ratio of 93 males per 100 females. The current population of Eydhafushi also shows that there are more females than males in Eydhafushi, however, the difference in the number of males and females have increased. The current sex ratio of Eydhafushi, according to the census 2014, is 86 males per 100 females.

**Annual Growth Rate**

According to census 2006 and 2014, the population of Baa atoll experienced a positive population growth with an average annual growth rate of 0.50. A similar trend is observed in Eydhafushi for the period between 2006 and 2014, with an average annual growth of 0.50. Table 4.11 below shows the population figures for Eydhafushi during census 2006 and 2014.

**Table 4.11: Population figures for Census 2006 and 2014 for B.Eydhafushi**

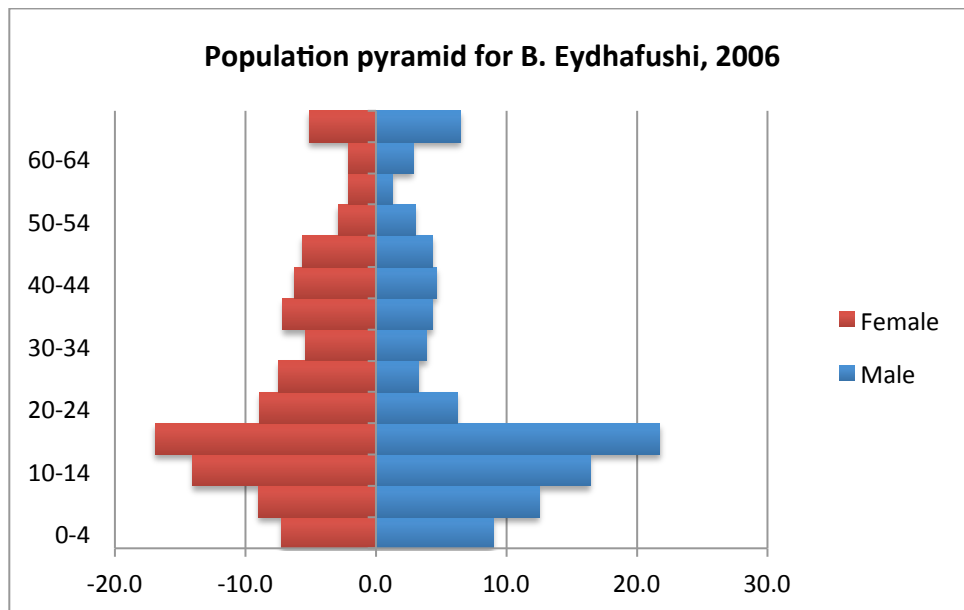
	<b>Census 2006</b>	<b>Census 2014</b>
Total Population	2409	2626
Male	1160	1255
Female	1249	1371

Source: Ministry of Planning and National Development, 2008 and National Bureau of Statistics, 2014

**Population Structure**

The general structure of Eydhafushi population is shown in Figure 4.18 below. The dependent population is 40%, which comprises of 34% children and 6% elderly. The working age population comprises 60% of the total population of the island. According to this pyramid, the most dominant age group for B. Eydhafushi is age group 15-19.

**Figure 4.18: Population Pyramid for B.Eydhafushi, Census 2006**



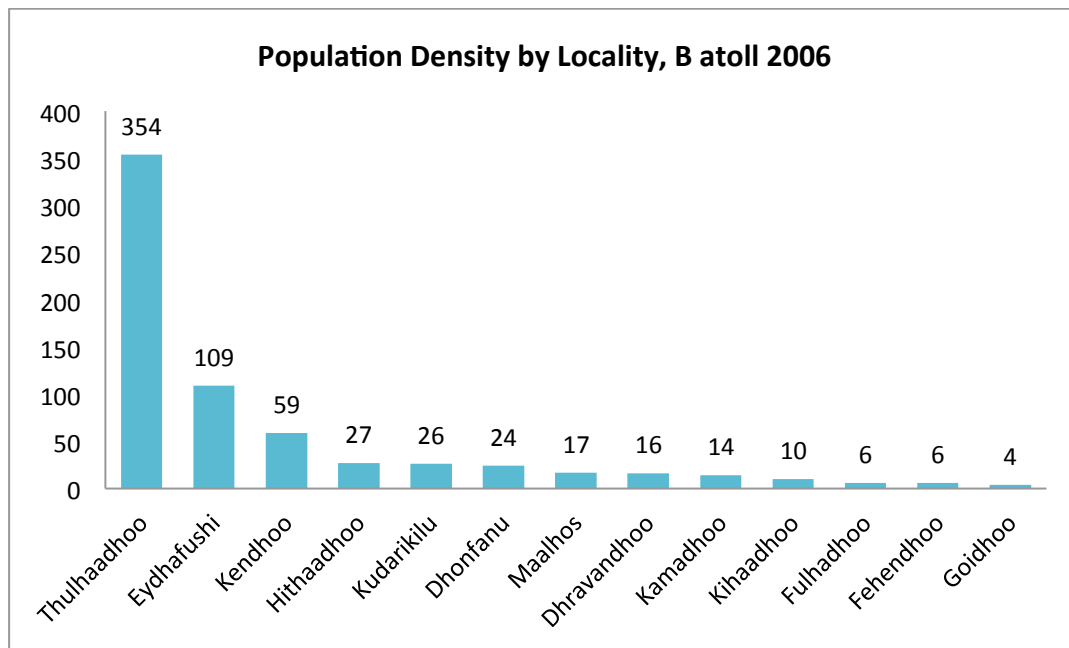
Source: Ministry of Planning and National Development, 2008

### Island Sizes and Population density

According to Maldives Population and Housing Census 2006, Goidhoo the biggest administered island in Baa atoll with an area of 114 hectares. The smallest administered island in the atoll is Thulhaadhoo with an area of 5 hectares. Eydhafushi has an area of 22 hectares according to census 2006.

Thulhaadhoo is the most densely populated island in the atoll with a population density of 354 persons per hectare. The most populous island is also Thulhaadhoo. The least populous island is Goidhoo with a population density of 4 persons per hectare. Figure 4.19 below shows population densities for all administered islands in the atoll. The density is given in persons per Hectare.

Figure 4.19: Population density for B Atoll, Census 2006

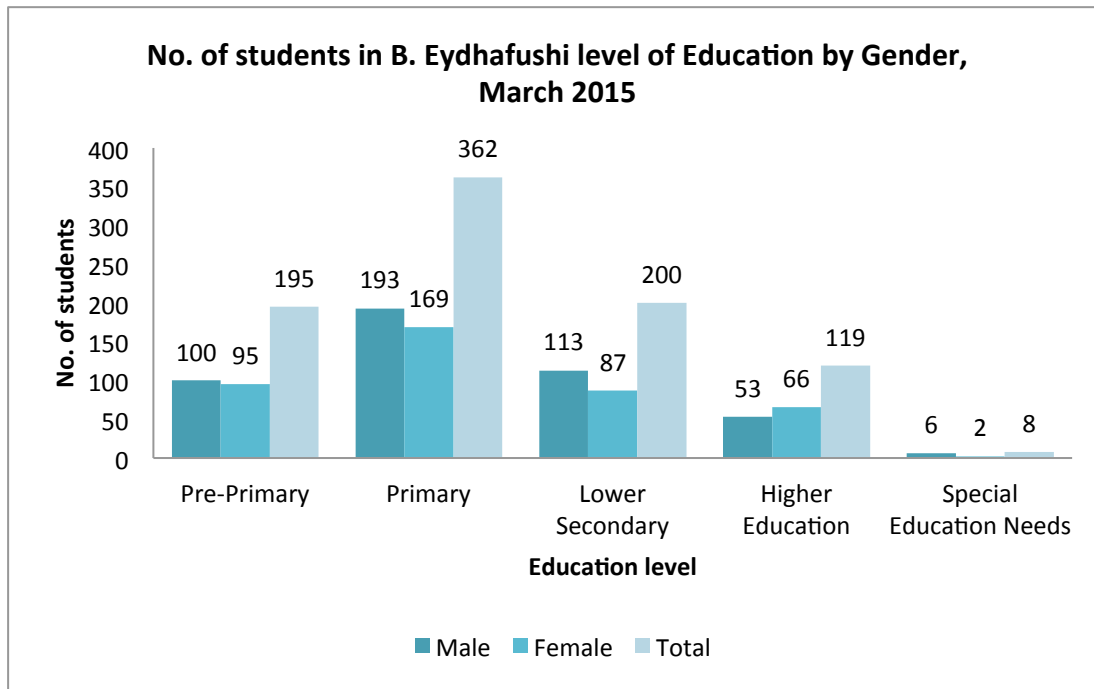


Source: Ministry of Planning and National Development, 2008

#### 4.4.1.2 Education

According to School Statistics report published by the Ministry of Education in 2014, there were a total of 884 students in Eydhafushi enrolled in different levels of studies. Out of the total student population, 465 were males and 419 were female students. Figure 4.20 below shows the number of students enrolled in different levels of education by gender in March 2014 in Eydhafushi.

Figure 4.20: Number of students in Eydhafushi by level of education and by gender in March 2015



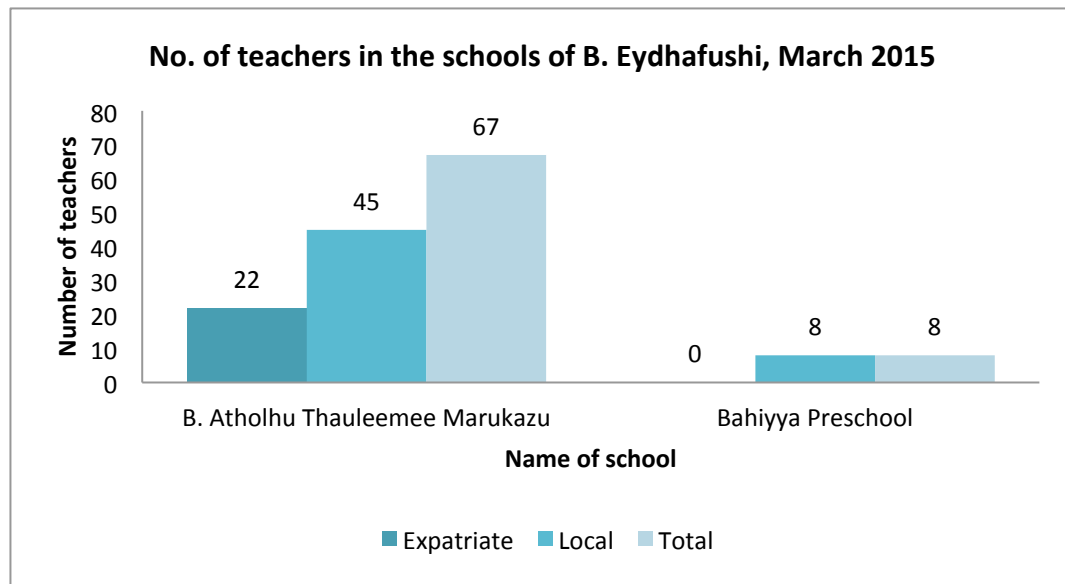
There is 1 Government school in Eydhafushi; B. Atholhu Thauleemee Marukazu, that teaches from grade 1 to 12 and they offer a special education needs program to students who are in need of such education. In March 2014, there were a total of 8 students enrolled in this program 6 of whom were male students and 2 were female students. Additionally there is one pre-school in the island, Bahiyya Preschool that is run by the community. Figure 4.21 shows the number of students enrolled in each school of Eydhafushi by gender in March 2014.

Figure 4.21: Number of students enrolled in schools of Eydhafushi by gender in March 2015



Bahiyya School had only local teachers in March 2014 while the number of local teachers outnumbers the expatriate teachers in B. Atholhu Thauleemee Marukazu. Figure 4.22 displays the number of teacher in the five schools of Eydhafushi in March 2014.

Figure 4.22: Number of teachers in the schools of Eydhafushi in March 2015



Source: Ministry of Education, 2014

#### 4.4.1.3 Employment

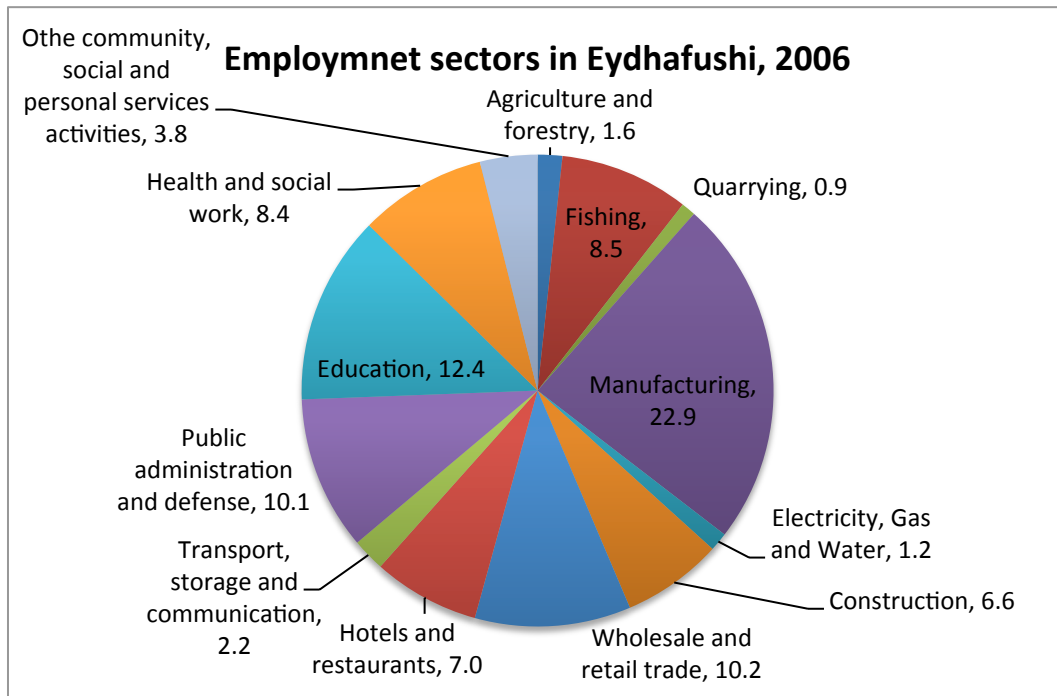
##### *Employment and Unemployment Rates*

According to census 2006, the total number of economically active population in Eydhafushi was 903. Amongst them 742 are employed and 161 are unemployed. The economically not active population is reported as 659 people. Labour force participation rate is 56.7% and unemployment rate is reported as 17.8%. Much of the unemployment is among the female population, with 27.8% of females unemployed compare to 6.2% males.

##### *Main Employment Sectors*

The four main employment sectors in Eydhafushi according to census 2006 are manufacturing (22.9%), Education (12.4%), wholesale and retail trade (10.2%) and public administration and defence (10.1%). Other economic activities practiced in the atoll include construction, fishing, wholesale and retail trade and other community, social and personal services activities. Figure 4.23 below shows the main employment sectors in Eydhafushi based on census 2006.

Figure 4.23: Employment sectors in Eydhafushi in 2006



Source: Ministry of Planning and National Development, 2008

#### 4.4.1.4 Infrastructure and Utility Services

##### Households

Eydhafushi has a total of 566 households.

##### Healthcare

Healthcare facilities are provided by Atoll Hospital in the island. The hospital also has a pharmacy operated by STO.

##### Utility Services

Power, water and sewerage system in the island is managed by FENAKA Corporation Limited. The island has a total power generating capacity of 1500 MW. According to FENAKA, with 798 consumers, the island has a minimum power load of 200 KW and maximum load of 786 KW.

A sewerage system was established in Eydhafushi in 2009.

Eydhafushi has a desalination plant, which is operated during times of water shortage. FENAKA facilitates the supply of water produced from this plant during this time. Normally the people of the island uses harvested rainwater and groundwater

#### **4.4.1.5 Ongoing Projects**

Ministry of Housing and Infrastructure has an ongoing road project in Eydhafushi. The project involves road development and paving and it is expected to commence in July 2016. Duration of the project is approximately 8 months.

## **5 IMPACT IDENTIFICATION**

### **5.1 Introduction**

Potential adverse and beneficial impacts of construction and operation stage of the proposed water supply system are identified and evaluated in this section. Significant impacts are identified and evaluated in two stages. The first stage identifies the environmental and socio-economic components that may be impacted from key project activities. The second stage determines the significance of impacts of each component. The following sections provide details of the evaluation of impacts.

Nature of potential impacts is defined here as No Impact, Adverse Impact or Beneficial Impact. Table 5.1 below provides the nature of potential impacts from the proposed project on environmental and socio-economic aspects by the project components. Where impacts are not applicable to different components, this is indicated as 'X'. Some aspects may be affected both adversely (indicated as [-]) and beneficially (indicated as [+]) from the project.

### **5.2 Impact Identification and Evaluation**

Environmental and socio-economic aspects that may be impacted by the project as identified in Table 5.1 are further evaluated to identify significant impacts. Assessments of the impacts are conducted using the four criteria of Magnitude, Reversibility, Duration and Distribution as described below. Evaluation of key impacts is provided in Table 5.2.

1. **Magnitude:** Refers to the quantum of change that will be experienced as a consequence of the impact.
2. **Reversibility:** Refers to the degree of reversibility of an impact (i.e. ease of reversing the conditions).
3. **Duration:** Refers to the temporal scale (i.e. duration, frequency) of the impact. It does not take into account the duration of the impact's effects.
4. **Distribution:** Refers to the spatial scale of the area impacted (e.g. a small portion of a reef or an entire lagoon)

Estimates for negative impacts represent a 'worst case scenario' based on the assumption that the project will undergo full-scale development with no consideration for its environmental and social consequences, i.e. significance is assessed prior to implementation of mitigation measures. Values are attributed by the EIA team on the basis of direct observation of surveyed sites, professional judgment and pre-existing experience in development projects of similar nature.

### **5.3 Evaluation of Cumulative Impacts**

While direct primary impacts are relatively easy to identify and evaluate, special consideration needs to be afforded to evaluating cumulative impacts. While it is relatively simple to identify and evaluate direct primary impacts, the complex nature of natural systems makes it difficult to accurately predict synergistic and interactive impacts of a particular development project. On the other hand, it is relatively simple to identify potential additive impacts.

The following sources of cumulative impacts were considered in evaluating the potential impacts of the proposed water supply system.

- Time crowding: overall impacts of many similar concurrent developments. E.g. While many marine species and birds are relatively versatile and can relocate to other similar habitats following disturbances, concurrent developments in nearby habitats will reduce their chances of relocation and survival.
- Space crowding: high density of impacts on a single environmental medium. E.g. release of effluent from different sources into the same area.
- Indirect impacts: secondary and tertiary impacts resulting from an activity. E.g. groundwater contamination can affect the growth of terrestrial plants, which result in loss of habitat for terrestrial fauna.
- Triggers and thresholds: ecological systems can undergo fundamental changes beyond certain thresholds. Standards and guidelines have been developed based on anticipated threshold levels, for instance, in determining water quality. Such standards have been considered, where available.

