Ministry of Environment

Environmental and Social Impact Assessment Report

Upgrading of infrastructure at Regional Waste Management Facility Zone II, Raa, Vandhoo

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Consultants Declaration

I certify that to best of my knowledge the statements made in this Environmental and Social Impact Assessment report for "Upgrading of Infrastructure at Regional Waste Management Facility at Zone II, R. Vandhoo" are true, complete and correct.

Name: Hussain Zahir

Consultant Registration Number: EIA P04-2007

Signature:

Company Name: Land and Marine Environmental Resource Group Pvt Ltd

Date: 24th January 2019

Proponents Declaration

بسم الله الرحمن الرحيم

Ministry of Environment
Male', Republic of Maldives.

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Date: 21 January 2019

No: 438/203/2019/8

Mr. Ibrahim Naeem
Director General
Environmental Protection Agency
Male', Maldives

Subject: Environmental and Social Impact Assessment Report for Upgrading of Infrastructure at Regional Waste Management Facility Zone 2, Raa, Vandhoo.

Dear Sir,

As the proponent of the project "Environmental and Social Assessment Report for Upgrading of Infrastructure at Regional Waste Management Facility Zone 2, Raa, Vandhoo", we hereby confirm that we have read and understood the report, and to the best of our knowledge all the information with regard to the project description and other non-technical information provided in this ESIA report are true.

We also confirm our commitment to execute and cover the cost of environmental mitigation and monitoring measures outlined in the ESIA report.

Sincerely,

MINISTRY OF ENVIRONMENT ★ REPUBLIC OF MALDIVES ★

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Executive Summary

The following Environmental and Social Impact Assessment (ESIA) is formulated to address the proposed upgrades to the existing Regional Waste Management Facility (RWMF) located on the island of Vandhoo in the Republic of the Maldives. The ESIA has been developed in accordance with the Environmental and Social Assessment Framework (ESAF) of the Maldives Environmental Impact Assessment Regulations (2012) and the World Bank requirement for a full Environmental Assessment to be undertaken for Category 'A' projects, which require a full ESIA. The ESIA contained herein aims to address those requirements.

The overall objective of the Environmental & Social Impact Assessment (ESIA) presented herein is to determine whether the project is feasible in terms of the non-mitigable social and environmental impacts that would offset positive contributions from the RWMF. The process used to develop this ESIA study follows the environmental reporting requirements for the proposed development of the RWMF on Vandhoo Island, Raa Atoll. A baseline for the most components of the proposed development had already been set by the initial ESIA process. Therefore, this report mainly aims to analyse the deviation from the baseline conditions through comparison of current conditions with that of the baseline conditions.

The main objective of the RWMF was to provide an alternative for the islands in the Northern Province to reduce the volume of waste that must be burned and dumped in an unsustainable manner by providing a RWMF that puts into practice the concept of waste separation and recycling, composting, and incineration of solid waste from islands in the Northern Province of the Maldives. However, the established facility at Vandhoo has failed to meet its ultimate goal due to lack of several facilities. As a result, upgrades to the existing facilities are proposed which are addressed in this ESIA.

The ESIA examined two possible scenarios, namely, the potential impacts associated with:

- **Scenario 1**: proposed upgrades to RWMF are established;
- **Scenario 2:** proposed upgrades to RWMF are not established and the facility is used as it is.

The analysis of Scenario 2, the situation without the proposed project, indicates that there *are 10 potentially significant negative changes* that would seriously affect the Maldives and its people. *Only 1 positive change were identified for Scenario 2.* Although it should be evident that no construction impacts would be expected if the RWMF is not built, it is noteworthy that the RIAM analysis identified a total of 10 significant negative changes both inside and outside of the immediate project area if the RWMF is not built and made operational. The results of the analysis

highlight the critical situation that is developing without immediate solutions to the solid waste issues facing the Maldives.

There are *16 potentially negative changes* expected to occur if the RWMF is upgraded and operated. However, only one of the impacts are identified as a significant negative change (-D) and it is associated with extensive vegetation clearance. However, all of the negative changes associated with the construction and operation of the RWMF can either be reduced or considerably eliminated, provided that the applicant and its contractors apply the best practice measures described in the Environmental and Social Monitoring Program (ESMP). The permanent elimination of vegetation on the building and road development areas is unavoidable and alternatives are proposed as a mitigation measure.

This notwithstanding, it is worth highlighting that there are 12 significantly positive changes associated with proposed upgrade to the existing RWMF at Vandhoo. Each potential change requires a corresponding baseline and mitigation measures, which are presented in Sections 6 and 7 respectively.

Based on the impact analysis, the ESIA concludes that the project is environmentally and socially viable, provided that the mitigation measures presented in Section 7 are closely followed. Additionally, monitoring is required for the priority impacts that are identified in Section 6.

1. ޚުލާޞާ

ތަޢާރަފު

މި ރިޕޯޓަކީ ރ. ވަންދޫގައި ހުރިފައިވާ ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީ އިތުރަށް ތަރައްޤީކުރުމުގެ ގޮތުން ކުރަން ހުށަހެޅިފައިވާ މަސައްކަތްތަކުގެ ފެށުމުގެ ކުރިން އެމަސައްކަތްތަކުގެ ސަބަބުން އަސަރުކުރާނެ ތިމާވެއްޓަށާއި އިޖްތިމާޢީ ގޮތުން އަންނާނެ ބަދަލުތައް އެނާލައިޒްކޮށްފައިވާ ރިޕޯޓެކެވެ. މި ރިޕޯޓަކީ ދިވެހިރާއްޖޭގެ އެންވަޔަރަންމަންޓަލް އެންޑް ސޯޝަލް އެސެސްމަންޓް ރެގިއުލޭޝަން، އަދި ތިމާވެއްޓަށް އަސަރު ފޯރާނެ މިންވަރު ބަޔާންކުރާ ރިޕޯޓު ހުށަހަޅާ ގަވާއިދު 2012 އާއި އެއްގޮތަށް ތައްޔާރުކުރެވިފައިވާ ރިޕޯޓެކެވެ. މީގެ އިތުރުން މިމަސައްކަތަކީ ވާރުވުމުގެ ޤާނޫނުގެ އެހީގައި ކުރެވޭ މަސައްކަތަކަށް ވުމުގެ ސަބަބުން އެ ގަވާއިދުގެ ޝެޑިއުލްގެ މަތިން ކެޓަގަރީ A ގައި ހިމެނޭ މަޝްރޫއުތަކެއް ކުރިއަށް ގެންދިޔުމަށް ފުރަތަމަ އެންވަޔަރަންމަންޓަލް އެންޑް ސޯޝަލް އިމްޕެކްޓް އެސެސްމަންޓް ހެދުން ލާޒިމުވެގެންނެވެ.

މިރިޕޯޓުގެ މައިގަނޑު މަޤްޞަދަކީ މިމަޝްރޫއުގެ ސަބަބުން ތިބާ ގެއްލުންތަކާއިއެކުވެސް (އެ ގެއްލުންތަކުގެ އަސަރު ކުޑަކުރުމަށް ކުރަ ކަންތައްތައް) މިމަޝްރޫއުގެ ސަބަބުން ތިމާވެށްޓަށް ފައިދާތަކާއި ގެއްލުންތަކާއި މިމަޝްރޫއު ކުރިއަށް ގެންދިޔުމަށް އެކަށީގެންވާ ކަންތައްތައް ބަލައިލުމެވެ. މިރިޕޯޓް ތައްޔާރުކުރުމުގައި ބޭނުންކޮށްފައިވަނީ ވަންދޫގައި ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީ ހަމަޖައްސައި ތަރައްޤީކުރުމުގައި ގެންގުޅޭ ރިޕޯޓުން މިނިސްޓްރީތަކުން. މިގޮތުން ދިރާސާތަކާއި ޑޭޓާ ބައިތަކުގެ ބޭސްލައިން ޑޭޓާ ވަނީ ފުރަތަމަ މަޝްރޫއު ތަރައްޤީކުރުމުގެ ކުރިން ކުރެވިފައިވާ ދިރާސާތަކުން ހޯދިފައެވެ. އޭގެއިތުރުން މިދިރާސާގެ ދިރާސާއިން ހޯދި ނަތީޖާ ބޭނުންކޮށްގެން ކުރިން ހޯދިފައިވާ ބޭސްލައިނާ އަޅާކިޔުމަށްފަހު ތިމާވެއްޓަށް އަސަރުކުރާ ބަދަލު ދެނެގަނެވުނު ގޮތުންނެވެ.

ވަންދޫގައި ހުރިފައިވާ ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީގެ މައިގަނޑު މަޤްޞަދަކީ އުތުރު ޕްރޮވިންސްގެ ރަށްތަކަށް އުފެދޭ ކުނީގެ ބެލެހެއްޓުމަށް ޚިދުމަތްދިނުން މިހާރު ގެންގުޅޭ ގޮތްތަކަށް ގޮތެއް ހޯދުމެވެ. މިގޮތުން މިހާރުގައި އެންމެ ފަހުން ފަށާފައިވާ ކުނި އެއްކުރުމުގެ ނިޒާމު ގޮތުގައި އުފެއްދުމުގެ ގޮތުން ކުނީގެ ބެލެހެއްޓުމުގައި ރީސައިކްލިންގ، އަދި ކޮމްޕޯސްޓިންގއާއި އިންސިނަރޭޓަރ އުފެއްދުން ވެސް ތަރައްޤީކުރުމަށް ފަރުމާކޮށްފައެވެ. އެހެންނަމަވެސް ރަށުގެ މަސައްކަތްތަކުން ހުރިހާ ބިންގަނޑު ބައެއް ކަންކަން ފުރިހަމަ ކުރުމުގެ ސަބަބުން އެތަންތަނުގެ މަސައްކަތްތަކެއް ނުކުރެވި އެކަން ކަންތައްތައް ފުރިހަމަ ނުކުރެވެއެވެ. އެހެންނަމަވެސް މިމަޝްރޫއުގެ އެއްޗެހި ފުރިހަމަ ކުރުމަށް ނުވާ ތަރައްޤީ ކުރުމަށެވެ.

މިރިޕޯޓުގައި ތިމާވެއްޓަށް ކޮންކޮން އަސަރުތައް ބޭރުވާނެ 2 ހާލަތެއް ބަލާފައިވެއެވެ:

1. ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީއަށް ގެންނަން ހުރަހެޅިފައިވާ ބަދަލުތައް ގެނައުމުގެ ސަބަބުން ކުރާނެ އަސަރުތައް
2. ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީއަށް ގެންނަން ހުރަހެޅިފައިވާ ބަދަލުތައް ނުގެނެސް އެތަން ބޭނުންކުރުމުގެ ސަބަބުން ކުރާނެ އަސަރުތައް

ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީއަށް ގެންނަން ހުރަހެޅިފައިވާ ބަދަލުތައް ނުގެނެސް އެތަން ބޭނުންކުރުމުގެ ސަބަބުން ކުރާނެ އަސަރުތަކަށް ބަލާލާއިރު، ތަފާތުކޮށް ގޮތުން ތިމާވެއްޓަށް ނުރައްކާ ގޮތުން ބޮޑެތި އަސަރުތަކެއް (10 ބާވަތެއް) ކުރާނެ ކަމަށް ފެނެއެވެ. މިއީ މިހާރުވެސް ހުރިފައިވާ ތަނަކަށް ވުރެން، އެތަން އިމާރާތްކުރުމުގެ ތެރޭގައި އަންނާނެ އަސަރުތައް މިރިޕޯޓުގައި ބަޔާންކޮށްދީފައި ހުންނާނެއެވެ.

މިހާރު ވަނީދޫގައި ހުރިފައިވާ ރީޖަނަލް ވޭސްޓް މެނޭޖްމަންޓް ފެސިލިޓީއަށް ގެންނަން ހުރަހެޅިފައިވާ ބަދަލުތައް ގެނެސް އެތަން ތަރައްޤީކުރުމަށް 16 ވައްތަރުގެ ނުރައްކާ އަސަރުތަކެއްކުރާނެ ކަމަށް ފެނެއެވެ. އެހެންނަމަވެސް މިއަސަރުތަކުގެ ތެރެއިން ފާހަގަކުރެވޭ ވަރުގެ ނުރައްކާ އަސަރެއްކުރާނެކަމަށް ފެނިފައިނުވޭ. ބިނާކުރުމުގެ ސަބަބުން ކުރާ އަސަރެވެ. އެހެންނަމަވެސް މިރިޕޯޓުގައި ދެވިފައިވާ އެންވަޔަރަމަންޓަލް އެންޑް މޮނިޓަރިން ޕްރޮގްރާމްގައިވާ ކަންތައްތައް ފުރިހަމައަށް ތަންފީޒުކުރެވިއްޖެނަމަ މިރިޕޯޓުގައި ފާހަގަކުރެވިފައިވާ ގިނަ ނުރައްކާ އަސަރުތަކުގެ މިންވަރު ދަށްކުރެވިދާނެކަމަށް ފެނެއެވެ. އެހެންނަމަވެސް މިމަޝްރޫއުގެ ތެރެއިން ބިންހިއްކުމުގެ ގޮތުން ނުރައްކާ އަސަރުތަކެއް ދިމާވާނެއެވެ. މިމަސައްކަތުގެ ސަބަބުން ކުރާ އަސަރުތަކުގެ ތެރޭގައި ކުރަންޖެހޭ ކޮށްފައިވާ މިރިޕޯޓުގައި ބަޔާންކޮށްފައިވާނެއެވެ (ބަދަލުގައި ކަންތައްތަކުގެ ތެރެއިން).

މިމަޝްރޫއުގެ ސަބަބުން ކުރާ ނުރައްކާ އަސަރުތައް ކުޑަކުރުމުގައި ފިޔަވަޅު ކުރާ ހަރަދު އަސަރުތައް ފިލުވައި މަދުކުރެވޭނެ ގޮތް (ޗެޕްޓަރ 12).
މިގޮތުން މިކަންކަމުގެ ތަފްސީލު މިރިޕޯޓުގެ ސެކްޝަން 6 އަދި 7ގައި ބަޔާންކޮށްފައިވާނެއެވެ.

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1 Introduction

Solid Waste Management (SWM) and proper disposal has been a persistent issue in the Maldives for a long time. It may well be argued that this is the greatest challenge currently imposing on the fast-growing population of Maldives spread over 250 small islands. Improper handling and lack of proper waste disposal systems are not just a social nuisance but also a cause of a number of detrimental environmental impacts. This is especially significant with the pollution of the marine environment which is the "blood line" of Maldives. The country's economy is driven by tourism and fishery industries, both of which are highly dependent on a healthy marine ecosystem.

Specific enclosed waste collection points are constructed on some islands of the Maldives. However, there is a lack of final disposal and treatment facilities even on these islands. Moreover, islands where an enclosed waste collection center is absent, waste dumping areas are allocated near the shorelines around the islands. Once these waste collection areas are full, they are burnt in the open air. It is not unusual in smaller congested islands for these landfills to be located very close to the local population.

As a result of improper waste management and disposal, all sorts of waste from organic to non-biodegradable waste make their way into the sea and it is a common sight in Maldives to see waste collected in harbors and on the shorelines around the inhabited islands. These solid wastes even drift on to the shorelines of uninhabited islands as well.

In efforts to overcome this formidable challenge, the Government of Maldives took a decision to invest heavily in the waste sector with support from various donors and international agencies to build necessary infrastructure to develop an integrated and sustainable solid waste management system throughout the country on a zonal approach. This process was initiated in 2008 with the support of the World Bank Group, under the International Development Association (IDA) credit to develop an integrated SWM system for Zone II, namely the Maldives Environment Management Project (MEMP). This project was completed in 2015, by developing SWM systems on inhabited islands as well as a Regional Waste Management Facility (RWMF) in the uninhabited island of Raa Vandhoo for final disposal of residual wastes from Zone II islands (Table 1). Figure 1 shows a map of the northern province of Maldives with Raa Atoll and 17 different islands taken into consideration for the Best Practicable Environmental Options (BPEO) report under the North Province Regional Waste Management Project (SENES and CDE, 2010).

Following completion of MEMP project, the Government of Maldives applied for a grant from IDA for another regional waste management project under the title "Maldives Clean Environment Project" (MCEP), effective from September 2017. Sub-component 2a of MCEP would support investment activities in Zone II for operationalization of the facilities created under MEMP in Vandhoo. Details of facilities under the new upgrade are discussed in the upcoming sections.

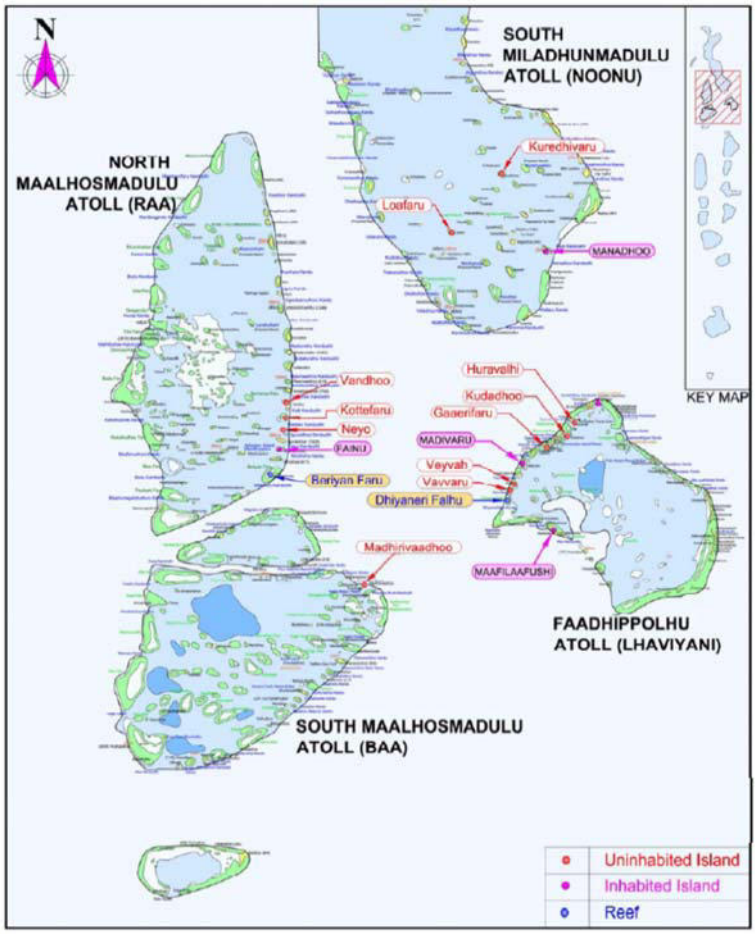

Figure 1. Map showing the Northern Province (Raa) Atoll, as well as seventeen different islands (in red font) taken into consideration by the BPOE Scoping Study (SENES and CDE 2010)

Prior to the development of RWMF at Vandhoo, a thorough Environmental and Social Impact Assessment (ESIA) had been done (Riyan and NIRAS, 2012) and this report will compare survey data from this initial assessment as a baseline wherever possible in order to understand any significant impacts on the environment since the proposed project took off.

The estimated investment cost of the proposed project is USD 1,820,000.00 Funding for project has already been secured through grant money from the World Bank.

1.1 Status of the existing facility at Vandhoo

The condition of the existing facility has been thoroughly analyzed by the Field Investigation Report prepared under the MCEP (Mostafa, 2018). The findings of the report are summarized below.

Zone II comprises of 4 Atolls: Noonu, Raa, Baa and Lhaviyani (Figure 1) which includes 46 inhabited islands, 226 uninhabited islands, 13 resorts, 15 proposed resorts and 9 industrial islands. Distribution of islands and resorts for the region is provided in Table 1 (Mostafa, 2018).

Table 1. Distribution of islands and resorts in zone II (Mostafa, 2018).

Atoll	No. of Inhabited Islands	No. of Uninhabited Islands	Resort	No. of Industrial Islands
Baa	13	57	6	1
Raa	15	66	1	2
Noonu	13	54	2	0
Lhaviyani	5	49	4	6
Total	**46**	**226**	**13**	**9**

The initial waste collection points are located at island levels at the Island Waste Management Centers (IWMC) of each island. The waste then gets transferred to the RWMF at Vandhoo via 2 vessels owned by Waste Management Corporation (WAMCO) of Maldives; *Saafu 1*, a large 200 ton vessel and *Saafu 2*, a smaller waste collection vessel. *Saafu 1* is equipped with a truck and loader onboard to facilitate loading from the IWMCs (which are usually far from the harbor and the Islands in general do not have the means to transport from the IWMC to the loading point) to the vessel. *Saafu 1* unloads manually to *Saafu 2* the jumbo bags, which are then taken to RWMF (Mostafa, 2018).

The operation is definitely very expensive and labor intensive. With significant time of the operation being spent at the Island level, supervision of the crew and their performance is questionable. *Saafu 1* being equipped with loader and truck (which consumes at least 40% of the volume of the vessel) and much heavier loads at all times translates to higher fuel costs and operational expenditures in general.

The harbour area where offloading takes place, is very small despite being designed to serve the purpose for 25 years. Due to the tide, the harbor is very shallow at the circumference and especially at the entrance area. The reception area is very small and packed with almost 7 months of accumulated waste, emptying of which will be a challenge as no maneuverability area is available. Shredder has been out of service for a period of time. Other reported problems include conveyor belt unalignment and smoke coming out from hopper area. These problems

are primarily due to the nature of waste fed to the plant (large size material that get clogged and pushed with continuous loading of waste) (Mostafa, 2018).

The incineration plant was not operational due to various reasons including unavailability of compressor oil and ongoing maintenance works. The consultant for the report highlights that even though the incinerator is of very high quality, the type and composition of waste fed to the plant is not compatible with the incinerator. Although grate technology used in the incinerator is a very flexible technology, it has its limitations and cannot deal with certain types and size of waste. WAMCO operation staff on site are not experienced, however to all fairness, no experienced operator can operate the plant under the existing plant configuration and lack of essential upstream processes / equipment (Mostafa, 2018).

The facility is designed as a treatment and final disposal facility and not a regional facility. As a result, recycles are stored at 10 random locations scattered on the island, either in large waste bins, jumbo bags, styrofoam boxes or loose. Moreover, electronic waste (e-waste) is stored along with bulk waste and are not separated (Mostafa, 2018).

Liners at various locations of the cells were torn/cracked. Fly and bottom ash are disposed of in the open air, which is a major health concern to the team onsite, surrounding areas and is an environmental concern. Leachate ponds have accumulated rain water, which due to stagnant conditions, is turning anaerobic with severe growth of algae, presenting major problems with the operation of these ponds (Mostafa, 2018).

All the operational staff (excluding laborers) are primarily for the incineration plant, with no staffing for other types of wastes or final disposal / landfill. Even so, staff onsite are not experienced in the operation and maintenance of the incineration plant (Mostafa, 2018).

1.2 Aims and objectives of the ESIA

The overall objective of the ESIA presented herein is to determine whether the project is feasible in terms of the non-mitigable social and environmental impacts that would offset positive contributions from the RWMF.

The process used to develop this ESIA study follows the environmental reporting requirements for the proposed development of the regional waste management facility on Vandhoo Island, Raa Atoll. It aims to the overall objective through the collection and analysis of primary and secondary data to establish a baseline on social, economic and environmental aspects that could be affected by the project. The results of the analyses of these diverse data sets provide a clear scope of the potential impacts associated with the project, as well as those

potential impacts that are considered to be significant or others that require that the Precautionary Approach be applied due to their uncertainty and unpredictability. As a consequence, the ESIA primarily focuses on those potential impacts that are considered to be significant, moderately significant or unpredictable. As a result, the Impact Analysis (described in Section 7) highlights only the most pertinent changes that require that a baseline be established in order to monitor the effectiveness of the mitigation measures that are included in the Environmental and Social Management Program (ESMP) and for selecting those parameters ESMP.

1.3 Structure of the ESIA

The structure of the report is based on the Terms of Reference formulated by Environmental Protection Agency (EPA) of Maldives after the EIA scoping meeting to finalise the terms of reference that were approved on 16th December 2018 (A copy of the Terms of Reference is given in Appendix 1). However, the sequence of these Sections is structured in a way that follows the iterative and systematic framework that is laid out by the RIAM method (described in Chapter 4), as well as to reduce the volume of the main body of the final ESIA. As a result, the ESIA Sections are structured according to the following sequence: -

- **EXECUTIVE SUMMARY**

Section 1 **Introduction**
Section 2 **Project Description**
Section 3 **Policy, Legal and Administrative Framework**
Section 4 **Methodology**
Section 5 **Existing Environment**
Section 6 **Stakeholder Consultations**
Section 7 **Impact Assessment and Baselines for Significance Impacts**
Section 8 **Project Alternatives**
Section 9 **Environmental and Social Management Plan (Mitigation and Monitoring)**
Section 10 **Conclusions and Recommendations**

1.4 Purpose of the report and need for the ESIA

The RWMF Project is classified under Safeguards Category "A", which requires that the potential risks and impacts involved in the construction and operation of the regional solid waste management facility take into account the fragile ecosystems surrounding all of the Maldivian islands and its inhabitants. Even with an operational waste management facility at Vandhoo, waste is still disposed in an *ad hoc* and unsanitary manner on all inhabited islands

within the project area, with considerable risks to human health and to marine and terrestrial ecosystems. Floating debris, plastic bags, nappies, sanitary napkins, discarded medicines and bandages, bottles, PET (polyethylene terephthalate) containers, cans, discarded electronic equipment and lubricant wastes are a growing and highly visible hazard to the coral reefs and marine life, and humans. Although upgrading the current facility at Vandhoo could generate adverse environmental impacts over the short term, the net environmental and social impacts should be highly beneficial.