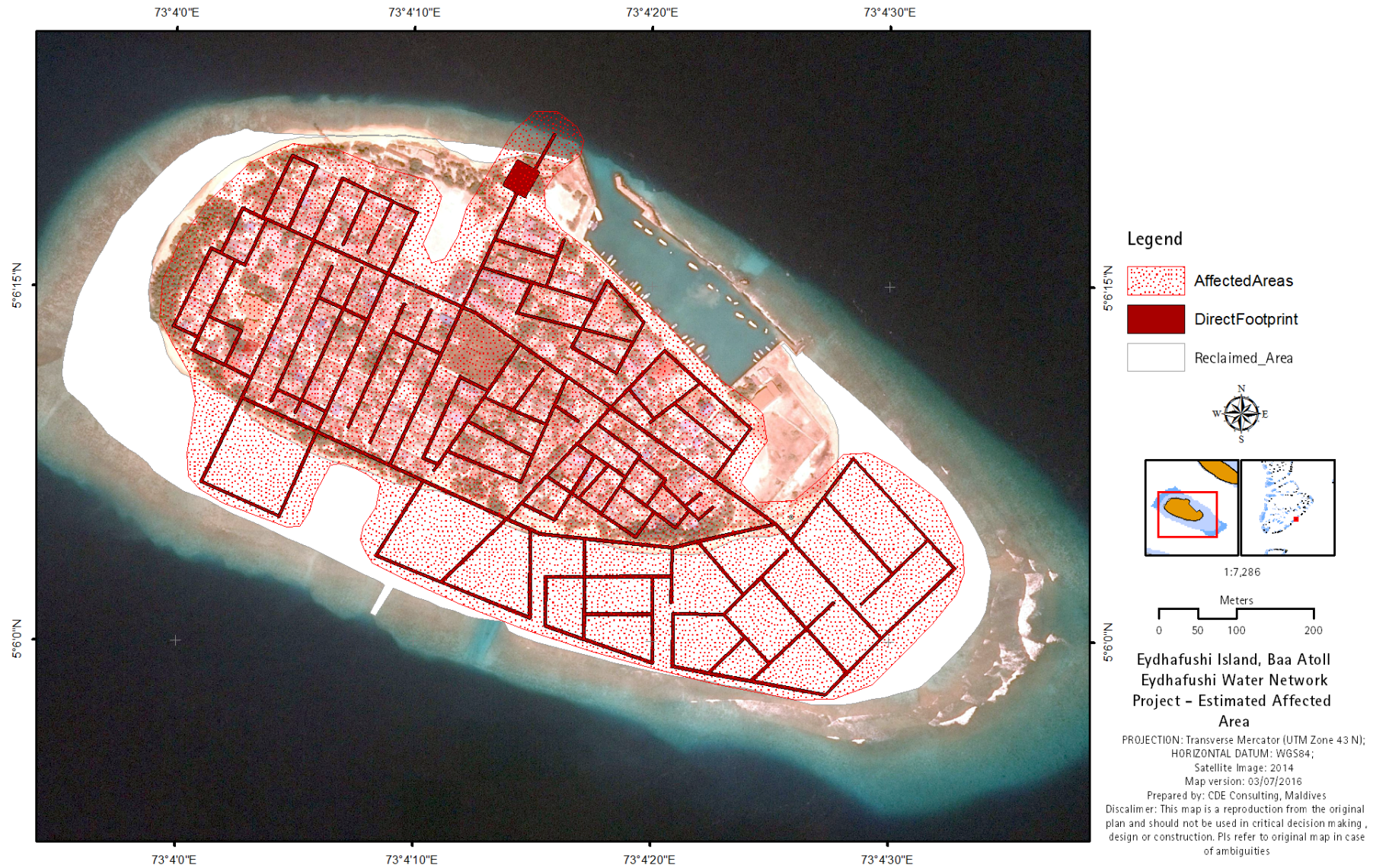


Figure 6.1: Project footprint and potential affected areas

Table 5.1: Impact Identification Matrix

Project Activity	Ambient noise level	Ambient air quality	GHG emissions	Groundwater	Coastal Processes	Marine water	Terrestrial Flora and Fauna	Soil Condition	Marine Flora and Fauna	Landscape Integrity/ Scenery	Natural Hazard Risk	Health and Safety	Demand for Resources and Services	Local Economy	Social Cohesion
<b>Construction Phase</b>															
Mobilization and site setup	-	-	-	X	X	X	X	X	X	-	X	-	X	+	+/-
Worker accommodation and activities	X	X	X	X	X	X	X	X	X	X	X	X	+	+	+/-
Equipment and material storage	X	X	X	X	X	X	X	X	X	-	X	X	+/-	+/-	+/-
Site clearance	-	-	-	-	X	X	-	-	X	-	X	-	X	X	+/-
Construction of RO plant building and storage tanks	-	-	-	-	X	X	-	-	X	-	X	X	+/-	X	+/-
Installation of RO plants	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tube well construction	-	X	-	-	X	X	-	-	X	-	X	-	X	X	X
Installation of brine outfall pipe	-	-	-	-	-	-	X	X	-	X	X	-	X	X	X
Excavation and dewatering	-	-	-	-	X	X	-	-	X	-	X	-	X	X	X
Installation of water network	-	X	-	-	X	X	X	X	X	-	X	-	X	-	-
Demobilization	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X
<b>Operation Phase</b>															
Operation of water supply system	-	-	-	X	X	X	X	X	X	X	+	-	+/-	+	+
Disposal of Brine	X	X	X	-	X	-	X	X	-	-	X	X	X	X	X
Maintenance works	X	X	X	-	X	-	X	X	-	X	X	X	+/-	+	X

X (no impact), - (negative impact), + (positive impact)

Table 5.2: Evaluation of key impacts on the natural and socio-economic environment

Impact area	Direct Impacts	Indirect/ Cumulative Impacts and Impact Interactions	Magnitude	Reversibility	Duration	Distribution	Significance
Ambient noise level	<b>Noise Pollution:</b> Operation of vehicles, machineries during mobilization, site clearance, construction activities (e.g. building, tube well construction, excavation), and demobilization is expected to generate noise. However these will not be operated continuously for a long period of time.	Loud noise generated during construction works may be a nuisance to residents of the island. Impacts cumulative overtime.	Minor negative	Easily reversible	Short term	Vicinity of project sites	Insignificant ( <i>Limited hours of operation</i> )
	<b>Noise Pollution:</b> Operation of RO plants and pump stations is expected to generate noise. However these will not be operated continuously for long periods of time.	Noise generated during operation of RO plants and pump-stations may be a nuisance to the residents of the island. Impacts cumulative overtime.	Minor negative	Reversible (with costly implications)	Long term	Vicinity of RO plant building and pump stations	Insignificant ( <i>Limited hours of operation</i> )

Impact area	Direct Impacts	Indirect/ Cumulative Impacts and Impact Interactions	Magnitude	Reversibility	Duration	Distribution	Significance
Ambient air quality	<b>Air quality degradation:</b> Negligible level of dust and air emissions during transport of labour force and equipment's to the project site. In addition small amounts of emission are anticipated during operation of machineries and vehicles.	Cumulative from different project activities	Minor negative	Easily Reversible	Short term	Island level	Insignificant ( <i>Negligible levels of dust and air emission</i> )
GHG emissions	<b>Increase in GHG in atmosphere</b> due to construction equipment, power generation for equipment	Cumulative from different project activities and over time	Minor negative	Reversible in the long term	Short term	Regional level	Insignificant ( <i>Negligible amount of GHG emissions over short period</i> )
	<b>Increase in GHG in atmosphere</b> due to operation of RO plants and pump stations.	Cumulative from different project activities and over time	Minor negative	Reversible in the long term	Long term	Regional level	Insignificant ( <i>Negligible amount GHGs is anticipated to be released</i> )

Impact area	Direct Impacts	Indirect/ Cumulative Impacts and Impact Interactions	Magnitude	Reversibility	Duration	Distribution	Significance
Groundwater	Accidental spillage of fuel or other hazardous substances could pollute the groundwater.	<p>Cumulative from different project activities</p> <p>Indirect impact on terrestrial flora, fauna, and soil condition</p> <p>Excavation can expose deeper soil layer and groundwater to increased risk of contamination by accidental spillages</p>	Moderate negative	Irreversible	Long term	Island level	Major
	Leakage of brine via cracks in the disposal pipeline into the groundwater, lead to salinization of the groundwater.	Indirect impact on terrestrial flora, fauna and soil condition in the affected area.	Moderate negative	Reversible over time	Short-term	Island level	Moderate

Impact area	Direct Impacts	Indirect/ Cumulative Impacts and Impact Interactions	Magnitude	Reversibility	Duration	Distribution	Significance
Marine water	Increased turbidity and suspended solids during installation of brine outfall reduce the quality of seawater.	Reduced water quality adversely effect marine life in the area, especially if the condition persists for a long period of time. Cumulative from different activities undertaken near this site (e.g. maintenance dredging of harbour)	Minor negative	Reversible over time	Long term	Site level	Moderate
	Increased level of salinity and chemicals (e.g. those used for cleaning the system, corrosion of system) in the area	Cumulative from different activities undertaken near this site (e.g. maintenance dredging of harbour)	Minor negative	Reversible over time	Long term	Site level	Insignificant ( <i>High flushing action expected to dilute brine</i> )
Terrestrial Flora and Fauna	Loss of terrestrial flora and fauna due to vegetation clearance and worker actions	Cumulative from different project activities and over time	Minor negative	Reversible in the long run	Short term	Site level	Insignificant ( <i>No major flora and fauna occurs within the</i>

Impact area	Direct Impacts	Indirect/ Cumulative Impacts and Impact Interactions	Magnitude	Reversibility	Duration	Distribution	Significance
							<i>project footprint</i>
<b>Soil Condition</b>	Accidental spillage/ leakage of fuel, lubricants, etc. during construction	Cumulative from different project activities and over time	Moderate negative	Reversible in the long term	Long term	Site level	Moderate negative
<b>Marine Flora and Fauna</b>	The marine biota and habitat of in the direct footprint of the brine outfall pipeline will be lost.	Cumulative from different activities undertaken near this site (e.g. maintenance dredging of harbour)	Moderate negative	Irreversible	Long term	Site level	Minor negative (total footprint of the pipeline is small)
	Brine disposal may adversely affect sea grass, plankton communities, change in-faunal community composition and other marine life.	Cumulative from different activities undertaken near this site (e.g. maintenance dredging of harbour)	Moderate negative	Reversible in long term if brine disposal is stopped	Long term	Site level	Insignificant ( <i>High flushing action is expected to dilute brine</i> )
<b>Landscape Integrity/ Scenery</b>	Loss of visual amenity due to built structures	Cumulative from other building and development works in the area	Minor	Reversible with costly implications	Short term	Site level	Minor negative

<b>Impact area</b>	<b>Direct Impacts</b>	<b>Indirect/ Cumulative Impacts and Impact Interactions</b>	<b>Magnitude</b>	<b>Reversibility</b>	<b>Duration</b>	<b>Distribution</b>	<b>Significance</b>
<b>Natural Hazard Risk</b>	Operation of RO Plants will ensure water security in the island, even during drought periods	-	Major positive	Reversible with costly implications	Long term	Island level	Major positive
<b>Health and Safety</b>	Accidents related to equipment handling and pollution	Indirect impacts from contamination of water, air and soil	Moderate	Possibly irreversible	Long term	Island level	Moderate negative
<b>Demand for Resources and Services</b>	Demand for freshwater, energy and waste disposal will increase during construction and operation	Cumulative impact on waste management facilities at Vandhoo or Thilafushi	Negligible	Reversible	Short term	Island level	Insignificant
<b>Local Economy</b>	Increase in employment opportunities: workers will be employed for operation of RO plant	-	Minor positive	Reversible	Long term	Island level	Minor positive
<b>Social Cohesion</b>	Choice of work methodology, construction workers or contractors for the project, may lead to dissatisfaction amongst island population.	-	Minor negative	NA	Short term	Island level	Minor negative

## **6 SIGNIFICANT IMPACTS AND MITIGATION MEASURES**

### **6.1 Impacts on Natural & Socio-Economic Environment during Construction and proposed Mitigation Measures**

This section describes potential negative impacts during construction stage of the activities involved in the establishment of water RO desalination system. Figure 6.1 presents project footprint and potentially affected area.

#### **6.1.1 Noise and Vibration**

Noise pollution and vibrations are likely to be caused by:

- Operation of machinery such as small excavators, dump trucks and concrete machines during construction, excavation and dewatering.
- Drilling of tube well.
- Construction works related to buildings and structures.

Increased noise levels from operation of machinery including drilling and construction works may cause some nuisance to people in the area at the time of undertaking work. In addition, higher noise levels could affect nocturnal fauna that use auditory communication such as bats. Nonetheless, any unfavourable disturbance to public and fauna in the island would be short term and limited to duration of construction.

#### ***Mitigation measures to manage Noise and Vibrations***

- Vehicles and machinery will be tuned and well maintained to reduce unnecessary noise emissions.
- All construction work will be carried out during daytime to minimise nuisance to the local community and disturbances caused to nocturnal fauna that uses auditory communication.
- Construction works will be completed in the shortest duration possible.
- Nearby communities will be notified of construction and drilling activities.

No additional cost are involved in undertaking these mitigation measures.

### **6.1.2 Air Quality Degradation**

Air quality may be deteriorated due to:

- Operation of machinery such as small excavators, dump trucks and concrete machines during construction, excavation and dewatering.
- Operation of drilling rig for borehole construction.
- Construction works related to buildings and structures.

Dust and emissions from vehicle and machinery exhausts may degrade the air quality leading to long term health risks to the community. Due to relatively small size of islands that allow rapid turnover and flushing of harmful emissions, impacts from air pollution due to operation of machinery and construction works is considered insignificant.

Dust nuisance may be caused if bentonite used in the drilling process is discharged on land and when the discharged bentonite is dried up in the sun. Given the small quantity of bentonite and with proper disposal, dust nuisance from bentonite is insignificant.

With proper mitigation measures, it is unlikely that air pollution impacts will cause long term effects such as human health risks that lead to increased public and private health costs.

#### ***Mitigation Measures for degradation of Air Quality***

- Vehicles and machinery will be tuned and well maintained to minimise air emissions.
- Construction work will be carried out in as short duration as possible.
- Ground/soil will be kept damp to minimise dust from construction works.

### **6.1.3 Groundwater Depletion, Salinization and Contamination**

Project activities that may lead to groundwater depletion, salinization, contamination of water resources are:

- Operation of machinery including drilling rig.
- Installation of pipes for water distribution network.
- Waste management and disposal including construction waste and domestic waste.
- Construction of buildings, and structures related to storage tanks, and desalination plant house.

Groundwater aquifer may be exposed during excavation and dewatering to lay pipes and, during other construction activities such as building of structures. Any accidental spill of oil and toxic substances has the potential to contaminate groundwater especially if the aquifer is exposed due to excavation. Likewise, during construction, significant quantities of waste will be generated

where any mishandling of solid and hazardous waste could also pollute the aquifer. Waste disposal also has the potential to cause contamination of groundwater from leachate while waste is stockpiled.

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. For this reason, contamination of groundwater is considered a significant impact.

It is anticipated that only small quantities of fuel and chemicals will be used during construction. Power will be sourced from existing power supply therefore fuel for power will not be handled at the site. However, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Drilling of the tube well may require dewatering. Installation of the network pipelines will involve excavation and dewatering although to a limited extent. The pipelines of the water distribution network are proposed to be buried to a depth of 600 mm requiring a maximum excavation depth of 1 m approximately.

Construction of buildings and structures will require excavation and dewatering for foundation purposes. Excavation depth desalinated water tanks structures and desalination plant house is estimated at 0.3 m.

Impacts from dewatering will be felt on the groundwater aquifer primarily salinisation and reduction in volume of water in the aquifer. Salinisation and depletion of groundwater aquifer is predicted to be short term and expected to be recharged during rainfall. Therefore, salinization and depletion of groundwater aquifer is considered insignificant.

***Mitigation measures to reduce depletion, salinization and contamination of groundwater***

- Dewatering will be carried out only if and where necessary after on the spot assessments by construction supervisor.
- Dewatering will be carried out during low tide in order to reduce the amount of dewatering required.
- All water extracted from ground during construction will be drained back into the system.
- All paints, lubricants, and other chemicals used on site should be stored in secure and bunded location.
- Littering and accidental disposal of construction wastes should be avoided by preplanning.
- General refuse should be stockpiled in one central area of the development site for easier management and monitoring.

- Construction activities should be carried out under the supervision of an experienced person.

Cost for this component is already embedded in the project contract to be signed with the successful contractor.

#### **6.1.4 Marine Water Degradation**

Installation of brine disposal pipeline is expected to impact the lagoonal area of the island. The lagoon bottom at the proposed reject water disposal pipeline is mainly made up of sand and a thick sea grass bed. Hence, it is likely that the lagoon water to become slightly turbid, when the brine disposal pipeline is placed on the lagoon bottom. But it is expected to subside shortly, without any significant damage and disturbance to biodiversity in this area. To reduce turbidity and sedimentation that might be incurred during this process, the following measures are proposed.

##### *Mitigation measures to reduce marine water degradation*

- Complete works in the shortest time period possible.
- Carryout work in low tide hours in calm sea condition.
- The project manager and workforce involved during construction will be briefed of environmentally practices.
- The pipe deployment site should be demarcated to ensure no work is carried out outside this boundary.

No additional cost are involved in undertaking these mitigation measures.

#### **6.1.5 Loss of terrestrial flora and fauna**

No significant terrestrial flora and fauna occur within the land allocated for the desalination plant house.

#### **6.1.6 Disruption to Road Traffic**

Pipe installation works will require blockage of roads to some extent and diversion of traffic.

##### *Mitigation measures to reduce disruption to road traffic*

- Work schedule will be effectively communicated with Island Council for traffic diversion and re-routing.
- Appropriate signboards will be put up in working areas.
- Public will be informed through Island Council on road blockages and traffic diversion.

- Work will be organised to complete work in shortest period possible.

Cost for this component is already embedded in the project contract to be signed with the successful contractor.

#### **6.1.7 Changes to Road Conditions**

Pipe installation will require roadsides to be excavated. Excavation will lead to changes in road condition such as levelling and compaction where roads are unpaved. Changes to road condition can lead to increased risk of flooding during heavy rainfall. In addition, poor levelling can lead to wear and tear in vehicles requiring more maintenance.

##### *Mitigation measures to reduce changes to road conditioning*

- Excavation will be coordinated with road construction work where possible.
- Filling activities at the end of pipe installation will be properly supervised.

No additional cost are involved in undertaking these mitigation measures.

#### **6.1.8 Pressure on Existing Resources**

If workers arrive from other areas there will be extra pressure on existing resources including natural environment as well as infrastructure and services. Groundwater will be used for non-potable purposes of the workforce. Domestic waste will be generated that will be disposed at islands waste disposal area. Sewage will be disposed in the existing sewerage system. Furthermore, there will be more demand for healthcare services as well as transportation services.

##### *Mitigation measures to reduce pressure on existing resources*

- Utilise locally available workforce as much as possible.

This mitigation measure does not incur any additional cost.

#### **6.1.9 Impact on Visual Amenity**

Construction stage of the project will have a visual impact on the island, specifically at the project site, including obstruction or alteration of scenic views. This might give rise to complaints from locals. However, 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 and short-term.

***Mitigation measures to reduce visual impact on the island***

- Complete the works in the shortest time possible.
- Fence off the construction site to shield off noise and unsightly views.

Cost for this component is already embedded in the project contract to be signed with the successful contractor.

**6.1.10 Risks to health and safety of construction workers**

Health and safety risks arising from construction work is high. Thus, it is important to take measures to reduce these risks as some of these accidents can be devastating impacts on lives of individual workers.

***Mitigation measures to reduce health and safety risk***

- Health checks prior to start of work
- Maintain on-site first aid kit
- Have qualified person to properly instruct and supervise the work
- Keep evacuation facility in place all the time during construction
- The construction site should be properly closed so access to any unauthorized person.

Main cost will be initial investment in first aid kits, and health checks (cost estimate range for these (MRF 7500 - MRF 10,000)).

**6.2 Impacts on the Natural & Socio-Economic Environment during Operational Phase and proposed Mitigation Measures**

This section will provide a brief description of each of the potential impacts and suggest appropriate mitigation measures for all potential adverse impacts.

Negative impacts during operation stage of the desalination plant are envisaged to be minor. Potential impacts anticipated during the operation stage of the RO include:

- Impact of brine discharge on marine environment.
- Possible occupational health risks to employees due to noise inside the plant (85 dBA at 1m).
- Possible contamination of ground/marine water due to handling, consumption, storage and disposal of chemicals used in the RO plant.
- Air pollution due to emission from power generation.

### **6.2.1 Degradation of Marine Environment**

RO plants generate concentrated brine solution as the effluent from the desalination process. Brine solution has the potential to kill marine organisms where it is discharged into the marine environment. The brine discharged might contain all or some of the following constituents:

- High salt concentration.
- Chemical used during pre-treatment stage.
- High total alkalinity as a consequence of increasing the calcium carbonate.
- Change of pH due to calcium sulphate and other elements in the seawater.
- Higher temperature of the discharge brine due to the high temperature is used in the desalination facility.
- Toxic metals, which might be produced if the discharge brine has contact with metallic materials used in the plant facilities.

It is noted that biocides such as chlorine is used for pre-treatment and periodical membrane and pipe cleaning. Such chemicals in brine may harm the marine environment if they are discharged into the marine environment without treatment. Marine assessment of the proposed brine outfall location shows that the area is pre-dominantly covered in dead coral and rubble and there is very low level of live coral. Land and Marine Environmental Resources Group Pvt Ltd (2010) notes that the chloride level of reject water from Male' water supply system is approximately 30 % higher than feed water.

It is also noted that temperature of the brine from RO plants are near ambient temperature since RO plants do not heat feed water unlike distillation plants. Therefore, impact to marine environment from RO reject temperature will not be significant.

The de-chlorination process of the RO plants may marginally reduce the pH of the waste brine compared to the feed water. However, the change in pH in brine and hence its effect on the receiving environment will not be significant.

Similarly, heavy metal concentration of the brine generated from RO plants is relatively low. RO facilities are less likely to release heavy metals as they are usually constructed largely of corrosion resistance stainless steel. The RO process also adds treated and cleaning chemicals that can include metals such as iron. However, Land and Marine Environmental Resources Group Pvt Ltd (2010) reports that Iron and Manganese levels tested in reject water by MWSC for Male' water supply system shows that the levels are lower than WHO and EPA guidelines. Based on this observation, it is considered that impact of heavy metal in brine on marine environment will be minor.

Further, given that the brine is discharged into the open sea, it is anticipated that adequate flushing and dilution of the effluents will bring the effluent to the background salinity of seawater quickly.

Due to absence of live coral colonies and moderately strong currents in the area, adverse impact on marine environment from discharge of brine is considered insignificant. The area will be monitored for significant adverse changes during the lifetime of the project as outline in the monitoring plan given in this EIA report.

Cost of monitoring is provided in section 9.

### **6.2.2 Local Noise Pollution**

Operation of desalination plants generate noise that may pose a potential health risk to the people who are working in the plant and may cause nuisance to those living nearby the site. For SWRO plants, noise levels of over 90 dB (A) have been reported (UNEP 2008). Major sources of noise during operation include the intake pumps, the RO high pressure pumps and other pumps and equipment such as the different pumps and equipment of the pre-treatment and cleaning systems. The facilities would normally be installed in buildings which may include additional noise attenuation measures, thereby reducing the noise emissions to surrounding areas.

It is reported that continuous exposure to noise levels exceeding 85dBA for more than 8 hours a day is considered hazardous and it is recommended that workers should not be exposed at any time to sound levels exceeding 115dBA, without the use of hearing protectors. Hence, the following mitigation measures are recommended to minimise the impact of noise pollution.

#### ***Mitigation measures to reduce local noise pollution***

- Provide personal protective equipment such as earmuffs to all staff working in the RO plant.
- Working shifts must be no longer than 8 hours.
- Make the desalination plant building soundproof as appropriate to anticipated noise levels.
- Enclose the desalination building with a boundary wall.
- Cost for this component is already embedded in the project contract.

Estimated cost of mitigation measure is MVR 1,000 – 2,000

### **6.2.3 Groundwater Salinisation and Depletion**

Pumping groundwater for desalination has the potential to cause draw down of groundwater which may lead to salinization and depletion of groundwater lens.

For desalination, water will be pumped at a depth of 32 metres at the rate of 17 m<sup>3</sup> per hour. Due to the unconfined nature of the freshwater lens, the proposed pumping may have some drawdown effect. Considering the depth at which water is withdrawn, the pumping rate and the location of the borehole on the edge of the freshwater lens, it is considered that the drawdown effect on groundwater lens will be minimal.

Based on the above factors, it is considered that salinisation and depletion of groundwater aquifer due to the proposed water intake for desalination will be minor in the short to medium term.

#### **6.2.4 Pollution due to Handling and Storage of Hazardous Materials**

The operation of a desalination plant requires the routine transport, storage and handling of hazardous materials. These may include chemicals used for:

- Pre-treatment of the intake water against biofouling, scaling, corrosion, etc.;
- Cleaning of the plant to remove biofilms, scales, etc.;
- Membrane preservation during transport and shutdown;
- Product water disinfection and stabilization.

In handling and storage of such chemicals, precautionary measures are generally taken to minimize hazards. Under reasonably foreseeable accident conditions, the risk of fire, explosion or release of hazardous materials into the environment is therefore low. However, despite all precautionary measures, a small risk remains that workers, the public or the environment is unexpectedly exposed to hazardous materials. The likelihood of an accident is low; however, in the unforeseen event that hazardous material is released, impacts may be severe (UNEP 2008).

The release of cleaning chemicals in larger quantities by accidental spills during routine transport, handling and storage may cause localized soil contamination. Chemicals may affect water quality if spilled on the ground or surface waters by rain and runoff after a spill. For example, high and low pH values of strongly alkaline or acidic cleaning solutions could affect the natural pH of the water body. Chemicals may also affect seawater quality if chemicals are accidentally spilled into the sea or washed into the sea by surface runoff. Accidental spills into the ground or surface water bodies may affect the local fauna and flora.

To avoid any pollution or contamination of the natural resources, the following measures will be undertaken for better storage and handling of hazardous chemicals.

##### ***Mitigation measures to reduce pollution due to hazardous waste***

- All chemical will be stored in a separate storage section of the RO plant building.

- In transportation, the danger of spilling chemicals into the sea or the coral environment as well as on the island will be reduced by tight fittings and appropriate material.
- Precautions to avoid spilling of chemicals will also be given by instructions to the staff.

Cost for this component is already embedded in the project contract to be signed with the successful contractor.

### **6.2.5 Air Quality Degradation and GHG Emissions**

Energy use is a major factor in the environmental assessment of desalination projects. Energy use associated with the operation of a desalination plant includes the electrical or thermal energy produced on site or taken from the electricity grid and used to operate the facility. The total energy demand of the facility comprises the energy for the desalination process, for air conditioning, for lighting and office supplies, as well as the fuel energy used for maintenance visits and employee vehicles. The specific energy demand refers to the energy demand of the desalination process only.

Power requirement for the proposed RO plant will be met by the existing power available from the island. Eydhafushi has a power generating capacity of 1.5 MW and has a peak demand of 810 KW. Hence, additional generators may be required to cater for the future power demand and emergency power failure at the RO plant. Since power is generated using diesel generators, air quality will mainly be affected by emissions of greenhouse gases (mainly CO<sub>2</sub>), acid rain gases (NO<sub>x</sub>, SO<sub>x</sub>) or fine particulate matter (PM<sub>10</sub>).

There is no air quality standards followed in the Maldives. Generally air quality is regarded as good. It is anticipated that emissions from the proposed project will contribute considerably to other existing or projected air emissions (cumulative impacts) due to the additional power requirement. However, pollutant concentration is not expected to be significant enough to create objectionable odours or pose a health risk to the community.

Although quantity of GHG emissions is considered low for the operation of desalination plant, contribution to national GHG emission levels is in contradiction to the national goal of carbon neutrality by 2020 and meeting Maldives Intended Nationally Determined Contribution (INDC) by 2030. On this note, GHG emissions are considered a significant impact of the project.

#### ***Mitigation measures to reduce air quality degradation***

- Desalination plant and water pumps will be regularly serviced.
- Low-emission energy technology or renewable energy options will be explored for feasibility in desalination.

Main cost will be servicing desalination plants and water pumps. Cost of servicing RO plant systems is estimated to be 10% of the total cost of the system.

### **6.2.6 Increased Cost of Living**

When the water supply system is operationalized, a user fee will be introduced based on the usage. Given the current economic situation of the country and the high inflation rate, levying a charge on the user will increase the cost of living. This may be an additional burden on the community.

## **6.3 Description of Positive Impacts from the Construction and Operation of the RO Water System**

### **6.3.1 Improved Quality of and Accessibility to Potable Water**

The most significant positive impact from the proposed water system will be the availability of quality piped water to the community. This will in turn improve the public health of the community. Such improvements to the public health can only be assessed through systematic recording and monitoring on the health of the community. Hospital reports can be used to monitor the number of water borne diseases such as diarrhoea.

### **6.3.2 Protection of Groundwater Aquifer**

Over extraction of groundwater has led to groundwater contamination and quality deterioration of groundwater. An additional source of water will contribute to protection of groundwater.

### **6.3.3 Increased Employment Opportunities**

The proposed development will create employment opportunities during both construction and operation stage. Construction stage is likely to create skilled and semi-skilled job opportunities. Staff will be hired for the operation and maintenance of the plant, administrative support and other areas of work.

### **6.3.4 Increased Business Opportunities**

Business opportunities will be opened up particularly as maintenance contracts and supply of office materials, chemicals and some spare parts. There will also be business opportunities for retail shops, restaurants and café especially during construction stage with the influx of staff for construction works. There will also be a demand for renting houses to accommodate some of the staff throughout the project.

## 7 ALTERNATIVES

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

### 7.1 “No-Project” Alternative

The option of a no project alternative has been considered for the installation of RO desalination plant. The no project option takes the following into account.

- Harvested rainwater will continue to be the source of drinking water for the people and whenever there is a drought spell, shortage of potable water will continue.
- Current health risks associated with an unreliable supply of water will continue.
- Social discontent over poor quality of water and associated health risks will continue and worsen.
- Mandate to provide water and sanitation facilities will remain unfulfilled.

*Table 7.1: Summary of “No Project” option*

Options	Advantages	Disadvantages
No installation of RO desalination System	<p>No development costs to the government.</p> <p>Community avoids increased living costs from the water services</p> <p>Adverse environmental impacts associated with the project are prevented.</p>	<p>Burden of diseases particularly water-borne diseases may increase.</p> <p>Socio-political issues may arise from the lack of access to clean water.</p> <p>Loss of employment opportunities to the island and atoll population.</p> <p>Loss of opportunity to the people in accessing proper water supply system.</p>

Given the disadvantages of the existing water situation, the preferred option is to go ahead with the project.

## 7.2 Alternative Brine Outfall Location

The following table provides a comparison of possible alternative sites for brine outfall against the proposed site.

*Table 7.2: Evaluation of alternative for RO plant brine outfall pipe*

Aspect	Proposed site	Alternative site
Impact on terrestrial environment	<ul style="list-style-type: none"> <li>No Vegetation clearance required along the pipeline length on land</li> </ul>	<ul style="list-style-type: none"> <li>No Vegetation clearance required along the pipeline length on land</li> </ul>
Impact on marine environment	<ul style="list-style-type: none"> <li>Impacts are predicted to be lower as no live corals occur within this site, and substrate was heavily covered with a thick layer of seagrass</li> </ul>	<ul style="list-style-type: none"> <li>Same as the proposed site.</li> </ul>
Impacts on coastal environment	<ul style="list-style-type: none"> <li>Requires excavating along the beach.</li> </ul>	<ul style="list-style-type: none"> <li>Same as the proposed site.</li> </ul>
Cost implications	<ul style="list-style-type: none"> <li>Lower compared to the alternative site</li> </ul>	<ul style="list-style-type: none"> <li>Higher as longer pipe line will be required</li> </ul>

Based on the advantages and disadvantages in the alternative described above, the preferred option is to go ahead with the proposed outfall location.

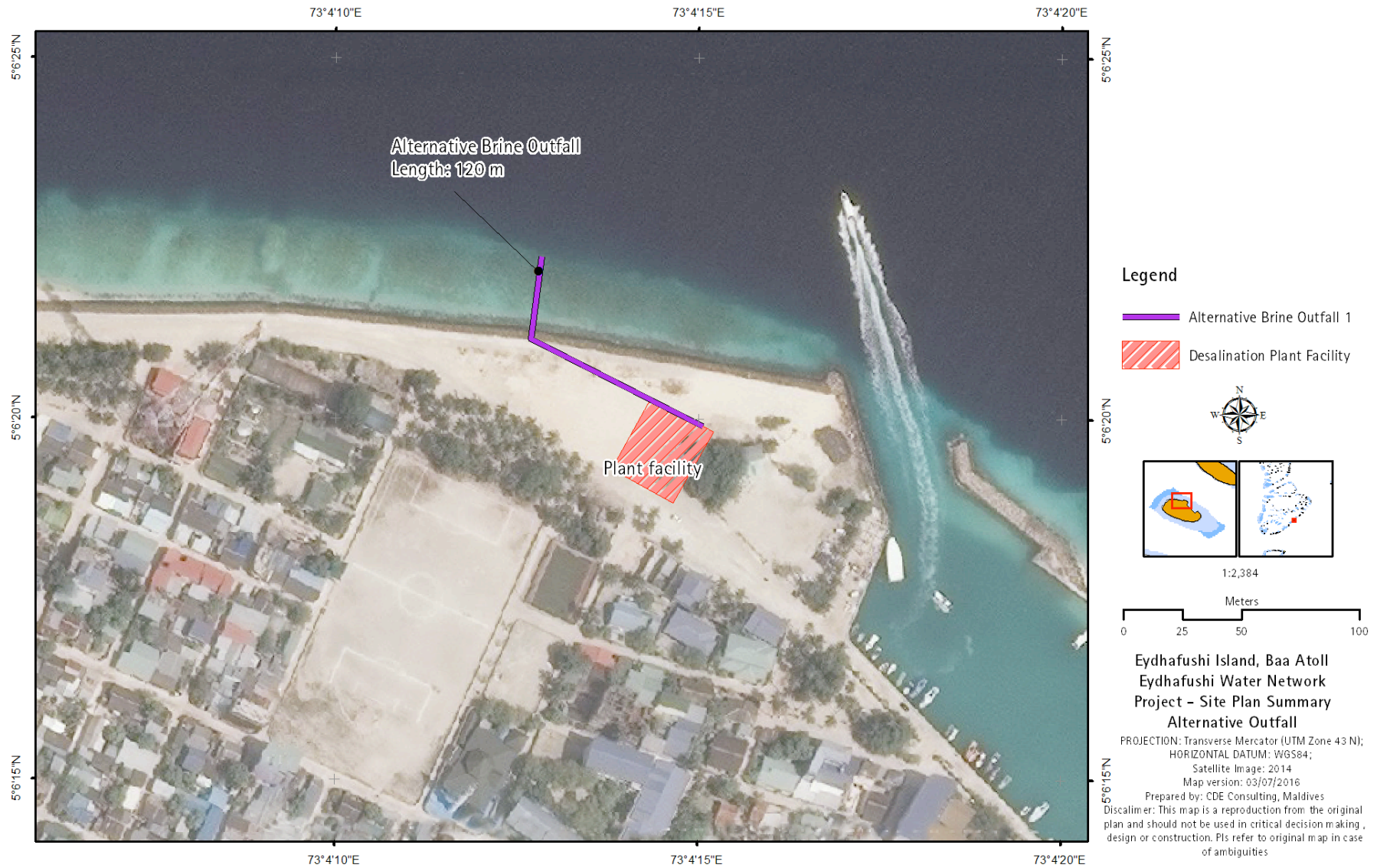


Figure 7.1: Project footprint and potential affected areas

## **8 ENVIRONMENTAL MANAGEMENT PLAN**

The Environmental Management Plan (EMP) is an important component of the EIA process, needed to determine the accuracy of impact prediction, the adequacy of mitigation measures, and level of compliance with commitments regarding implementation of mitigation measures and monitoring of relevant environmental aspects.

The main objectives of the environmental management plan are to:

- Produce a framework for managing anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions.
- Provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.

### **8.1 Environmental Management System**

The environmental management framework for the proposed project is based on the standards and policies set out by the Environmental Protection Agency of the Maldives.

- **Environmental Management Planning and establishment of key performance indicators:** The EMP specifies environmental management measures and required performance standards
- **Monitoring and corrective action:** The implementation of EMP measures will be monitored. Any inconsistencies between the EMP and its on-site implementation will be identified and addressed through corrective actions
- **Auditing, reviews and improvement:** The EMP will be reviewed. Improvements to the EMP will be made as necessary to achieve desired environmental outcomes.

The environmental management strategy is demonstrated in the following figure.

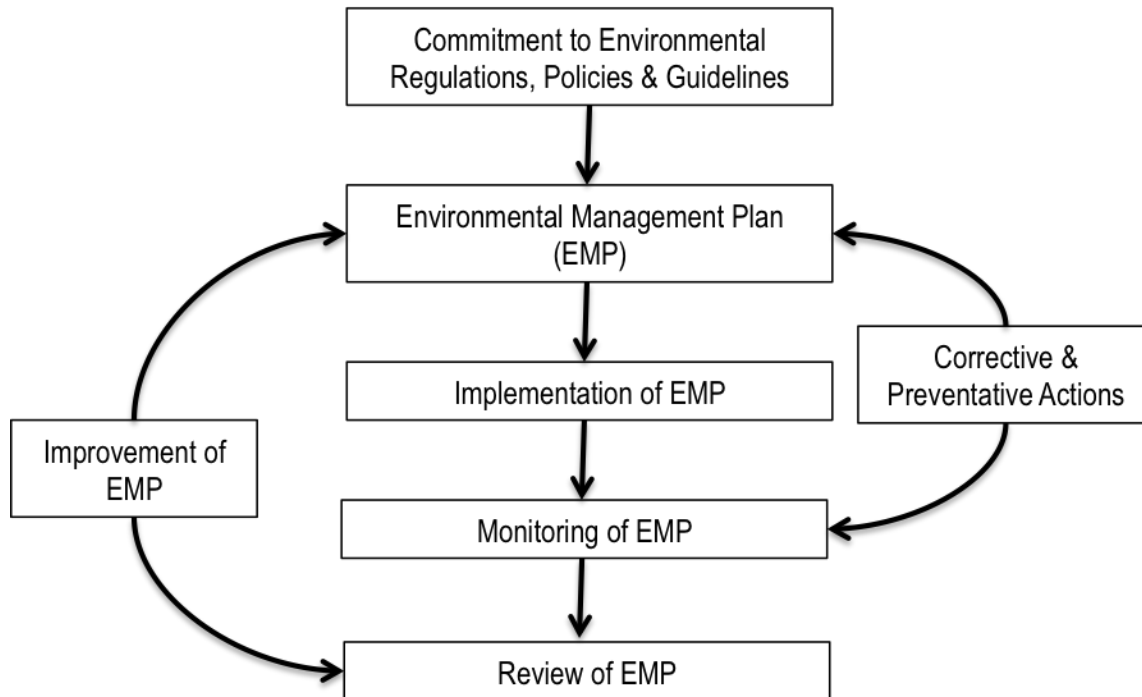


Figure 8.1: Environmental Management Strategy flow diagram

## 8.2 Management Structure and Responsibilities

The following parties are involved in the EMP of this project:

- Project proponent
- Environmental consultant
- Environmental Protection Agency (EPA)

The roles and responsibilities of the parties involved are as follows.

### 8.2.1 Project proponent

- Execution of all project activities
- Preparation of EMP
- Detailed designs of proposed water supply system
- Monitoring of the project activities
- Submission of annual environmental monitoring reports as required by the EPA

### 8.2.2 Ministry of Environment and Energy

- Approval of detailed drawings

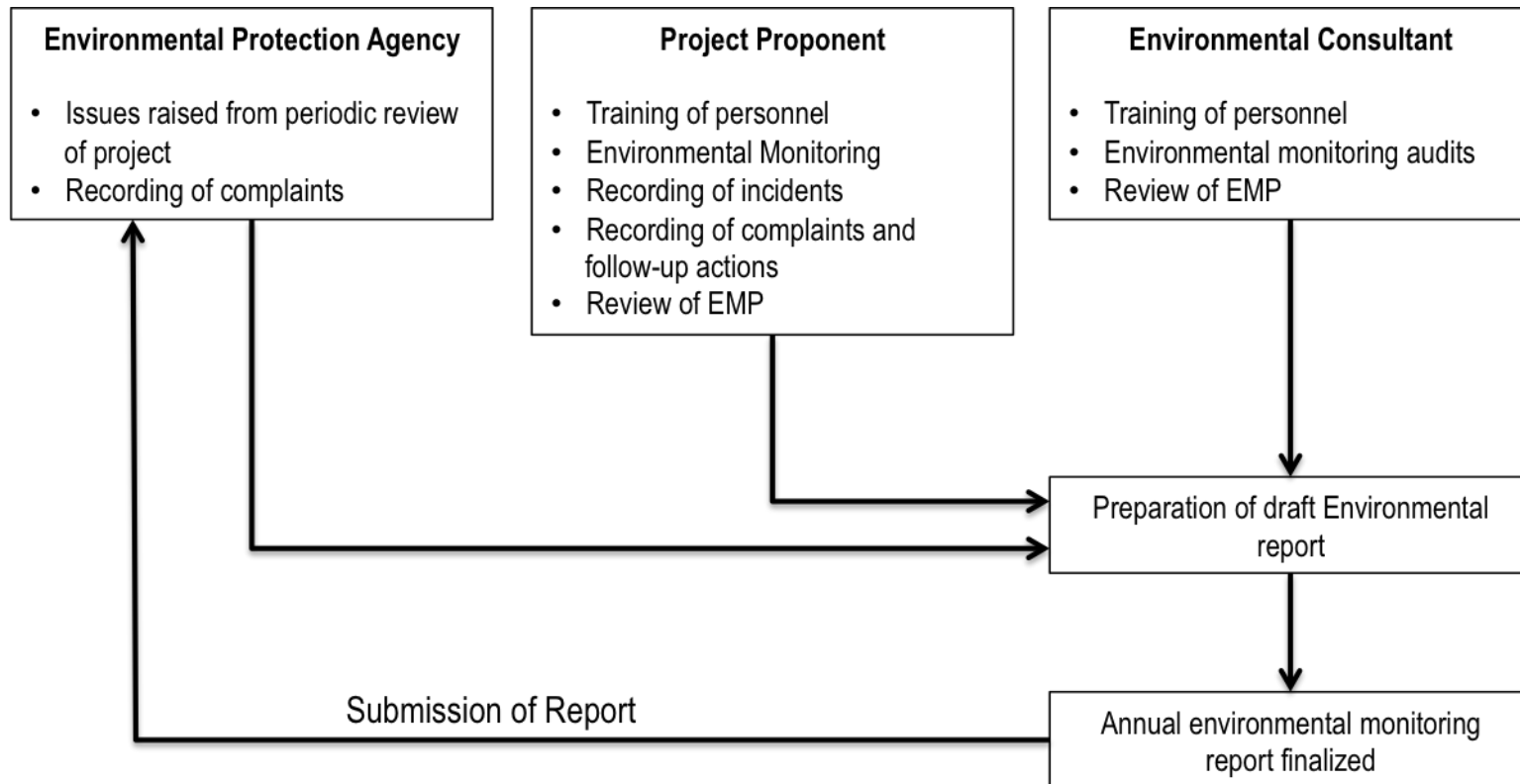
### **8.2.3 Environmental Consultant**

- Preparation of EMP
- Monitoring of performance of project activities according to the EMP
- Auditing the EMP to ensure desired outcomes are achieved
- Making amendments to the EMP according to the results of the audits
- Preparation of environmental monitoring report as required by the EPA (detailed in Chapter 9 of this report)

### **8.2.4 Environmental Protection Agency**

- Review environmental monitoring report
- Intervention in the event of a breach in environmental permit conditions
- Site visit and inspection before commissioning of water supply system

Figure 8.2: Environmental Management Plan for construction and operation phase



### 8.3 Management Strategies and Actions

#### 8.3.1 Environmental Education

Environmental education and awareness is the key to the success of an environmental management system and thus will be an integral part of the total environmental management system. The education and awareness programme will be addressed to labour force undertaking construction works, and staff that will be operating the water supply system.