In accordance with the Environmental and Social Assessment and Management Framework (ESAMF), the Project will support the development of a full Environmental and Social Impact Assessment in accordance with the Maldives Environmental Impact Assessment Regulations (2012) and the World Bank Social and Environmental Safeguards Operational Policies; Environmental Assessment and Natural Habitats. The Maldives Environmental Impact Assessment Regulation (2012) is administered by the Maldives EPA, and describes the process for assessment and concurrence of development which has the potential to cause harm to the environment in the Maldives.

Additionally, the World Bank require a full Environmental Assessment to be undertaken for Category 'A' projects in order to ensure that all potential adverse environmental impacts can be identified and suitable mitigation measures can be incorporated into project design and implementation.

1.5 Scope of the ESIA

In broad terms, the scope of ESIA covers the four fundamental dimensions of sustainable development and it attempts to balance the demands that the project will place on the Biological-Ecological (BE) and the Physical-Chemical (PC) dimensions and maximize the benefits the project offers to the Social-Cultural (SC) and Economic-Operational (EO) dimensions associated with the project (Figure 2). The Consulting Team identified *30* scoping components (i.e., potential changes that project produces within each of the 4 dimensions of sustainable development) for the analysis of potential impacts associated with the project. Each Component was subsequently analysed using the Rapid Impact Assessment Method (RIAM). Each component was derived from the Consultancy Team's field studies, as well as previous studies carried out by other consultancies (SENES 2010, 2011; GreenTech *et al.* 2010; Riyan and NIRAS 2012).

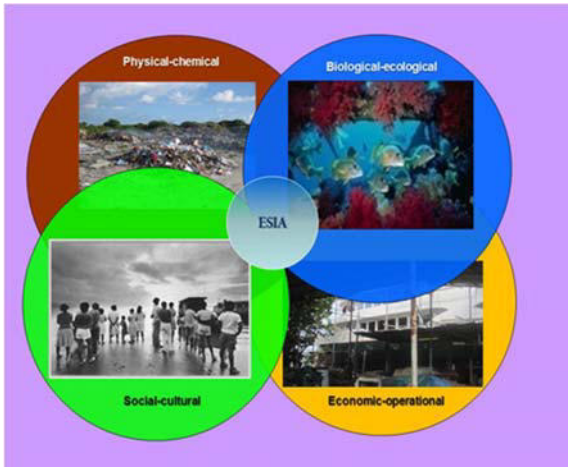

Figure 2. Conceptual diagram showing how ESIA integrates the 4 dimensions of sustainable development.

1.6 Terms of Reference (ToR)

All development projects that have a socioeconomic environmental relevance and are listed in Appendix Raa of the EIA Regulations 2012 are required to submit an Environmental Impact Assessment report which forms the basis for project approval. As such, projects are required to follow a screening process identifying the environmental impacts associated with the project. Projects which are not listed in the above-mentioned schedule has to follow a screening process, based on which EPA decides whether the project requires the submission of an Initial Environment Evaluation report or an Environmental Monitoring report. Based on the findings of this report, EPA as the regulator makes a decision on whether the specified project further requires the submission of an ESIA based on the impacts associated with the project.

In accordance with the regulations of Ministry of Environment, an EIA application form and project brief were sent stating the nature of the project and likely impacts associated with the environment. The scoping meeting was held at EPA on the 3rd of December 2018 with the project proponent, consultant and EPA officials. Based on the discussions at the meeting, a draft Terms of Reference (TOR) which had been submitted was finalized and approved by EPA on the 16th of December 2018 (see Appendix 2).

Moreover, since this is a World Bank funded project, social and environmental safeguard operational policies of the World Bank need to be taken into account. As such, the draft TOR that was submitted to the EPA was communicated to the World bank and approved on 9th October 2018.

The ESIA report is prepared as per the TOR given by EPA. All efforts have been made to address the requirements identified in the TOR and the World Bank Social and Environmental Safeguards Operational Policies; Environmental Assessment and Natural Habitats.

2 Project Description

2.1 Project objectives and components

The proposed development is undertaken as a sub-component of MCEP and has the following objectives: -

- The project development objective is to support improvements to solid waste management in participating Atolls and Islands.
- The project development objective would be achieved through the design, implementation, operation and maintenance of integrated solid waste management systems.

Information used for the preparation of this and subsequent Sections of the ESIA is cited in the subsections that follow and the referenced material can be found in the bibliography section in this report.

2.2 Land ownership

Even though state owned, the island of Vandhoo was historically leased by Raa Atoll Council. On August 2010, an area of 0.15 km^2 (15 ha) was allocated for construction of the RWMF on this island (Riyan and NIRAS, 2012). As a bigger area is required for the current upgrade, as well as for the expansion of waste management facility to Zone I islands, the whole island has now been handed over to ME. Land acquisition letter issued from the President's Office to ME is attached in Appendix 3 of this report.

2.3 The proponent

The proponent of the proposed project is the Government of Maldives, who will implement the project through the ME. Overall operating agency as well the party enforcing environmental standards and regulations during operational phase for the project will be WAMCO. Financing of the project has already been secured through grant money from the World Bank.

2.4 Need and justification of the project

The need of the proposed upgrade to the existing facility at RWMF is justified in light of the condition of existing facility at Vandhoo.

The initial area allocated for RWMF is 15 ha. Within these 15 ha the following components have already been established: Waste unloading and primary segregation shed, temporary

storage recyclables, incineration plant, landfill cell, leachate collection and management system, coastal protection structure, fencing, berth and access channel, administration building, utility building, water and fuel storage tabks, roads and storm water drains (refer to Appendix 4 for the masterplan showing existing and proposed facilities).

However, the existing facilities are not provided with sufficient facilities to cater to the growing demand in waste management facility for the Zone II islands. Consequently, it has been proposed to upgrade the existing facilities.

Condition of the existing facility has been analyzed after consultation with the current operator of Vandhoo RWMF, WAMCO, as well as by referring to the Field Investigation Report prepared under MCEP (Mostafa, 2018). Operational challenges currently met by WAMCO are outlined below:-

- Lack of offloading facility- The capacity of the harbour is too small to accommodate the number of vessels incoming from several resorts as well as inhabited islands. Moreover, the harbour design does not cater to offloading of the incoming waste. As there is no offloading mechanism, a wheel loader and a tele handler is used for offloading purpose which takes about 5 to 6 hours minimum. Moreover, the waste which is being brought in are not properly sorted.
- Temporary storage capacity is too low- Even though the capacity of the incinerator is 36 tons/hr, enough volume of burnable waste is not brought in for a continuous operation of the incinerator. The maximum quantity of burnable waste which could be collected from all Zone II islands combined is estimated at 16 tons. Therefore, since the incinerator does not run continually, waste needs to be collected and stored until enough volume is collected, however, storage space is limited.
- Lack of component storage space- Another problem of not having enough storage space is not being able to sort the waste. Component storage is required for recycling as well. Nevertheless, some recyclables such as metals are segregated for distribution, however enough volume to meet the customers demand is not available for export as it is.
- Technical issues- Lack of electric engineers qualified enough to work with the incinerator used in the facility;
- Shortage of staff – Disinterest of people with technical backgrounds to work at Vandhoo RWMF. Even though there is a shortage in support staff, accommodation facility is limited. Currently, staff from Innamaadhoo and Rasmaadhoo return home once the shift is over daily, however, the accommodation blocks are crowded with staff from other islands.

- Delay in waste collection – Currently, WAMCO does not have a fleet large enough to cater to all Zone II islands. This, as well as the aforementioned problems all add up to delays in waste collection from Zone II islands and loss of customer satisfaction.

Furthermore, the Field Investigation Report concludes that the RWMF at Vandhoo has not been designed and built as a "regional solid waste management facility", but rather, it has been designed and built as a "treatment and final disposal facility" (Mostafa, 2018).

Therefore, in order to provide a solution to the limitations in the RWMF at Vandhoo, the GOM has secured funding to upgrade the facility. However, not all aforementioned problems can be addressed at this phase of the project as the funding is limited.

2.5 The Project

The RWMF at Vandhoo has been designed to provide long term environmentally sustainable solutions for waste management in north province. The design of RWMF has been done considering factors such as waste composition, quantity reaching RWMF, applicability in the local condition and regulatory compliance. Limitations of scarcity of land and the requirement to protect the fragile eco-system have also been considered during the design of RWMF.

The proposed project is an upgrade of the existing waste management facility. Scope of work includes the following: -

1. Extension of existing waste processing bunker 1;
2. Construction of additional waste storage bunker;
3. Construction of hazardous waste storage facility;
4. Construction of proposed recycling facility with storage for recyclables;
5. Construction of new staff quarters (accommodation) with mess;
6. Extension of utility building (to accommodate additional genset);
7. Construction of incinerator maintenance room (for tools and critical spares);
8. Construction of store room 3 (for spares);
9. Construction of additional water tanks (250 m^3 x 2 nos.);
10. Relocation and upgrade of fuel storage (100 m^3 x 2 nos.);
11. Rehabilitation of the existing landfill and leachate pond (with pumps);
12. Upgrading/upscaling of existing fire protection system (include additional buildings);
13. Upscaling of existing RO plant (with borehole); and

14. Upscaling of the existing RO plant (with borehole).
15. Establishment of water and sewer network to the accommodation blocks.

Schematic of the existing facilities and proposed facilities are detailed in the drawings on Appendix 4 of this report.

2.5.1 RO plant, water tanks and distribution network

The existing facility has a Reverse Osmosis (RO) plant of capacity 15 m^3/day (15 ton/day) and 3 x 10,000L water storage tanks. Drinking water is provided to the personnel working on site.

It has been proposed to upgrade the existing system to an RO plant of capacity 50 tons. Water intake for the RO plant will be via a borehole. Typical water treatment process from borehole to storage tanks is provided on the diagram below (Figure 3). A borehole to a depth of 30 m will be constructed at the proposed utility building (Refer to Figure 4 and masterplan in Appendix 4). Brine outfall from the RO plant is proposed to be established at the southern side of the island where wave action is not very strong (refer to Figure 4 for brine outfall location). Additionally, 2 x 200 m^3 water storage tanks are to be built for water storage. Refer to Figure 4 and masterplan in Appendix 4 for the location of water storage tanks (building no. 06). Water distribution from the RO plant to accommodation block will be via HDPE pipe DN110 laid from the main road.

Once the new water storage tanks have been established, the existing storage tanks will be decommissioned. The new water production facility will be established at a new location. Figure 4 below indicates the current location as well as the proposed location of desalination building where RO plant, borehole and water storage tanks will be located. Details of water storage tanks are provided in Appendix 5 of this report.

Properties of product water quality produced from the RO plant will be in compliance with EPA's guideline for drinking water quality.

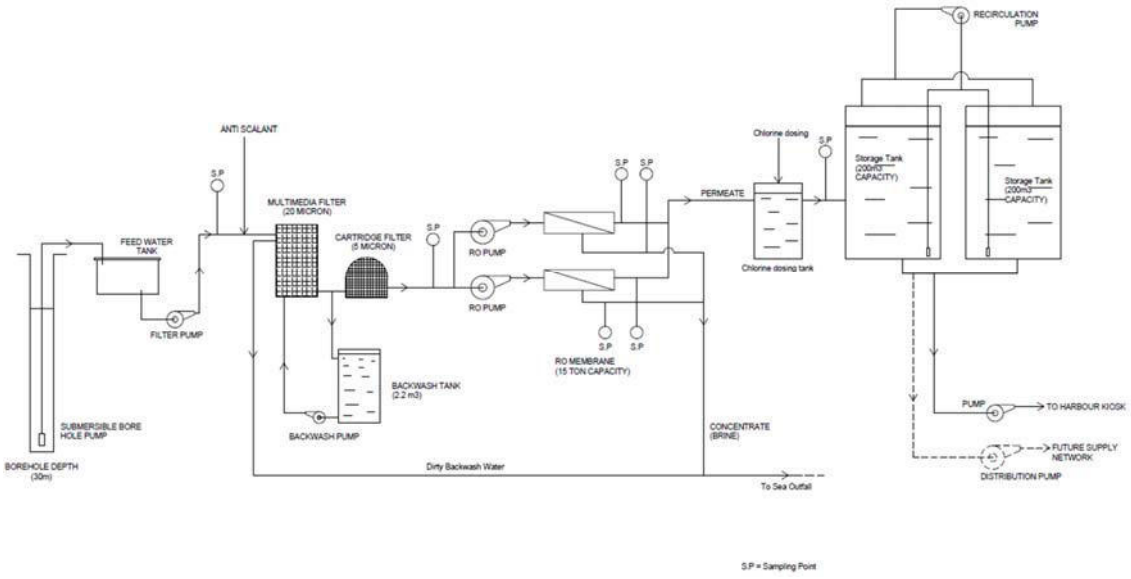

Figure 3. Typical water treatment process from borehole to water storage tanks

2.5.1 Relocation and upgrade of fuel storage tanks

At present, the RWMF consists of 1 x 24,000 L diesel storage tank and 1 x 8,000 L used oil storage tank. These storage tanks are located at the existing utility building as shown on Figure 4.

It has been proposed to construct a new fuel farm near the harbor area with fuel supply pipeline (building no. 05 on Figure 4 and Appendix 4). The newly established fuel farm will consist of 2 x 200 m^3 for diesel and used oil storage purpose. Refer to the drawing in Appendix 6 for the location of inlet and outlet pipes of fuel transfer. Oil storage tanks will be constructed with carbon steel with flat steel flooring for placement on concrete foundation. Moreover, existing fuel tanks will be relocated to the proposed fuel farm. Specifications of diesel steel tanks are attached on Appendix 7 of this report.

A Genset of capacity 250 KVA is currently present in Vandhoo located in the existing powerhouse. Moreover, an additional Genset of capacity 250 KVA will be provided at extension of existing utility building (building no. 08A in Figure 4 and Appendix 4). There is a backup Genset of capacity 120 KVA at the project site.

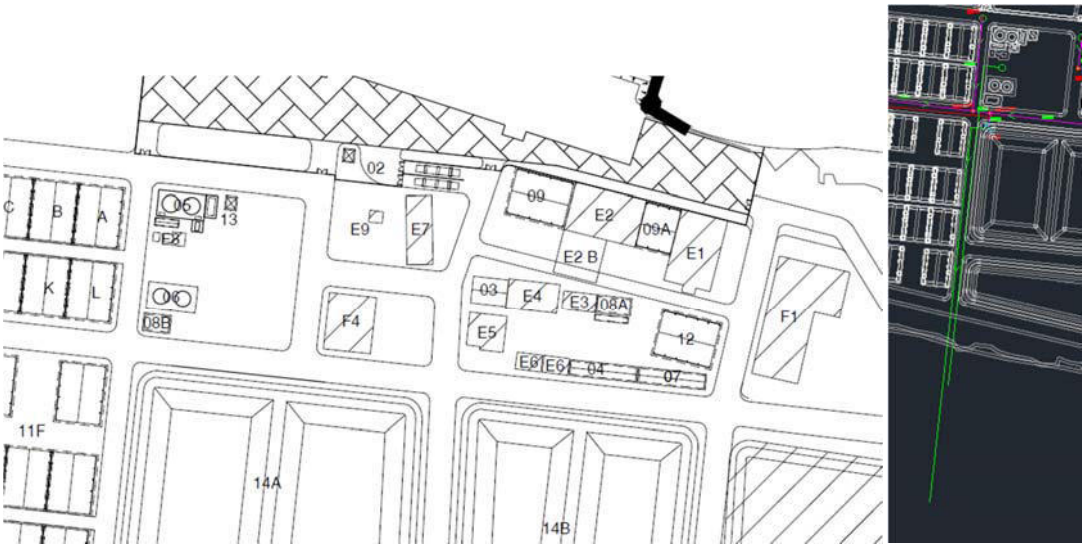

Figure 4. Location of utility building and brine out fall. Existing utility building is marked as E3. New borehole will be established adjacent to the proposed desalination building (image on right). Water storage tanks are to be established at building no. 06 and fuel and waste oil storage tanks at building no. 05. Building no. 08A is the proposed powerhouse and 08B desalination building.

2.5.2 Rehabilitation of ash disposal landfill and leachate pond

The existing landfill has a total volume of 18,500 m^3 (cut and fill) that is surrounded by a 3 x 300 mm compacted subgrade. The landfill covers an area of about 1.39 ha. Reticulation includes a leachate pond/ stormwater pond, pump station and an integral HDPE pipe, sprinkler (1l/s, 15m cast). The landfill has a stormwater collection and storage area with a capacity to receive 4,850m^3 of stormwater. A sub-grade of 3 x 300mm compacted to minimum 95 % of Proctor density would also be employed. The leachate pond takes up an area of about 0.72 ha.

The proposed rehabilitation works to the landfill include placing of an additional geo textile layer and changing the existing pumps to submersible type. Same boundaries will be maintained and no change will be brought to the size and dimension of the landfill cell.

2.5.3 Upgrading of existing fire protection system

The firefighting system will be located next to the fuel farm (building no. 03 on Figure 4 and master plan on Appendix 4). Following upgrades will be applied to the existing firefighting system:-

Fire extinguishers	- Servicing of existing fire extinguishers for performance and content. Undertake refilling if required. - Placing of fire extinguishers in cabinets.
Fire hydrant system	-Connect electricity to the existing fire hydrant system.

	- Servicing the pumps - Grease all hydrants.
Fire alarm system	-Commissioning of existing fire alarm system.
Drencher and foam pouring system	- Automate the existing system, redesign and install according to MNDF's latest requirements.

The following components will be installed at the proposed development: -

Fire alarm system	- Installation of fire alarm systems in all new infrastructures where required.
Fire hydrant system	- Installation of fire hydrant systems in the proposed area for development.
Fire extinguishers	- Installation of fire extinguishers in all new infrastructure where required.
Drencher and foam pouring system	- Relocation of existing drencher and foam pouring system to the new location and automating and redesigning the system as per MNDF's latest requirements. - Installation of drencher and foam pouring system in the proposed new fuel tanks.
Mobile firefighting pumps	-Installation of mobile firefighting pumps for use in emergencies.

2.5.4 Construction of roads and paving

Road paving is only proposed just enough to provide access to the buildings proposed to be constructed during this phase of the project (highlighted areas in Figure 5). The roads will have a 2m green zone, 1m side walk pavements, 1m green zones and curb stones on either side. Additionally, provision for pipelines for utility services under the road will be provided. Typical road section and road paving details are given in Appendix 8 of this report.

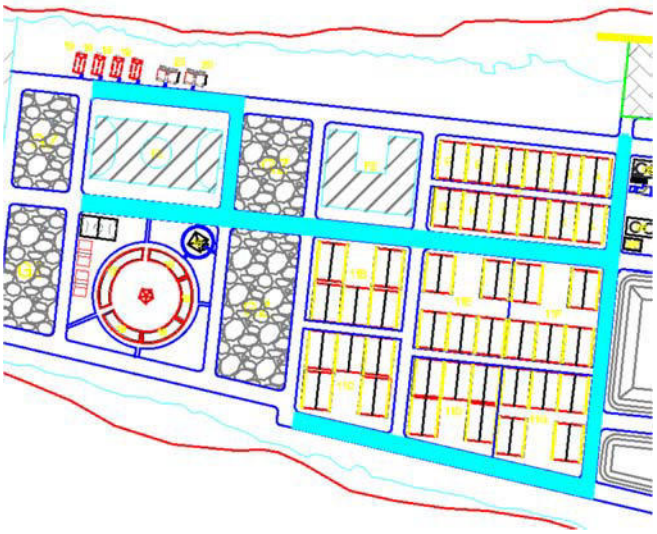

Figure 5. The roads proposed to be paved are highlighted in blue

2.5.5 Construction of new infrastructure

Only the following facilities are proposed to be constructed during this phase of the project. These facilities are marked with an asterisk on the masterplan (Appendix 4).

Table 2. Building sizes of the facilities to be constructed under this project

Building No.	Details	Size (m^2)
02.	Guard house and weigh bridge	32.9
03.	Vehicle shed extension building	197.8
04.	Storage extension building	223.2
05.	Fuel farm	431.3
06.	Water storage tanks	272.7
07.	Mechanical storage	223.2
08A.	Power house	191.9
08B.	Desalination building	103.8
09.	Waste sorting shed extension	613.3
09A.	Sorting shed to incinerator shading	361.3
11. 11B. 11C. 11D. 11E. 11F. 11G.	Waste management facilities:- -Recyclables -Recycling (with compaction and bailing plant) -E-waste -Bulk waste -Compost -Hazardous waste	18529.2
12.	Unprocessed waste bunker	616.1
13.	Fire pump room	32.9
20.	Consultants accommodation x 2	362.3

2.5.6 Construction of water and sewer network to the accommodation blocks

Sewer and water network will not be laid on the whole island during this phase of the project. However, water distribution from the RO plant to accommodation block will be via HDPE pipe DN110 laid from the main road. Waste water from the accommodation blocks will be via lifting stations from the accommodation block to the outfall pumping station (Appendix 6).

2.5.7 Composting

Composting will not take place at the RWMF. Composting facility will be provided to the islands and any biodegradable (food and green waste) shall be composted. This compost, produced at the IWMF will be packaged and distributed via the RWMF. The packaging process will take place at building no. 11F (refer to Master Plan on Appendix 4).

2.5.8 Trainings

There are continuous training programs for the WAMCO staff working at RWMF at Vandhoo. In addition to this, a 12 month training program from support contractors hired from overseas is planned for 2019 facilitated by ME.

Weighing scales will be provided to all the serviced islands in order to log the weight of different types of waste prior to loading to the vessel.

2.6 Construction phase

No demolition works is required for the proposed works, however, vegetation clearance is necessary for the proposed plots and roads. The extent of vegetation clearance and types of vegetation to be removed are specified in section 5 of this report.

2.6.1 Major Inputs and Outputs

2.6.1.1 Inputs (description of the project in terms of raw materials, processes, equipment and work force)

Access to site, mobilization and material unloading

Construction material for the project, such as building material, galvanized iron pipes and nets will be brought to the island on bigger vessels. Materials will be unloaded to the island at the existing harbor. Construction materials will be temporarily stored at the areas indicated on Figure 6 below as these areas are currently barren. Vegetation clearance for temporary storage is not recommended. Once the land gets cleared for building plots, some material can be moved about to those areas as well.

Figure 6. Recommended areas for temporary material storage

Construction methodology

The construction methodology and equipment planned to be utilized for the works proposed under this development is summarized in the inputs and outputs table below:-

Table 3. Inputs and Outputs for the proposed project

Inputs			Outputs	Management
Materials	**Equipment**	**Source**		
Steel rolled tapered panels (RTP panels)	Excavator	Imported material, contractor may purchase locally or import directly	Water tanks and network pipes	ME
Steel rolled tapered panels (RTP panels)	Hydraulic jacks (tank erection) Excavator (foundation works)		Fuel storage tanks and pipeline	
Tar/Asphalt	Conventional civil construction methods employed in Maldives		Paved roads	
Cement			Building structure and walls	
River sand			Building structure and walls	
Aggregate			Building structure and walls	
Gypsum board			Building ceilings	
Wood			Building ceilings	
GI pipes			Building ceilings	
Corrugated sheets			Building ceilings	
Geo textile			Ash disposal cell	

Conventional civil construction methods employed in Maldives will be used to construct the buildings and concrete tanks; concrete foundations, columns, beams and sheets, masonry walls, wall plastered. Building sizes of the facilities to be built under this project are provided in Table 2. Mobile concrete machine will be used for concrete mixing, only a limited heavy machinery will be mobilized due to small scale of the project. Water for construction will be sourced from existing RO plant on the island.

2.6.2 Workforce and temporary facilities

The exact size of workforce, workers and their origin will be decided by the contractor. An estimate is provided in Table 4 based on the scale of the work needed. Recruitment process of the workers/contractors will comply with the World Bank's tender process as well as the National Competitive Bidding process. As for the temporary accommodation facilities, Contractor can decide whether to construct temporary accommodation blocks within the facility or alternatively find accommodation in nearby islands Rasmaadhoo and Innamaadhoo.

Food should be provided by the contractor; currently there are 2 chefs and a mess room at Vandhoo. Contractor has the option to make arrangements with the existing facility. Utility services such as sewer, water and electricity will be provided via the existing facility at Vandhoo.