#### 8.3.2 Environmental Monitoring, Reporting and Audit

A regular environment monitoring programme will be conducted to observe any changes taking place and this programme would be mainly directed at continuously understanding and reporting the reef health, lagoon water quality, ground water quality, and the product water quality.

An independent environmental audit will be conducted every year. The purpose of this audit is to check whether all the operations of the water supply system conform to the standards set by the government authorities and to evaluate the success of the policies and programmes implemented by the water supply system operator and identify where improvements can be made.

*Table 8.1 Environmental Management Plan for Construction and Operation Phase*

Activity	Management measures	Responsible party	Timing
Training of staff and contractors	All construction workers and project management staff will be provided information on general environmental issues, compliance with environmental permits and EMP.  All staff involved with environmental monitoring will be provided training in environmental monitoring procedures.	Project proponent & Environmental Consultant	Before commencement of construction activities
Documenting non-conformances and corrective actions	All non-conformances to the environmental permit conditions, observed during monitoring will be documented.  Necessary corrective actions and preventative actions will be identified  Corrective actions will be implemented, with systematic follow ups to ensure effectiveness of these measures	Project proponent & Environmental consultant	Continuous during construction phase

Activity	Management measures	Responsible party	Timing
Control of water contamination	<p>Oil, solid waste and hazardous waste handled carefully and transported in sealed containers.</p> <p>All paints, lubricants, and other chemicals used on site stored in a secure and bunded location.</p> <p>Littering and accidental disposal of construction wastes avoided by preplanning.</p> <p>All raw materials stored away from the vicinity of the coastal areas.</p> <p>General refuse stockpiled in one central area.</p> <p>Construction activities carried out under the supervision of an experienced person.</p> <p>Regular visual inspection of surrounding marine environment for waste</p>	Project proponent	Continuous during construction phase
Waste management (Waste generated from construction activities, the construction workforce will generate domestic and sewage waste)	The island waste management system will be integrated to accommodate waste disposal from project activities and project workforce.	Project proponent	Continuous, during construction phase
Supervision of project activities	Assign suitably experienced and qualified personnel to supervise the entire project and ensure that all activities are carried out with minimal adverse impact on the environment	Project proponent	Before commencement of the project

#### **8.4 Non-conformances and Corrective Action**

All non-conformances to the environmental permit conditions, observed during monitoring will be documented.

Necessary corrective actions and preventative actions will be identified

Corrective actions will be implemented, with systematic follow-ups to ensure effectiveness of these measures.

#### **8.5 Reporting**

Reporting shall be undertaken to provide evidence of the ongoing implementation of the EMP and will cover any training activities, site conditions and operations, monitoring data, details of non-conformances, incidents, complaints and follow up action, results of audits and reviews. Reporting shall be undertaken by the project proponent and the Environmental Consultant.

The environmental reporting process is summarized in the figure 8.2. All non-compliances and complaints during the execution of the project are to be reported to the EPA.

## **9 ENVIRONMENTAL MONITORING PLAN**

### **9.1 Introduction**

This chapter will outline the monitoring plan for the proposed project. Environmental monitoring is essential because, although with proper mitigation measures, the overall environmental damage can be significantly minimized, an unforeseen impact may still occur. Furthermore, some of the impacts predicted may turn out to be far greater than predicted, making mitigation measures ineffective. Therefore, in order to avoid or reduce the chances of such events, regular and frequent environmental monitoring is vital.

### **9.2 Objectives of the Monitoring Plan**

The main objectives of the monitoring plan are:

1. To identify whether the predicted impacts are accurate and mitigation measures taken are effective
2. To identify any unforeseen impacts so that appropriate mitigation measures can be taken at the earliest
3. To identify and resolve any issues of social unrest at the earliest
4. To eliminate or reduce environmental costs

### **9.3 Before Construction**

The monitoring assessments prescribed in Table 9.1 are required before construction, if the construction activities begin 12 months after this EIA.

### **9.4 Monitoring during Construction Phase**

Table 9.2 shows the details of the different monitoring attributes and parameters must be monitored during the construction stage.

Additionally, the following aspects will be monitored during the construction stage to ensure that environmental impacts are minimized.

- 1) Daily monitoring to ensure that the cleared areas and other construction processes are not creating any significant dust nuisance for the local environment.

- 2) Daily monitoring of vehicle refuelling and repair should be undertaken 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. The site supervisor will conduct spot checks.
- 3) Daily inspection of site clearance activities to ensure that the proposed building plans are followed.

**Table 9.1: Monitoring Schedule for Before Construction**

<b>Monitoring Attribute</b>	<b>Objective</b>	<b>Indicator</b>	<b>Methodology</b>	<b>Locations &amp; samples</b>	<b>Frequency and responsible agency</b>	<b>Applicable standard</b>	<b>Est. Total Costs RF*</b>	<b>Responsible Agency</b>
Marine Water Quality (Marine)	To determine the baseline condition of marine water at proposed outfall site and alternative outfall site	The following parameters will be tested: Temperature, pH, Salinity, Total Dissolved Solids, Conductivity, Dissolved Oxygen, BOD, Total Coliform, and Faecal Coliform	Laboratory analysis	Two Locations  SW1 – proposed outfall SW2 – alternative outfall  One sample for each site taken at 1 m depth	Once prior to commencement of construction activities and	WHO marine water quality standards	3,000	Proponent
Ground Water Quality (ground water)	To determine the baseline condition of groundwater at project site	The following parameters will be tested: pH, Salinity, Conductivity, and Total Hydrocarbon	Laboratory analysis	Two Locations (sites G1 and G2)	Once prior to commencement of construction activities	Maldivian (EPA) ground water monitoring standards	2,000	Proponent
Coral Reef Health	To assess the status of reef of the island and to determine fish species and abundance	Fish species composition and population size	Visual Fish Census	Proposed brine outfall location (T1) and alternative brine outfall	Once prior to commencement of construction activities	Maldives EPA standards	10,000	Proponent

				location (T2)				
		Coral genera composition and coverage	Photo Quadrat Method	Proposed brine outfall location (T1) and alternative brine outfall location (T2)	Once prior to commencement of construction activities	Maldives EPA standards	10,000	Proponent
Noise	To determine the baseline noise level at project site	Noise levels	Measurement using sound meter	Proposed location for RO plant house	Once prior to commencement of construction activities	Ambient noise standard in most OECD countries	10,000	Proponent

\* Does not include logistic and consultant fees

**Table 9.2: Monitoring Schedule for Construction Stage**

Monitoring Attribute	Objective	Indicator	Methodology	Locations & samples	Frequency	Applicable standard	Est. Total Costs RF*	Responsible Agency
Marine Water Quality (Marine)	To determine the impact of marine water during construction stage	The following parameters will be tested: Temperature, pH, Salinity, Total Dissolved Solids, Conductivity, Dissolved Oxygen, BOD, Total Coliform, and Faecal Coliform	Laboratory analysis	Two Locations  SW1 – proposed outfall SW2 – alternative outfall  One sample for each site taken at 1 m depth	On every six months during construction	WHO marine water quality standards	6,000	Proponent
Ground Water Quality (ground water)	To determine the impact of groundwater during construction stage	The following parameters will be tested: pH, Salinity, Conductivity, and Total Hydrocarbon	Laboratory analysis	Two Locations (sites G1 and G2)	On every six months during construction	Maldivian (EPA) ground water monitoring standards	4,000	Proponent
Water Contamination	To determine the impact of oil spillage and leakage on	Oil spills (Surface layer of groundwater)	Visual observation	All area where oil is handled	Daily for the duration of the project	NA	Included in contract or fees	Contractor
		Oil leakage from machinery or vessels	Maintenance and tuning of all machinery & vessels	All area where oil is handled	Weekly during the construction phase	NA	Included in contract or fees	Contractor

Monitoring Attribute	Objective	Indicator	Methodology	Locations & samples	Frequency	Applicable standard	Est. Total Costs RF*	Responsible Agency
Noise	To determine the impact of noise during construction	Noise levels Noise complaints received from neighboring residents	Noise meter Logs	Around project site	Weekly during construction	Ambient noise standard in most OECD countries	Included in contract or fees	Contractor

- Does not include logistic and consultant fees

**Table 9.3: Monitoring Schedule for Operation Stage**

Monitoring Attribute	Objective	Indicator	Methodology	Locations & samples	Frequency	Applicable standard	Est. Total Costs RF*	Responsible Agency
Marine Water Quality	To determine the impact on marine water quality	The following parameters will be tested: Temperature, pH, Salinity, Total Dissolved Solids, Conductivity, Dissolved Oxygen, BOD, Total Coliform, and Faecal Coliform	Laboratory analysis	Two Locations  SW1 – proposed outfall SW2 – alternative outfall  One sample for each site taken at 1 m depth	Bi-annually during operation phase for 5 years	Maldives EPA marine water monitoring standards	30,000	Proponent
Ground Water Quality	To determine the impact on ground water quality	The following parameters will be tested: pH, Salinity, Conductivity, and Total Hydrocarbon	Laboratory analysis	One Location (GW1)	Bi-annually during operation for 5 years	Maldives EPA ground water monitoring standards	10,000	Proponent
Desalinated Plant Intake Water quality	To assess the quality of the intake water sourced for desalination plant	pH, Temperature, Conductivity, Salinity, Dissolved Oxygen, TDS, Total Coliform, Faecal Coliform	Laboratory analysis	3 samples from water intake site	Bi-annually during operations	Maldives EPA desalination plant intake water standards	3,000.00 (approx.. per year)	Proponent

Monitoring Attribute	Objective	Indicator	Methodology	Locations & samples	Frequency	Applicable standard	Est. Total Costs RF*	Responsible Agency
Desalinated Plant Product Water quality	To ensure the quality of product water from desalination plant conforms to the standards of potable water	pH, Temperature, Turbidity, Conductivity, Total Dissolved Solids, Free Chlorine, Boron, Copper, Fluoride, Iron, Total Hardness, Iodine, Nitrates, Nitrite, Ammonia, Phosphate, Sulphate, Sulphide, Total Coliform, Faecal Coliform	Laboratory analysis	Storage Tank, 2 random locations on the island,(3 samples)	Bi-annually during operation	Maldives EPA desalinated product water standards	15,000.00 (approx. per year)	Proponent
Coral reef health	To determine the general status of the reef and to determine the species abundance and composition of the reef system	Percent of live coral cover, and fish species abundance and composition	Photo Quadrat survey; Fish census	Transect sites T1, T2	Once annually for 5 years	Maldives EPA standards	Included in environmental consultant fees	Contractor
Noise	To assess and ensure the noise levels during RO plant operation are within acceptable limits	Noise levels Noise complaints received from neighboring residents	Noise meter Logs	At RO plant house	Bi-annually during operation	Ambient noise standard in most OECD countries	Included in environmental consultant fees	Contractor

## **9.5 Monitoring report**

A detailed environmental monitoring report is required to be compiled and submitted to the EPA annually based on the data collected for monitoring the parameters included in the monitoring plan given in the EIA. 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 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. 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.

## **9.6 Cost of monitoring**

The cost of monitoring is estimated to be Rf 100,000 annually. Professional consultants shall be hired to undertake the monitoring or the necessary equipment for monitoring shall be procured. The collected data and report must be checked by a professional.

For pre-construction and construction stage monitoring, individual parameter costs are provided in the relevant tables above.

## **9.7 Commitment to monitoring**

The proponent is fully committed to undertake the monitoring programme given in this chapter (see Appendix H).

## **10 STAKEHOLDER CONSULTATIONS**

Stakeholder consultations were conducted for this project to provide information about the proposed project and to seek stakeholder's views on the project. During consultations, stakeholders were provided with a brief description of the project and were asked about their opinions or concerns regarding the project and their recommendations to address the key issues. The following stakeholders were consulted for this EIA;

1. Eydhafushi Island Council
2. FENAKA
3. Eydhafushi Public
4. Ministry of Housing and Infrastructure

Consultations with Eydhafushi Island council and FENAKA revealed that the island is in great need for quality water supply system and they anticipate the project to proceed at a speedy rate. Both stakeholders stated that the existing groundwater condition in the island is unfit for drinking and they normally rely on rainwater.

A household consultation was also conducted to provide information about the project to the island community, to seek their views about the project and to assess their willingness to pay for the service that will be provided by the proposed water supply system. Among the 53 households consulted, all of them expressed that they are willing to pay for the service and 39% stated that they are willing to pay the lowest fee possible.

Consultation with Ministry of Housing and Infrastructure regarding their ongoing road project in Eydhafushi revealed that the roads identified for pipeline installation for water project would be paved under the road project. Hence, Ministry of Housing and Infrastructure stated that they can lay out duct lines on these roads or they could delay the works on these roads until the pipelines are installed. The Ministry recommended Ministry of Environment and Energy to coordinate regarding project components and schedule to facilitate this process.

Following section will provide details of the discussions held in the each stakeholder consultation meetings.

## **10.1 Eydhafushi Island Council**

*Date: 13 June 2016*

*Venue: Eydhafushi Island Council*

*Participants: Naazneena Yoosuf (Council President), Mohamed Naurif (Council Vice-President), Mohamed Raamiz (Council Member), Ahmed Afsal (Council Member), Naushad Ahmed (Council Member)*

### ***Summary of Discussions***

- Council stressed the need for a clean water supply system in Eydhafushi and anticipates that a standard supply system will be established under this project
- Quality of groundwater varies in different parts of the island, however in most parts it is not suitable for drinking. Hence, it is normally used for showering and cooking purposes.
- At times of water scarcity, FENAKA Corporation in Eydhafushi assists in providing water supplies to the island community.
- The council does not have any restrictions for using the existing RO plant site in the island for this project.
- Council highlighted that they are willing to pay for the water service, however the rate of charge should not be higher than the rate set for Greater Male' Region.
- Council anticipates the project to go ahead as rapidly as possible.

## **10.2 FENAKA**

*Date: 13 June 2016*

*Venue: FENAKA (Eydhafushi Branch)*

*Participants: Ahmed Anwar (Station Manager), Ali Naseer (Site Supervisor), Mohamed Hameed (Site Official)*

### ***Summary of Discussions***

- FENAKA Corporation in Eydhafushi manages water, electricity and sewerage in the island and they assist in providing potable water supply to the island community at times of need.

- FENAKA believes a standard water supply system, which provides quality water is crucial for the island given the unusable condition of groundwater in the island. The groundwater lens is expected to deteriorate even further when the road project begins.
- Once the water supply system is established, FENAKA staff will require trainings to operate and maintain the system.
- FENAKA anticipates, the project will involve professional consultants during construction stage and quality pipelines will be used for network connections. They also hope that a quality EIA will be conducted for this project.

### **10.3 Eydhafushi Public**

Consultations were held with the public of Eydhafushi to provide information about the project and to seek their views. Consultations were conducted at individual households selected randomly. During this consultation, public's willingness to pay for the proposed piped portable water facility was also assessed. Questions asked during the consultations are attached in Appendix F.

All of the 53 households consulted have high expectations for the proposed water supply system in Eydhafushi and they anticipate the system will provide standard quality water. Out of the households consulted, 30% of the households stated that the groundwater quality in the island is not appropriate for drinking. Especially after the tsunami event, condition of groundwater has deteriorated further. Hence households normally use groundwater for laundry, cooking and showering and almost all of the households consulted harvest rainwater.

When the public was asked about their willingness to pay for the water service, all of the households stated that they are willing to pay. A few of the households stated that they are willing to pay if the water supplied from the system is of quality. An overwhelming 39% of the households consulted did not state an exact figure they are willing to pay, however they prefer to pay the lowest rate possible. A few of the households stated that they would like the rate of charge to be the same as that in Male' and one household stated that they would prefer to pay less than MVR 100 for the service.

In general, the project is well received by the public and they anticipate the project will be processed at a speedy rate and the end product will of standard quality.

## **10.4 Ministry of Housing and Infrastructure**

*Date: 26 June 2016*

*Venue: Ministry of Housing and Infrastructure*

*Participants: Mohamed Jinan Saeed (Engineer), Nafha Aujaz (Environment Analyst)*

### ***Summary of Discussions***

- Ministry has planned a road project in Eydhafushi which is planned to be commenced at the end of July and is expected to be completed in January 2017 or by the end of February 2017.
- All the roads identified for pipeline installation in Eydhafushi will be paved under the road project led by the ministry, hence to facilitate the installation of pipelines for the water project, Ministry of Housing can lay out duct lines during construction stage of the road project.
- Since the civil works of the water project are expected to begin in mid December 2016, Ministry of Housing can delay their work on the roads identified for pipeline installation and prioritize other roads. In this way, pipelines can be installed on these roads prior to paving.
- Ministry of Housing recommended Ministry of Environment and Energy to coordinate regarding water supply project and its schedule to facilitate the works of both projects

## **11 Potential Data Gaps and Assessment Limitations**

### **11.1 Gaps in Information**

### **11.2 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 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 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, wave and terrestrial modification history.
- Absence of historical and long-term records on reef and lagoon environment.
- Lack of detailed data on geology and soil 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.

### **11.3 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 note earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. It is important to consider that there will be uncertainties and voluntary monitoring of natural processes as described in the monitoring programme is absolutely essential.

## **12 Conclusions**

The assessment shows that the RO systems can be developed on the island with limited implications on the environment. The assessment shows that the proposed developments involve significant impacts on the marine environment and terrestrial environment due to brine outfall construction, brine discharge, ground excavation and operation of vehicles and machinery. The project also involves moderately significant health and safety risks due to equipment handling and pollution. However, the predicted impacts can be minimized considerably with the proposed mitigation measures. Significant impacts of operation stage include marine degradation due to brine discharge, increased GHG emissions due to RO plant and operation of pumps stations, and increased cost of living due to additional cost in purchasing water. The assessment shows that the proposed project has many positive impacts including improved quality and accessibility to potable water, protection of groundwater aquifer, reduction of water related disaster risk, and increased employment and business opportunities

The key conclusions of this EIA are summarized below.

### **12.1 Proposed Systems**

- Reverse Osmosis desalination technology has been determined as the most appropriate technology, given the proven record of success in Maldives. The project proposes to establish an integrated water supply system in Eydhafushi by installing two modules of 8,000 Litres/hour RO plants and establishing a rainwater harvesting system.

### **12.2 Environmental Aspects**

- Overall the project is beneficial to the environment specifically due to improved quality and accessibility of potable water and the protection of groundwater aquifer from over-extraction.
- Although there are negative impacts from all activities of the project, only a small number of activities cause relatively significant adverse impacts.
- Activities with the highest potential to cause negative impacts are excavation, operation of desalination plant, construction of brine outfall, and discharge of brine water.
- Adverse impacts from operation of desalination plant are mostly related to power consumption and associated air emissions.
- With proper mitigation measures, the project is not expected to cause significant damage to the environment.

### **12.3 Socio-economic Aspects**

- The proposed water supply system will significantly improve the quality and accessibility of potable water in the island Eydhafushi.
- The result of willingness to pay survey shows that residents of Eydhafushi are willing to pay for water supply system, though with differences in preference of fee structure.

### **12.4 Legal Aspects**

- Land allocated by island council for the proposed project has an area of 2,500 sqft. The site already has an existing water facility with desalination plants. The land has been approved by Ministry of Housing and Infrastructure and has been given on leasehold to Ministry of Environment and Energy for the project.
- However, the site plan proposed by the design contractor has an area of 11,302 sqft. Hence, MEE has requested the Council to revise and increase the size of the land to 10,000 sq ft.

In conclusion, this project has been designed in conformance to the relevant laws and regulations of Maldives but requires final approval from EPA for the detailed drawings. Given the positive outcomes associated with this project, overall conclusion is that this is a beneficial project for the island community of Eydhafushi.

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**APPENDIX A – Approved Terms of Reference**

TOR Number: 203-ADMIN/438/2016/101

# Terms of Reference for Environmental Impact Assessment for the Proposed Water Supply System in Eydhafushi, Baa Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 30/5/2016 for undertaking the EIA for the proposed Water Supply System at Eydhafushi, Baa Atoll. The proponent of this project is Ministry of Environment and Energy.

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

- 1. Introduction and rationale** – Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this project is link other activities that are carried out or that is being carried out within the project boundary. Identify the project financing and institutional arrangements relevant to the project. This should include the following information:
  - Name and contact details of the proponent
  - Rationale and background to the project
  - Aims and objective of the project
  - Information of the project/activity and the tasks already completed
  - Information and other activities that have been carried out or that is being carried out within the project boundary.
  - Institutional arrangements relevant to this project
  - Project Location and boundaries of the study area
- 2. Study area** – Submit a minimum A3 size scaled plan with location of proposed facility. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size.
- 3. Scope of work** – Identify and number tasks of the project including preparation, construction and decommissioning phases.

## Task 1. Description of the proposed project

### Desalination Plant Design

- a) Submit an A3 size plan of proposed RO systems with labeled drawings
- b) Describe the technology (reverse osmosis, disinfection) and capacity (envisage population growth in the next 30 years);
- c) Water storage tank capacity;
- d) Water quality monitoring and water security logistics
- e) Describe operations for dewatering excavations for pump stations and pipeline installation;
- f) Describe rain water collection potential in the proposed project site

Environmental Protection Agency

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Male', Rep. of Maldives, 20392

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Fax: [+960] 333 5953 ފެކްސް: 333 5953

ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި

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Email: secretariat@epa.gov.mv ފޯމިޔާންކުރުމުގެ ގޮތުގައި

Website: www.epa.gov.mv ފެކްސް: 333 5953



- g) Specify materials, equipment, heavy machinery, staff estimate (quantity and period of time), key personnel positions, intermittent technical expertise required;
- h) Project management: Include communication of construction details, progress, target dates and duration of works, construction/operation/closure of labor camps, access to site, safety, equipment and material storage, waste management from construction operations (mainly dredged materials), power and fuel supply;
- i) Specify an emergency water supply plan if system fails;

**Brine Outfall Pipeline**

- a) Justify brine outfall site selection depth and distance from shore using oceanographic and ecological information. Currents and waves ought to disperse the discharged water with minimum impacts on marine ecosystems and economic activities.
- b) Describe equipment needed and construction methods for laying the offshore pipeline including handling transportation.

**Borehole**

- a) Description of borehole design and location of boreholes
- b) Description and justification of borehole locations
- c) Description of equipment needed and construction methods for boreholes drilling.

**Distribution network**

- a) Detailed description of the distribution network including pipe materials, house connections, water metering and pumping facilities.

**Temporary facilities**

Project management: Include communication of construction details, progress, target dates and duration of works, construction/operation/closure of labor camps, access to site, safety, equipment and material storage, water supply, waste management from construction operations (mainly dredged materials), power and fuel supply temporary site setup;

**Task 2. Descriptions of the environment – Assemble, evaluate** and present the environmental baseline study/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks.

All data must be collected as per the requirements of the EPA Data Collection Guidelines (published on [www.epa.gov.mv](http://www.epa.gov.mv)). The report should outline detailed methodology of data collection utilized.

All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects, vegetation transects and manta tows sites for posterior data comparison. Information should be divided into the categories shown below:

**Climate**

- Temperature, rainfall, wind and waves,
- Risk of hurricanes and storm surges;

**Hydrography/hydrodynamics (localized maps)**

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;



- Wind induced (seasonal) currents;

Physical parameters

- Marine water quality assessment measuring these parameters; temperature, pH, salinity, total dissolved solids, conductivity, dissolved oxygen, BOD, COD, total coliform and faecal coliform from a minimum of 2 locations
- Ground water quality assessment of desalination plant site and borehole locations and an additional 2 locations from the island, measuring these parameters; temperature, pH, salinity, conductivity, and Oil (total hydro carbon).
- Noise level near the proposed desalination plant area

Biological Assessment

Marine:

- A quantitative and qualitative assessment of coral reef environment (the benthic coral fauna and fish fauna cover) at the proposed brine concentrate discharge area and alternative locations

Terrestrial

- Type of vegetation, exact number and extent of vegetation to be cleared (if any).
- Terrestrial baseline monitoring surrounding all inland developments (See appendix 1 for monitoring guidelines). Include a description of all flora and fauna and any threatened or endangered species in the area.

Socio-economic environment

*Assessment of socio-economic conditions of Baa.Eydhafushi*

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Land use planning and natural resource use
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).

Hazard vulnerability:

- Vulnerability of the site to flooding.

Absence of facilities in the country to carry out the water quality tests will not exempt the proponent from the obligation to provide necessary data. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

**Task 3. Legislative and regulatory considerations** – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.





and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, financial commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided.

**Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) –**

Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government authorities, NGOs, engineers/designers, development managers, staff and members of the general public. The EIA report should include a list of people/groups consulted and summary of the major outcomes. The following parties should be consulted

- a) FENAKA
- b) Ministry of Housing regarding ongoing road project and its scheduling which may impact this project
- c) Public consultation
- d) Eydhafushi Island Council

**Presentation-** The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations of any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012 and subsequent amendments.

**Timeframe for submitting the EIA report** – The developer must submit the completed EIA report within 6 months from the date of this Term of Reference.

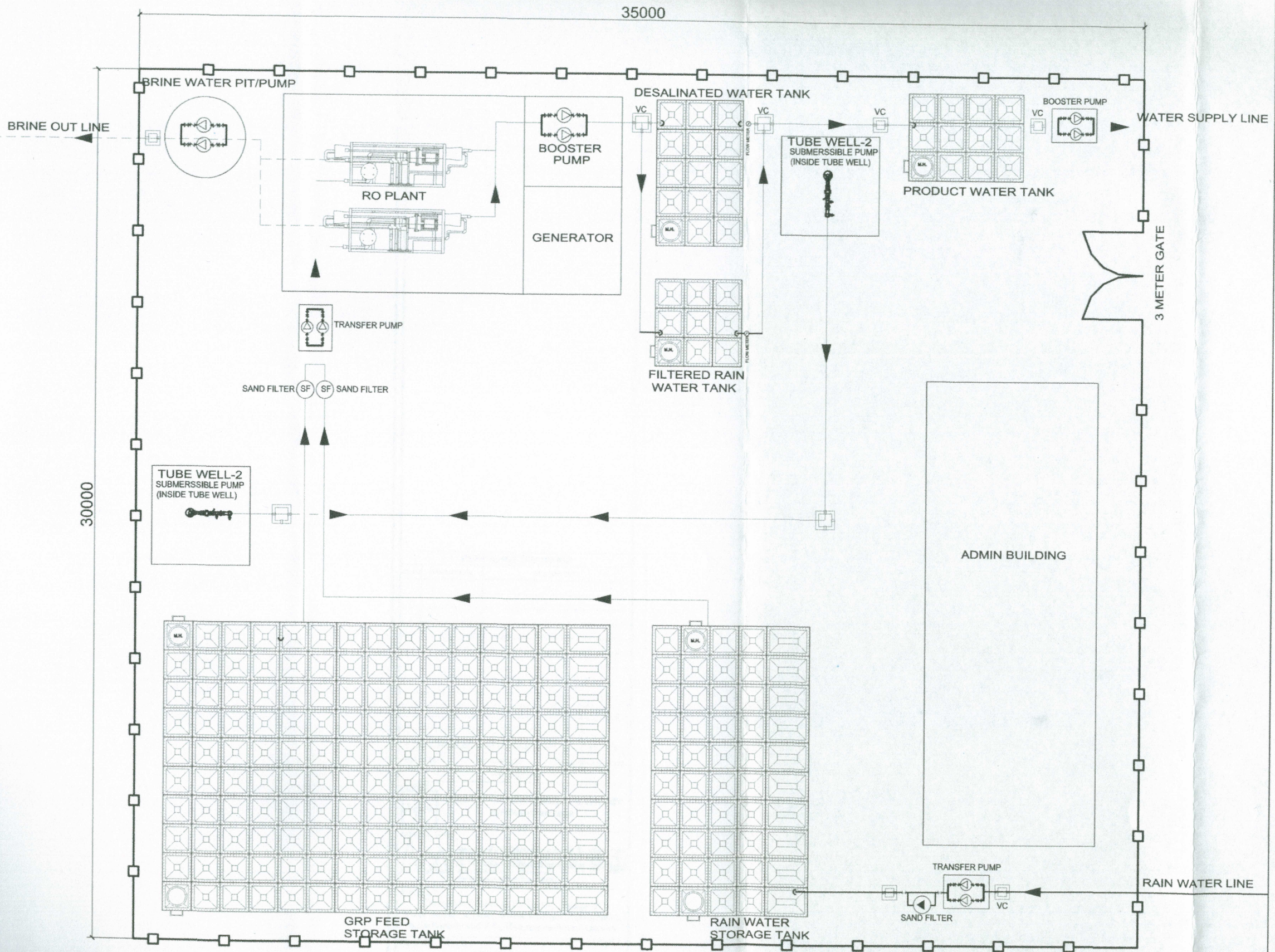
30 May 2016



**APPENDIX B – Site Plan and required land use permits**







**NOTES:-**

1. ALL DIMENSIONS SHOWN ARE IN MILLIMETERS (MM), UNLESS OTHERWISE SHOWN
2. ALL LEVELS SHOWN ARE IN METERS. ALL LEVELS SHOWN ARE FROM MEAN SEA LEVEL
3. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS, GENERAL NOTES AND SPECIFICATIONS.

REFERENCE DRAWINGS

SL.No	DRAWING No.	DESCRIPTION

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPRD.
0	22.10.15	CONCEPT DESIGN SUBMISSION	JP	MP	MA

CLIENT  
**MINISTRY OF ENVIRONMENT & ENERGY**  
 REPUBLIC OF MALDIVES

CONSULTANT:  
**ACO** Al Habeshi Consultants Office

PROJECT:  
 Consultancy Services for Survey, Design of Water supply Facilities in Tha.Vilifushi, F.Nilandhoo, B.Eydhafushi and Adh. Hanyaameedhoo, Maldives

DRAWING TITLE:  
**RO PLANT LAYOUT**  
**B.EYDHAFUSHI ISLAND**

DESIGNED	DRAWN	CHECKED	APPROVED	SCALE	DATE
SK	JP	MP	MA	1:150	22.10.15

PROJECT No. SHEET No. DRAWING No.  
 K-627 1 OF 1 BE-WS-105



73°4'10"E

73°4'20"E



5°6'15"N

73°4'20"E

73°4'10"E

### Legend

● Rainwater Tanks

— Rainwater collection Network

### Water Network

— Pipe Size (mm)

— 225

— 160

— 110

— 90

▨ Desalination Plant Facility

□ Reclaimed\_Area



1:4,711



Eydhafushi Island, Baa Atoll  
 Eydhafushi Water Network  
 Project – Site Plan Summary  
 Rainwater Collection Network

PROJECTION: Transverse Mercator (UTM Zone 43 N);  
 HORIZONTAL DATUM: WGS84;  
 Satellite Image: 2014  
 Map version: 03/07/2016

Surveyed and Prepared by: CDE Consulting, Maldives



**Legend**

- Bore hole
- ▬ Brine Outfall
- Water Network**
- Pipe Size (mm)
  - 80
  - 100 (supply main)
- ▨ Desalination Plant Facility
- Reclaimed\_Area



1:7,286



**Eydhafushi Island, Baa Atoll  
Eydhafushi Water Network  
Project - Site Plan Summary**

**Proposed Network**

PROJECTION: Transverse Mercator (UTM Zone 43 N);  
HORIZONTAL DATUM: WGS84;  
Satellite Image: 2014

Prepared by: CDE Consulting, Maldives

Map version: 03/07/2016  
Disclaimer: This map is a reproduction from the original plan and should not be used in critical decision making, design or construction. Pls refer to original map in case of ambiguities

73°43'00"E

73°42'00"E

73°41'00"E

73°40'E

73°43'00"E

73°42'00"E

73°41'00"E

73°40'E

5°6'15"N

5°6'0"N

Plant facility  
Brine Outfall

B1  
B2

**APPENDIX C –Water Quality Results**

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ



MALE' WATER & SEWERAGE COMPANY PVT. LTD.  
މާލެ ފޯވަރު ސަވަރެޖް ކޮމްޕަނީ ޕްރައިވެޓް ލިމިޓެޑް



23<sup>rd</sup> June 2016

Our Ref. MWSC-A/5/2016/ 3566

Dr. Ahmed Shaik  
Director,  
CDE Pvt Ltd,  
4<sup>th</sup> Floor, H. Orchidmaage,  
Ameeru Ahmed Magu,  
Male',  
Maldives.

Dear Sir,

**Re: Unavailability of Testing Services at MWSC QA&C Laboratory.**

It is with regret that we inform you that the following tests were unavailable in our Laboratory at the time of your request (14<sup>th</sup> June 2016, B. Eydhafushi) due to the shortage of reagents/chemicals;

- Chemical Oxygen Demand (High Saline)

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

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

Adam Rasheed  
Manager, Quality

Ibrahim Akram  
Assistant Manager, Marketing



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

FEN Building 5th Floor, Machangoalhi, Ameenemagu, Male', Maldives  
 Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

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**WATER QUALITY TEST REPORT**

Test Report No: 300678/2016/40

**Customer Informations :** **CDE Consulting Pvt Ltd**  
 H.Orchidmaage 4th Floor  
 Ameeru Ahmed Magu  
 Male'  
 Rep.of Maldives



Date: 22/06/2016

Sample Description / Location~	B. Eydhafushi		TEST METHOD	UNIT
	SW1 (Outfall)	SW2 (Alternative Outfall)		
Sample Type~	Sea water			
Sampled Date~	14/6/2016			
Sample Received Date	15/6/2016			
Test Requisition Form No.	900164342			
Sample No.	824223	824224		
Date of Analysis	15/6/2016 - 21/6/2016			
<b>PARAMETER</b>	<b>ANALYSIS RESULT</b>			
Physical Appearance	Clear	Clear	Visual	-
Conductivity	52000	51500	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 22nd edition)	µS/cm
pH	8.09	8.10	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	34.13	33.75	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	‰
Dissolved Oxygen (DO)	7.59	7.71	Standard Methods 19th edition APHA	mg/L
Temperature	21.8	21.4	Electrometry	°C
Biological Oxygen Demand (BOD)	1	<1 (LoQ 1mg/L)	HACH Method 8043	mg/L
Total Dissolved Solids (TDS)	26000	25700	Electrometry	mg/L
Total Coliforms	>2420	>2420	Collilert®-18/Quanti-Tray®	MPN/100mL
Faecal Coliforms	20	30	Collilert®-18/Quanti-Tray®	MPN/100mL

**Keys:**

µS/cm: Micro Siemens per centimeter, mg/L: Milligram Per Liter, ‰: Parts Per Thousand, °C: Degree Celcius, MPN: Most Probable Number

LoQ: Limit of Quantification

<p><b>Checked by:</b></p>  Afnan Farooq Laboratory Executive	<p><b>Approved by:</b></p>  Mohamed Eyman Senior Technical Officer
---	---

**Notes:**

**Sampling Authority:** Sampling was not done by MWSC Laboratory

This report shall not be reproduced except in full, without written approval of MWSC

This test report is ONLY FOR THE SAMPLES TESTED.

~ Information Supplied by the customer

\*\*\*\*\*END OF THE REPORT\*\*\*\*\*

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

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بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ



**WATER QUALITY TEST REPORT**

Test Report No: 300678/2016/41

**Customer Informations :**

**CDE Consulting Pvt Ltd**

H.Orchidmaage 4th Floor  
 Ameeru Ahmed Magu  
 Male'  
 Rep.of Maldives

Date: 22/06/2016

Sample Description / Location~	B. Eydhafushi		TEST METHOD	UNIT
	GW1	GW2		
Sample Type~	Ground water			
Sampled Date~	14/6/2016			
Sample Received Date	15/6/2016			
Test Requisition Form No.	900164342			
Sample No.	824225	824226		
Date of Analysis	15/6/2016 - 16/6/2016			
<b>PARAMETER</b>	<b>ANALYSIS RESULT</b>			
Physical Appearance	Clear with particles	Clear with particles	Visual	-
Conductivity	3380	3330	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 22nd edition)	µS/cm
pH	7.43	7.42	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	1.77	1.74	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	‰
Temperature	22.3	22.1	Electrometry	°C
Total Petroleum Hydrocarbon (TPH)	1.26	2.28	UV Fluorescence	mg/L

**Keys:**

µS/cm: Micro Siemens per centimeter, mg/L: Milligram Per Liter, ‰: Parts Per Thousand, °C: Degree Celcius

<p><b>Checked by:</b></p>  <p>Afnan Farooq                  Laboratory Executive</p>	<p><b>Approved by:</b></p>  <p>Mohamed Eyman                  Senior Technical Officer</p>
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**Notes:**

**Sampling Authority:** Sampling was not done by MWSC Laboratory

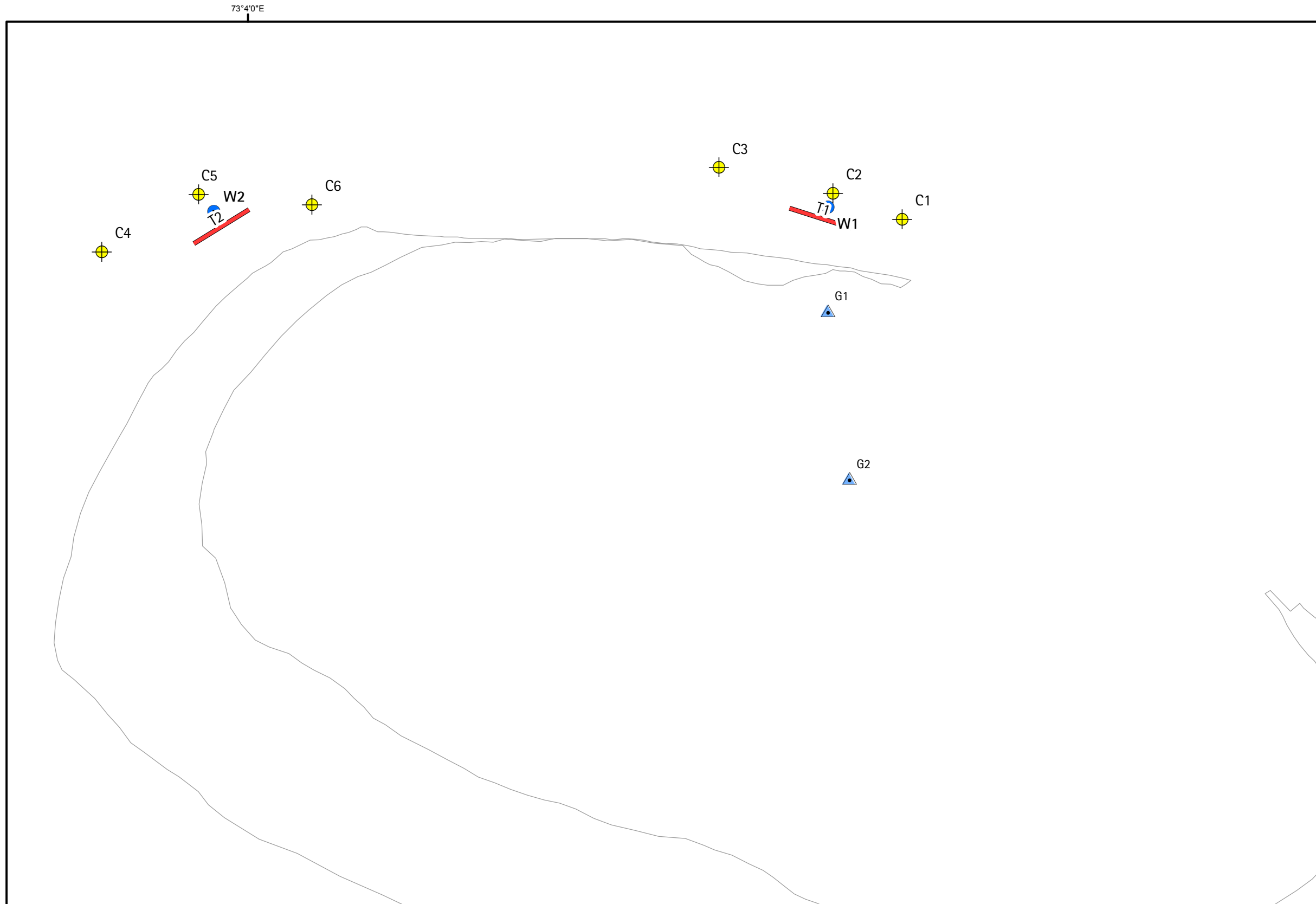
This report shall not be reproduced except in full, without written approval of MWSC

This test report is ONLY FOR THE SAMPLES TESTED.