Table 4. Estimated workforce required for the project

Designation	Numbers
Project manager	1
Works manager	1
Project administrator	1
QA/QC/HSES officer	1
Chief surveyor	1
Project engineer	1
Laborers: Construction	34

2.6.3 Waste management

Since the island itself is a waste management facility, all the construction wastes will be segregated on site and then disposed of at the facility according to the current practice.

2.6.4 Project schedule

The project duration for the construction and establishment of proposed facilities at RWMF is estimated to last about 2 months. Detailed work schedule is provided in Appendix 9 of this report.

2.6.5 Outputs

Key outputs of the project include:

- new staff accommodation and guest accommodation facilities,
- waste processing bunkers and additional storage bunkers;
- utility buildings with additional gensets, RO plant and firefighting facility;

Secondary outputs as a result of the operation of the facility include better waste management from Zone II islands. Recycling of waste and better training are additional outcomes expected as a result of the proposed upgrade of RWMF at Vandhoo.

2.7 Operational phase

The operation will involve the following components: -

- Island Waste management System in terms of waste segregation and packing;
- Transportation of waste from islands to RWMF; and
- Operation and management at RWMF.

Waste management process is summarized in the flow diagram below (Figure 7).

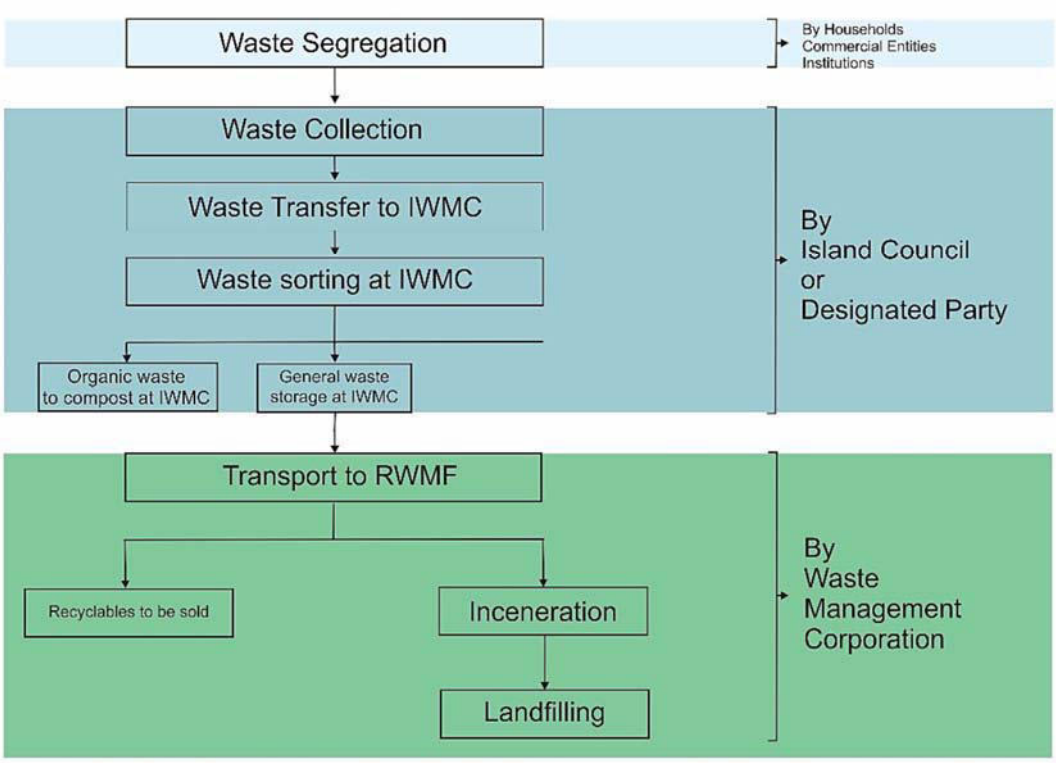

Figure 7. Waste management process flow from island waste management centers to RWMF

2.7.1 Service Area

The RWMF of Vandhoo will be operated by WAMCO. Figure 8 below shows the areas (known as zone II) serviced under the mandate of RMFW at Vandhoo.

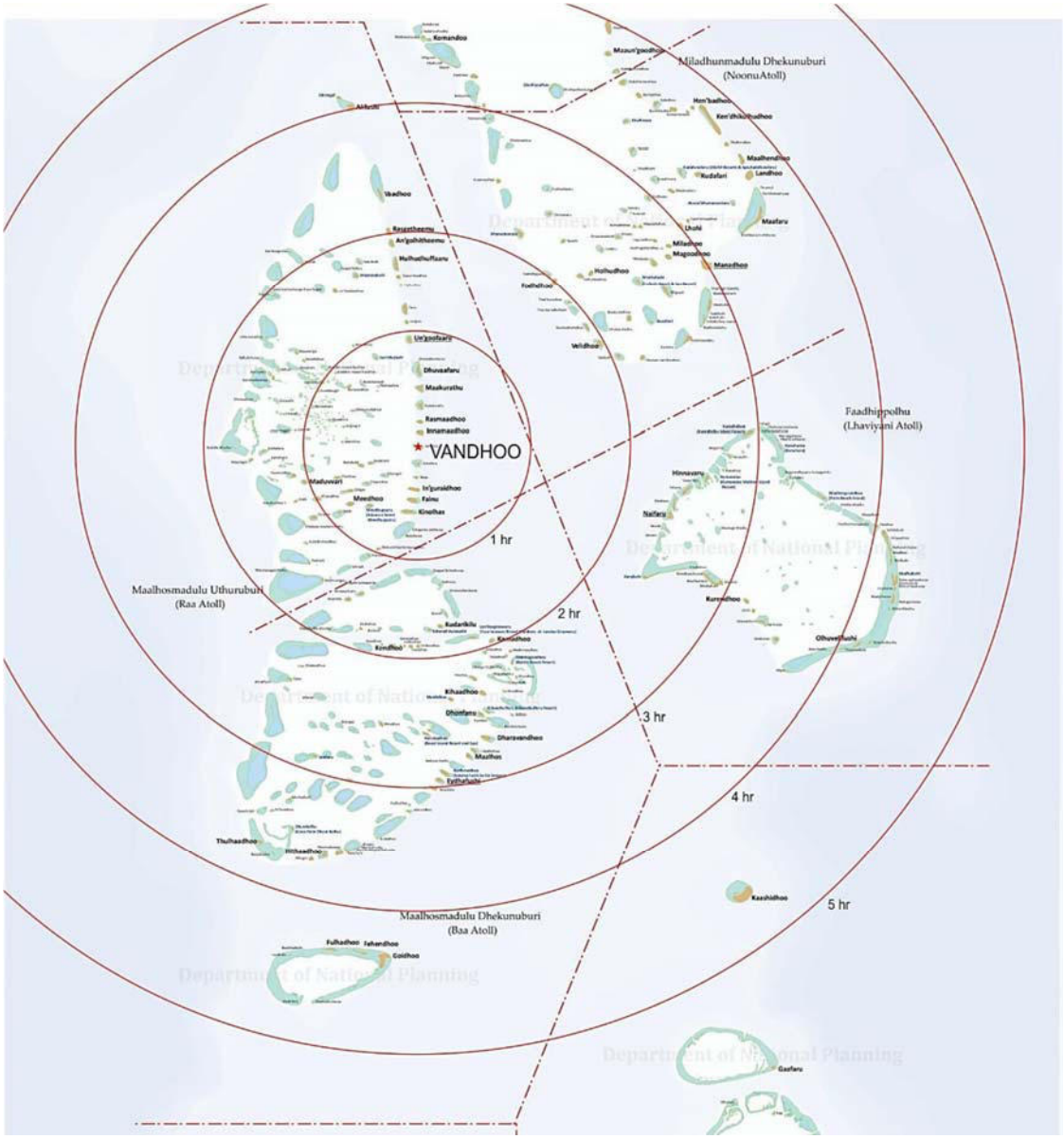

Figure 8. Coverage area serviced under the mandate of RWMF, R. Vandhoo

2.7.2 Human resource plan

Figure 9 below shows the human resource plan proposed during the operational phase of RWMF.

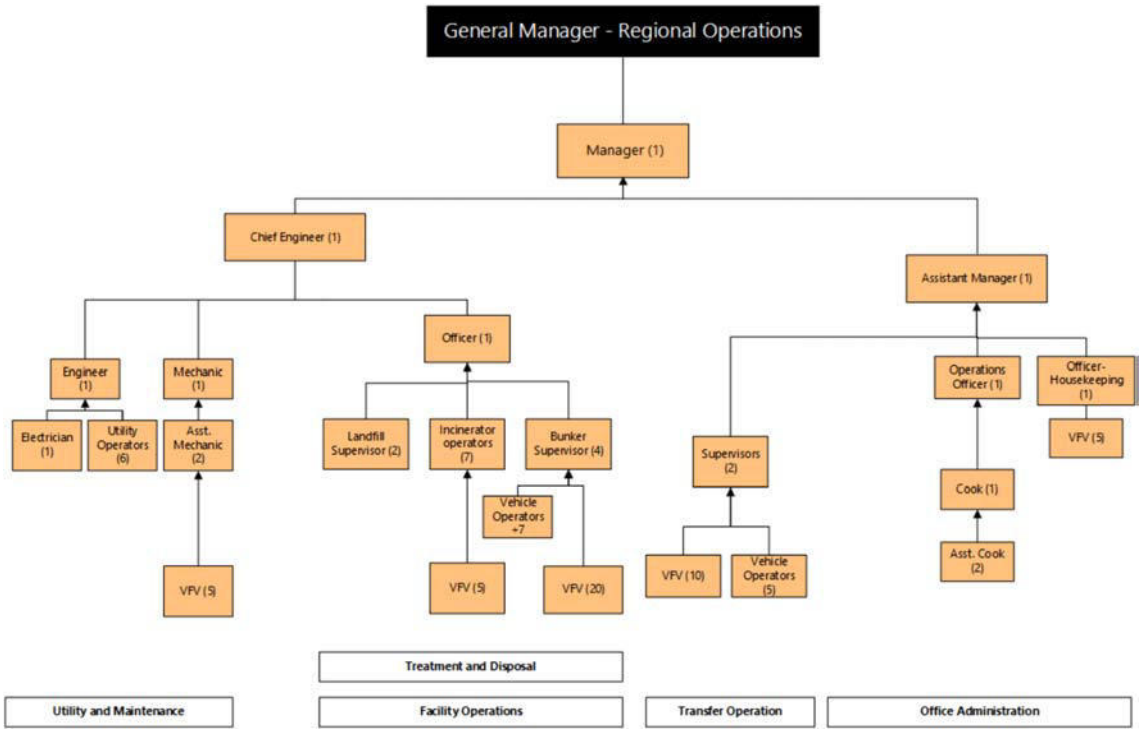

Figure 9. Human resource management plan of RWMF, Vandhoo

2.7.3 Occupational health and safety

WAMCO has formulated an exhaustive occupational health and safety procedure for the employees. All management and employees are thoroughly instructed and integrated into comprehensive safety philosophy when first hired. The occupational health and safety measures extracted from the operations and maintenance procedure of WAMCO for the RWMF at Vandhoo is attached in Appendix 10 of this report.

2.7.4 Future expansion plans

In addition to zone II islands, the GOM has decided to expand the serviced islands under RWMF at Vandhoo to zone I islands as well. The waste from Zone I will first be collected at a zonal collection point prior to transferring to the RWMF. An island will later be assigned as a zonal collection point after carrying out the necessary assessments.

2.8 Location and Extent of Site Boundaries

The locations proposed for the proposed facilities are shown on the masterplan in Appendix 4 of this report

3 Policy, legal and administrative framework

The project conforms to the requirements of the Environmental Protection and Preservation Act of the Maldives (Law no. 4/93). The EIA has been undertaken in accordance with the EIA Regulation 2012 of the Maldives by a registered consultant. It adheres to the principles underlined in the regulations, action plans, programs and policies of the Maldives, as well as international agreements that are pertinent to the construction and operation of the project

3.1 Environmental Protection and Preservation Act (Law 4/93)

The Environmental Protection and Preservation Act (EPPA) of Maldives (Law 4/93) was enacted in 1993 and serves as the main legal instrument to protect and preserve the environment of Maldives. EPPA stipulates that all developmental projects which have a potential impact on the environment should have an Environmental Impact Assessment done, prior to commencement of the project. Furthermore, with relevance to this project, EPPA also stipulates that "any type of waste, oil, poisonous gases of any other substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives. In case where the disposal of such a substance 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 precautions shall be taken to avoid any harm to the health of the population".

3.2 Environmental Impact Assessment Regulation (N0. 2012/R-27) and amendments

EPA stipulates that any development project which has the potential to impact the environment should be cleared through an Environmental Impact Assessment prior to work commencement. The EIA Regulation was developed in 2012 to better facilitate this process. Appendix D of the Regulation gives a list of projects which require submission and approval of an EIA prior to work commencement and the proposed works falls under the category of projects listed in this Appendix.

3.3 The Regulation on Environmental Liabilities (Regulation No. 2011/R-9)

The objective of the regulation on Environmental Liabilities is to prevent actions violating the Environmental Protection and Preservation Act 4/93 and to ensure compensations for all the damages that are caused by activities that are detrimental to the environment.

The regulation sets mechanisms and standards for different types of environmental liabilities and equal standards that shall be followed by the implementing agency while implementing the regulation.

According to this regulation the Government of Maldives reserves the right to claim compensation for all the activities which have breached the Environmental Protection and Preservation Act 4/93.

3.4 Leasing of Uninhabited Islands

The authority to lease uninhabited islands is vested within the Ministry of Fisheries and Agriculture through Law 20/98 (Law on Uninhabited islands of Maldives). As per regulation the Ministry also has the authority to take back islands leased through the Varuvaa system, even though the lessee has not violated the agreement, for different reasons; if the island is required for defense purposes or for use by the government or to carryout works approved by the government. However, as per the Regulation, in such instances, the lessee should be given an amount equivalent to 2 years worth of payment for lease. While the regulation states this, the *Guidelines followed in leasing of uninhabited islands* published in the Government Gazette states that in an instance where the island given under the Varuvaa system is taken back by the government, the lessee should be given back balance of his payment for remaining part of his agreement (given that the payment has been made).

3.5 Waste Management Regulation (R-58/2013)

The Waste Management Regulation of the Maldives was gazetted on the 5th of August 2013 and came into effect 6 months from the date, on 5th of February 2014. The Regulation was enacted through the powers given to the Ministry through Law 4/93. The main objective of this regulation is to implement the national policy on waste management and through its implementation, facilitate the following so as to preserve the environment:

- Minimise both direct and indirect impacts due to waste on environment and human health.
- Establish standards for waste management
- Formulate an integrated framework for waste management, and establish environmentally sound and sustainable means for waste management
- Encourage waste minimisation, reuse, recycling and recovery
- Implement “Polluter Pay” principle
- Introduce “Extended Producer Responsibility”

The regulation has five focus areas:

- Waste Management Standards; defines standards for waste collection, transfer, treatment, storage, site management, landfills and managing of hazardous waste
- Procedure for approval of Waste management permits (for waste management sites)
- Standards and permits required for transport of waste (land and sea)
- Monitoring and reporting requirements
- Enforcement and implementation procedures and penalties

3.6 National Solid Waste Management Policy of 2015

The first National Solid Waste Management Policy of Maldives was formulated in 2008, with a new policy being announced in 2015. The policy has 10 key points:

1. Every individual is responsible for the waste they generate and should treat/dispose the waste as per measures and regulations established by his/her local governing authority
2. Waste generated at household level should be disposed of as per measures and regulations established by the local governing authority
3. Waste management at all inhabited islands should be according to a plan formulated by the Island Council and community and which has been approved by the governing authority
4. Waste collection and management should be carried out based on a fee-based system for all households and industries
5. Encourage waste management work to be carried out by government utility companies on the islands, through agreements made with these companies
6. Establish waste management centres on all inhabited islands of the Maldives with sufficient capacity to facilitate the process on these islands (based on population)
7. Establish and operate Regional Waste Management Centres throughout the country
8. Establish and operate a system to facilitate removal of residual waste from inhabited islands and transport to a RWMF
9. Encourage waste management as an income earning avenue, on islands with such capacities and use the income generated for proper waste management on the island
10. Carryout waste management training and awareness campaigns on a national level

3.7 Dewatering Regulation (2013/R-1697) – 31st January 2014

The Dewatering Regulation has been formulated to introduce measures so as to minimize impact on the environment and ecosystem due to dewatering which may be carried out as part of construction works or during other works. Any development which requires dewatering as part of the project, can only implement the dewatering phase after obtaining the required approval from the EPA, which is the implementing agency for the regulation. The regulation does not apply to dewatering which may be required for the installation/cleaning of a groundwater well for personal use or use of groundwater for agricultural purposes.

Prior to carrying out dewatering the proponent of such projects have to submit an application form to EPA with required documents which are detailed in the regulation and application form. It is also the responsibility of the proponent to inform the relevant councils, if there are residential areas or agricultural lands within 100m radius of the site where dewatering will be carried out.

The regulation further details what should be done with the water extracted during dewatering, and what actions should be taken should dewatering impact resource users within 30m radius of the site.

The regulation further specifies fines which will be applicable if the regulation is not followed.

3.8 Regulation on fuel storage and use (2015/ R-160)

The objective of this regulation is to:

- Decrease the number of accidents due to fuel usage and storage and protect the people and their belongings from such incidences
- Raise awareness regarding protective measures which should be in place when using/storing fuel
- Establish means which would enable all places which sell fuel (currently established and in the future) to do so under proper protective measures

The implementing agency for this regulation is the Ministry of Defense and National Security and enforcement of the regulation began on the day the regulation was published in the government gazette (12th August 2015).

All current establishments which use and store fuel have to abide by the regulation and existing establishments were given grace periods of 6 months and 1 year to modify their setups so as to meet the criteria outlined in the Regulation.

Future establishments should be set up as per the regulation, inclusive of firefighting and safety measures. Operation of new facilities can only commence once its been checked and approved by the implementing agency Maldives National Defense Force (MNDF). Existing facilities (at time of implementation of regulation) which had not prior obtained permission from MNDF should also continue their operations after getting the required approval.

Appendix 6 of the Regulation states distance which should be left between the bund wall adjacent residential areas (inclusive of road). These distances are based on the capacity of the facility.

The implementing agency has the authority to make inspections at the facilities once every 6 months and this will be done in the presence of the owner of the facility. During such inspections, the implementing authority will advise if any changes have to be brought to the facility. In such instances the facility will be checked again after been given a time period to make this change.

3.9 By-law on cutting down, uprooting, digging out and export of trees and palms from one island to another

As stated in previous ESIA report for the development of RWMF at Vandhoo (Riyan and NIRAS, 2012) pursuant to law number 4/93 (Environment Protection and Preservation Act of Maldives), the Ministry of Housing and Environment has made a by-law with the purpose of educating developers about the importance of trees including best management practices for maintaining trees and provide standards for preservation of trees in the Maldives and set down rules and regulations to be adhered to prior to commencing felling, uprooting, digging out and exporting of trees and palms from one island to another in Maldives.

The bylaw states that the cutting down, uprooting, digging out and export of trees and palms from one island to another can only be done if it is absolutely necessary and there is no other alternative. It further states that for every tree or palm removed in the Maldives, two more should be planted and grown in the island.

The bylaw prohibits the removal of following tree types;

- The coastal vegetation growing around the islands extending to about 15 meters into the island are protected by this bylaw;
- All the trees and palms growing in mangrove and wetlands spreading to 15 meters of land area are protected under this bylaw;
- All the trees that are in a designated protected area;
- Trees that are being protected by the Government in order to protect species of animal/organisms that live in such trees; and
- Trees/palms that are unusual in structure

3.10 IFC Requirements

3.10.1 Environmental, Health and Safety Guidelines

IFC Environmental, Health and Safety Guidelines relevant to the prposed work are:

EHS guideline on air emissions and ambient air quality

EHS guideline on Hazardous materials management

EHS guidelines for Waste management facilities

These guidelines were formulated in 2007 and have been discussed in detail in Riyan and NIRAS (2012). Readers are referred to Section 3.6 of Riyan and NIRAS (2012) for further details.

4 Methodology

4.1 Context and General approach for data collection

One of the most important aspects of the ESIA is the analysis of potential impacts associated with the project and the subsequent collection and compilation of environmental and socio-economic data for establishing baseline conditions. This is essential for addressing the primary requirements of the Terms of Reference, which were formulated by the EPA. Consequently, the main focus of this Section is to provide a concise account of the overall approach to the ESIA and the methods used to collect relevant information and data in the indicated target areas that have been highlighted by the Consulting Team's approach.

The approach to data collection and compilation of this report includes;

- Consultation and discussion with the proponent with regard to design and work methodology that would be used to implement the proposed activities of the project,
- Examination of the existing environment to identify significant environmental components that are likely to be affected,
- Consultation with major stakeholders to exchange information on the project and to follow the ESIA procedures required for the report, and
- Evaluation of available and relevant literature on environmental impacts associated with similar projects.

Information on existing environment was collected during the field visit to the project site in November 2018. General information on the existing environment was based on available secondary data, such as climatic data from the meteorological center.

The following sub sections describe the methods that were employed to: *a) guide the iterative process for identifying potentially significant changes in the environmental, social and economic dimensions of the construction and operation of the proposed Regional Waste Management Facility at Vandhoo,* and *b) measure and establish baselines for those potentially significant impacts so that they can be monitored over time in order to assess the effectiveness of the proposed mitigation measures presented in the ESMP*. Additionally, baseline data from the initial ESIA report (Riyan and NIRAS, 2012) has been used to compare the current environmental conditions at Vandhoo.

4.2 The RIAM Approach

Rapid Impact Assessment Method was used in Riyan and NIRAS (2012) to understand the potential impacts associated with the construction and operation of RWMF at Vandhoo. The same approach is used here to assess impacts associated with proposed work for the current project. The methodology for this approach is summarized in this sub-section and has been directly sourced from Riyan and NIRAS (2012).

The RIAM approach also helps to establish a framework that enables the GoM to develop and implement mitigation measures. These measures will not only help reduce or eliminate impacts, but to contribute to the economic, social and environmental sustainability of the project as well. Figure 10 summarizes the iterative framework that was used to guide the revised ESIA process and to evaluate potential impacts associated with the RWMF.

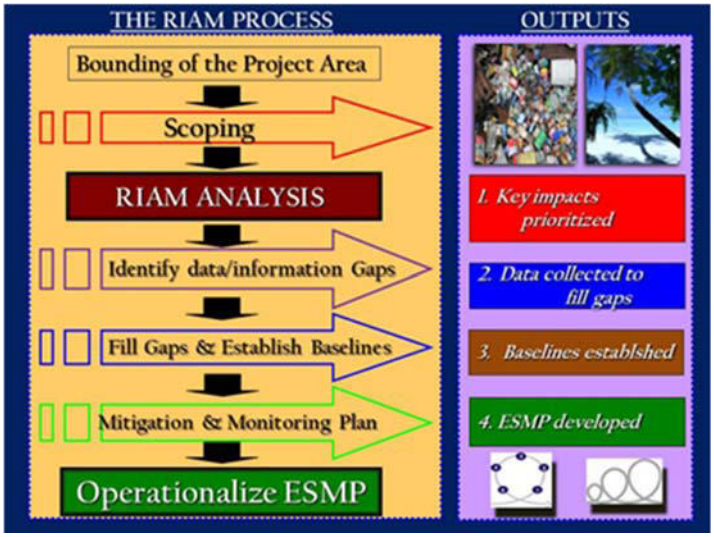

Figure 10. Diagram showing the RIAM process

STEP 1: RIAM initiates with **Bounding** or a definition of the primary and secondary areas of the project's influence. The area is divided into the Area of Direct Impact (ADI) and the Area of Indirect Impact (AII). The ADI is the area where the project is most likely to produce changes identified in the RIAM analysis, whereas the AII encompasses those areas where the impacts (changes) are due to indirect spillover of the project.

STEP 2: Once the delimitation has been completed, the next step is the detailed exercise of **Scoping**, which involves identifying the social, economic and environmental *changes* (i.e., *impacts*) that are potentially caused by the project and that could affect the sustainable use of the island and its surrounding marine biodiversity, potential risks if no action is taken and the

level (and costs) of interventions required to ensure sustainable use of coastal resources. The Scoping (component identification) exercises are carried out by a multidisciplinary team that identifies all potential socio-cultural (S/C), biological-ecological (B/E), physical-chemical (P/C) and economic –operational (E/O) changes.