~ Information Supplied by the customer

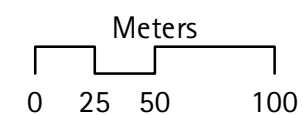
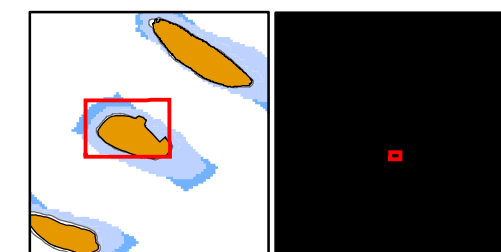
\*\*\*\*\*END OF THE REPORT\*\*\*\*\*

**APPENDIX D– Survey Locations**



### Legend

-  Fonadhoo basemap
-  Currents
-  Ground Water Samples
-  Soil Profiles
-  Marine Water Samples
-  Marine Transects
-  Reclaimed\_Area
-  Outer reef line



#### Ground water samples

code	X	Y
G1	73.0708	5.10544
G2	73.0709	5.10427

#### Marine Transects

Site_ID	X_Start	Y_Start	X_Finish	Y_Finish
T1	73.0709	5.10602	73.0705	5.10616
T2	73.0667	5.10613	73.0664	5.1059

#### Marine Water Sampling

code	X	Y
W1	73.0708	5.10616
W2	73.0665	5.10612

#### Currents

SiteID	X	Y
C1	73.0713	5.10608
C2	73.0708	5.10626
C3	73.07	5.10644
C4	73.0657	5.10584
C5	73.0664	5.10624
C6	73.0672	5.10617

### Eydhafushi Island, Baa Atoll Desalination plant and network establishment project Survey Locations

PROJECTION: Transverse Mercator  
(UTM Zone 43 N); HORIZONTAL DATUM: WGS84;  
VERTICAL DATUM: Hulhule Tide Gauge  
Map version: 17/07/2016

Surveyed and Prepared by: CDE Consulting, Maldives

**APPENDIX E–Work Plan**

**DETAILED WORK PLAN- B. EYDHAFUSHI**

SI No.	Activity	Duration in Months																															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
<b>Construction Phase</b>			<b>Construction phase</b>																		<b>Defects Liability Phase</b>												
		<b>18.00</b>																															
i	<u>Contract Award and Mobilization to site</u>	1.00																															
ii	<u>Civil Works</u>																																
	RO Building, Admin Building, tank foundations etc	8.00																															
	Boreholes	4.00																															
	Water supply network and House connections	8.00																															
	Rainwater Collection Network	6.00																															
	Erection of Storage Tanks	3.00																															
	Brine Outfall	2.00																															
iii	<u>Mechanical &amp; Electrical works</u>																																
	Installation of RO and related works	4.00																															
	Installation of Bore wells and related works	2.00																															
	Generators	1.00																															
	PV system installation	2.00																															
	Testing of system	1.00																															
iv	<u>Works commissioning</u>	0.50																															
<b>Defects Liability phase</b>			<b>12.00</b>																														

**APPENDIX F– List of attendees for the public consultation**

**Public Consultation****EYDHAFUSHI**

No.	NAME	ADDRESS	CONTACT
1	Milna	Husnuseenaage	7776050
2	Wahid	Alamaage	7598271
3	Abdullah Rasheed	Dhimmeege	794880
4	Naeem	Hathalae	
5	Haleem	Lilyge	
6	Areefa	Alhivilaage	6608177
7	Nafeesa	Husnooge	
8	Fathmath	Bageechaage	
9	Mohamed Waheed	Husnooge	7839877
10	Ibrahim Rasheed	Heenaamaage	7991960
11	Navaal	Annaarumaage	7911224
12	Ali Rasheed	Helengili	7789383
13	Fazlee	Kotharumaage	7842482
14	Ali Waheed	Manzaru	743331
15	Abdurrahman	Sterling	
16	Abdulla	Lilypark	
17	Adam Haleem	Velivaru	7708852
18	Abdussattar	Moodhuwina	
19	Shafeega	Raigaa	7932587
20	Abdusattar	Maaolhu	9852266
21	Ibrahim Waheed	Villa Dhondhi	
22	Abdullah Ibrahim	Villa de Rose	7933646
23	Ibrahim Rashdyh	Veli raalhu feshuge	7759542
24	Ibrahim Ahmed	Thuni Veli	7655214
25	Mohamed Nizar	Terrace	
26	Abdullah Saeed	Olhuveli	7754528
27	Mohamed Rasheed	Everchance	
28	Hamza	Munich	7641050
29	Aisth Yousuf	Beach Villa	
30	Naseeru	Rihi Veli	
31	Shareef	Sunshine	7794562
32	Umar Ahmed	Night Rose	7609514
33	Abdulla Hameed	Naina	7998067

34	Zuhury Mohamed	Mainaage	9696535
35	Naushad	Maafolheyge	9676070
36	Mode Ramiz	Maaolhu	7784775
37	Farhana	Geeza	7959566
38	Waheeda	Hiyaavahi	
39	Ibrahim Sifau	Dheyliyaage	9999745
40	Ahmed Afsal	Azum	9995954
41	Mamnooha	Javaahirumaage	7748462
42	Niuma	Metrovilla	7972068
43	Muhmoriya	Fanhiya	
44	Anisa	Hushuheena	
45	Mary	Kashidooge	
46	Reetha	Orchid Villa	7904327
47	Shiras	Dhonveli	7903065
48	Abdulla	Araaim	7859577
49	Naazneen	Seetmaage	7932889
50	Zakiya	Binhimaage	
51	Ibrahim Shaheem	Maaviha	9731111
52	Ihsaan Ibrahim	Sea Weed	7771862
53	Shaheema	Maakoni	7956111

**APPENDIX G – CV's of Consultants**

# Ahmed Shaig

Phone: (+960) 77 88 758    shaig@cde.com.mv

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## Personal Details

---

**Date of Birth:** 19/02/1976    **Nationality:** Maldivian    **Gender:** Male    **Marital Status:** Married  
**Permanent Address:** Maldives    **Present Address:** M. Muleege, Orchid Magu, Male', Maldives.

## Education

---

### **PhD, Environmental Science, 2009**

James Cook University, Townsville, Australia

Research degree on 'Settlement Planning for Natural Hazard Resilience in Small Island States: The Population and Development Consolidation Approach'

### **BSc Land and Spatial Information Studies/Information Science. (double major), 1999-2001**

University of Otago, Dunedin, New Zealand

### **Diploma in project planning, implementation, monitoring and evaluation, 1995**

ILO training Centre, Turin, Italy

## Employment History

---

### **Director, Environmental Services**

2008 to present

#### **CDE Consulting**

Supervisor: Dr. Simad Saeed

Republic of Maldives

Phone: +(960) 7777445

Head of environmental wing

### **Assistant Under-secretary, Spatial Planning**

2002-2004

#### **Ministry of Planning and National Development**

Supervisor: Hon. Hamdun Hameed

Republic of Maldives

Phone: +(960) 332-3919

Head of Spatial Planning Unit. Relevant Tasks include:

- ◆ Oversee environment related projects and application of environmental guidelines for planned projects.
- ◆ Plan, implement and oversee the development of a National GIS;
- ◆ Aid/facilitate/oversee urban planning, housing, land use planning, natural resource planning and environment related projects; Provide assistance in project planning (includes urban and regional planning, natural resources planning)

### **Project Manager, National Digital Mapping Project**

2005 (8 months)

#### **Ministry of Planning and National Development**

Supervisor: Hon. Hamdun Hameed

Republic of Maldives

Phone: +(960) 332-3919

- ◆ Project involved aerial photography and satellite imagery of entire Maldives, ground surveying of key settlements, digital conversion of data and setting up a Mapping Unit.

### **Assistant Planning Officer/Planning Officer**

1994-1999

#### **Ministry of Planning and National Development**

Supervisor: Mr. Mohamed Hunaif

Republic of Maldives

Phone +(960) 331-3040

Relevant tasks involved:

- ◆ Assisting in the National GIS Development Programme (Junior GIS developer)
- ◆ Facilitate urban planning, housing, land use planning, natural resource planning and environment related projects.

## Experience in Consultancy

---

- *September 2002:* Member of the team appointed for environmental surveying and carrying capacity assessment of islands for tourism development in the southern atolls of Maldives for Ministry of Tourism Maldives.
- *October 2002:* Developed the Census GIS for United National Population Fund
- *December 2002:* Developed the Maldives Protected Areas Systems GIS for Maldives Home Affairs Housing and Environment.
- *February 2003:* Participated in the preparation of Royal Island and Spa Resort Annual Environmental Monitoring Report for Royal Island and Spa.
- *April 2003:* Member of the team selected for developing town plans for urban centres in Northern and Southern Regional Development Zones, looking specifically into environmental control measures, for Ministry of Planning and National Development.
- *April 2003:* Participated in the preparation of Environmental Impact Statement for Coastal Modifications on Rihiveli, South Malé Atoll, Maldives.
- *April 2003:* Participated in the surveying and preparation of Environmental Impact Statement for the proposed coastal improvements to address coastal erosion concerns on Royal Island Spa Resort, Baa Atoll, Maldives.
- *May 2003:* Participated in the bathymetry survey and preparation of Initial Environmental Examination for Deepening of Existing Entrance Channel to Service Jetty, Soneva Gili Resort and Spa, North Malé Atoll, Maldives
- *May 2003:* Participated in the preparation of Initial Environmental Examination for development of an access channel into the natural inner lagoon (*Vilu*) of Mayafushi resort, North Ari Atoll.
- *May 2003:* Participated in the preparation of Environmental Impact Assessment for Landaa Giraavaru Pvt. Ltd. for the development of a Four Season's Tourist Resort on the island of Landaa Giraavaru in Baa Atoll, Maldives.
- *June 2003:* Participated in survey and preparation of Initial Environmental Examination for the Development of a Mooring Area and Associated Beach Replenishment in, Boduhithi Club, North Malé Atoll, Maldives.
- *July 2003:* Participated in the surveying and preparation of Initial Environmental Examination for Short-term and Long-term Shore Protection Measures at Alimatha Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Conducted shoreline and vegetation line of Alimatha Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Participated in the surveying for Initial Environmental Examination for Short-term and Long-term Shore Protection Measures at Dhiggiri Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Participated in conducting and preparation of Fun Island Resort Annual Environmental Monitoring Report.
- *July 2003:* Participated in conducting and preparation of Sun Island Resort Annual Environmental Monitoring Report.
- *July 2003:* Participated in conducting and preparation of Holiday Island Resort Annual Environmental Monitoring Report.
- *August 2003:* Developed the Initial Environmental Examination for the construction of Sun Decks along the southern beach of Kudarah Island Resort.
- *September 2003:* Participated in surveying and preparation of Fonaddoo Environmental Impact Assessment Report for the development of fisheries complex, Fonaddoo, Maldives.
- *October 2003:* Participated in surveying and preparation of Kuda Rah Erosion Study and recommendations for shore protection and erosion prevention
- *November 2003:* Conducted vegetation and shoreline survey of Dhonveli Beach and Spa and Four Seasons Report for the Boundary Delineation between the two islands.
- *December 2003:* Contributed to the Landuse Planning Guidelines of Maldives (environmental aspects) for Ministry of Housing and Urban Development.
- *December 2003:* Contributed to the Development of a Building Code of Maldives for Ministry of Housing and Urban Development.
- *January 2004:* Co-author to the Environmental Guidelines for the Development of Resort Islands in Maldives, Ministry of Tourism.
- *February 2004:* Developed the Baa Atoll Spatial Development Plan for Ministry of Planning and National Development.

- *April-July 2004:* Participated in the preparation of the Environmental aspects of the 8 bid proposals for resort Development for various proponents.
- *November 2005:* Participated in the preparation of EIA for L.Gan Resettlement Project for Ministry of Housing.
- *December 2005:* Participated in the surveying and preparation of EIA for Gn Fuvahmulaku Tourist Hotel Development
- *November 2005:* Developed a GIS for strategic planning to select islands for tourism development for Ministry of Tourism.
- *January 2006:* Local consultant for the Strategic Environmental Assessment (SEA) of Maldives Regional Development Plan, for AGRIFOR Consult Consortium, Belgium.
- *June 2006:* Developed the Baa Atoll Resource Management GIS for Ministry of Environment and Energy.
- *August 2006:* Consultant to the Integrated Climate Change System (ICCS) project – Assessment of vulnerability of Maldives Islands and Beaches to climate change
- *September 2006:* Consultant to the ICCS project – Assessment of vulnerability of Maldives Infrastructure to climate change
- *November 2006:* Consultant to the preparation of National Adaptation Programme of Action in Maldives for Ministry of Environment.
- *December 2006:* Environmental Consultant to the United Nations Development Programme (UNDP) Project: Disaster Risk Assessment of Selected nine Safe Islands in Maldives.
- *April 2007:* Prepared the Coastal Erosion Assessment and Management Report for Ga.Meradhoo Island.
- *May 2007:* Participated in the preparation of EIA for N. Randheli Resort Development Project, I&T Management group.
- *June 2007:* Participated in the preparation of Millennium Development Goals, Maldives Country Report.
- *October 2007:* Natural Hazard Assessment consultant to the UNDP Project: Disaster Risk Assessment of Selected Safe Islands in Maldives.
- *November 2007:* Prepared the EIA for proposed coastal protection, beach replenishment and access improvement of Elaa, Thaa Atoll, for Mr Abbas Mohamed, H. Merry Rose.
- *May 2009:* Participated in the preparation of EIA for sand sourcing and beach replenishment project of Viligilli Island, Addu Atoll, for Shangri-La at Viligilli..
- *April 2009:* Participated in the preparation of EIA for N. Maafaru Airport Development Project for Noonu Hotels Pvt Ltd.
- *May 2009:* Participated in the preparation of EIA for resort development in Huvandhumaavattaru, Noonu Atoll
- *June 2009:* Prepared a status of the environment report Randheli Island, Noonu Atoll.
- *July 2009:* Prepared the Environmental EIA for harbour development in Fiyoari, Gaafu Dhaalu Atoll.
- *July 2009:* Participated in the preparation of EIA for Jetty and arrival lounge development project in Gan, Addu Atoll, for Island Aviation Services Private Limited.
- *July 2009:* Team Leader for the socio-economic risk assessment of Selected Safe Islands in Maldives.
- *August 2009:* Coastal erosion data synthesis for selected islands of Maldives, for World Bank Maldives Environmental Management Project.
- *September 2009:* Prepared the beach management plan and development control measures for Reethibeach Island Resort, Baa Atoll.
- *September 2009:* Participated in the preparation of EIA for agricultural island development in Felivaru, Noonu Atoll, for Fantasy Private Limited.
- *September 2009:* Consultant to review the safer islands programme and cost benefit study of mitigation measures in three islands in the Maldives for UNDP.
- *October 2009:* Consultant to the Maldives Environmental Management Project for waste management technical assistance for World Bank.
- *December 2009:* Environmental consultant for advising on resort development and development control measures in Randheli Island, Noonu Atoll.
- *January 2010:* Prepared the beach management plan and development control measures for Shangri-La Island Resort, Addu Atoll.
- *January 2010:* Consultant to the Atoll Ecosystem Conservation project conservation component defining conservation areas and development controls.
- *February 2010:* Prepared the environmental audit of Thunbafushi Island, Kaafu Atoll, for Champa Brothers Private Limited.

- *March 2010:* Prepared the beach management plan and development control for Herathera Island Resort, Addu Atoll.
- *March 2010:* Lead author in the preparation of EIA for power plant upgrading project in Palm Beach Island in Lhaviyani Atoll.
- *April 2010:* Lead author in the preparation of EIA for Seagrass removal and beach replenishment project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- *April 2010:* Prepared an EIA addendum for resort development in Gaakoshibee Island, Shaviyani Atoll.
- *May 2010:* Consultant to undertake island environmental scoping studies in 30 islands in North Maldives to determine islands with resort development potential for GMR Group of India.
- *May 2010:* Lead author in the preparation of EIA for harbour development project in Madidhoo Island, Shaviyani Atoll.
- *June 2010:* Lead author in the preparation of EIA for deep piling project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- *July 2010:* Lead author in the preparation of EIA for the development of an aquaculture site in Kanduoigiri, Kaafu Atoll.
- *July 2010:* Environmental planning consultant for Shangri-La at Viligilli Maldives, Addu Atoll.
- *July 2010:* Environmental planning consultant to the Addu Land Use Planning project (including defining development controls) in Addu Atoll Maldives for South Province Office.
- *August 2010:* Environmental Consultant for the Atoll Ecosystem Conservation Project to declare Baa Atoll as a UNESCO Biosphere reserve.
- *September 2010:* Lead author in the EIA for Seagrass removal and beach replenishment project in Herathera Island, Addu Atoll.
- *September 2010:* Lead author in the EIA for resort redevelopment in Vilamendhoo Island Resort, Ari Atoll.
- *September 2010:* Lead author in the preparation of EIA for Gulhifalhu land reclamation project in Gulhifalhu, Male' Atoll, for Capital Investment and Finance Limited, UK.
- *September 2010:* Participated in the preparation of EIA for sewerage system development project in Miladhoo, Noonu Atoll.
- *October 2010:* Consultant to undertake the coastal adaptation survey of 40 islands in Maldives for Ministry of Housing and Environment.
- *November 2010:* Environmental consultant for advising on resort development and development control measures in Maamigili Island, Raa Atoll
- *January 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Hithadhoo Island, Addu City for Bi-water International Private Limited.
- *February 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo Island, Addu City for Bi-water International Private Limited.
- *March 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Feydhoo Island, Addu City for Bi-water International Private Limited.
- *April 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo-Feydhoo Island, Addu City for Bi-water International Private Limited.
- *May 2012:* Coastal erosion mitigation assessment and planning for Six Senses Laamu, Laamu Atoll
- *January 2012:* Lead author in the preparation of EIA for sewerage and water system development project in Fuvahmulah Island, Addu City for Bi-water International Private Limited.
- *February 2012:* Coastal erosion mitigation assessment and planning for Fushivelavaru Island
- *March 2012:* EIA for the proposed resort redevelopment project in Conrad Rangali Island for Champa and Crown Resorts
- *March 2012:* EIA for the proposed resort redevelopment project in Gasfinolhu Island Resort, Champa and Crown Resorts
- *May 2012:* Environmental consultant for advising on resort development and development control measures in Gasfinolhu Island, Male' Atoll
- *June 2012:* Environmental consultant for advising on resort development and development control measures in Nakachchaa Huraa Island, Male' Atoll
- *April 2012:* Member of the consultant team that prepared the Tourism Opinion and Profile Survey 2011, Ministry of Tourism.
- *October 2012:* Environmental consultant to the preparation of 4<sup>th</sup> Tourism Master plan for Ministry of Tourism, Maldives.
- *November 2013:* Environmental consultant for advising on land reclamation, resort development and development control measures in Dhiffushi Island Reef, Male' Atoll.

- *January 2013*: Environmental consultant for advising on resort development and development control measures in Hankedede Island, Addu Atoll
  - *January 2013*: Environmental consultant for advising on resort development and development control measures in Hankedede Island, Addu Atoll
- June 2013*: Local Environment consultant to the WCCM project, HIDRIA and Aquatica, Spain.

## Membership of Professional Bodies

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- Member of Building Code Committee, Maldives
- Member of Commission on Sustainable development
- Member of the Technical Committee for Developing Spatial Plans for conducting tourism related activities in Ari Atoll.
- Member of Climate Advisory Council to the President of Maldives 2009- to present.
- Registered EIA Consultant in Maldives Environment Protection Agency roster.

## Major Publications

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SHAIG, A. (2001) "An Overview of Web Based Geographic Information Systems". In Proceedings: Thirteenth Annual Colloquium of the Spatial Information Research Centre. P.A. Whigham (ed). 2 - 5 Dec, Dunedin, New Zealand. University of Otago, pp.255-264.

SHAIG, A. (2006). Climate Change Vulnerability and Adaptation Assessment of the Coastal Infrastructure of Maldives. Technical Paper submitted to Maldives National Adaptation Plan of Action for Climate Change. Ministry of Environment, Energy and Water, Male', Maldives.

SHAIG, A. (2006). Climate Change Vulnerability and Adaptation Assessment of the Land and Beaches of Maldives. Technical Paper submitted to Maldives National Adaptation Plan of Action for Climate Change. Ministry of Environment, Energy and Water, Male', Maldives.

SHAIG, A. (2007) Land Study of Maldives, 2006. Ministry of Planning and National Development, Male' Maldives.

SHAIG, A. and Aslam, M (2007) Detailed Island Risk Assessment Maldives Volume I to Volume IV – Natural Hazard Assessment (Final Draft). UNDP, Male' Maldives

SHAIG, A. (2007) Detailed Island Risk Assessment Maldives Volume I to Volume IV – Environmental Vulnerability Assessment (Final Draft). UNDP, Male' Maldives.

## Academic Achievements

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### **2001 Critchlow Associates Prize in Surveying, New Zealand.**

Prize awarded annually by University council for the highest standard of Achievement in Spatial Information Studies in University of Otago.

### **1994 Certificate for best results in General Certificate of Examinations, Advanced Level.**

Science Education Centre, Male', Maldives

## References

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Hamdun Hameed  
Member of Parliament  
Male', Maldives  
Tel: (+960) 3323414  
minister@planning.gov.mv

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Managing Director,  
CDE Consulting  
Male', Maldives  
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James Cook University  
Townsville, QLD, Australia, 4811  
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Email: david.king@jcu.edu.au

Peter Valentine  
Head of School, TESAG Department  
James Cook University  
Townsville, QLD, Australia, 4811  
Tel: (+61) 747 81 4441 ,Fax: (+61) 747 81 5581  
Email: peter.valentine@jcu.edu.au

## Clarification

---

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications and my experience. I understand that any willful misstatement described herein may lead to my disqualification or dismissal, if engaged.

  
Signature

Date: 15 July 2013

# Mohamed Faizan

## Contact Details

**Address:** H. Pent Land,  
Lansimoo Goalhi,  
20041 Male',  
Maldives

**Tel:** +960-7501205

**E-mail:** Mohamed.faizan@gmail.com

## Education

- August 2012 – September 2014**                      **University of Malaya, (Malaysia)**
- Master of Technology (Environmental management),
  - Dissertation title “Study on the impact of anthropogenic pressure on coral reefs around Cape Rachado, Malacca and recommendations to improve its management”
- July 2006- June 2010**                      **International Islamic University Malaysia, (Malaysia)**
- Bachelor of Biotechnology (Honours).
  - Final year thesis title “Spatio-temporal study on coastline changes along Tanjung Lumpur – Cherok Paloh Coast”.
- June 2002 – June 2004**                      **Centre for Higher Secondary School, (Maldives)**
- GCE Advanced level.
- January 1997 – February 2002**                      **Majeediyaa School, (Maldives)**
- GCE Ordinary level.

## Employment History

- July 2014 – Present**                      **CDE Consulting**
- **Environmental Consultant** at CDE Consulting. Roles and responsibilities include preparation of Environmental Impact Assessment reports, undertaking environmental baseline surveys, and conduct environmental monitoring.
- June 2010 – July 2012**                      **CDE Consulting**
- **Environmental Consultant** at CDE Consulting. Responsibilities included undertaking environmental baseline studies for Environmental Impact Assessments, and environmental monitoring. In addition, co-ordination of field surveys.
- February 2005 – April 2006**                      **Integrated Climate Change Strategy**
- **Project Assistant** for the Integrated Climate Change Strategy implemented by Ministry of Environment, Energy and Water (Maldives).
  - Responsibilities included assisting the project manager, in preparation of financial reports, organizing workshops.
  - Helped launch monthly newsletter on climate change “Nakaiy”.

## EIA experience

<b>Environmental Impact Assessment (EIA)</b>	<b>Proponent</b>	<b>Date</b>
EIA for the proposed sewerage system project at Kanditheem, Shaviyani - Marine environment assessment and report for the EIA	Male' Water and Sewerage Company Pvt Ltd	April 2014
EIA for the proposed beach replenishment project in Holiday Inn Resort Kandooma, Maldives, South Male' Atoll - Marine environment assessment and report for the EIA	Holiday Inn Resort Kandooma Maldives	April 2014
EIA report for the proposed sewerage system at Maduvvari, Raa Atoll - Undertook the baseline assessment surveys, including stakeholder consultations. Complied the EIA report.	Mr. Ibrahim Shazyl, Venture Maldives Pvt Ltd	February 2012
EIA report for the proposed installation and operation of desalination plant at Hithaadhoo, Baa Atoll - EIA report compilation.	Mr. Ismail Shafeeu, Static Company Pvt Ltd	January 2012
EIA report for the proposed Solid Waste Management facility at Thilafushi - Baseline marine assessments and EIA report compilation.	Tatva Global Renewable Energy (Maldives) Private Limited	December 2011
EIA for the development of a domestic airport on Koodoo, GA. Atoll - Undertook baseline assessments for the EIA, and prepared the existing environment chapter for the EIA.	Bonavista (Maldives) Private Limited Singapore	October 2011
EIA prepared for the proposed harbor entrance channel dredging project in Bodufolhudhoo Island, North Ari Atoll - Undertook the baseline assessments for the EIA, and prepared the existing environment chapter of the EIA and compiled the overall EIA report.	Ministry of Housing and Environment	August 2011
EIA prepared for the proposed re-development – phase I of Gasfinolhu Island Resort, Kaafu Atoll, Maldives - Baseline marine assessments and report preparation for the EIA.	Mr. Hussain Afeef	July 2011
EIA prepared for the proposed re-construction of Shaviyani Foakaidhoo Harbour - Undertook the marine baseline assessments and, prepared the marine assessment report for the EIA.	Ministry of Housing and Environment	March 2011
EIA for the sewerage system development in N. Miladhoo - Marine environment assessments	Works Corporation Limited	September 2010

## **PERSONAL DETAILS**

Name in Full : Ali Moosa Didi  
Date of Birth : 18.06.1985  
Gender : Male  
Nationality : Maldivian Address:  
Permanent : Saraasaruge Aage, S.Hithadhoo  
Neelonfaru Magu

Present : Ma. Rose Villa SE, 4<sup>th</sup> Floor Dhevina Magu  
Male'

Telephone : +960 9912001

## **EDUCATIONAL QUALIFICATIONS**

### **Madharasthul Islamiya School**

Certification, University of Cambridge General Certification of Education O/L

**Subject** English Mathematics  
Business Account Commerce  
Economics

Secondary School Certificate Islamic Studies  
Dhivehi Language

## **WORK PLACE DETAILS**

Commerce Development and Environment Pvt.  
H. Orchidmaage, 4<sup>th</sup> Floor  
Ameeru Ahmed Magu,  
Male', Republic of Maldives  
Telephone: + 960 3312514  
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E-mail: ali@cde.com.mv

## **EMPLOYMENT RECORD**

January 2004 – December 2008      Commerce Development & Environment Pvt

Assistant Surveyor January 2009 – December 2009   Ryco Investment Pvt  
HR. Officer

January 2010 – To Current Date   Commerce Development & Environment Pvt Surveyor

## **WORK EXPERIENCE**

### **Assistant Surveying Officer (Sep 2008 – To Current Date)**

-Survey proposed areas for the new projects under the instruction of survey officer.

-Determine precise location and measurements of points, elevations, lines, areas, contours for the construction studying the morphology of the seabed mapmaking and for construction staking, defining and managing parcels data, as-built and profiling.

-Utilize recourses to the optimum level.

-Use company civil/ survey software for contouring, setting alignments, setting points construction, land division.

-Edits and troubleshoot incoming data collector files in accordance with company procedures.

Processing Survey Data's Using Topcon Tools, Surfer, Sonar XP, etc

-Reviews and utilize survey crew field notes. -Imports verified data into the appropriate CAD drawing file, using company standards point layer management and description keys.

-Prepares survey drawings and documents using company standards, prototypes, templates and blocks.

- Operate digital cameras and download photo files into database and/ or CAD drawings.
- Utilize company scanners to transfer reference maps into CAD files to facilitate utility mapping and property line.
- To perform bathymetric and topographical survey before start of the Projects
- Plotting survey data using AutoCAD 2006-2009
- Processing Survey Data's Using Topcon Tools, Surfer, Sonar XP, etc.
- Modeling accurate contours
- Advanced at ESRI ArcGIS (ArcMap, Arc Catalogue)
- GPS, wetland vegetation species identification, extensive geological identification skills
- Preparation of survey maps
- Make sure all the survey instruments are working in good condition.

## AHMED HAIMAN RASHEED

### PERSONAL DETAILS

Full Name: **Haiman Rasheed, Ahmed** NIRC: **A297924**  
Gender: **Male** Date of birth: **September 24, 1993**  
Place of birth: **S.Feydhoo, Republic of Maldives** Nationality: **Maldivian**

Permanent Address: **Goal Corner**  
**S.Feydhoo 19040**  
**Republic of Maldives**

Contact Details: **(Mobile): +960 7684393**

Email for correspondence: **haiman@cde.com.mv**

### EDUCATION

Year	Name of Education Institute	Title of Qualification	Status
2007 – 2009	DHARUMAVANTHA SCHOOL	GCE / IGCSE O' Level under the curriculum of University of Cambridge	Graduated

### EMPLOYMENT HISTORY

Time Period	Position Held, Employee	Task assigned
February 2014 – present	Associate Consultant, CDE Consulting	<ul style="list-style-type: none"><li>- Marine surveying (Conducting inspections, surveys &amp; examinations of reefs)</li><li>- Beach surveying</li><li>- Compiling Marine reports (Prepare reports on types of surveys conducted)</li></ul>
August 2013 – February 2014	Assistant technician, Ministry of Fisheries and Agriculture	<ul style="list-style-type: none"><li>- Designing the structure of FAD (Fish Aggregating Device)</li><li>- Research on the status and pelagic fishes found near FADs</li></ul>
January 2011 – January 2012	Research officer, CDE Consulting	<ul style="list-style-type: none"><li>- Marine surveying (Conducting inspections, surveys &amp; examinations of reefs)</li><li>- Beach surveying</li><li>- Compiling Marine reports (Prepare reports on types of surveys conducted)</li></ul>
December 2009 – June 2010	Research officer, CDE Consulting	<ul style="list-style-type: none"><li>- Marine surveying (Conducting inspections, surveys &amp; examinations of reefs)</li><li>- Beach surveying</li><li>- Compiling Marine reports (Prepare reports on types of surveys conducted)</li></ul>

## REFERENCES

Name	Address, Telephone & Fax	Email, Occupation & Business Title
<b>Ahmed Shaig, PhD</b>	<b>CDE Pvt Ltd 4<sup>th</sup> Floor, Orchidmaage Ameer Ahmed Magu, Henveiru Male', Maldives (Telephone): +960 3312514 (Fax): +960 3315926</b>	<b>Director CDE Pvt Ltd info@cde.com.mv</b>
<b>Ahmed Yameen</b>	<b>Ministry of fisheries and agriculture 7th Floor, velaanaage Ameer Ahmed Magu, Henveiru Male', Maldives (Telephone): +960 3322625 (Fax): +960 3326558</b>	<b>Assistant director</b>

# Mohamed Ali

ID #: A 094918  
Nationality: Maldivian  
Languages: English, Sinhalese, Dhivehi  
Date of Birth: 13/09/1983  
Telephone: 960-790-6007  
Email: mohamed.ali@cde.com.mv

## Experience

Marine Environmental Specialist June 2011- Present  
*CDE Consulting*

Marine Environment Officer July 2008 – May 2011  
*Banyan Tree Vabbinfaru*

Freelance Lobster Hunter, Shark Fisherman Jan 2007 - July 2008  
*Laamu Atoll*

Dock Assistant Sep 2006 - Jan 2007  
*Tourist Submarine Maldives*

## Education and Certifications

PADI Rescue Diver June 2011  
PADI Enriched Air Diver June 2011  
Emergency First Responder May 2011

Basic Computer Science 2001 - 2006  
*Singapore Informatics, Colombo Sri Lanka*

## **Profile**

I am very passionate about protecting the marine environment. After having worked as both a fisherman and a marine environment officer I am aware of the impact that human activity has on our fragile marine environment. My favorite activities are reef monitoring and planting coral gardens. With my undying passion for the underwater world and also with my vast experience diving all over the Maldives, educating people on the marine environment is my greatest mission, to ensure the preservation and protection of our most valuable treasure. Furthermore, I have got the opportunity to work besides the greatest marine experts in the world namely Prof. J.E.N. Veron, Dr. Norman Queen and Dr. Daphne G. Fautin.

## **References**

N.D. Abdul Azeez Abdul Hakeem  
*Former Director of Conservation*  
*Mobile: + 960 7784263*  
*Banyan Tree Maldives*

Dr. Steve Newman  
*Former Marine Lab Manager at Banyan Tree*  
*steve.newman@ncl.ac.uk*

Robert James  
*Former Marine Lab Manager at Banyan Tree*

# Shahdha

Sustainable Development Consultant

CDE Consulting Pvt Ltd

Phone: +960 9700169 E-Mail: shahdha@cde.com.mv

## Professional Experience

Sustainable Development Consultant

CDE Consulting Private Limited, Male', Republic of Maldives.

1 March 2015- Present

### ■ Experience

#### Environmental Impact Assessments

- EIA for the proposed test drilling For Hulhule'-Male' Bridge construction project
- EIA for the proposed redevelopment of Nasandhura Palace Hotel, Male'
- EIA for the proposed Hulhule'-Male' Bridge Project
- EIA for the proposed construction of a 9-storey building at the compound of ADK Hospital, Sosun Magu, Male', Maldives
- EIA for the proposed tourist development project at Madivaru Island, Kaafu Atoll
- EIA for the proposed land reclamation and resort development project in Ithaafushi Reef, South Male' Atoll
- EIA for the proposed resort development in Bodukaashihuraa, Alifu Dhaalu Atoll, Maldives

#### Surveys

- Maldives Visitor Survey 2015 for the Ministry of Tourism
- Maldives Democracy Survey 2015 for International Foundation for Electoral Systems (IFES)

#### Environmental Monitoring Projects

- Environmental and Social Performance Annual Monitoring 2014 for Shangri-La's Vilingili Resort & Spa, Addu Atoll, Maldives

### ■ Key Skills and Competencies

- Ability to interpret environmental laws and regulations and act accordingly
- Sound knowledge of environmental management procedures and assessment of risk
- Solid understanding of waste management, climate change, disaster prevention and mitigation, and coastal environment and processes
- Profound knowledge of sustainable development issues
- Ability to assess and analyze complex social problems
- Competent in identifying and communicating with stakeholders
- Skilled in data collection, analysis and report writing

Clinical Assistant

Indhira Gandhi Memorial Hospital, Male, Republic of Maldives

February 2010- December 2011

## Relief Teacher

HDh. Atoll School, HDh. Vaikaradhoo, Republic of Maldives

July 2009- November 2009

## Academic Qualifications

**Bachelor of Environments** 2012-2014

Major: Environmental Geographies, Politics and Cultures,  
The University of Melbourne, Melbourne, Victoria, Australia.

### Advanced Level Edexcel Examination

**Higher Secondary Certificate (HSC) Examinations** 2007-2009

Center for Higher Secondary Education, Male', Republic of Maldives

### Cambridge GCE O-level

#### IGCSE Examinations

**Secondary School Certificate (SSC) Examination** 2004-2006

Cener for Higher Secondary Education, Male', Republic of Maldives

## Achievements

- Dean's Honours Award for outstanding academic achievement in 2014 (University of Melbourne) 2014
- Australian Development Scholarship 2011
- Fourth place among the National Top 10 Achievers in the Higher Secondary School Completion Examinations 2009 2009
- Second place among the National Top 10 Achievers in the Secondary School Completion Examinations 2006
- Best All Round Student of H Dh. Atoll School 2006
- Haveeru Atolls Scholarship Award 2007-2009
- School Captain at H Dh. Atoll School.
- Student Association's Vice President in 2006 at H Dh. Atoll School 2006
- Deputy and Acting School Captain in 2005 at H Dh. Atoll School
- Student Association's President in 2005 at H Dh. Atoll School 2005

## Professional Development and Memberships

- Member of the University of Melbourne Australian Awards Club 2013- 2014
- Participated in the Women's Mentoring Network at the University of Melbourne 2013
- Completed a 21 hours course on Standard First Aid at the Faculty of Health Sciences, Maldives College of Higher Education 2010
- Member of the Science Club at the Center for Higher Secondary Education 2007-2009
- School Prefect Board member at the H Dh. Atoll School 2004-2006

## Computer Skills

- Experienced in using Microsoft office Word, Excel, Powerpoint and Project.

## Language Skills

	<u>Understanding</u>	<u>Speaking</u>	<u>Writing</u>
▪ English	Excellent	Excellent	Excellent
▪ Dhivehi	Excellent	Excellent	Excellent

# Ali Nishaman Nizar

G. Dhoores Villa, 20132

06<sup>th</sup> March 1988

(00) 960 778 5767

[ali.nishaman@gmail.com](mailto:ali.nishaman@gmail.com)

A strategic and creative thinker who has effective communication and writing skills, and is ready and willing to use my skills and knowledge to add significant value to aid in your organization's development and enhance its values.

## **EDUCATION**

### **Cyprus Forestry College (2006 - 2008)**

- Adv. Diploma in Forestry

### **Center for Higher Secondary Education (2004 - 2006)**

- Edexcel - G.C.E. A'levels (Statistics, Business, Accounts)
- Cambridge - Certificate in Advanced English

### **Majeedhiyya School (2001 - 2003)**

- Cambridge - O'levels (Mathematics, Economics, Commerce, English, Accounts)

## **EXPERIENCE**

### **Terrestrial Environment Consultant – CDE Consulting, (July 13 – Present)**

- Provides technical assistance to various national and international projects, specifically providing input in areas such as; wetlands, agriculture, forestry, vegetation mapping, mangroves, waste management, composting...etc.
- Working on and contributing to several Environmental Impact Assessment studies.
- In charge of sourcing/developing innovative tools and methodologies for improving teamwork and cohesion at the office.
- Lead designer for iPad based surveys and in charge of the Data Management System for surveys.

### **Local Consultant – Vegetation Expert – Hidria, Spain, (May 13 – Aug 13)**

- Worked as a local consultant for Hidria, on developing the Wetland Management Plan for Addu Hithadhoo Eidhigali Kilhli and Gn.Fuvahmulah Bandaara & Dhandimagu Kilhi.
- Specifically on the areas of terrestrial biodiversity and vegetation mapping.

### **CSR Consultant – Secure Bag Maldives Pvt Ltd (Jan 12 – Jan 13)**

- In charge of all activities of the company to improve its CSR image.
- In charge of handling all the activities carried out on the company owned Private Island. This includes doing various agricultural activities such as hydroponics, goat keeping, poultry, orchid farming, land-based agriculture and agro-tourism. The task involves leading staff personnel of 13 employees on the island.
- Developed a home-based CSR project to organize and reduce household waste.
- Developed a school program to increase awareness of recycling.

**Agriculture Implementation Officer (AIO) – Project Implementation Unit, MOFA (Oct 10 – Jun 13)**

- Worked on the “Post-Tsunami Agriculture and Fisheries Rehabilitation Programme” & the “Fisheries and Agriculture Diversification Programme”
- In charge of planning, organizing and implementing all the activities under the agriculture component of the project.
- Planning and coordinating all agriculture and cooperative related training programs.
- Focal point for forming and mobilizing agriculture cooperatives in island based communities.
- Lead instructor for conducting Enumerator Training Programs and the Team leader for conducting baseline surveys for FADIP project
- Established 5 agricultural cooperatives in the Maldives and working closely towards the formation of several additional cooperatives.

**Head of Agriculture Research & Extension – Ministry of Fisheries and Agriculture (Jan 10 – Sept 10)**

- Lead a team of 5 staff at the Agriculture Research and Extension Section in the Capital city and an additional 15 staff at our regional research centers in the North and South
- Devised agricultural research programs that develop and improve agriculture in a sustainable manner in the country.
- Conducted training programs, workshops and awareness session at various venues.

**Marketing Manager – BCube Signage Pvt Ltd (Aug 08 – Present)**

- In charge of handling all marketing and client relations for the company.
- Designed layouts and concept notes for various publications and marketing campaigns.
- Lead focal point for all communications with the company’s foreign suppliers and local clients.

**Agriculture Officer – Ministry of Fisheries and Agriculture (Aug 08 – Dec 09)**

- Handled the “Training & Extension Unit” (Agriculture Division).
- Planned and coordinated all agriculture related training programs in the Maldives on a daily basis according to the staff availability.
- Promoted general agriculture and other related activities using modern extension methodologies.
- Conducted training programs, workshops and awareness session at various venues.

**National Project Assistant – F.A.O, United Nations (Aug 06 – Oct 06)**

- Worked on a Post-Tsunami forest rehabilitation project.
- Worked with international consultants on several aspects of Maldivian forestry, agriculture and especially focusing upon Maldivian Mangrove ecosystems.
- Worked closely with community members, local officials and visiting consultants in understanding local environments.
- Studied the different vegetation types in the Maldives (30 islands, mostly including wetlands).

**Graphic Designer – BCube Signage Pvt Ltd (Jan 04 – Oct 06)**

- Designed various logos and graphics for several clients.
- Created layouts and concept designs for several clients
- Create routine layouts for signboards.
- Design graphic advertisements ready for print, billboard and signboards.