STEP 3: Once the potential changes have been identified in the scoping process, the **RIAM Analysis** is carried out in order to prioritize the potential changes according to their significance. Table 5 summarizes the RIAM scoring system which is based on a set of five different criteria (A1 and A2, B1, B2 and B3) that are used to assess the degree to which the impact is significant:

Table 5. Summary of the criteria used to assess significance of an impact

Code	Criterion	Measurement	Scores	
A1	Importance	*Spatial extent of the Change*	International/national influence	4
			National/regional influence	3
			Extending outside the local area	2
			Within the local area	1
			No change/not applicable	0
A2	Magnitude	*Magnitude of Change*	Major change	3
			Significant change	2
			Slight change	1
			No change/not applicable	0
			Slight negative change	-1
			Negative significant change	-2
			Major negative change	-3
B1	Permanence	*Permanence of the Change*	Permanent	3
			Temporary	2
			No change/not applicable	1
B2	Reversibility	*Reversibility of the Change*	Irreversible	3
			Reversible	2
			No change/not applicable	1
B3	Cumulativity/ Synergy	*Cumulative or synergistic effects of the Change (its influence on other factors)*	Cumulative/synergistic	3
			Non-cumulative/synergistic	2
			No change/not applicable	1

One feature of the RIAM system is that it can eliminate components that are not relevant - any RIAM component that scores "0" would receive a value of "N", and therefore not warrant further attention. The scores obtained are then translated into range bands, as shown in Table 6. Each color-coded band describes the level of an expected change (positive or negative) and they also represent the final judgment from the RIAM analysis.

Table 6. Summary of RIAM scores and corresponding color bands to identify change impacts

Scoring Values			Alphabetic Criteria	Value of the Criterion	Description of the Color Band
108	to	72	**E**	5	Important Postive Change/impact
71	to	36	**D**	4	Significant Postive Change/impact
35	to	19	**C**	3	Moderate Postive Change/impact
10	to	18	**B**	2	Postive Change/impact
1	To	9	**A**	1	Minimal Postive Change/impact
	0		**N**	0	Neutral/ No impact
-1	To	-9	**-A**	-1	Minimal Negative Change/impact
-10	to	-18	**-B**	-2	Negative Change/impact
-19	to	-35	**-C**	-3	Moderate Negative Change/impact
-36	To	-71	**-D**	-4	Significant Negative Change/impact
-72	to	-108	**-E**	-5	Important Negative Change/impact

The bands range from +/- A (A'' values represent slight, but insignificant) to +/-E change (E being an important change/impact) and these values are used as the determination of the overall picture of change (Figure 11).

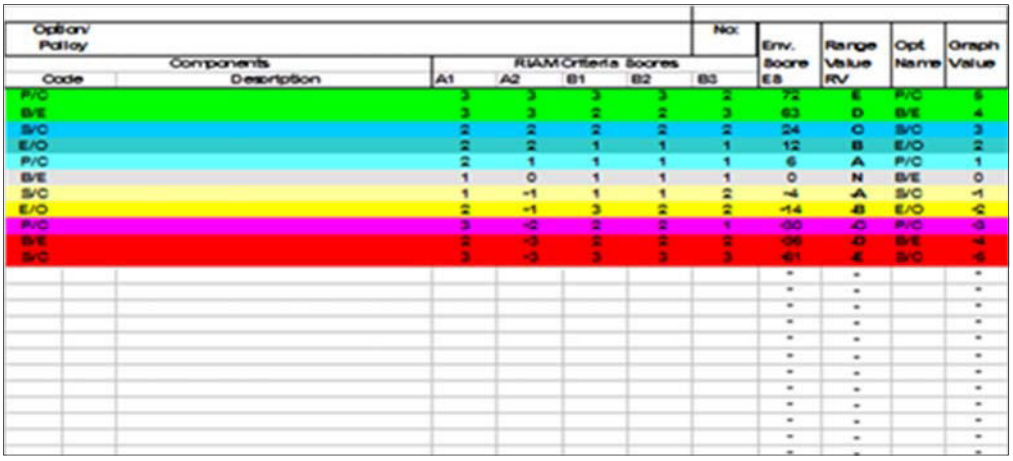

Figure 11. Example of a hypothetical RIAM Matrix showing the values for each criterion and the corresponding color bands for each criterion

Because RIAM is independent of any specific discipline, it can be used as a comparative platform for all disciplines. Green and blue color bands represent positive changes; whereas magenta and red bands identify significant and priority negative changes that require immediate management measures.

Figure 12 shows the results of the RIAM analysis of two scenarios - with and without the RWMF project at Vandhoo. In the figure it is easy to compare two scenarios using the different color bands. The red and magenta color bands highlight those potential changes that require a *pre-project baseline*, as well as *mitigation measures* and *monitoring* of the effectiveness of those measures based on changes in the baseline for each of the relevant physical-chemical (P/C), Biological/ecological (B/E), social-cultural (S/C) and economic-operational (E/O) components changes caused by the project.

Figure 12. Graph showing the results of the RIAM analysis of the scenario with the RWMF and the scenario without it.

In the figure, negative values between –D and –E all require setting up a baseline, as well as mitigation measures and a monitoring plan designed to evaluate the effectiveness of management tools selected to confront the negative changes. In some cases, the team has invoked the Precautionary Principle for some –C and –B values because there is just not enough information to determine the magnitude of those potential impacts. This structured approach is transparent and facilitates the development of relevant mitigation measures and the ESMP.

STEP 4: Establishing the **Baseline** involves reviewing each component to determine whether sufficient reliable information is available. The Baseline will serve as a measure of the situation *before* the project took place. The monitoring system must be designed so that the

observed changes in the baseline are due to the project or the proposed mitigation measures, or whether the changes resulted from another driver that was not related to the project at all.

The lack of reliable, time series data is a major constraint to any form of predictive assessment, and obtaining reliable data is difficult. Practical forms of obtaining primary data are through interviews (socio-cultural dimension) and direct observations (which may be recorded by meeting notes and photographs).

STEP 5: Developing Mitigation Measures and Contingency Plans involves identifying mitigation measures that can be used to confront significant negative changes identified in the previous steps. These management tools and their formulation are addressed in Section 8. The mitigation measures (*social*, *regulatory*, *physical structures* and *financial-economic incentives and disincentives*, described elsewhere) are tested through the monitoring and evaluation (M&E) process to evaluate their effectiveness in changing the color bands over time, using the baseline as a reference point, and completing the Project Cycle.

STEP 6: Monitoring and Evaluation By using the dynamic project cycle framework, the effectiveness of the management tools are tested and evaluated through the monitoring and evaluation (M&E) process. Effectiveness of the mitigation measures (which are essentially management tools) is measured during the evaluation step by examining any changes in the colors of the color bands produced during the RIAM analysis. For example, if a priority issue (red band) changes to yellow and then green, then the management tool would be considered to be effective. However, if there is little or no change, the management tool must be reconsidered, and/or eliminated and replaced with another mitigation measure that is more effective.

This monitoring process is the motor for a dynamic ESIA that fits well into protecting the fragile ecosystems surrounding the Maldives and the people who depend on the rich biodiversity. However, it also requires a transparent, understandable (through awareness and education) and participatory approach that allows for the active participation of all relevant stakeholders. The process aims to eventually put the Maldives on a path toward the sustainable development by confronting and eventually reducing an environmental and health problem that is of considerable magnitude. The lessons learned on Best Management practices could subsequently be institutionalized and used for other waste management issues in the Maldives.

4.3 Physical environment

4.3.1 Climate

The meteorological data including wind climate, rainfall, temperature, waves, currents and tides presented here are from secondary data collected by the nearest meteorological station to Vandhoo at Hanimaadhoo metrological center of the Maldives.

4.3.2 Shoreline and vegetation line survey

Shoreline survey was carried out using Topcon HiperII Differential Global Positioning System (DGPS) system with fixed error margin of ±15mm for horizontal coordinates. Initially three Permanent Survey Marks were established on the island, after which static survey method is used to attain Global Positioning System (GPS) coordinates. The shoreline survey is done in Real Time Kinematic (RTK) mode using one DGPS as base and the other as a rover. Data is processed using Topcon Tools software.

Vegetation line was surveyed using drone imagery technology. Drone image data set was collected using DJI Phantom 4 Pro drone, using Drone Deploy software. Images were collected at 60 m elevation with 70% overlap front and side. The image processing was done using Drone Deploy platform while georeferencing was done using Surfer 13 software. Ground Control Points were established initially using Topcon Gr5 DGPS. These control points were used for referencing to Universal Transverse Mercator (UTM) 43N, WGS84 projection.

4.3.3 Beach profiles

For the initial ESIA report, 5 beach profile locations were established as a baseline, out of which 2 were not accessible at present. Beach profiles were repeated at 3 remaining locations, in addition to 3 new locations. Ongoing beach profile survey has been carried out by LaMer Pvt Ltd. for Vandhoo as part of the monitoring works since initial ESIA. The accumulated data has been used to compare the beach movement around the island in this report.

Beach profile locations are indicated on Figure 13 and GPS coordinates are given in Table 7 below. Beach profiles were taken using an electronic level instrument (Leica Sprinter 200M).

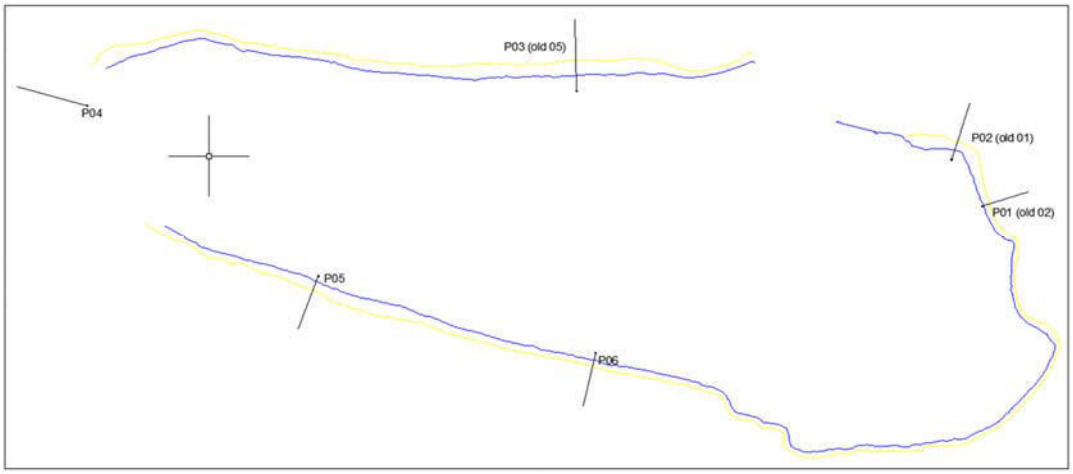

Figure 13. Beach profile locations

Table 7. GPS coordinates of beach profile locations

Profile	Grid Northing (m)	Grid Easting (m)
P01 (old-02)	611815.7490	283589.9980
P02 (old-01)	611873.8940	283551.9680
P03 (old-05)	611958.2930	283087.5780
P4	611940.2130	282480.7220
P5	611728.3340	282767.5600
P6	611633.5220	283110.5540

4.3.4 Bathymetric survey

Bathymetric survey of project area was carried out using Ohmex Sonarmite Echo sounder combined with Trimble Geo explorer 7 GPS system. The depth reading data collected was reduced to MSL using predicted tide data for Hanimaadhoo.

4.4 Biological environment

4.4.1 Vegetation survey

Coconut palms which fall on the proposed construction plots were identified using the drone imagery. Other plants were identified using a hand held GPS (Trimble Geo explorer 7 GPS system).

4.4.2 Reef survey

Two Reef Survey sites RS1 and RS2 that was surveyed for the ESIA of the first phase in December 2012 was resurveyed along with an additional site, RS3. All three sites were geo-referenced and are shown in Figure 14 and Table 8. The data for the sites RS1 and RS2 were

compared with the data taken in the 2014 Monitoring survey, and the data for RS3 would be considered a new baseline.

A coral reef expert using snorkeling gear and an underwater camera took a series of photos along the reef at a depth of 2-3m, in a belt measuring 200m by 5m, at each site. 40 of these photo quadrats were randomly selected from each site and analysed using Coral Point Count with Excel extension (CPCe) software. The mean percentage live coral cover, the species of coral present, the cover of other life forms and abiotic substrate was calculated.

Reef fish abundance and diversity was assessed along the same belt the reef survey was done, at a depth of 2-3m. The assessment was generally made at the family level, with the focus on estimating the presence of major fish groups and predominant species.

Figure 14. Reef survey and water sampling sites at Vandhoo

Table 8. The GPS coordinates of the reef survey and water sampling sites at Vandhoo

Site	Latitude	Longitude
RS1/SW1	5° 32.098'N	73° 2.704'E
RS1/SW2	5° 32.094'N	73° 2.350'E
RS3/SW3	5° 31.826'N	73° 2.278'E
SW4	5° 31.729'N	73° 2.544'E
Borewell East	5° 31.814'N	73° 2.784'E
Borewell West	5° 31.834'N	73° 2.641'E

Well	5° 31.912'N	73° 2.684'E

4.4.3 Water quality

Water quality samples were taken at the four marine survey rise sites SW1-SW4, two borewells and a well on the island. SW3 and SW4 (proposed sewage outfall location) are new sites and the data from these sites would be considered a baseline for any further monitoring whereas rest of sites have been surveyed during the ESIA done in December 2012. All sites were geo-referenced and shown in Figure 14 and Table 8.

Water quality (physical and chemical parameters) were analysed in-situ using a (in) portable multi-parameter water testing instrument (that has been calibrated in accordance to manufacturer's guidelines): Hanna HI 9820 at all the marine and groundwater sites. Laboratory analysis of the water was carried out at the Water Quality Assurance Laboratory of the Malé Water and Sewerage Company Pvt Ltd at all the marine sites except SW4, and all the groundwater sites.

4.5 Noise and air quality

The proposed upgrade to RWMF at Vandhoo do not include any facilities which may have a more significant impact than the already existing facilities in terms of noise level to the nearby islands, R. Rasmaadhoo and Innamaadhoo. Therefore, data collected from initial ESIA are used as the ambient noise level.

The proposed upgrade of waste management facility at Vandhoo does not involve installation of new incinerators, although the powerhouse at the facility will undergo an upgrade. Given this scope, while there will be added emissions from the new generators to be installed, these are considered insignificant to the existing conditions at the site, due to waste incineration and other waste management processes. Air quality of the site prior to construction of the RWMF at Vandhoo is discussed in detail in Riyan and NIRAS (2012) (Page A34). For the purpose of this report, air quality at the site will be discussed as sourced from predictions for incinerator emissions in the project ESIA report.

4.6 Socio-economic environment

As the project is an upgrade of an already existing facility located in R.Vandhoo, where extensive social assessments have already been conducted, the socio-economic aspects for his report were concentrated more on the natural features, landscapes and cultural/traditional significance of the island.

The previous studies that discussed the socio-economic environment of the project impact area includes the Social Assessment for the Solid Waste Management Component carried out by Greentech et al (2010) for the 46 inhabited islands that would be served by the waste management facility, BPEO report prepared under the North Province Regional Waste Management Project by SENES et al (2010).

In addition, in order to understand the social issues related to this facility, the issues and challenges associated with operation of the existing facility, were explored. These in the form of qualitative data were obtained from structured interviewing, focus group discussions. These are detailed in Chapter 6.

5 Existing environment

The paragraphs that follow describe the general characteristics of the project area. Baseline data from the initial ESIA is used as a reference to compare the current environmental conditions with the conditions prior to any development on Vandhoo.

5.1 General setting

The double chain of 25 natural atolls that make up the Maldives archipelago (Figure 15) are part of the largest submarine carbonate structure in the Indian Ocean lying on the submarine ridges known as Lacadive-Chagos ridge in the central part of the Indian Ocean. The atolls are separated by deep running channels that run predominantly east to west. The atolls contain 1190 islands that vary in shape from circular and oval to elliptical, of which only 198 are inhabited. The total reef area of Maldives is 4,493.85km^2 while the total land area is 227.45km^2 (Naseer, 2004). Approximately 80% of Maldivian land area is less than 1m above mean sea level.

The characteristics of reefs and coral islands of the Maldives vary considerably from north to south. The atolls to the north are broad banks discontinuously fringed by reefs with small coral islands and with numerous patch reefs and faros (the word faros is derived from the Maldivian word "*faru*") in the lagoon. To the south the depth of atoll lagoon increases, faros and patch reefs are rare in the lagoon, the continuity of the atoll rim is greater and a large proportion of the perimeter of the atolls is occupied by islands (Woodroffe, 1992). The islands have shallow reef flats on their seaward side, some with shingle ramparts at the seaward limit of the reef flat. The islands and the shingle ramparts owe their origin to the deposition of shingle or coral debris during storms. A number of islands can be found on a single reef. These islands may be separated by shallow passages that run across the reef flat. The width of some of these passages could be less 100m while some passages are over a few hundred meters wide.

5.2 Geographic location and general setting of Vandhoo

Vandhoo is located on the eastern periphery of the Raa Atoll, some 158 km South-east of the capital located at Male'. The length and width of the island are approximately 1.27 km and 0.34 km respectively with an area of about 40.4 ha.

Vandhoo is about 15 km north from Ungoofaaru which is the capital of Raa Atoll (Figure 15). The island is just 1.96 km to Innamadhoo, the nearest inhabited island, and about 3.46 km

to the north of Rasmaadhoo. The uninhabited island of Kottefaru is located about 2.42 km to the south.

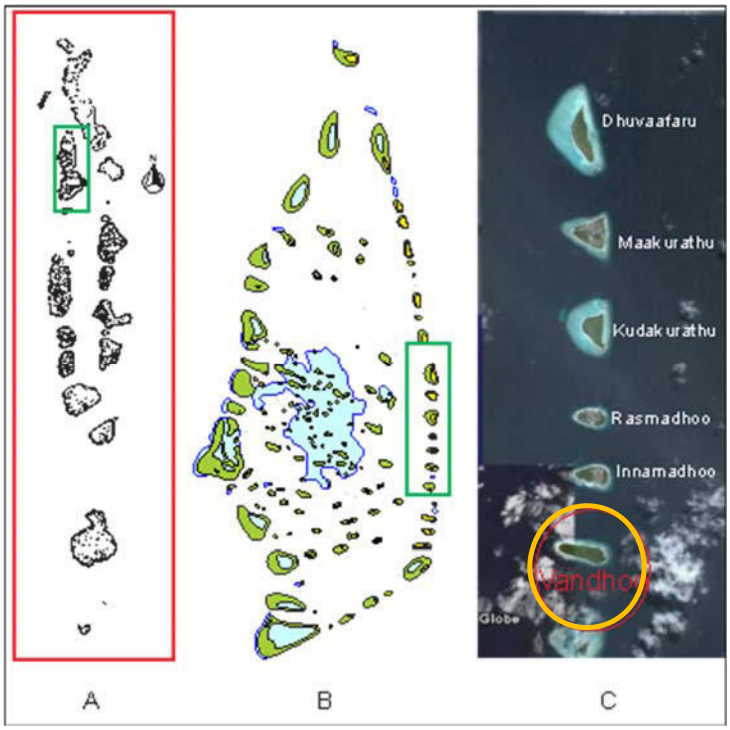

Figure 15. Geographic location of Vandhoo within the Raa Atoll

5.3 Physical environment

5.3.1 Wind climate

Wind climate in the Maldives is dominated by the Indian monsoon climate South West (SW) monsoon and North East (NE) monsoon. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia (Overpeck et, al., 1996). The monsoon climate is driven by the atmospheric pressure differences that arise as a result of rapid warming or cooling of the Tibetan Plateau relative to the Indian Ocean (Hastenrath 1991; Fein and Stephens 1987). During the summer of northern hemisphere the Tibetan Plateau warms rapidly relative to the Indian Ocean which results in an atmospheric pressure gradient (Low pressure over Asia and high pressure over the Indian Ocean) between the Asian landmass and the Indian ocean, which drives the prevailing wind from south to westerly directions. The period during which prevailing winds are from south to westerly direction is known as the SW monsoon. In the winter of northern hemisphere, the continent cools relative to the ocean. This reverses the pressure gradient (low pressure over the Indian Ocean high pressure over the Asian landmass) and the prevailing winds become northeasterly.

The period during which prevailing winds are from northeasterly directions is known as NE monsoon. The transitions from NE to SW monsoon and vice versa are distinctly different from SW or NE monsoon. During these transition periods the wind becomes more variable.

The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the Hulhangu Halha, while the transition period from SW monsoon to NE monsoon is known as Iruvai Halha, which lasts from October to November (Table 9).

Table 9. The months characterizing the two monsoon periods and the transition periods

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

The SW monsoon is generally rough and wetter than the NE monsoon. Storms and gales are infrequent in this part of the world and cyclones do not reach as far south as the Maldivian archipelago (Ministry of Construction and Public Works, 1999).

Since there were no site-specific wind data, wind regime around the island was assumed to be similar to that at the closest meteorological station, which is at Haa Dhaalu Hanimaadhoo, approximately 135 km north of Vandhoo. An analysis of the wind climate was done using hourly wind data between the period of May 2008 to December 2012 from Hanimaadhoo meteorological station. In this analysis, wind rose diagram based on wind speed and direction and the frequency of speeds and direction was produced.

Wind rose plot (Figure 16) shows that winds from the western quadrant are dominant reaching speeds as high as 30 knots. Winds from the northern and eastern quadrant are less prevalent and with comparatively low speeds. Wind speeds above 18 knots were found to be a rare occurrence, and the instances when it does occur, wind direction was from the western quadrant (Table 9), thus indicating that this was during the SW monsoon, when winds are generally stronger.

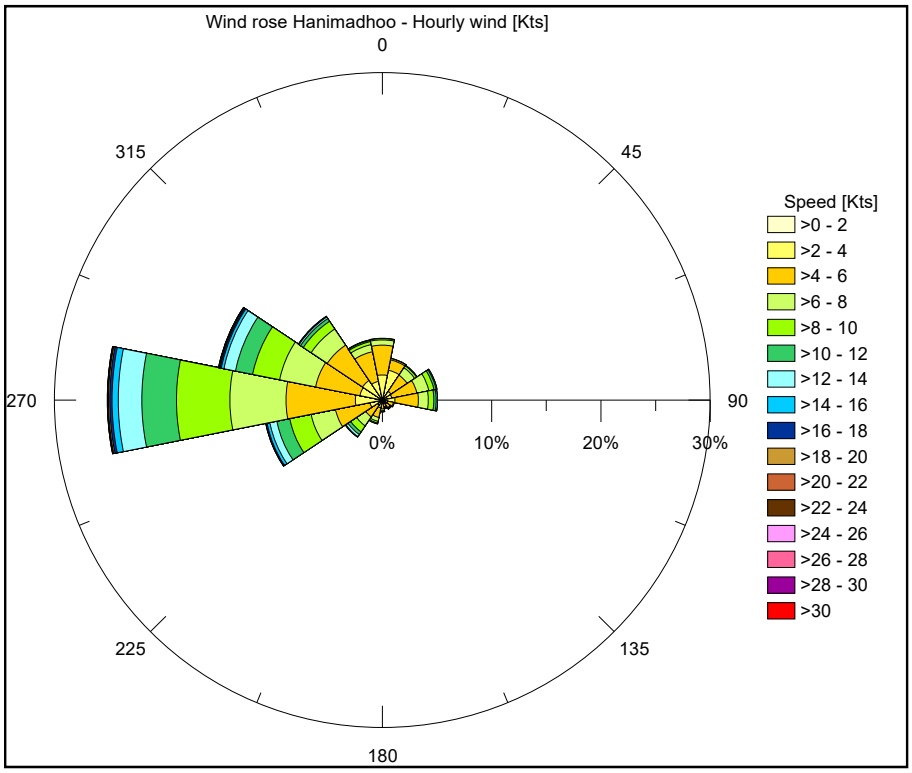

Figure 16. Wind rose plot for Hanimaadhoo Meteorological station, based on hourly wind data for the period of May 2008 to December 2012

Table 10. Hourly wind data from Hanimaadhoo Meteorological station

				Wind Speed (Knots)															
Wind Direction		Freq	Cum. Freq.	>0 - 2	>2 - 4	>4 - 6	>6 - 8	>8 - 10	>10 - 12	>12 - 14	>14 - 16	>16 - 18	>18 - 20	>20 - 22	>22 - 24	>24 - 26	>26 - 28	>28 - 30
22.5	NNE	3.9%	3.9%	0.005%	2.784%	0.964%	0.119%	0.020%	0.005%	0.008%									
45	NE	3.8%	7.7%		0.961%	1.777%	0.821%	0.211%	0.033%	0.015%	0.005%	0.003%							
67.5	ENE	5.1%	12.8%		0.882%	2.339%	1.111%	0.486%	0.191%	0.074%	0.015%	0.005%							
90	E	5.1%	17.9%		1.154%	2.146%	0.905%	0.511%	0.211%	0.104%	0.018%	0.003%							
112.5	ESE	1.1%	19.0%		0.501%	0.534%	0.069%	0.013%											
135	SE	1.0%	20.0%		0.440%	0.422%	0.086%	0.036%		0.003%	0.003%								
157.5	SSE	0.8%	20.8%		0.285%	0.346%	0.114%	0.041%	0.020%	0.003%									
180	S	1.1%	21.9%		0.338%	0.460%	0.168%	0.066%	0.028%	0.005%			0.003%						
202.5	SSW	2.2%	24.1%		0.702%	0.913%	0.358%	0.163%	0.064%	0.013%	0.005%								
225	SW	4.1%	28.2%		0.519%	1.312%	0.994%	0.661%	0.297%	0.226%	0.051%	0.010%	0.005%						
247.5	WSW	10.9%	39.0%		1.147%	3.216%	2.278%	1.996%	1.200%	0.653%	0.264%	0.074%	0.036%	0.005%	0.005%				
270	W	25.2%	64.2%		2.464%	6.349%	5.133%	4.884%	3.165%	2.153%	0.572%	0.211%	0.117%	0.043%	0.041%	0.013%	0.008%	0.003%	
292.5	WNW	15.3%	79.5%		2.087%	4.131%	3.351%	2.520%	1.599%	1.078%	0.249%	0.117%	0.066%	0.033%	0.025%	0.008%	0.008%	0.003%	
315	NW	9.2%	88.7%		2.174%	3.882%	1.775%	0.859%	0.305%	0.153%	0.046%	0.028%	0.008%	0.003%					
337.5	NNW	5.6%	94.3%		1.752%	2.771%	0.658%	0.287%	0.107%	0.043%	0.005%	0.013%							
360	N	5.7%	100.0%		2.303%	2.733%	0.481%	0.114%	0.023%	0.013%									
Cumulative %				0.005%	20.49%	34.30%	18.42%	12.87%	7.249%	4.543%	1.233%	0.463%	0.234%	0.084%	0.071%	0.020%	0.015%	0.005%	

5.3.2 Rainfall Characteristics

Vandhoo is located in the northern region where the average rainfall tends to be less than southern regions of Maldives. This is corroborated by the weather records from the closest weather station, Hanimaadhoo and weather station in the South, S. Gan. Rainfall records indicate that the average annual rainfall is 1697.3 mm (Standard deviation of 251.0 mm) and mean monthly rainfall is 141.4 mm (Figure 17).