## WORKSHOPS / SHORT-TERM TRAININGS ATTENDED

- 2009,
  - Workshop on Strengthening Plant Quarantine and Inspection, Male', Maldives, 15-16 July 2009
  - "Awareness of Food Security" Workshop, Male', Maldives, 22<sup>nd</sup> October 2009
  - Workshop on Updating and Finalization of the Agriculture Development Master Plan (ADMP), Male, Maldives, 21<sup>st</sup> December 2009
- 2010,
  - Fisheries & Agriculture Diversification Programme, Financial, Procurement & M&E Training, Male', Maldives, 26-28 January 2010
  - Team Leaders Meeting, 8<sup>th</sup> Virtual University for Small States of the Commonwealth's (VUSSC) International Training and Materials Development Workshop, Singapore, 14-20 April 2010
  - Prevention, Control and Management of Forest Invasive Species in South Asia, (by APFSIN), Male', Maldives, 29<sup>th</sup> April 2010
  - 8<sup>th</sup> Virtual University for Small States of the Commonwealth's (VUSSC) International Training and Materials Development Workshop, Male', Maldives, 15-31 March 2011
  - Loan Administration Training, Hdh.Kulhudhufushi, Maldives, 3-8 July 2010
  - Workshop to Finalize the Draft Pesticides and Plant Protection Bill, Male', Maldives, 12-13 July 2010
  - International Workshop on Climate Change Extreme Events Adaptation Practices and Technological Solutions, New Delhi, 16-18 August 2010
- 2011,
  - FADIP "Rolling Baseline Survey" Workshop, Male, Maldives, 2-3 March 2011
  - Knowledge Sharing in Asia Workshop #3: Participatory Techniques in the Field, Godavri, Nepal, 30<sup>th</sup> March 2011 – 2<sup>nd</sup> April 2011
  - Knowledge Sharing in Asia Workshop #2: Writing to Share Knowledge Effectively, Godavri, Nepal, 3-6 April 2011
  - Consultation Workshop for Facilitators on Cooperatives and Business Development, UNDP Building, Male, Maldives, 21<sup>st</sup> April 2011
  - AFE's Workshop on "Value Chain Program Design", Chiang Mai, Thailand, 12-16 September 2011
  - Training of Trainers Workshop on Systematization, Nepal, 8-10 December 2011
- 2012,
  - Workshop on Knowledge Management, tools and techniques (as a trainer for the programme), Maldives, 29<sup>th</sup> November 2012 – 02<sup>nd</sup> December 2012
  - Partnering 4 Development Forum, UNDP, Paradise Island Resort, 2<sup>nd</sup> December 2012
- 2013,
  - Consultative Workshop on ICRAF's Capacity Development Strategy & ICRAF's South Asian Partner's Capacity Needs Assessment, BRAC (Bangladesh Rural Advancement Committee) Centre, 30-31 January 2013
  - Certificate in Co-operative Poverty Reduction, Co-operative College of Malaysia, Malaysia, 3-21 March 2013

## **ENVIRONMENT IMPACT ASSESSMENT WORK**

- Was a member of the team, and provided contributions to both the field work and report writing of the following EIA's:
- Tourism Development Projects:
  - Adh. Bodukaashihuraa Resort Development EIA
  - B. Dhigufaruvinagandu Resort Development EIA
  - K. Madivaru Resort Development EIA
  - Lh. Fushifaru Resort Development EIA
  - N. Thanburudhuffushi Picnic Island Development EIA
  - K. Gasfinolhu Addendum EIA (Palm transplanting)
  - K. Taj Vivanta Resort Shore Protection EIA
- Agricultural Development Projects:
  - Sh. Madidhoo Agricultural Development EIA
  - Lh. Maduvarri Agricultural Development EIA
- Airport Development Projects:
  - R. Ifuru Airport Development EIA
  - N. Maafaru Airport Development EIA
- Major public/ private sector Projects:
  - Tree Top Hospital Development EIA
  - Nasandhura Palace Hotel Redevelopment EIA
  - Male-Hulhule Bridge, Borehole Drilling EIA
  - Male-Hulhule Bridge EIA
  - Addu and Fuvahmulah ESIA for Wetland Project

## **ACADEMIC ACHIEVEMENTS**

### **Cyprus Forestry College (2006 - 2008)**

- Highest Overall Performance: Presidential Prize (2nd prize)
- Best Academic Performance: Nature Conservation
- Best Academic Performance: Ecology
- Best Botanical Collection
- Best Fire Protection Project
- Best Forest Management Project
- Best Nursery Management Project

### **Center for Higher Secondary Education (2004 - 2006)**

- 10<sup>th</sup> place in the national Top Ten.

### **Majeedhiyya School (2001 - 2003)**

- 8<sup>th</sup> place in the national Top Ten.
- A Prefect

## **PROFESSIONAL ACHIEVEMENTS**

- Designed and structured an online system to coordinate training programs and staff travel plans. This led to an overall increase in the number of trainings by 400% from 2008 to 2009.
- Played active roles in the planning and organizing of key events and workshops such as;
  - Agriculture Fair 2009, Hdh.Kulhudhufushi
  - Farmers Day 2009, F.Nilandhoo
  - Food Security Workshop 2009, (In collaboration with Department of National Planning)
- Worked with a team from the Sultanate of Oman on a research program focusing on the local mango variety “Dhivehi Anbu”. The discovery of the Maldivian mango variety having a polyembryonic seed structure was one of the key findings of the research.
- Co-director and technical advisor for the Agriculture TV program, “dhanduveriya” for a full season, featuring over 13 episodes.
- Group leader in a materials development workshop for a course titled “Diploma in Sustainable Agriculture for Small States” for the Commonwealth of Learning, collaborating with 20 other experts from different parts of the world. My work was focused on writing specifically the chapters of “Agriculture Production Systems” and the “Importance of Working Together (CBPO’s)”.
- Team leader for the “Fisheries and Agriculture Diversification Program” (FADiP) baseline survey on the RIM’S Impact Questionnaires and the Project Questionnaire which included over 450 households in 4 different islands.
- Introduced an iPad-based real-time data entry system in 2014, that eliminated the need for paper-based questionnaire forms, reduced survey times, improved security features and provided real-time partial analytics on the data for our clients, at CDE. This system has since been replicated in over 5 separate surveys carried out by CDE.

## **SKILLS**

- ICT Competent (MS Applications, Corel Suite...etc)
- Flexible to travel at any time
- Able to Multi-task and work in stressful conditions
- Able to co-ordinate and work with CBPO’s / Co-operatives / NGO’s
- Decision Making Skills
- Logistical Planning Skills
- Good Interpersonal Skills (Community Consultation Expert, specifically on participatory approaches and conflict resolution exercises)
- Training Skills in “Agri-Business”, “General Agriculture”, “Hydroponics”, “Agro-Forestry”, “Home-gardening”, “Baseline Surveys” and “Co-operatives”.

## **MEMBERSHIPS IN PROFESSIONAL ASSOCIATIONS**

- Bluepeace - an Environmental NGO
  - Advisor on environmental and agricultural issues since the year 2009.
  - Participated in several beach and reef cleanup programs.
  - A member since the year 2008.
- United Artists of Maldives - an association focusing on Maldivian Art and Artisans
  - Sits in the Steering committee of UAM as the Media Coordinator, since January 2013
  - Participated in the International Hay Festival Activities held in the Maldives in 2010.
  - A member since the year 2008.
- UN Global Compact Maldives Network - a network of local private sector parties
  - Representative for Addu Meedhoo Cooperative Society
  - Representative for CDE Consulting

## **REFEREES**

- Dr. Ahmed Shaig,  
Director of Environment, CDE Consulting,  
[shaig@cde.com.mv](mailto:shaig@cde.com.mv)  
+9607788758
- Dr. Aminath Shafia,  
Former State Minister, Ministry of Fisheries and Agriculture,  
[shafia@fishagri.gov.mv](mailto:shafia@fishagri.gov.mv)  
+9607792458

## **LANGUAGE PROFICIENCY**



- Fluent in both writing and reading of Dhivehi (mother tongue)
- Fluent in both writing and reading of English

# MARIYAM HANA SAEED

## ADDRESS

 G. Quest, Alikilegefaanu Magu  
Galolhu, 20118, Malé  
Republic of Maldives

## CONTACTS

 960 797 0022  
 mariyamhanas@gmail.com  
hana@cde.com.mv

## NATIONALITY

 Maldivian

## ACADEMIC QUALIFICATIONS

2014

December

**Bachelor of Environments**  
University of Melbourne, Parkville Victoria

Recipient of Australia Awards Scholarship  
Majored in Environmental Geographies, Politics and Culture

2010

June

**Higher Secondary Education, Edexcel A' Level**  
Centre for Higher Secondary Education, Male' Maldives

Achieved Fourth Place among the National Top 10 Achievers in 2010

Maths (Mechanics)	A	Biology	B
Chemistry	A	Physics	B
Islam	A	Dhivehi	B

2007

November

**Secondary Education, GCE O' Level**  
Aminiya School, Male' Maldives

Achieved First Place among the National Top 10 Achievers in 2007

Maths	A	Physics	A	English (IGCSE)	B
Biology	A	Computer Studies	A	English (GCE)	A
Chemistry	A	Dhivehi	A	Islam	A

## LANGUAGES

### English

●●●●● Fluent

### Dhivehi

●●●●● Fluent

## SKILLS

- + Excellent customer service skills
- + Expert knowledge in environment and development field
- + Familiar with the concept of environmental psychology
- + Knowledge on coastal landforms and processes
- + Familiar with risk assessment projects
- + Experience in communicating effectively with key decision makers and clients
- + Ability to learn quickly and understand complex work
- + Excellent organisation skills
- + Excellent computer skills



## EMPLOYMENT HISTORY

*March 2015 to Present*

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**Sustainable Development Consultant** | CDE Consulting, Malé, Maldives

**Specialised Work Areas** | Renewable energy, Water, Sewerage and Housing

### Duties

- + Involved in cross-business, community and regulatory agencies
- + Contribute to development plans, policy analysis, institutional and sectoral reviews, project appraisals and designs
- + Planning and designing of strategies and programs of intervention on key social issues, major economic sectors and environmental issues
- + Conduct consultation, education and outreach programs
- + Prepare baseline, suitability analysis, due diligence, consultation, impact assessment, monitoring and evaluation and audit reports
- + Research and maintain up to date knowledge about current policies, best practices and potential future policies.

*February 2011 to January 2012*

---

**Administrative Assistant** | The President's Office, Malé, Maldives

### Duties

- + Monitored the policies under governance section in the Policy Office
- + Organised meetings of Narcotics Control Council board and updated the progress of the policies and actions under the council
- + Managed all admin-oriented work in the section, updating minutes of each council meeting, updating databases, and filing
- + Led administrative work to organise the 17th SAARC Summit in November 2011 and worked in coordination with other government bodies, private agencies and key decision makers to organise meetings and circulate information



## EXPERIENCE

### EIA for the proposed development of a tertiary hospital

---

**Year** . 2015

**Location** . Hulhumalé

**Client** . Tree top Health Pvt Ltd

**Position** . Team leader

**Activities Performed**

Stakeholder consultations, socioeconomic impact assessment and contributed to report writing

### EIA for the proposed redevelopment of Nasandhura Palace Hotel

---

**Year** . 2015

**Location** . Malé

**Client** . NPH Investments Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Stakeholder consultations, conducted baseline surveys and contributed to report writing

### EIA for the proposed construction of a 9-storey building at the compound of ADK Hospital

---

**Year** . 2015

**Location** . Malé

**Client** . ADK Hospital Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Contributed to report writing

### EIA for the proposed land reclamation and resort development project at Ithaafushi Reef

---

**Year** . 2015

**Location** . South Malé Atoll

**Client** . Sumaiyya Holdings Pvt Ltd

**Position** . Team Leader

**Activities Performed**

Designed stakeholder consultations, socioeconomic assessment and contributed to report writing

### EIA for the proposed land reclamation and resort development project at Bodukaashihuraa

---

**Year** . 2015

**Location** . Adh. Atoll

**Client** . Millennium Capital Management Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Undertook baseline surveys, Stakeholder consultations, and contributed to report writing

### EIA for the channel dredging and beach replenishment activities at Canareef Resort Maldives

---

**Year** . 2015

**Location** . Addu City

**Client** . Canareef Resort Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Contributed to report writing

### **EIA for the proposed resort development project at Kudadhoo Island**

---

**Year** . 2015

**Location** . Lhaviyani Atoll

**Client** . Champalars Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Contributed to report writing

### **EIA for the proposed land reclamation and resort development project at Madivaru Island**

---

**Year** . 2015

**Location** . Kaafu Atoll

**Client** . Shuaz Investments Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Undertook baseline surveys, Stakeholder consultations, and contributed to report writing

### **EIA for the proposed Hulhule' - Male' bridge project**

---

**Year** . 2015

**Location** . Malé

**Client** . Ministry of Housing and Environment

**Position** . Consultant for Water and Energy

**Activities Performed**

Contributed to report writing

### **EIA for the proposed test drilling for Hulhule' - Male' bridge construction project**

---

**Year** . 2015

**Location** . Malé

**Client** . Ministry of Housing and Environment

**Position** . Consultant

**Activities Performed**

Stakeholder consultations and contributed to report writing

### **EIA for the proposed harbour maintenance project at Cheval Blanc Randheli**

---

**Year** . 2015

**Location** . Noonu Atoll

**Client** . Cheval Blanc Randheli Maldives

**Position** . Consultant

**Activities Performed**

Designed questionnaire for stakeholder consultations, undertook baseline surveys, socioeconomic impact assessment and contributed to report writing

### **EIA for the proposed resort development project at Miriandhoo island**

---

**Year** . 2016

**Location** . Baa Atoll

**Client** . Miriandhoo Maldives Resorts Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Designed questionnaire for stakeholder consultations, undertook baseline surveys, socioeconomic impact assessment and contributed to report writing

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**EIA for the proposed land reclamation and resort development project at Maagaa reef**

---

**Year** . 2016

**Location** . North Ari Atoll

**Client** . Big Stone Investments Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Designed questionnaire for stakeholder consultations, undertook baseline surveys, socioeconomic impact assessment and contributed to report writing

---

**EIA for the proposed resort development project at Aluvifushi island**

---

**Year** . 2016

**Location** . Dhaalu Atoll

**Client** . Ocean Islands Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Contributed to report writing

---

**EIA for the proposed land reclamation and resort development project at Rasdhoo Madivaru**

---

**Year** . 2016

**Location** . North Male' Atoll

**Client** . Veli Madivaru Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Socioeconomic impact assessment and contributed to report writing

---

**EIA for the proposed Raffaluhuraa land reclamation and resort development project at Mai Falhu Reef**

---

**Year** . 2016

**Location** . Kaafu Atoll

**Client** . Mesa RF Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Socioeconomic impact assessment and contributed to report writing

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**EIA for the proposed nationwide submarine cable by Ooredoo Maldives**

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**Year** . 2016

**Location** . Maldives

**Client** . Ooredoo Maldives

**Position** . Consultant for Water and Energy

**Activities Performed**

Socioeconomic impact assessment and contributed to report writing

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**EIA for the proposed development of plot N3-55 under 3,000 housing units project**

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**Year** . 2016

**Location** . Hulhumalé

**Client** . Sea Life Global Inc Pvt Ltd

**Position** . Consultant for Water and Energy

**Activities Performed**

Designed methodology and survey questionnaires for public consultations, stakeholder consultations, socioeconomic impact assessment and contributed to report writing

## **EIA for the proposed development of plot N3-56 and N3-57 under 3,000 housing units project**

---

**Year** . 2016

**Location** . Hulhumalé

**Client** . Sea Life Global Inc Pvt Ltd

**Position** . Consultant for Water and Energy

### **Activities Performed**

Designed methodology and survey questionnaires for public consultations, stakeholder consultations, socioeconomic impact assessment and contributed to report writing

## **Maldives visitor survey 2015**

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**Year** . 2015

**Location** . Hulhule

**Client** . Ministry of Tourism

**Position** . Team leader and Enumerator

### **Activities Performed**

Supervised survey enumerators and conducted the survey

## **Maldives democracy survey 2015**

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**Year** . 2015

**Location** . Maldives

**Client** . International Foundation for Electoral Systems (IFES) and Transparency Maldives

**Position** . Team leader and Enumerator

### **Activities Performed**

Supervised survey enumerators and conducted the survey

## **Environmental and social performance annual monitoring report of Shangri-La's Vilingili Resort & Spa 2014**

---

**Year** . 2015

**Location** . Addu City

**Client** . Shangri-La's Vilingili Resorts & Spa

**Position** . Consultant for Water and Energy

### **Activities Performed**

Quantifying energy production and consumption rate, water quality assessment and analysis advice and reporting.

## **Environmental and social performance annual monitoring report of Shangri-La's Vilingili Resort & Spa 2015**

---

**Year** . 2016

**Location** . Addu City

**Client** . Shangri-La's Vilingili Resorts & Spa

**Position** . Consultant for Water and Energy

### **Activities Performed**

Quantifying energy production and consumption rate, water quality assessment and analysis advice and reporting.

## **Environmental monitoring of Vilamendhoo Resort & Spa**

---

**Year** . 2015

**Location** . Alifu Dhaal Atoll

**Client** . Vilamendhoo Resort & Spa

**Position** . Consultant for Water and Energy

### **Activities Performed**

Water quality assessment, beach profiling, coastal area surveying, Energy audit

## **Finolhu Villas energy audit 2015**

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**Year** . 2015

**Location** . Kaafu Atoll

**Client** . Finolhu Villas

**Position** . Consultant for Energy

### **Activities Performed**

Conducted an onsite comprehensive energy audit of the resort, quantified energy consumption and production patterns, data analysis and report writing.

## **Feasibility study for solar panel installation in F.Nilandhoo**

---

**Year** . 2015

**Location** . Faafu Atoll

**Client** . F.Nilandhoo

**Position** . Consultant for Energy

### **Activities Performed**

Conducted baseline surveys of potential buildings for solar panel installation, gathered baseline information about the existing power generation capacity, demand and expenditure for fuel and powerhouse maintenance, data analysis and contributed to report writing.

## **Understanding the risks to and vulnerability of energy sector to climate change in tourist resorts of the Maldives**

---

**Year** . 2015 - 2016

**Location** . Maldives

**Client** . Tourism Adaptation Platform / UNDP

**Position** . Consultant for Energy

### **Activities Performed**

Undertook baseline studies on dependency of the Maldives to fuel and its vulnerability; designed methodology and energy audit questionnaire; conducted a comprehensive energy audit in Vila-mendhoo Resort & Spa, Kurumba Maldives, Bandos Island Resort, The Sun Siyam Irufushi Maldives, Embudu Village; data analysis and presentation of audit findings. Conducted workshops with engineers in each of the 5 resorts on climate change awareness and vulnerability of tourist resorts to climate change. Conducted a workshop to present the findings of the project to stakeholders.

## **Introducing green healing hospital concept at Adh. Atoll Hospital**

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**Year** . 2016

**Location** . Adh. Mahibadhoo

**Client** . Adh. Atoll Hospital

**Position** . Consultant for Energy and Water

### **Activities Performed**

Conducted the energy and water audits of the hospital, consulted hospital engineers and utility providers of the island, conducted a feasibility assessment of the hospital roofs for solar panel installation, data analysis and presentation of findings with recommendations, conducted a workshop to present the findings of the baseline study to hospital staff and community member.

## **Desalination plant registration at Conrad Maldives Rangali Island**

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**Year** . 2015

**Location** . Alifu Dhaal Atoll

**Client** . Conrad Maldives Rangali Island

**Position** . Consultant for Water

### **Activities Performed**

Undertook baseline studies and facilitated the registration process

### **Desalination plant registration at Kudarah Island Resort**

---

**Year** . 2016

**Location** . Alifu Dhaal Atoll

**Client** . Kudarah Island Resort

**Position** . Consultant for Water

**Activities Performed**

Undertook baseline studies and facilitated the registration process

### **Desalination plant registration at Mirihi Island Resort**

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**Year** . 2015

**Location** . Alifu Dhaal Atoll

**Client** . Mirihi Island Resort

**Position** . Consultant for Water

**Activities Performed**

Undertook baseline studies and facilitated the registration process

### **Terminal Evaluation for the project titled increasing climate resilience through an integrated water resource management programme in Ha.Ihavandhoo, Adh.Mahibadhoo Gdh.Gadhdhoo**

---

**Year** . 2015

**Location** . Ha. Ihavandhoo, Adh. Mahibadhoo and Gdh.Gadhdhoo

**Client** . UNDP

**Position** . National consultant

**Activities Performed**

Reviewed project documents, conducted stakeholder consultations, logistics management, designed survey methodology and questionnaire for consultations in coordination with the international consultant, visited the three islands and conducted council meetings and public consultations with focused groups. Contributed to report writing and presented preliminary findings to stakeholders.

**APPENDIX H – Commitment Letter**



Ministry of Environment and Energy  
Male', Republic of Maldives.

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އިތުރު ފުރުޞަތު ހޯދަމަޅުވަމެވެ.

Date: 17 July 2016

No: 438-PDU/203/2016/57

Mr. Ibrahim Naeem  
Director General  
Environmental Protection Agency  
Male', Republic of Maldives

Dear Sir,

**Sub: EIA for the Proposed Water Supply System in B. Eydhafushi**

This is in reference to the Environmental Impact Assessment report for the proposed water supply system in B. Eydhafushi.

As the proponent of the above mentioned project, we guarantee that we have read the report and to the best of our knowledge all information provided here are accurate and complete.

We also assure you our commitment to undertake the proposed mitigation measures and monitoring programme outlined in the EIA report.

Sincerely,

Ajwad Musthafa  
Permanent Secretary



**APPENDIX I – Letter of Acknowledgment from Atoll Council**





**Ministry of Environment and Energy**  
Male', Republic of Maldives.

ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކުރި ގޮތުގައި ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކުރި ގޮތުގައި  
މާލެ، ދިވެހިސަރުކާރުގެ ގެޒެޓް.

Date: 17 July 2016

No: 438-PDU/203/2016/56

Mr. Ibrahim Naeem  
Director General  
Environmental Protection Agency  
Male', Republic of Maldives

Dear Sir,

**Sub: EIA for the Proposed Water Supply System at B.Eydhafushi**

With respect to the captioned project, we forward herewith three hard copies and soft copy of the Environment Impact Assessment (EIS) Report for your approval.

Sincerely,

Ajwad Musthafa  
Permanent Secretary



"Dhivehin" – Always Maldivian, Forever Independent

Green Building, Handhuvaree Hingun,  
Maafannu, Male', 20392, Republic of Maldives.

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މި ލިޔުމުގެ ތެރޭގައި، ސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކުރި ގޮތުގައި  
މާލެ، ދިވެހިސަރުކާރުގެ ގެޒެޓް، 20392.

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