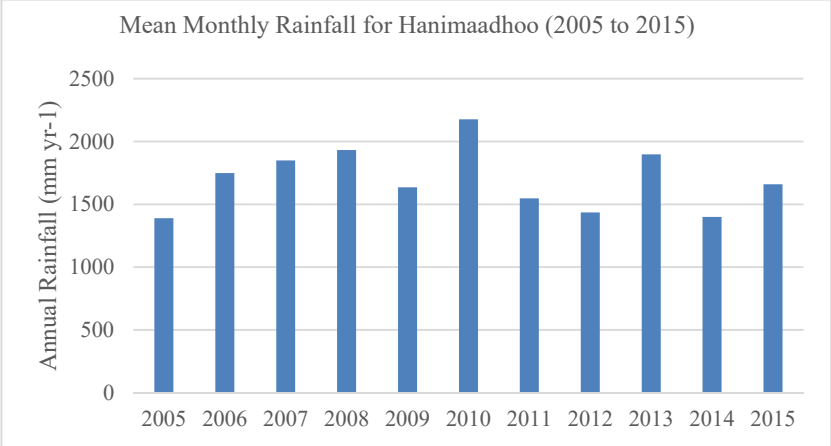

Figure 17. Rainfall pattern for Hanimaadhoo Meteorological Centre (rainfall data provided by Maldives Meteorological Centre)

Intensity Frequency Duration (IFD) Curves was derived from data provided by meteorological department for the period August 2013 to February 2017 (Figure 18). In addition to this, three-hour rainfall data from January 2005 to July 2013 were also used.

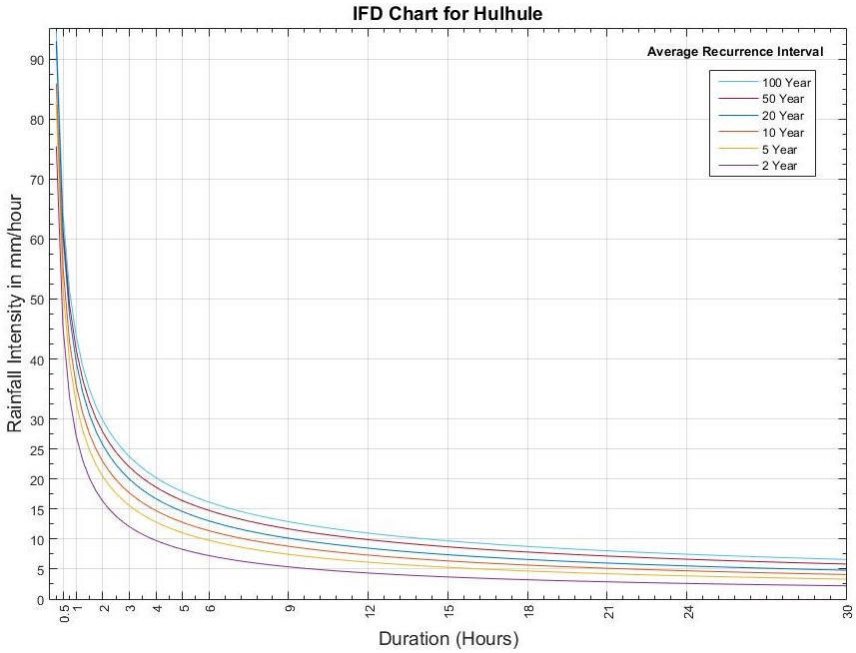

Figure 18. IFD chart for Hulhule (source: Riyan Pvt Ltd, 2017)

5.3.3 Temperature

The Meteorological station at HDh. Hanimaadhoo records temperature on an hourly basis. Data on mean daily temperature was obtained from the station for the period of May 2008 to

December 2012. The whole data set was analyzed to obtain a frequency distribution of daily mean temperature for the given period. Results of this analysis are shown in Figure 19, which shows that temperature in the region was most commonly at temperatures between 28°C and 29°C. The lowest recorded temperature was at 24.2°C while the highest recorded temperature was at 32.5°C.

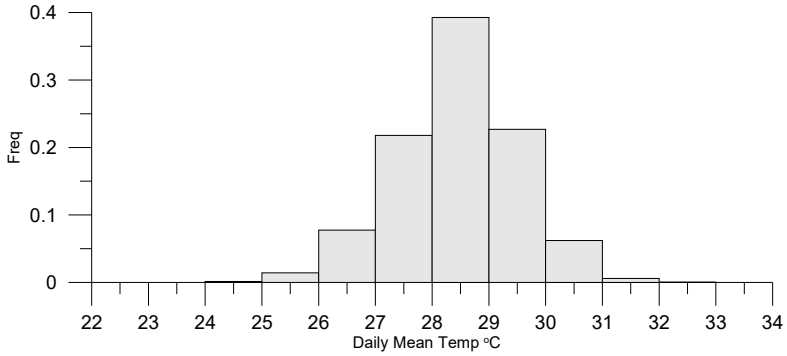

Figure 19. Frequency distribution of daily mean temperature recorded at HDh. Hanimaadhoo station (May 2008 – December 2012)

5.3.4 Waves and currents

Data on wave climate in the Maldives is limited, but ten years of satellite altimetry data on wave climate for the region (Young 1999) indicates that the dominant swell approaches Maldivian archipelago from southerly quarters (Young 1999).

On a seasonal basis, swell is from the south-southwest from March to October with a peak significant wave height (Hs) of 1.8 m in July, and from the southeast from November to February with a minimum mean Hs of 0.75 m in March. These estimates and seasonality in wave height conditions are consistent with independent analysis of a shorter three-year record of satellite altimetry data by Harangozo (1992).

A study carried out in Baa Atoll shows that there is a general reduction in wave energy across the atoll (windward to leeward) in each season. Therefore, there is a wave energy gradient across atolls. There is a shift in dominance from swell to wind-generated wave energy across the atoll. The direction of wind-generated wave energy switches between monsoon periods although oceanic swell propagates from the Southern Ocean throughout the year. The wave energy gradient across the atoll reverses between the west and northeast monsoons.

Kench *et al.* (2006) also reported from the experiments carried out on reef platform scale around the perimeter of reef islands which showed that: -

- Windward shorelines receive greater input of energy through a combination of swell and wind-wave energy.
- Leeward shorelines receive lower total energy input in each season as wind-wave energy is effectively dissipated on windward reef surfaces.
- Swell wave energy is of equal height around reef island shorelines as it refracts around island shorelines.
- Tides act to modulate the amount of wave energy that leaks onto reef surfaces. Greatest wave energy accesses reef island shorelines at higher tidal stages.
- Monsoon seasons promote changes in the areas of a reef island shoreline that receive greatest wave energy.
- Velocities under waves are sufficient to entrain sediment in the near-shore and beach environment under normal energy conditions.

Since site specific wave data is not available for Vandhoo; data collected at a nearby island (located at the eastern periphery as Vandhoo) was used to understand the wave climate of the area. The island of Kudakurathu is proposed for resort development and as part of Environmental data collection; LaMer Pvt Ltd has collected wave and tide data from this island. The island of Kudakurathu is approximately 4.7 km north of Vandhoo (Figure 20 shows location of Kudakurathu and wave gauge). RBR model TWR 2050 was used to collect wave data at 30 min interval burst.

Figure 20. Location of Kudakurathu with respect to Vandhoo and location of wave gauges

The Vandhoo reef system is subject to three main oceanic climate factors. These include diffracted swells, which hit the eastern side of the island (swell waves at "*Baraveli kandu*" sea

between greater Thiladhumathee Atoll, Raa Atoll and Lhaviyani Atoll), the southwest monsoon wind waves, and the northeast monsoon wind waves.

Waves play a significant role in the modification of the beach environment and the surrounding. Determining its characteristics is crucial in the designing of harbours, jetties, water bungalows etc. Waves around Kudakurathu were studied using an RBR- gauge deployed in the shallow lagoon on the northern and southern side of the island. Figure 20 shows the location where RBR-gauge was deployed to study the wave characteristics. Water level was sampled at a frequency of 2 Hz for a period of 30 minutes and a total of 3421 bursts were recorded over a period of 15 days. The data is analyzed using the spectral analysis method. Among the various parameters analyzed, following characteristics are highlighted: -

- Significant wave height (Hs)
- Mean period of significant wave heights (Ts)
- Percentage of capillary waves observed
- Percentage of wind waves observed
- Percentage of swell waves observed
- Percentage of infra-gravity waves observed
- Percentage of far-gravity waves observed

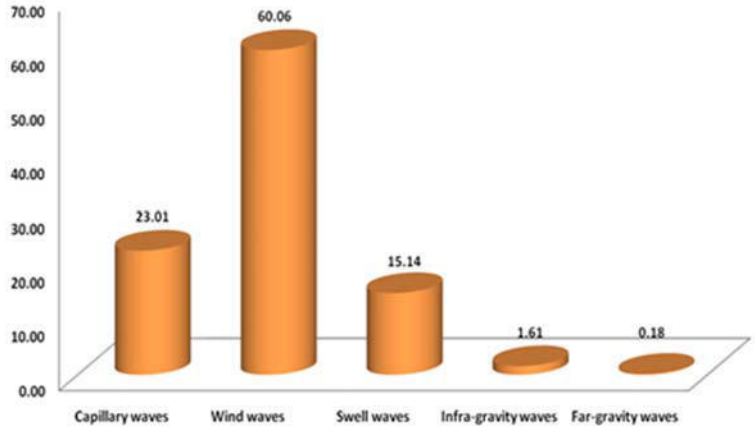

Figure 21. Types of waves observed on the northern side

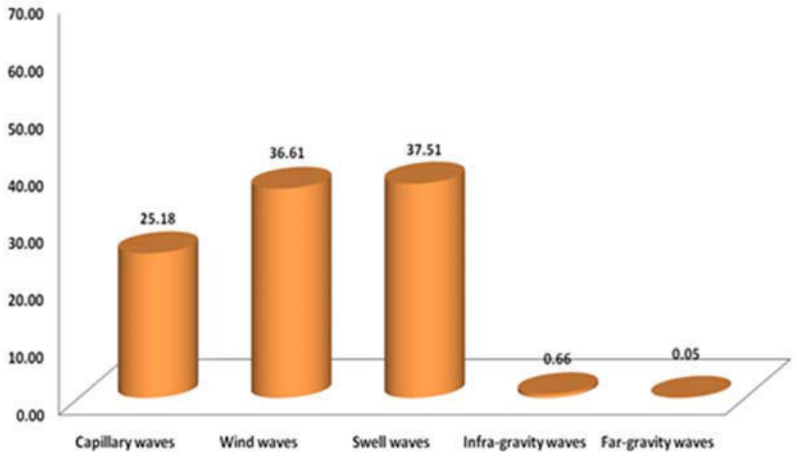

Figure 22. Types of waves observed on the southern side

Figure 21 and Figure 22 shows the types of waves observed during the field visit at the northern side and southern side respectively. Analysis of the results indicates that wind waves are the dominant type (60%) at the northern side of the island while wind (36.6%) and swell waves (37.5%) have a similar share on the southern side during the observation period. Probably this share is similar since the opening on the reef flat is more compared to the northern side. These dominant types of wind and swells could be expected since the observations were done undertaken towards the end of the southwest monsoon where high winds and swells are expected.

It could be inferred that in general, the significant wave heights at both the locations are very similar in height at any given time although differences are observed. Significant wave heights vary between 0.1 m – 0.52 m. The mean wave period of the significant waves varies between 2.47 – 5.47 seconds in the north and 1.92 – 5.39 seconds in the south.

The swells breaking at the eastern side also creates a current east to westwards inside the lagoon at the southern and northern side of the island. Surface current which is associated with the monsoonal wind waves are strongest during the NE monsoon since swell, wind waves and current associated with tidal flux are combined. During the NE monsoon, wind wave induced currents will be flowing east to west at the channels, which will be coupled with swell induced currents. During the SW monsoon, wind wave induced currents will be in the direction of west to east and northwest to east (see Figure 23 for assumed current regime at Vandhoo reef system based on wind data).

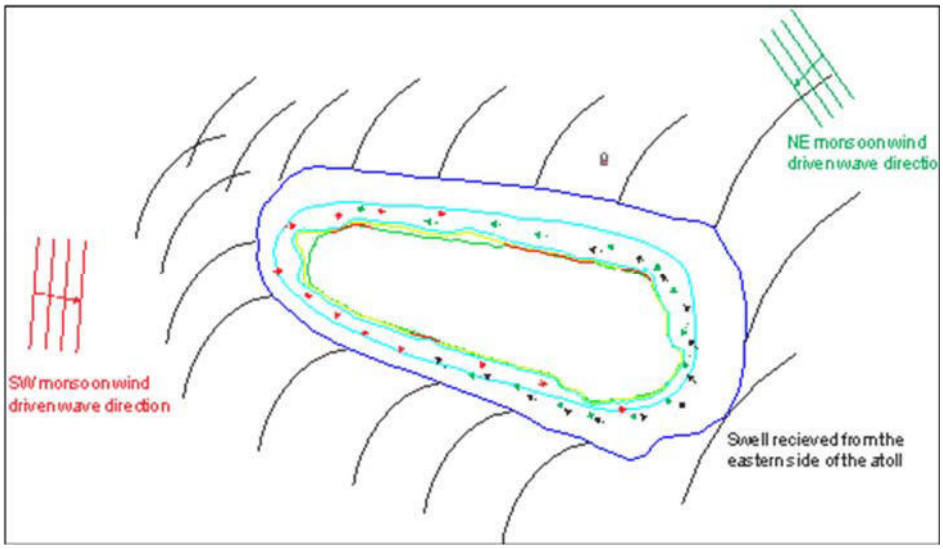

Figure 23. Assumed current regimes around the Vandhoo (colour of arrows represents wave types that generates current)

5.3.5 Tides

All coastal development projects require determination of the water level or water datum. The tide which consists of a number of wave forms, termed tidal constituents, generate many different water levels that are used as different datums. The most commonly used tidal datum in the Maldives is the Mean Sea Level (MSL). The Consultancy Team assumes that the astronomical tide at Vandhoo is the same as that at Hanimaadhoo (closest tide station – Figure 24).

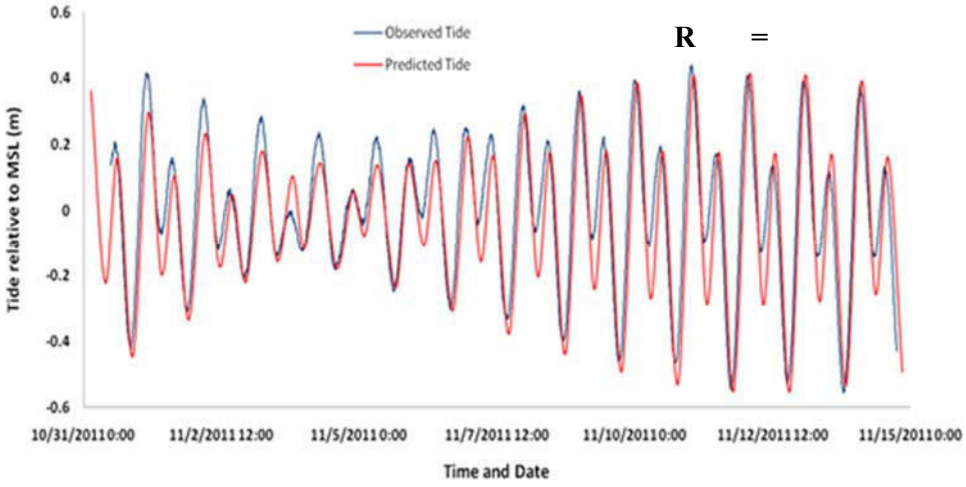

Figure 24. Tide measured by the tide gauge and the superimposed predicted tide

Long-term water-level records for Hanimadhoo are available from the website of University of Hawaii. Analysis of the long-term tidal records from Hanimadhoo (November 2002 to November 2007) indicated that the tide at Hanimadhoo is a mixed diurnal – semi diurnal tide with a dominant lunar semidiurnal constituent followed by the Luna-solar declinational diurnal constituent (Figure 25 and Figure 26). The diurnal constituent of the tide at Hanimadhoo is 23% greater than the second largest constituent (Luna solar declinational diurnal constituent) (Table 11 and Table 12).

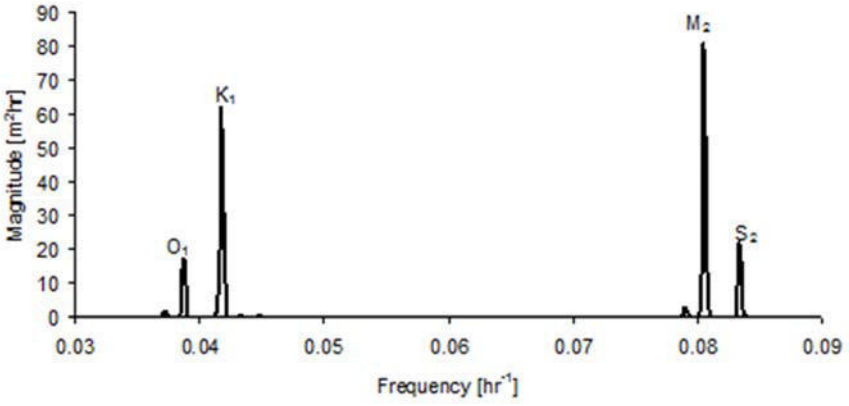

Figure 25. Spectral density for the tide of Hanimaadhoo

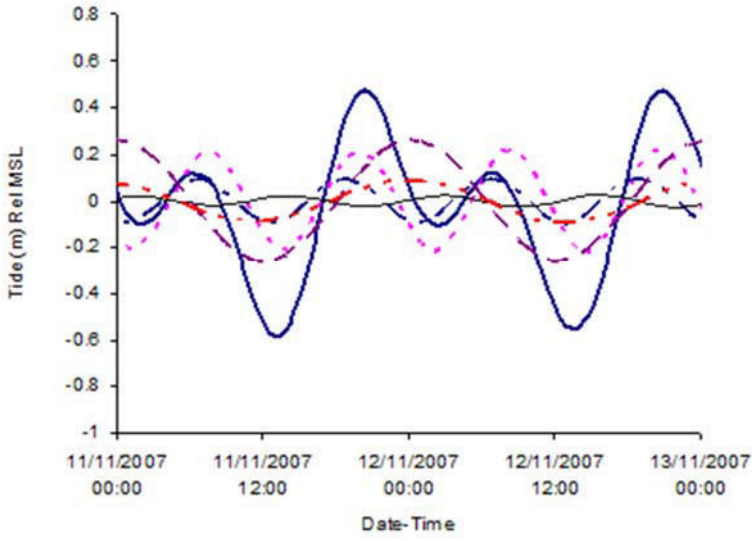

Figure 26. Time series plot of the dominant constituents of the tide at Hanimaadhoo showing the significance of each of these constituents in the tidal signal

Table 11. Magnitude of the dominant tidal constituents for the tide at Hanimaadhoo

Tidal Constutuent	Magnitude
M_2 - Principal lunar semidiurnal constituent	80.84
S_2 – Principal solar semidiurnal constituent	21.68
N_2 - Larger Lunar elliptic semidiurnal constituent	2.92
K_1 - Luni-solar declinational diurnal constituent	62.34
O_1 - Lunar declinational diurnal constituent	16.94

Table 12. Summary of tide levels at Hanimaadhoo, Hdh Atoll (nearest tide station)

Tide Level	Water level reference to mean sea level (m)
Highest Astronomical Tide (HAT)	0.56
Mean Higher High Water (MHHW)	0.26
Mean Lower High Water (MLHW)	0.06
Mean Sea Level (MSL)	0
Mean Higher Low Water (MHLW)	-0.34
Mean Lower Low Water (MLLW)	-0.54
Lowest Astronomical Tide (LAT)	-0.74
Maximum Tidal Range	1.32

5.3.6 Beach profiles

Beach profiles at P01 showed that the beach height had remained relatively stable between 0.9 m to 1.8 m. Sediment loss was observed at beach berm since baseline (Feb 2012). However, beach length was observed to have increased, indicating that the beach at this location had flattened (Figure 27).

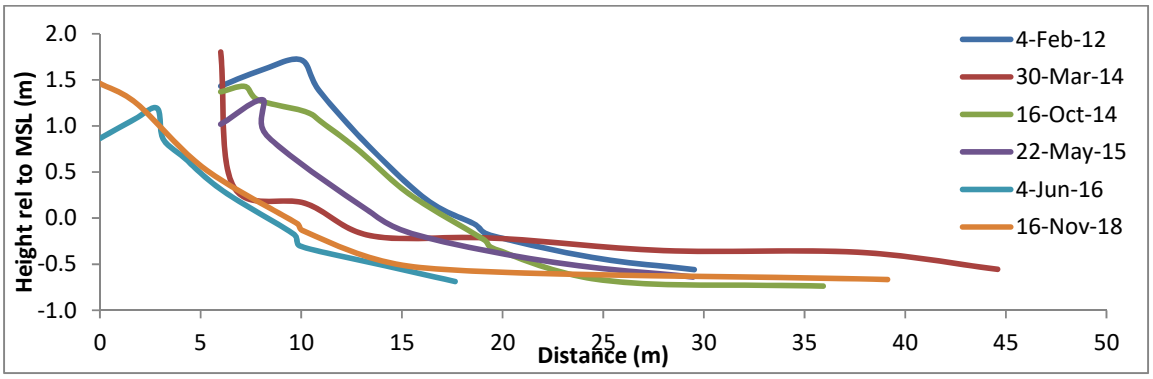

Figure 27. Beach profile P01 (old 02) showing shoreline characteristics from February 2012 to November 2018 at Vandhoo.

Beach accretion was observed at profile P02 area. Seasonal loss and gain of sand were clearly visible at this area, i.e. beach erosion was observed on March 2014 since Feb 2012. Beach accretion was observed on Oct 2016 and major erosion was observed on May 2015 which accreted on June 2016 yet again. Most significant increase in beach volume in terms of beach height and length was observed during the current survey period (Nov 2018) (Figure 28).

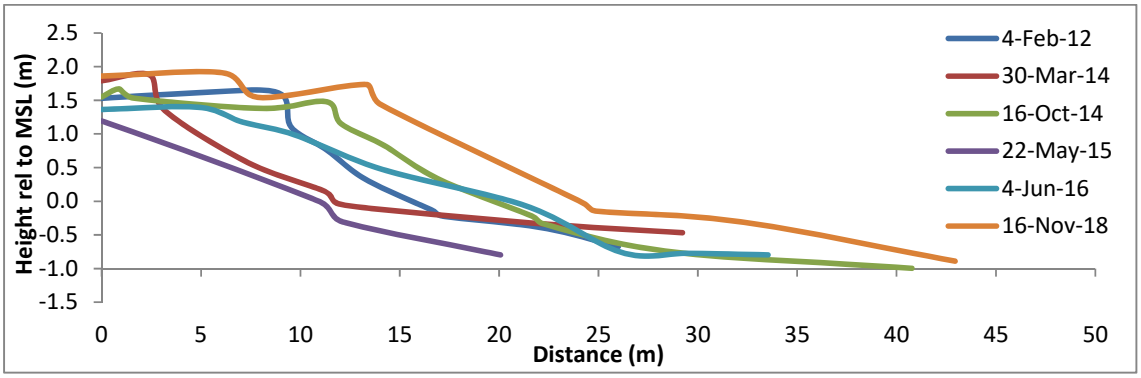

Figure 28. Beach profile P02 (old 01) showing shoreline characteristics from February 2012 to November 2018 at Vandhoo.

A similar trend in seasonal gain and loss of beach material was observed at P03 as well. Beach profile analysis further showed a significant increase in beach height and length compared to the baseline and monitoring dates (Figure 29).

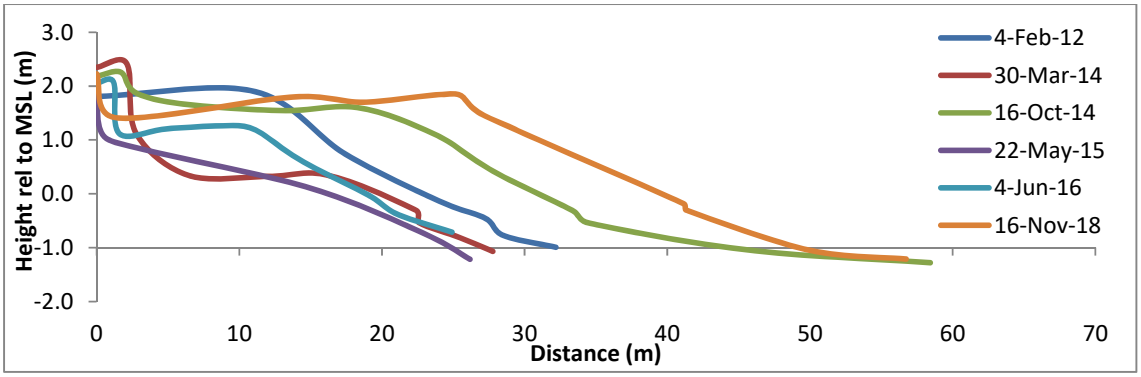

Figure 29. Beach profile P03 (old 05) showing shoreline characteristics from February 2012 to November 2018 at Vandhoo.

New beach profiles were established at locations P04 to 06. Beach height at these locations were between 1.5 to 2.0 m and beach lengths were between 24 and 33 m (Figure 30 to Figure 32).

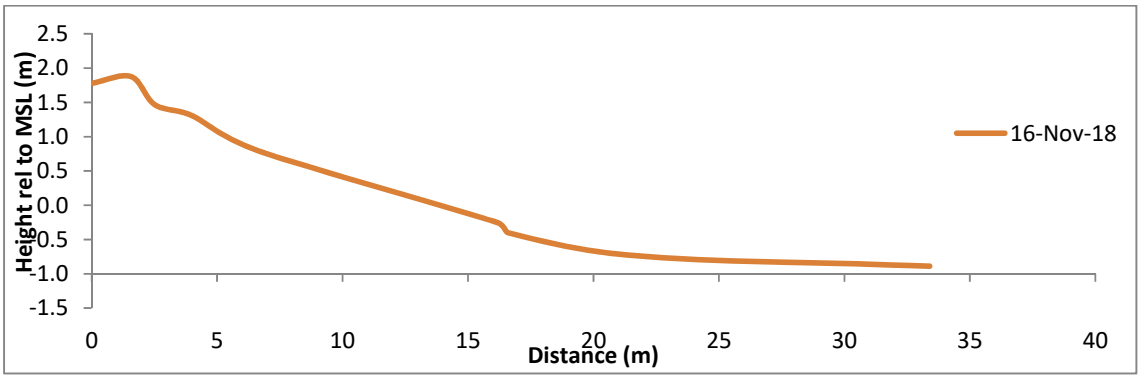

Figure 30. Beach profile P04 showing shoreline characteristics on November 2018 at Vandhoo.

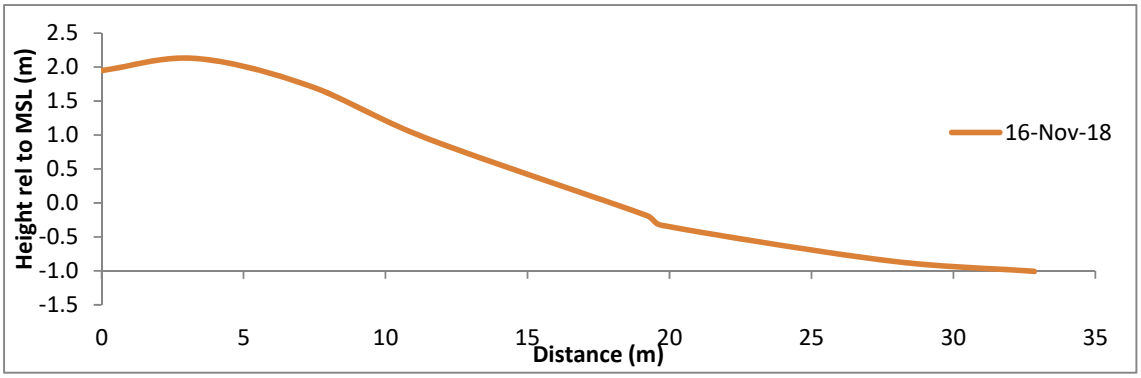

Figure 31. Beach profile P05 showing shoreline characteristics on November 2018 at Vandhoo.

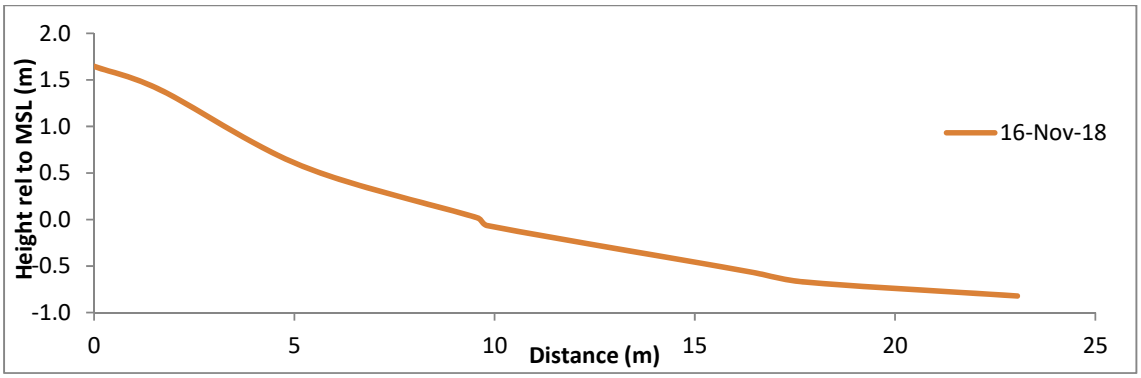

Figure 32. Beach profile P06 showing shoreline characteristics on November 2018 at Vandhoo.

5.3.7 Shoreline survey

In addition to the shoreline survey carried out during this survey period (Nov 2018), shoreline surveys during the monitoring period from December 2011 to June 2016 were used to further analyze the beach movement around the island. Seasonal movement of beach material at the western tip of the island is very prominent from the shoreline analysis.

Shoreline survey maps are attached on Appendix 11 of this report.

5.3.8 Description of aquifer

Riyan and NIRAS (2012) gives a thorough description of the groundwater aquifer, as a part of the description of the existing environment of the island prior to project commencement. This section of the report has been directly sourced from Riyan and NIRAS (2012).

Groundwater occurs in the form of 'freshwater lenses' on atoll islands all over the world including islands in the Maldives. These freshwater lenses are an important and valuable source of water supply both to the ecology and domestic use. Freshwater lenses are highly susceptible to saline intrusion as a result of excessive extraction and vulnerable to various types of pollution from surface and sub-surface waste disposal, particularly from leachates, solid waste and leaks from sewage disposal systems. On some islands, they are also vulnerable to saline intrusion as a result of overtopping from tidal surges and other similar flooding (Riyan and NIRAS, 2012).

Freshwater lens conditions in selected islands of the Maldives have been described in a number of groundwater investigation reports (e.g. Falkland; 2000, 2001a, 2001b, 2004 and GWP; 2005, 2006). These reports are based on extensive investigations including drilling, geophysical surveys and well surveys to assess the occurrence and behaviour of freshwater lenses. The investigations revealed that there are considerable variations in thickness, area and volume of freshwater lenses between the islands. Some islands show quite thick and extensive freshwater zones, while others have very small and thin freshwater zones (Riyan and NIRAS, 2012).

Detailed studies on other atolls in the Pacific and Indian Oceans, including extensive coring on the Cocos (Keeling) Islands in the Indian Ocean (Woodroffe and Falkland, 1997), have commonly found the existence of two layers of sediments. A geological unconformity, separating these two layers at typical depths of 10-15 m below mean sea level, is one of the main controls to freshwater lens thickness. The freshwater zone is mainly or solely contained in the relatively low permeable coral sediments as mixing of freshwater and seawater occurs readily in the high permeability limestone. Based on limited coring on Addu atoll, similar conditions were found on that atoll (Falkland, 2000). Hence, it would be expected that similar conditions apply throughout the islands of the Maldives including Vandhoo (Riyan and NIRAS, 2012).

In addition to the vertical variation in permeability, there is often an across-island variation in permeability. Often finer sediments with lower permeability accumulate on the more

tranquil side of the island while coarser, higher permeability sediments are found on the more exposed shorelines. In this context, exposed shorelines are those that are most affected by storms and wave action. Where finer sediments are found, the freshwater lens tends to be thicker due to less mixing of fresh and saline water than in coarser sediments. For this reason, wells at a given distance from the more tranquil shoreline tend to have lower salinity than wells at the same distance from the more exposed shoreline (Riyan and NIRAS, 2012).

The water balance estimation data from initial ESIA for Vandhoo RWMF is summarized in Table 13. The estimation was made based on annual rainfall estimate per year from the nearest meteorological center at Hanimaadhoo which was valued at1800 mm/year (Riyan and NIRAS, 2012).

An exponential relationship between the ratio of the lens thickness and the annual rainfall and the logarithm of the island width is given as:

H = p (6.94logW-14.39

H= Depth of the freshwater-seawater interface (m)

P = Annual rainfall rate (m/y) = 1.8

W = island width (m) = 350

Based on this relationship the depth or the thickness of the freshwater lens is estimated as 6m.

Table 13. Water balance calculation for Vandhoo (Sourced from Riyan and NIRAS, 2012)

Basic data and calculations		
Parameter	**Unit**	**Amount**
Area	Ha	36
Population	number of people	Na
Houses	number	Na
Average population density	people/ha	Na
Average number of people per house	people/house	Na
Annual Rainfall	mm	1800
Recharge		
A. Estimated Annual Recharge using simple relationship	mm	450
	% of rainfall	25
B. Estimated Annual Recharge detailed water balance	mm	Not calculated but adopted from Holhudhoo from detailed water balance study, Falkland 2010)
	% of rainfall	
% increase in recharge from A to B	%	125
Adopted recharge value	mm	560

Sustainable yield	proportion of recharge	0.3
Annual sustainable yield	mm/year	168
Daily sustainable yield	kL/day	165.7
	kL/day (rounded)	160
Daily sustainable yield per unit area	kL/day/ha	4.4

5.3.9 Bathymetric survey

Bathymetric survey at Vandhoo reef was done at the proposed brine and sewer outfall area at the southern side of the island. Bathymetric survey shows that the depth of lagoon area where outfall pipes will be laid ranges between -0.6 m to -4 m from MSL (see Appendix 11 for bathymetric survey map).

5.4 Biological environment

5.4.1 Vegetation survey

Vegetation survey shows that a thick coconut grove exists at the areas proposed for most development plots. Island vegetation consists of plant typically found in Maldivian soil. Table 14 below shows the number and names of plants required to be cleared from the footprint areas. It is estimated that about 18.5 % of vegetation will need to be cleared from the existing vegetation. Building / road footprint areas which require vegetation clearance to develop the plots and roads as per the proposed masterplan are indicated on Figure 33.

Table 14. Number and names of plants which fall into the building/road foot print areas

Block	Name of plant	Scientific name	Local Name	Foot print Area	Qty (nos)
Accommodation	Pandanus tree	*Pandanus tectorus/ P.zeylanicus*	Boa-kashikeyo	10,505 m^2	7
	Coconut palm	*Cocos nucifera*	Dhihevi ruh	Thick growth of Sea hibiscus (shrub form spreading at large area), Pandanus patches and Sea lettuce within the block	23
	Sea hibiscus	*Hibiscus tiliaceus*	Dhigga		10
	Corkwood	*Ochrosia borbonica*	Dhun'buri		2
	Sea lettuce	*Scaevola taccada*	Magoo		1
	Country Almond	*Terminalia catappa*	Midhili		22
	Nit pitcha	*Guettarda speciosa*	Uni		13
Block 11 (waste management, bulk storage)	Pandanus tree	*Pandanus tectorus/ P.zeylanicus*	Boa-kashikeyo	27,125m^2	19
	Coconut palm	*Cocos nucifera*	Dhihevi ruh	Thick growth of Sea hibiscus (shrub form spreading at large area), Pandanus	169
	False Elder	*Premna obtusifolia/syn.p. acuminata*	Ginaveli		1
	Sea hibiscus	*Hibiscus tiliaceus*	Dhigga		9
	Corkwood	*Ochrosia borbonica*	Dhun'buri		1

	Alexander Laurelwood	*Calophyllum inophyllum*	Funa	patches and Sea lettuce within the block	16
	Sea lettuce	*Scaevola taccada*	Magoo		1
	Country Almond	*Terminalia catappa*	Midhili		64
	Banyan tree	*Ficus benghalensis*	Nika		1
	Nit pitcha	*Guettarda speciosa*	Uni		21
Utility Block	Pandanus tree	*Pandanus tectorus/ P.zeylanicus*	Boa-kashikeyo	5,014 m^2	5
	Coconut palm	*Cocos nucifera*	Dhivehi ruh	Predominantly Coconut palms	81
	Sea hibiscus	*Hibiscus tiliaceus*	Dhigga		2
	Country Almond	*Terminalia catappa*	Midhili		10
	Nit pitcha	*Guettarda speciosa*	Uni		1
Consultant Accommodation	Coconut palm	*Cocos nucifera*	Dhivehi ruh	422 m^2	1
	Nit pitcha	*Guettarda speciosa*	Uni		1
	Alexander Laurelwood	*Calophyllum inophyllum*	Funa		1
Roads	Pandanus tree	*Pandanus tectorus/ P.zeylanicus*	Boa-kashikeyo	10,400 m^2	12
	Coconut palm	*Cocos nucifera*	Dhivehi ruh	Thick growth of Sea hibiscus (shrub form spreading at large area), Pandanus patches and Sea lettuce within the block	126
	False Elder	*Premna obtusifolia/syn.p. acuminata*	Ginaveli		1
	Sea hibiscus	*Hibiscus tiliaceus*	Dhigga		13
	Alexander Laurelwood	*Calophyllum inophyllum*	Funa		1
	Jack in the Box tree	*Hernandia nymphaeifolia*	Kin'bi		2
	Sea lettuce	*Scaevola taccada*	Midhili		2
	Country Almond	*Terminalia catappa*	Midhili		31

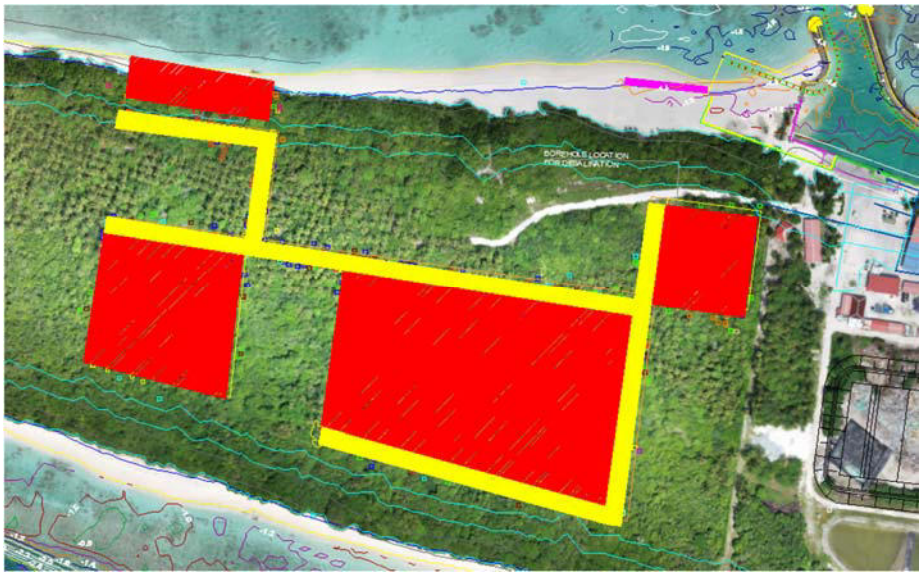

Figure 33. Areas which require vegetation clearance to develop the plots (red) and roads (yellow) as per the proposed master plan

5.4.2 Terrestrial fauna

Visual observations of several bird species commonly found in the Maldives were identified during the field visit. These include crows, common sandpiper, asian koel, white-tailed tropic bird, grey heron, white-breasted waterhen, whimbrel and cattle egret. In addition to birds, mammals observed include fruit bats and mice as well as presence of rats were obvious from rat-eaten coconuts.

Since Vandhoo is identified as a turtle nesting site, evidence of turtle nesting sites was assessed by walking on the beach and visually inspecting the beach for signs such as nesting pits and turtle crawls. As such, about 4 turtle nesting pits were observed during the site visit in November 2018. Absence of tracks at these pits indicated that the pits were about few weeks to few months old. Human exploitation was observed at all 4 pits. The nesting pits were not necessarily confined to the turtle conservation area identified in the Masterplan (Appendix 4), but rather, the nesting pits were observed all around the island.

Figure 34. Evidence of turtle nesting pits observed at Vandhoo

5.4.3 Soil characteristics

The soils of the Maldives are geologically young and consist of substantial quantities of the coral reef-based material, coral rock and sand that are not weathered. In most of the places, soils are coarse in texture and shallow in depth with a top layer of brown soil (0 to 50 cm in depth) followed by a transition zone on top of the underlying parent material of coral reef limestone (MFAMR, 1995). In many places, top layers of the soils have a weakly developed structure and at times a 30 cm thick hard-pan layer cemented with calcium carbonate is present, preventing penetration of the roots of most plants except large trees. The water-holding capacity of the soil is very poor due high porosity and very high infiltration rates.

Soils are generally alkaline with pH values between 8.0 and 8.8. This is mainly due to the presence of excess calcium and soils containing higher levels of humus, as in depressions and lagoons, are less alkaline. The soils are generally poor and deficient in nitrogenous nutrients, potassium and several micronutrients particularly iron, manganese and zinc. Though the phosphorus content of the soils is high it is present mostly in the form of calcium phosphate and, thus, remains unavailable to plants (Riyan and NIRAS, 2012).

5.4.4 Groundwater quality

Water quality results were compared with the reference ranges specified for groundwater by the EPA, Maldives (Table 15). Among the parameters tested only a few guideline values are specified by the EPA of Maldives. pH remained within the reference range at all sites. Total Dissolved Solids (TDS), Conductivity and sulphate levels were higher than the reference range at site named “well”. The site is located near the shore (Figure 14) which explains the higher concentrations of all the parameters than the rest of the sites tested (Table 16 and Table 17).

Table 15. Optimal conditions for drinking water as specified by EPA, Maldives (source WHO)

PARAMETER	REFERENCE RANGE
PH	6.5-8.5
Physical Appearance	Clear and colourless
Conductivity	< 1500 µS/cm
Total Dissolved Solids	<1000 mg/l
Sulphates	<250 mg/l

Table 16. Insitu water testing data at the three groundwater sampling sites taken using the Hanna HI 9820 multi-probe, taken during November 2018 ESIA survey.

Parameter	Site		
	Bore well East	Bore well West	Well
Temperature (°C)	28.63	28.73	29.09

pH	7.64	7.53	7.38
Conductivity (µS/cm)	612.70	439.00	4604.40
Total Dissolved Solids (ppm)	306.40	219.80	2302.30
Salinity (PSU)	0.29	0.21	2.44
Dissolved Oxygen (mg/L)	0.13	0.00	1.06

Table 17. Results of water testing done for water from the three ground water sampling sites tested at the Water Quality Assurance Lab at Malé Water and Sewerage Company Pvt Ltd (full reports attached in Appendix 13).

Parameter	Site		
	Bore well East	**Bore well West**	**Well**
Physical Appearance	Pale yellow with particles	Pale yellow with particles	Pale yellow with particles
Total Suspended Solids	285	82	<5 (LoQ 5 mg/L)
Nitrogen Ammonia	0.03	0.46	0.06
Sulphate	<10 (LoQ 10 mg/L)	<10 (LoQ 10 mg/L)	270
Phosphate	0.1	0.12	0.22
Zinc	0.05	0.02	0.04

5.4.5 Reef survey

Hard coral was the dominant form of benthic cover at RS1 and RS2 during the 2014 and 2018 ESIA survey (Table 18). The dominant form of benthic cover at RS3 was rock (Table 18). There was no recently bleached or killed coral at any of the sites during the 2018 survey. Algae and Dead Coral Covered with Algae decreased at RS1 and RS2 between 2014 and 2018.

Table 18. Summary of the benthic cover data taken during the monitoring survey done in 2014 compared with the data taken during the 2018 ESIA survey.

Type of benthic cover	RS1				RS2				RS3	
	2014		**2018**		**2014**		**2018**		**2018**	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Algae	1.53	0.74	0.38	0.13	6.37	2.28	0.38	0.24	1.25	0.63
Hard Coral	60.08	6.07	55.00	0.96	41.63	5.04	31.88	4.21	12.13	3.94
Sponges	0	0	0.13	0.13	0	0	0	0	0.13	0.13
Zoanthids	0.52	0.32	0	0	0	0	0	0	0	0
Macroalgae	0.77	0.77	0	0	0	0	0.25	0.14	0	0
Other life forms	0.77	0.32	0.38	0.13	0.25	0.25	0.25	0.14	0	0
Dead Coral Covered with Algae	1.28	0.57	1.25	0.92	1.28	0.57	2.13	1.26	1.63	0.63
Coralline Algae	18.17	2.95	2.00	0.74	19.22	4.01	1.88	0.97	0.88	0.59

Soft Coral	0	0	0	0	0	0	0	0	0.13	0.13
Rock	15.60	3.89	37.00	1.31	27.15	1.08	47.75	4.33	40.63	1.99
Rubble	0.26	0.26	1.75	0.92	1.53	0.74	14.00	1.54	42.38	5.77
Sand	0.51	0.51	2.13	0.38	2.32	1.44	1.50	0.61	0.88	0.24

The mean percentage coral cover decreased slightly at RS1 from 2014 to 2018 and decreased at R2S as well between 2014 and 2018 (Figure 35). During the 2018 survey, the mean percentage coral cover was the lowest at RS3 (Figure 35).

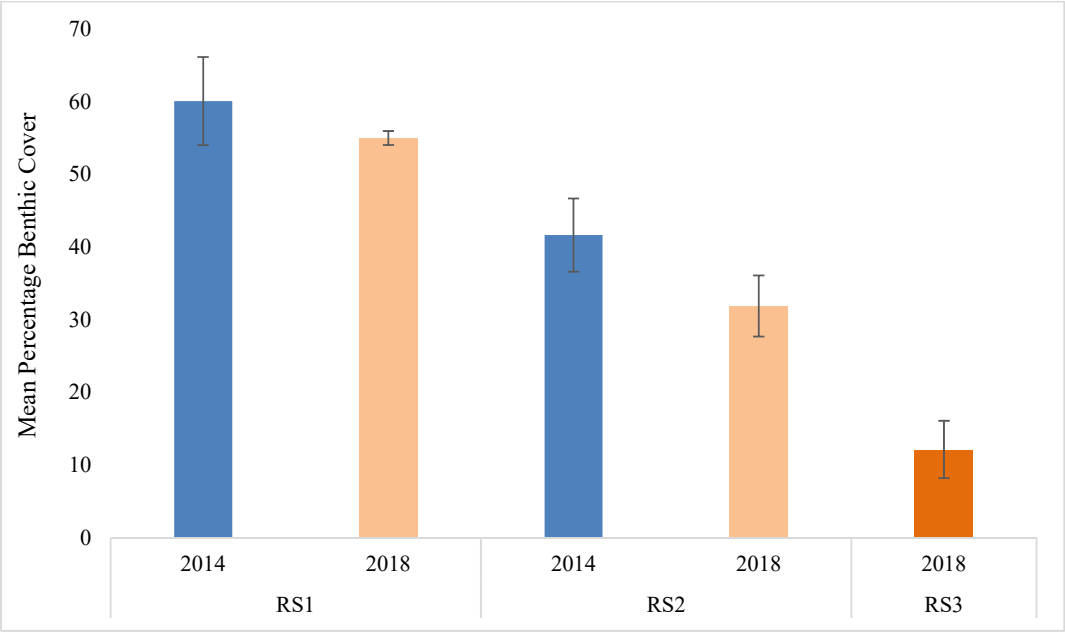

Figure 35. Comparison of mean percentage live coral cover at RS1 and RS2 during the 2014 monitoring survey and the 2018 ESIA survey, and the mean percentage live coral cover at R3 during the 2018 ESIA survey.

Porites (massive) was the most dominant type of coral across all three sites during both the 2014 and 2018 ESIA survey (Figure 36). The mean percentage cover of Porites (massive) increased from 35.71% to 49.75% from 2014 to 2018, and the mean percentage cover of Porites decreased from 34.68% to 29.13% from 2014 to 2018 at R2 (Figure 36). During the 2018 survey, the mean percentage cover of porites was the lowest at R3 at 7.25% which was considerably lower compared to the other two sites. There was no Acropora found at R1 during both survey years and the mean percentage cover was less than 1% at R2 during both survey years and less than 1% at R3 (Figure 36)

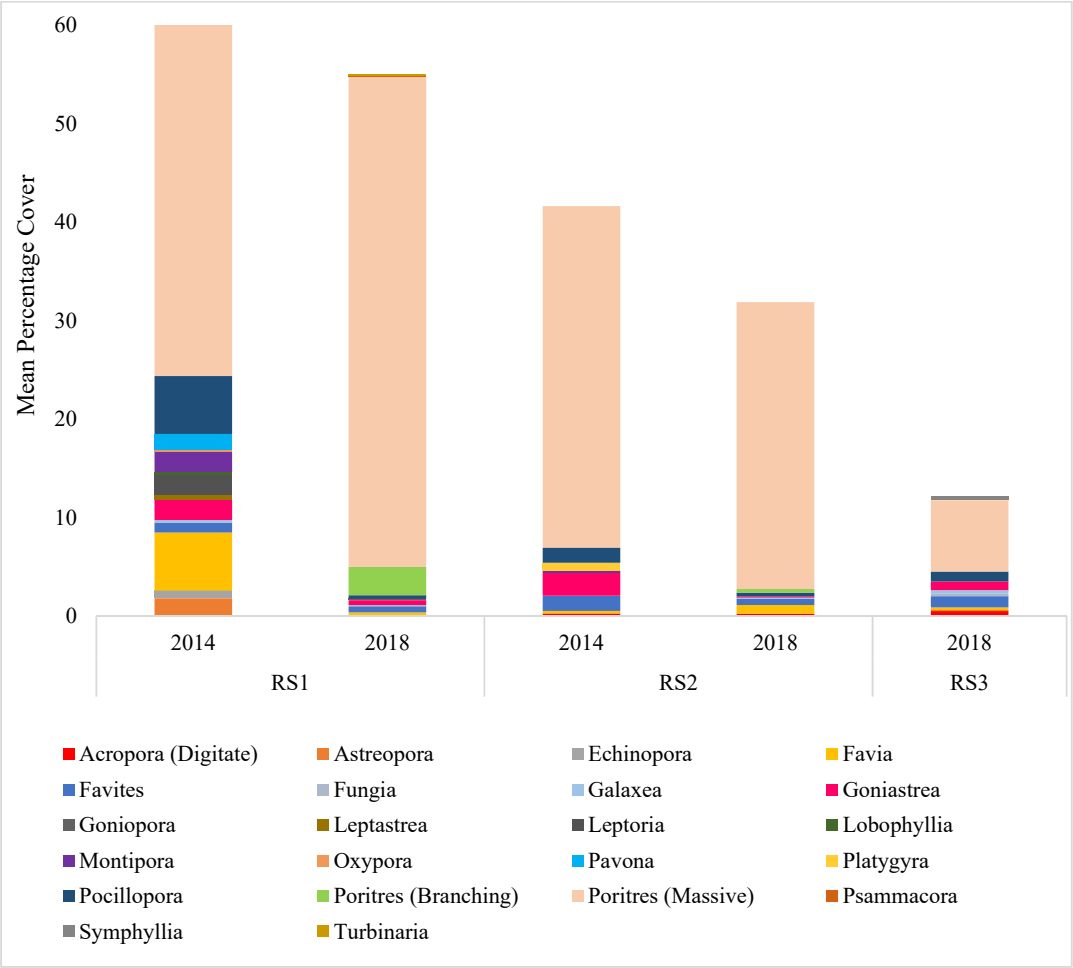

Figure 36. Percentage composition of hard coral at R1 and R2 during the 2014 monitoring survey and 2018 ESIA survey, and the mean percentage live coral cover at R3 during the 2018 ESIA survey.

Figure 37. General condition of the reef at site RS1, as of November 2018.

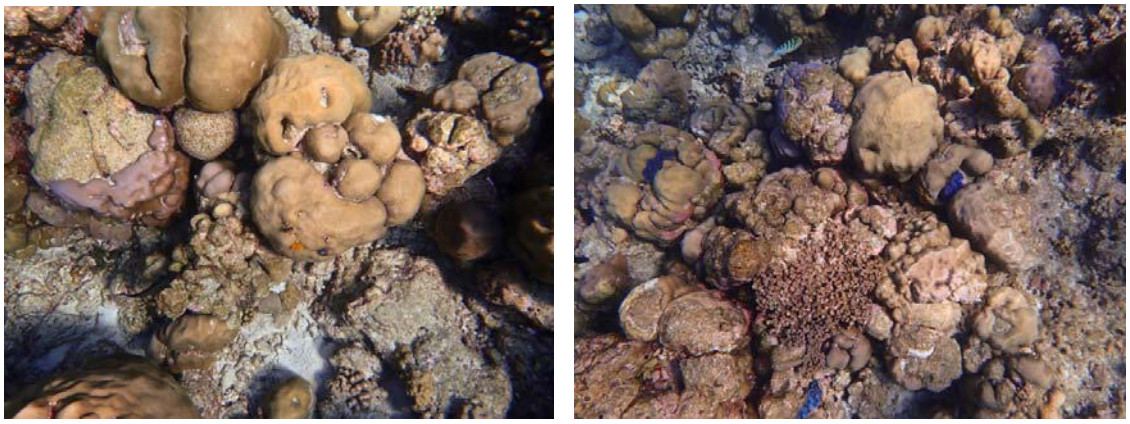

Figure 38. General condition of the reef at site RS1, as of November 2018.

Figure 39. General condition of the reef at site RS1, as of November 2018.

A total of 46 different fish species were seen during the 2014 survey at RS1 whereas the number decreased to 34 in 2018 (Table 19). 43 different fish species were seen during the 2014 survey at RS2 whereas the number decreased to 37 in 2018 (Table 19). 35 different fish species were observed at RS3 (Table 19). There was a decrease of the number of herbivorous fish species observed at RS1 and RS2 between 2014 and 2018, but there was no substantial difference in the number of different carnivorous fish species at these two sites between 2014 and 2018. Overall, at RS1 and RS2, there has been a reduction in the abundance of fish species observed in 2018 compared to 2014. There were no fish species that can be classified as being abundant (A) in RS1 or RS3 during the 2018 survey. *Thalassoma amblycephalum* was the only species that was considered abundant during the 2018 survey at it was observed at RS2.

Table 19. Fish survey data at R1 and R2 during the 2014 and 2018 ESIA survey and the fish survey data at R3 during the 2018 ESIA survey.

Family	*Species*	Functional Group	R1		R2		R3
			2014	2018	2014	2018	2018
Herbivores							
Acanthuridae	*Acanthurus bariene*	Grazer	C	N	C	N	N
Acanthuridae	*Acanthurus dussumieri*	Grazer	C	N	C	N	N
Acanthuridae	*Acanthurus leucocheilus*	Grazer	C	N	C	N	N
Acanthuridae	*Acanthurus leucosternon*	Grazer	C	C	C	C	C
Acanthuridae	*Acanthurus lineatus*	Grazer	A	N	A	N	C
Acanthuridae	*Acanthurus nigricauda*	Grazer	A	N	A	N	R
Acanthuridae	*Acanthurus triostegus*	Grazer	N	N	N	N	R
Acanthuridae	*Ctenochaetus striatus*	Grazer	N	C	N	C	C
Acanthuridae	*Naso brevirostris*	Browsers	A	N	A	N	N
Acanthuridae	*Naso elegans*	Browser	N	N	N	R	R
Acanthuridae	*Naso lituratus*	Browsers	A	N	A	N	N
Acanthuridae	*Naso unicornis*	Browser	N	C	N	N	N
Acanthuridae	*Zebrasoma desjardinii*	Grazer	N	N	N	N	R
Acanthuridae	*Zebrasoma scopas*	Grazer	C	R	C	N	N
Acanthuridae	*Zebrasoma veliferum*	Grazers	R	N	R	N	N
Kyphosidae	*Kyphosus cinerascens*	Browsers	C	N	C	N	N
Scaridae	*Cetoscarus bicolor*	Grazer	C	N	C	N	N
Scaridae	*Chlorurus sordidus*	Grazer	N	R	N	C	C
Scaridae	*Chlorurus strongylocephalus*	Grazer	N	N	N	C	N
Scaridae	*Hipposcarus harid*	Grazer	C	N	C	N	C
Scaridae	*Scarus festivus*	Grazer	C	N	C	N	N
Scaridae	*Scarus frenatus*	Grazer	C	C	C	R	N
Scaridae	*Scarus ghobban*	Grazer	C	N	C	N	N
Scaridae	*Scarus niger*	Grazer	N	R	N	C	R
Scaridae	*Scarus scaber*	Grazer	N	C	N	R	C
Siganidae	*Siganus corallinus*	Grazer	R	N	R	N	N
Siganidae	*Siganus canaliculatus*	Grazer	C	N	N	N	N
Zanclidae	*Zanclus cornutus*	Browser	C	N	C	R	C
Carnivores							
Acanthuridae	*Naso hexacanthus*	Planktivore	C	C	C	N	N
Balistidae	*Balistapus undulatus*	Browser	C	C	C	R	C
Balistidae	*Balistoides conspicillum*	Grazers	R	N	N	N	N
Balistidae	*Melichthys indicus*	Browser	A	C	A	C	C
Balistidae	*Odonus niger*	Browser	A	N	A	N	N
Caesionidae	*Caesio xanthonota*	Planktivore	A	N	A	N	N
Caesionidae	*Pterocaesio chrysozona*	Planktivore	A	N	A	N	N
Chaetodontidae	*Chaetodon melannotus*	Coralivore	C	N	C	N	N
Chaetodontidae	*Chaetodon collare*	Coralivore	N	C	N	R	N
Chaetodontidae	*Chaetodon falcula*	Coralivore	N	N	N	C	C

Chaetodontidae	*Chaetodon guttatissimus*	Coralivore	C	R	C	N	N
Chaetodontidae	*Chaetodon kleinii*	Coralivore	C	N	C	C	R
Chaetodontidae	*Chaetodon lunula*	Coralivore	N	N	N	R	N
Chaetodontidae	*Chaetodon meyeri*	Coralivore	N	N	R	N	R
Chaetodontidae	*Chaetodon triangulum*	Coralivore	N	R	N	N	R
Chaetodontidae	*Chaetodon trifasciatus*	Coralivore	C	C	C	C	C
Chaetodontidae	*Chaetodon bennetti*	Coralivore	N	N	R	N	N
Chaetodontidae	*Chaetodon xanthocephalus*	Coralivore	N	N	N	R	R
Chaetodontidae	*Forcipiger longirostris*	Coralivore	C	N	C	C	N
Chaetodontidae	*Hemitaurichthys zoster*	Planktivore	N	C	N	C	C
Chaetodontidae	*Heniochus pleurotaenia*	Browser	N	N	N	C	C
Diodontidae	*Diodon hystrix*	Browser	N	N	N	N	R
Holocentridae	*Sargocentron microstoma*	Browser	C	N	C	N	N
Labridae	*Bodianus diana*	Browser	N	N	N	N	C
Labridae	*Gomphosus caeruleus*	Browser	N	R	N	R	N
Labridae	*Halichoeres hortulanus*	Browser	N	N	N	R	R
Labridae	*Hemigymnus fasciatus*	Browser	N	R	N	N	N
Labridae	*Labroides dimidiatus*	Browser	N	C	N	R	C
Labridae	*Thalassoma amblycephalum*	Planktivore	N	N	N	A	C
Labridae	*Thalassoma hardwicke*	Browser	N	N	N	C	C
Labridae	*Thalassoma lunare*	Browser	N	R	N	N	N
Lethrinidae	*Gnathodentex aurolineatus*	Browser	A	N	A	N	N
Lethrinidae	*Monotaxis grandoculis*	Browser	C	N	C	N	N
Lethrinidae	*Lethrinus harak*	Predator	R	N	N	N	N
Lutjanidae	*Lutjanus argentimaculatus*	Predator	C	N	N	N	N
Lutjanidae	*Lutjanus Kasmira*	Predator	A	N	A	N	N
Lutjanidae	*Aprion virescens*	Predator	N	R	N	N	N
Lutjanidae	*Lutjanus biguttatus*	Predator	N	C	N	N	N
Lutjanidae	*Lutjanus gibbus*	Predator	A	R	N	C	N
Mullidae	*Parapeneus macronema*	Browser	N	R	N	N	N
Mullidae	*Parapeneus trifasciatus*	Browser	N	N	N	N	R
Pomacanthidae	*Pomacanthus xanthometopon*	Browser	R	N	R	N	N
Pomacanthidae	*Centropyge multispinis*	Browser	R	R	R	N	N
Pomacanthidae	*Pygoplites diacanthus*	Browser	C	R	C	N	R
Pomacentridae	*Chromis opecularis*	Browser	C	N	C	N	N
Pomacentridae	*Chromis ternatensis*	Planktivore	C	N	C	N	N
Pomacentridae	*Chromis viridis*	Planktivore	A	N	A	N	N
Pomacentridae	*Dascyllus aruanus*	Planktivore	C	N	C	N	N
Pomacentridae	*Abudefduf notatus*	Browser	N	R	N	N	N
Pomacentridae	*Abudefduf vaigiensis*	Browser	N	C	N	C	C
Pomacentridae	*Chromis atripectoralis*	Planktivore	C	N	C	N	C
Pomacentridae	*Chromis dimidiata*	Planktivore	N	C	N	C	N
Pomacentridae	*Chromis flavipectoralis*	Planktivore	N	N	N	C	C

Pomacentridae	*Chromis weberi*	Planktivore	N	N	N	C	N
Pomacentridae	*Pomacentrus indicus*	Planktivore	N	C	N	C	C
Pomacentridae	*Pomacentrus philippinus*	Planktivore	N	R	N	R	N
Serranidae	*Aethaloperca rogaa*	Predator	N	C	N	C	N
Serranidae	*Anyperodon leucogrammicus*	Predator	N	N	N	R	N
Serranidae	*Cephalopholis argus*	Predator	N	C	N	C	R
Tetraodontidae	*Arothron meleagris*	Browser	N	R	N	R	N
Tetraodontidae	*Arothron nigropunctatus*	Browser	N	N	N	R	N

5.4.6 Seawater quality

Table 21 shows comparison between baseline (Dec 2011) conditions and current conditions at 2 sites SW1 and SW2 for the parameters tested In-situ. Test results show a slight increase in conductivity, TDS and salinity at both sites, however, not significant. Dissolved oxygen concentration, on the other hand, had increased at SW1 but decreased at SW2.

Optimal conditions specified by EPA, Maldives for sea water are given on Table 20 below.

Table 20. Optimal conditions for seawater quality specified by EPA, Maldives.

PARAMETER	OPTIMAL RANGE	REFERENCE
TEMPERATURE	18^0C and 32^0C *Changes should not surpass 1^0C above the average long-term maximum	GBRMPA, 2009
PH	8.0-8.3 *Levels below 7.4 pH cause stress	
TURBIDITY	3-5 NTU >5 NTU causes stress	Cooper *et al.* 2008
AMMONIA	Max. 2-3 mg l^{-1} N	UNESCO/WHO/UNEP, 1996
PHOSPHATE	0.005 - 0.020 mg l^{-1} PO_4^-P	UNESCO/WHO/UNEP, 1996
SULPHATE	2 mg l^{-1} and 80 mg l^{-1}	UNESCO/WHO/UNEP, 1996

Comparing the current conditions with that of the reference ranges, it can be observed that pH, turbidity, Nitrogen Ammonia are within the reference range. Sulphate and phosphate concentrations, however, had exceeded the reference value (Table 21 and Table 22).

Table 21. Insitu water testing data at the four seawater sampling sites, SW1-4, taken using the Hanna HI 9820 multi-probe, taken during the November 2018 ESIA survey and February 2012.

Parameter	Site					
	SW1		SW2		SW3	SW4
	Dec-11	Nov-18	Dec-11	Nov-18	Nov-18	Nov-18
Temperature (°C)	28	29.45	29.45	29.14	28.93	26.06
pH	8	8.15	8.15	8.11	8.10	8.11

Conductivity (µS/cm)	50801	51906.00	51906	51820.00	51398.00	48903.10
Total Dissolved Solids (ppm)	25664	25949.00	25949	25908.00	25697.00	24449.76
Salinity (PSU)	33	34.00	34	33.95	33.65	31.91
Dissolved Oxygen (mg/L)	1	1.82	1.82	1.30	0.83	1.41

Table 22. Results of water testing done for water from three sea water sampling sites, SW1-3, tested at the Water Quality Assurance Lab at Malé Water and Sewerage Company Pvt Ltd (full reports attached in Appendix 13).

Parameter	**Site**		
	SW1	**SW2**	**SW3**
Physical Appearance	Clear with particles	Clear with particles	Clear with particles
Total Suspended Solids	<5 (LoQ 5 mg/L)	<5 (LoQ 5 mg/L)	<5 (LoQ 5 mg/L)
Turbidity	0.162	0.156	0.165
Nitrogen Ammonia	<0.02 (LoQ 0.02 mg/L)	0.03	0.03
Sulphate	3550	3400	2850
Phosphate	0.26	0.1	0.08

5.4.7 Environmentally sensitive areas

A small mangrove area exists at the southeastern periphery of the island just below the leachate ponds (Figure 40). This area is preserved and no development activities will reach this area. Moreover, an area of about 42,400 m^2 at the western tip (Figure 40) of the island is preserved for turtle conservation under this project, however, turtle nesting is not necessarily confined to the area marked as a turtle conservation area on Figure 40. Vandhoo was reportedly a nesting site for hawksbill turtles (*Eretmochelys imbricata*) (Riyan and NIRAS, 2012).

Figure 40. Area with mangrove (red highlight) and turtle conservation area (green highlight).

5.5 Air quality

The proposed upgrade of waste management facility at Vandhoo does not involve installation of new incinerators, although the powerhouse at the facility will undergo an upgrade. Given this scope, while there will be added emissions from the new generators to be installed, these are considered insignificant to the existing conditions at the site, due to waste incineration and other waste management processes. Air quality of the site prior to construction of the RWMF at Vandhoo is discussed in detail in Riyan and NIRAS (2012) (Page A34). For the purpose of this report, air quality at the site will be discussed as sourced from predictions for incinerator emissions in the project ESIA report.

Final choice of incinerator to be installed at the facility had not been decided at the time of ESIA report preparation for the project. Based on the assessment of air emission impacts, it was suggested to install a system with a good Air Pollution Control System which includes Electrostatic Precipitator (ESP) and multiple scrubbers, spray-dryer and baghouse or other similar combinations (Riyan and NIRAS, 2012) and various options for incinerator technology were discussed and are given in the ESIA report for the project, although some were opted out due to economical restrictions.

The USEPA's ISCTS3 Model was used for dispersion modelling to calculate contribution of various pollutants from the incinerator to the background concentrations present in the ambient air at the surroundings. At the time of survey for the main project, no data existed on background concentrations of pollutants of interest in the project area. However, predictions for background concentrations were made based on a study done in Male' and for other remote areas (Riyan and NIRAS, 2012). Table 23 gives emission factors used for best- and worst-case scenarios for the incineration system (sourced from Riyan and NIRAS, 2012).

Table 23. Emission factors used for relevant scenarios with and without APCS implemented for the given parameters (Sourced from Riyan and NIRAS, 2012)

	Unit	Emission factor	
		Best case (with APCS)	Worst case (no APCS)
PM_{10}	g/sec	0.13	6.34
TSP	g/sec	0.17	8.47
SO_2	g/sec	Not relevant	0.79
NO_x (NO_2)	g/sec	Not relevant	0.83
Dioxins / furans*	Pg I-TEQ/sec	Not relevant	162,037

Furthermore, it was predicted that the stack gas at the time of release would potentially be high (approximately 350^{o}C), for an incinerator without APCS. However, the system at

Vandhoo was planned to have an APCS for particulate matter, which would reduce the temperature to 150ºC.

The study zone for the project EIA was defined within a radius of 6000m from the location of the incinerator. All receptor points were observed to be between 0 to 1m above sea level. Based on the model calculations, Innamaadhoo, about 1.7km to the north of Vandhoo was predicted to have the highest impact, while impact on other islands within 6km radius of Vandhoo was significantly less.

5.6 Noise amenity

Baseline noise measurements for both inhabited and uninhabited islands in the Maldives were established in June 2009 using a calibrated Quest 2200 noise measurement device owned and operated by EPA. The Quest 2200 was field calibrated between recordings and the field calibration device was within its calibration range. Background noise measurements were recorded as 15-minute time weighted averages (LEQ). The highest 10% of the noise measured over a 15-minute period (LA Max) was also taken for each site. Wind speed is taken to be in the range of 15-20 km/h, the temperature around 30°C and conditions fine. The baseline noise measurement results for typical inhabited and uninhabited islands in the Maldives are given in Table 24. Although there may be some seasonal variation with changes in wind strength and direction across monsoons, the noise levels are considered to be typical for most islands (Riyan and NIRAS, 2012).

Table 24. baseline noise measurement results for typical inhabited and uninhabited islands in the Maldives (Riyan and NIRAS, 2012)

Description	dbA (LEQ)	dbA (LAMax)	Influences
Uninhabited island (typical background noise level)	45-46	50	Ambient influences- wave action/ wind action/ bird
Inhabited island harbour (typical daytime noise level)	50-55	62-64	Influences noted for ambient- chatter/ birds/ vehicles (motorbikes)/ wave action Influences noted for maximum range- motor bikes/ vessels entering and existing harbour/ prayer call

Sensitive noise receptors in R. Innamaadhoo and Rasmaadhoo

Given the high per capita populations of islands in the Maldives, and the lack of historical planning mechanisms it is not particularly useful to distinguish noise levels at particular sensitive receptor locations. On both R. Innamadhoo and Rasmaadhoo the school is the only distinguishable potential sensitive noise receptor, however, in both cases the schools are

affected by the same background and maximum noise influences as elsewhere on the island. This is to say that any noise contribution made by future activities on R.Vandhoo will influence the island as a whole with no particular effect on the schools (Riyan and NIRAS, 2012).

Noise level at proposed facility on R. Vandhoo

The main noise generating activity from the proposed activity likely to affect background noise levels on the nearest and adjacent island is the operation of the incinerator. The incinerator has a sound power level of 85 dbA. Other activities which may influence the maximum noise levels generated on R. Vandhoo are the operation of the front-end loaders, operation of the generator and tipping of bins. Such activities will be generated routinely during the day but not at night. Although these activities may contribute to the cumulative background noise levels from time to time, they are unlikely to exceed the LEQ sound power level of the incineration plant. Incident noise levels may occasionally be generated such as during maintenance but these are unlikely to significantly contribute to noise nuisance at the nearest or adjacent islands. Nominally maximum (LA Max.) noise levels are given at 95 dbA. Night time noise levels will be limited to the operation of the incinerator as the waste bunker will be filled during the evening in preparation for automatic loading over the night, and ash disposal at the landfill will only occur during daylight hours (Riyan and NIRAS, 2012).

As for the impacts of noise on staff accommodation, the staff accommodation blocks are located away from the incinerator and utility area. Furthermore, a green buffer zone is considered adjacent to the facility operating area which would also act as a noise barrier.

5.7 Socio-economic environment

Aspects such as accessibility, health, population, income etc. covering the project impact area have already been discussed in detail in the initial ESIA-subsection 5.9 (Riyan and NIRAS, 2012) which was also based on the social assessments carried out by GreentTech et.al (2010). Thus, this section briefly discusses the existing landscape and natural features of the island, its visual amenity and its cultural significance.

5.7.1 Natural Features and Landscapes with cultural significance

The island's strategic location and its dense vegetation are the most significant attributes of the island. The dense vegetation offers many resources that the neighbouring islands were benefitting from. These includes wood, dry coconut leaves, coconut husks, coconuts, other fruits trees such as breadfruits, mango etc. The details of vegetation are presented in subsection

7.4.1 of this report. The island also has a small wetland area at the southern side of the island and Vandhoo is also noted as a turtle nesting site.

5.7.2 Visual Amenity from nearest uninhabited islands

The island still remains to be highly vegetated hence there is no significant change in the visual amenity from the nearest and adjacent inhabited islands. This is mainly because the developments are carried out within a very wide buffer zone surrounding the island.

5.7.3 Cultural/Religious significance

As it was also noted in the initial ESIA, the only potential cultural/archaeological site on Vandhoo is a decomposed gravesite which is not considered to have any important religious, cultural or archaeological significance (Riyan and NIRAS, 2012). Traditionally, up until the development of the RWMF, the island has been used by neighbouring islands for its forest resources and recreation such as going to Vandhoo for picnics.

6 Stakeholder consultation

A stakeholder analysis was carried out during the scoping meeting to identify the relevant stakeholders of the proposed project. It was decided that all the atoll councils of Zone 2, the Ministry of Environment, EPA and the closest inhabited island to the RWMF shall be consulted regarding the project.

All the identified stakeholders were consulted to understand the current status of the RWMF and to discuss the proposed changes to the site. Considering the fact that extensive consultations and studies have already been carried out for the development of Vandhoo as a Regional Waste Management Facility at its initial phase, the current consultations were mainly focused on the upgrade of the project. Through the meetings, the specifics of the proposed project and the current issues faced by the different stakeholders were discussed. Based on the outcomes of the consultations, the possible impacts, both positive and negative were identified (see section 7). Recommendations were then discussed with the project unit on addressing the issues and to minimize the potential negative impacts. The discussions were carried out in the form of focus group discussions and interviews. The flow diagram below (Figure 41) summarises how the consultations were carried out in the order they were carried out and how the outputs shall be incorporated into the project in the different stages of this assessment.

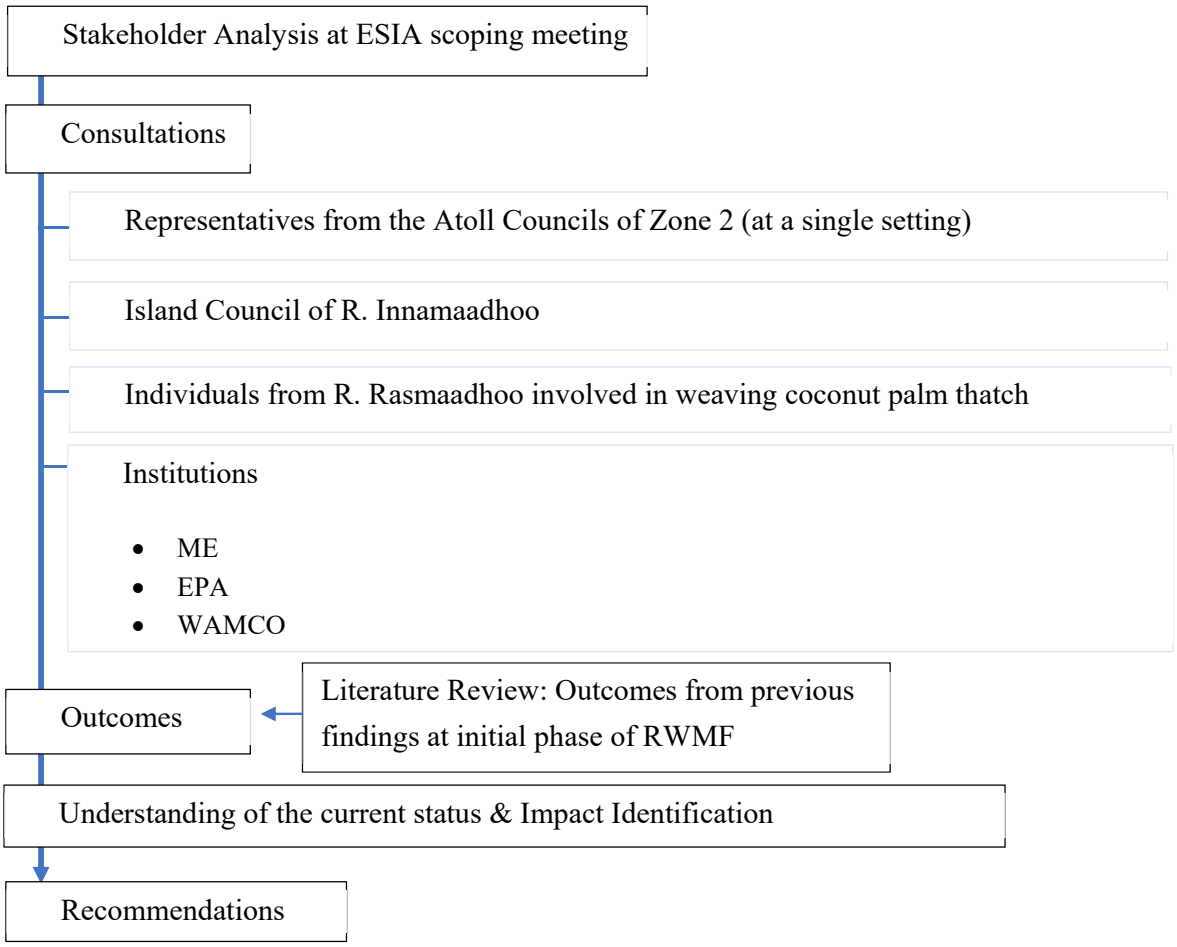

Figure 41. Stakeholder consultation methodology

6.1 Outcomes from previous findings at initial phase of RWMF

Extensive consultations were conducted (Greentech et al, 2010; SENES et.al, 2010; NIRAS et.al 2012) to understand the environmental and socials aspects related to the development of Vandhoo as a Regional Waste Management Facility at the initial development phase. Below is a summary of these consultations (mostly in regards to the social-cultural findings). The summary also includes findings that are already presented in section 5.9 of the initial ESIA prepared for Vandhoo RWMF (Riyan and NIRAS 2012) as well.

In 2010, a comprehensive social assessment was conducted in 46 islands of north province for solid waste management component of the Maldives Environmental Management (EMP) project. The report presented the situation of solid waste management in the 4 atolls of the north province. The report noted the awareness level of the communities on the social impacts associated with not having an organised solid waste management system (72%) and the economic impacts (54%). The raising issues related to waste management in the islands were

discussed in detailed. The assessment also included a willingness to pay survey for a proper waste management system (Greentech et al, 2010).

The public consultations conducted as part of the assessment concluded that awareness/education campaign regarding all aspects of waste management is most necessary at that stage.

Adding to the social assessment, a Best Practicable Environmental Option (BPEO) report was also prepared in the same year (SENES et al,2010). This was carried out "to implement a best practicable option selection process for the RWMF islands and waste technology and to undertake a technical and financial feasibility study for the preferred regional waste management system option at the final selected locations(s)" (SENES et al, 2010, p.1-2). As per this report, R. Vandhoo was selected as the most feasible option to develop the waste management facility for the North Province.

Traditionally R. Vandhoo was used by the communities of the neighbouring islands for agriculture and to gather forestry resources (coconut, wood, and dry coconut leaves). During the time of preparation of the BPOE, R. Vandhoo was under the Atoll Council whereby locals can visit the island on Saturdays with an Island Office official to gather the resources. In addition, some of the communities showed interest to get plots for boat building and others for small scale economic purposes (SENES et al, 2010).

Nevertheless, the communities were generally in favour of establishing the RWMF in Vandhoo provided that they are allowed to conduct their boat building activities at a part of Vandhoo as they have a genuine shortage of land in both Rasmaadhoo and Innamaadhoo and it is not safe to carry our fibre works near the residential areas. They were in favour of a mixed development.

It was also noted in the BPOE that the potential development of Kottafaru Island (2.1km) as a tourist resort may not be aesthetically acceptable if the RWMF would be developed in Vandhoo as recommended.

6.2 Outcomes from current consultations

The above-mentioned studies were conducted as part of the initial development of the RWMF which was prior to any operation of the facility. Further consultations have now been conducted as part of this upgrading project to understand the current issues experienced by the islands during the operation of the facility. Also, the reservations of the island communities

regarding the expansion of the facility to use the whole island for the RWMF were also discussed which also reflects some of the findings already stated in the previous reports.

6.2.1 Consultation with Atoll Councils of Zone 2 (Baa, Raa, Lhaviyani & Noonu Atoll) of the Maldives

Consultation with the Atoll Councils was held at the Ministry of Environment on the 19th of December 2018 at 10:30 am. Participants of the meeting are listed in Appendix 11. PMU also participated in this meeting. A brief presentation was provided by the PMU on the background of the project, the current status of the RWMF and the proposed developments. Major concerns highlighted at the consultation meeting are listed below: -

- The current status of the RWMF.
    - It was noted that though there are 45 islands, only 30 islands are under WAMCO and among these 30, for now WAMCO is able to do regular collections from 20 islands
    - The challenges of not fully being able to operate the system were highlighted. These include
        - Segregation of solid waste that has been accumulated for 10 years to 30 years in some islands
        - Irregular monthly-collection due to lack of means of collection
        - Lack of human resources to provide an efficient service
        - Lack of capacity; shortage of vessels and vehicles, shortage of storage, lack of technical capacity
        - 10 islands remained to be registered to the system which has been kept on-hold given the challenges.
- Raa Atoll council noted their disappointment regarding how the island which was leased to the Atoll Council as "*Varuvaa"* by the Ministry of Fisheries was taken back for the development of RWMF without proper consultation/information. Following are some of the concerns raised by the Atoll council of Raa"
    - Even after the initial development of the RWMF in part of Vandhoo, the rest was used by the Atoll council until they were not allowed to enter the island.
    - It was noted that due diligence was not followed in taking back the island and handing over the whole island to Ministry of Environment for development of the facility.
    - Atoll council noted the importance of the forest resources to the neighbouring islands. Eg: Weaving coconut palm thatch by the women of R. Rasmaadhoo was noted as an example as they were earning a good income by selling the thatch works to resorts for Palm Thatch Roofing of their rooms.
    - It was proposed that a possible alternative to Vandhoo shall be provided for these two islands.

- They also said that although Vandhoo is in Raa Atoll, now the island does not belong to the atoll.
- Communication gaps, information sharing gaps:
  - It was also noted that although it is under the mandate of the atoll council to maintain the register of the islands in the atoll, they are not informed of the new developments in the islands, notable the uninhabited islands. They only come to know when they see a physical development or when someone is not allowed enter the island.

- All councils were asked to share their concerns regarding the existing waste management system. The issues presented are summarized below:
  - Lack of vehicles at island level to collect waste
  - Lack of a proper waste management system due to lack of capacity
  - The Fee system is not feasible in islands with smaller populations
  - The frequency at which waste needs to be collected from the islands are not met. It was noted by Baa Atoll council that, it takes more than 3 months for the collection of waste from Eydhafushi and other islands of Baa Atoll.
  - Resorts bringing waste to islands, which is not allowed.
  - Issue of composting in islands: not sustainable in most islands due to lack of space and human resources.
  - Just one landing craft is not enough to cater to whole region.
  - Issues regarding how WAMCO has been handling the whole process were raised. All atolls shared a common dissatisfaction over the existing system.
  - Some were concerned about the amount of garbage that will be disposed at Vandhoo and whether this would cause any negative impact to the neighboring islands and its environment.

- ESIA consultant raised the issue of vegetation clearance. Things discussed include:
  - What will happen to the uprooted trees, especially the coconut palms
  - It was noted by PMU that the local islands can take them and replant in their islands and that they will not sell it to other parties
  - It was noted that no plant will be removed from the Turtle conservation zone proposed in the new development

6.2.2 Consultation with R. Innamaadhoo (nearest inhabited island) and R. Rasmaadhoo

Consultation with R. Innamaadhoo Council was held at the island council office on the 23rd of December 2018. Participants of the meeting are listed in Appendix 14. The proposed project was shared with the council and their concerns discussed are as follows:

- Their main concern was that with this new development, they will not be able to get land for boat yard which was already given by the atoll councils before it was decided to develop the whole island.
- They also noted that the people of Innamaadhoo was using the island as a picnic island but now they have lost that opportunity as well- both Rasmaadhoo and Innamaadhoo do not have good enough beaches for the locals to enjoy.
- As for the services provided by WAMCO, they noted that they are yet to get the service and it has been more than a year since they have signed the contract with WAMCO with no avail and Innamaadhoo is the nearest uninhabited island to Vandhoo. Until today they have been practicing open burning, even the waste from the boat yards are disposed this way which is a bigger health hazard.
    - According to WAMCO, at the initial phase Innamaadhoo did not want to get the service and later after the facility was handed over to WAMCO, they have been having challenges in catering all islands. With the new upgrades they hope to provide a better service.

In addition to meeting with Innamaadhoo council, few women of R. Rasmaadhoo who highly depended on the forest resources from Vandhoo for their income generating activities were also consulted to understand how this would impact their livelihood.

- The women of Rasmaadhoo, in every household, are actively involved in weaving as there is a high demand for the coconut leaves thatches from resorts in Raa and Baa atoll. One of the women (Aarifa Hussein) who has been doing this for decades raised her concerns:
    - Previously when they were allowed to go to Vandhoo and bring the forest resources, it was very convenient. But now they do not get enough coconut leaves to cater for the demands as now they have to source it from other islands with limited supply. Also, now they have to buy the leaves. Since there is a high demand for this material, both Innamaadhoo and Kinolhas is not able to meet the demand. It was informed that interested individuals pay in advance to get their supply. Ms. Aarifa noted that they usually have to wait 1 or 2 months to get their supplies. They used to earn approximately MRF 6,000 per month but now they earn MRF 4,000 maximum provided they get a relatively good amount of leaves from the islands. In addition to coconut leaves, they used to collect coconut husks from Vandhoo from which they make coir rope which are used in weaving and sold separately too.

6.3 Consultation with Environmental Protection Agency-EPA

Consultation with EPA was held on the 31st of December 2018. Participants of the meeting are listed in Appendix 14. The concerns raised by EPA that needs to be considered in completing the ESIA and also developing and operating the project are summarised below:

- They noted that all due processes regarding waste management shall be adhered, both in construction and operation phase.
- They were concerned about the water and sewer networks. They noted that both brine outfall and sewer outfall shall be properly anchored to avoid any leakage issue and special consideration needs to be given as a turtle conservation area is located just near the proposed outfall area. As for RO plant, they recommended to have 2 boreholes than 1 proposed for the project.
- They asked about the contingency plans and frequency of transport of waste from the islands to the facility. These are included in the Operation and Management Plan of WAMCO prepared in 2018.
- Rainwater harvesting possibilities were discussed.
- Concerns were raised regarding the extensive vegetation clearance that would be required for the proposed development. They wanted to know the percentage of uprooted vegetation that will be recovered within the island of Vandhoo. These are further discussed in the Section 10 (Project Alternatives).
- Regarding the proposed conservation zone for turtle breeding, emphasis was made on following code of conduct of the conservation guidelines which requires adequate buffer zones, zero disturbance, no lights, no intrusion, etc.

6.4 Consultation with the Ministry of Environment (Waste Management Section)

Consultation with Ministry of Environment (Waste Management Section) was held at the Ministry on 6th of January 2019. Things discussed are summarized below:

- The roles of the section are waste management planning and monitoring of waste management practices in the different regions of Maldives
- As for Vandhoo, they have outsourced the management to WAMCO though they will still be monitoring the process on a regular basis.
- Future plans of developing regional waste management facilities in all the zones were discussed.
- It was noted that given the quantity of waste from the whole zone 1, it has now been decided that all waste of Zone 1 shall be collected at a single point and brought to

Vandhoo with Zone 2 waste. Likewise, other zones may also be combined to one island in that region with regards to the amount of waste produced per zone.

6.5 Consultation with the Waste Management Corporation (WAMCO)

Consultation with WAMCO was also held at the Ministry of Environment on 6th of January 2019. Details of the participant is listed in Appendix 14. The representative from WAMCO detailed out the challenges they have been facing up to date in operation of Vandhoo RWMF. These are summarised below:

- Shortage of Harbour facility due to its small size and design:
    - The existing harbor cannot cater the Island and resort vessels at one time.
    - Difficulty in offloading as there is only 1 ramp and there is no mechanism built for off-loading. Now it is done manually and takes 5 to 6 hours to offload.
- Segregation of waste at site:
    - The waste which has been already collected at the islands without proper segregation for decades needs to be sorted before they are being incinerated or sent for recycling. This takes a long time as most works are done manually with limited human resources.
    - Lack of storage facilities at the island of Vandhoo
- Incinerator Issues:
    - The incinerator is not able to function at its full volume, as only 16 tonnes of combustible waste can be brought from zone 2 per day though the capacity of Incinerator is 36tonnes/day. It is not feasible to run the incinerator if can't feed full volume. Hence, they need more storage space to store the waste and collect the full volume prior to feeding the incinerator.
- Technical issues:
    - lack of technical capacity to address the issues
- Delayed island collection
    - Island collection from some islands are kept on hold due to lack of storage facilities, shortage of vessels and human resources.
- Staff Accommodation needed in the island
- Currently recycling process also cannot be implemented due to lack of storage space and technology.
- They hope with this upgrade, many of these issues will be addressed and they can commence their service as per their plans.

6.6 Summary of consultations

From the consultations it is evident that both the service provider and the customers are facing challenges with the current system. With the proposed developments, it is envisaged that most of these issues will be addressed. However, in addition to the positive impacts predicted with the expansion of this project, there are some negative impacts that needs to be addressed which includes the impact to the communities who were depending on the island of Vandhoo for different needs (forest resources, land, economic opportunities). How to mitigate these impacts with recommendations are presented in Section 11 of this report.

7 Impact assessment and baseline for significant impacts

This section provides the results of the RIAM analysis (described earlier in Section 4) of two possible scenarios, namely, the potential impacts associated with:

- **Scenario 1**: proposed upgrades to RWMF are established;
- **Scenario 2:** proposed upgrades to RWMF are not established and the facility is used as it is.

The discussions that follows will focus only on those potential changes that are considered to be either negatively or positively *moderate* or *significant*. They also describe any of the identified changes that are associated with *uncertainty* (e.g., synergies between project-related impacts and climate-change-induced impacts), which have led the team to invoke the Precautionary Principle, so that if there were errors in estimating impacts, they would be made to favor the Maldives people and its fragile environment.

Taking the previous paragraph as a point of departure, the RIAM analysis flagged significant and moderate impacts that could be caused *with* and *without* proposed upgrades to the RWMF. Figure 42 a and b summarize those.

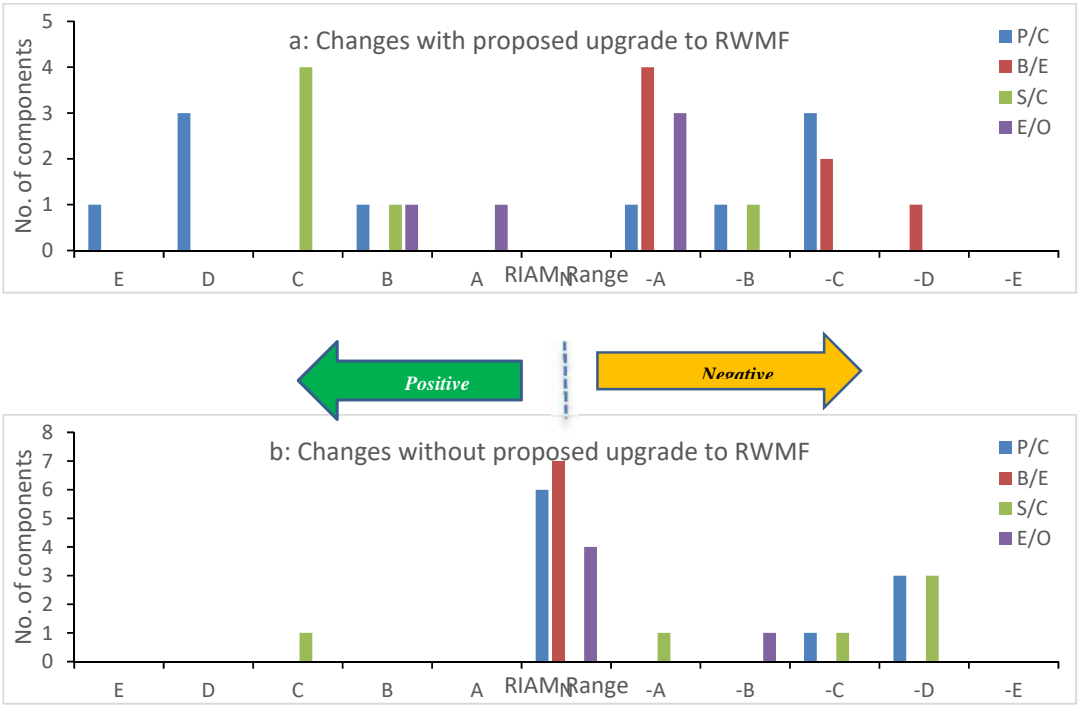

Figure 42. a and b summary of the potential changes resulting from the RIAM analysis of the two scenarios (with and without the RWMF). Significant changes are classified as D or E (see section 4 for a

more detailed explanation of RIAM). Negative changes are to the right side of neutral values, whereas positive changes are shown on the left side of the graph.

The most significant changes associated with the project are identified on the far left (positive impacts) and far right (significant negative changes) hand sides of the two figures (Figure 42). Neutral (N) values in the center of the figures indicate that there are no changes expected. Values labeled +/-D (positive or negative) and +/-E (positive or negative) are considered to be *significant changes*. Significant positive changes are highlighted in green (on the left-hand side of the graph), whereas significant negative changes are circled in red (on right hand side of the graph).

Results of the analyses of the two scenarios shown in Figure 42 can also be presented in a different way. Table 25 shows the same results of the RIAM analysis for the scenario with the proposed upgrade to the RWMF and without it, but presented in a matrix format in which the different color-coded bars correspond to different values assigned to a potential change caused by the project (the values assigned to each color-coded bar are described in Section 4). The reason for presenting Table 25 is that the Consultancy Team has organized the subsections that follow according to those potential changes that are considered to be significant (D and E values). Significant changes (negative changes are highlighted by red shading, whereas significant positive changes are represented by green shading) for the scenario with and without the RWFM.

Table 25. Comparison of the RIAM color-shaded matrices that were generated for the analysis of the two different scenarios (with and without RFWM). Red-shaded rows designate significant negative changes (-D and –E categories), magenta shading highlights moderate

Option/ Policy Components Code		Option with proposed upgrades to RWMF Description	RIAM Criteria Scores A1	A2	B1	B2	B3	Env. Score ES	Range Value RV	Opt. Name	Graph Value	Option without proposed upgrades to RWMF Range Value RV
P/C	1	Changes in landscapes due to clearing of vegetation for construction operations	1	-1	2	2	3	-14	-A	P/C1	-1	N
P/C	2	Changes in hydrocarbon concentrations on the island due to storage facility leaks	1	-3	3	3	3	-27	-C	P/C2	-3	N
P/C	3	Changes in hydrocarbon concentrations on the island due to spills associated with motorized construction vehicles	1	-2	3	3	3	-18	-B	P/C3	-2	N
P/C	4	Changes in groundwater chemistry of Vandhoo due to leachates from the waste facility	1	-3	3	3	3	-27	-C	P/C4	-3	N
P/C	5	Changes in groundwater chemistry due to oil and waste oil leachate from power house and fuel farm	1	-3	3	3	3	-27	-C	P/C5	-3	N
P/C	6	Changes in untreated daily waste volumes in the northern province	2	3	3	2	3	42	D	P/C6	4	-D
P/C	7	Changes in untreated clinical and e-waste volume in the northern province	4	3	3	2	3	40	D	P/C7	4	-D
P/C	8	Changes in pollutant concentration in the sea due to poor waste management practices	4	3	3	2	3	75	E	P/C8	5	-D
P/C	9	Changes in recyclable waste usage and availability	4	3	3	2	3	45	D	P/C9	4	-C
P/C	10	Changes in water quality for daily use to the workers due to provision of RO plant	1	1	3	2	3	15	B	P/C10	2	N
B/E	1	Changes in endemic terrestrial flora due to construction site clearing	3	-1	3	3	3	-27	-C	B/E3	-3	N
B/E	2	Changes in littoral flora and fauna due to construction operations	1	-1	2	2	3	-7	-A	B/E4	-1	N
B/E	3	Changes in vegetation cover due to clearing for construction	1	-3	3	3	3	-37	-D	B/E5	-4	N
B/E	4	Changes in turtle nesting patterns due to disturbance	3	-1	3	3	3	-27	-C	B/E6	-3	N
B/E	5	Impacts on marine habitat due to sewer and brine outfall pipe laying activities	1	1	2	2	3	-7	-A	B/E7	-1	N
B/E	6	Changes in flora and fauna of Vandhoo in response to pollutants released from inadequately treated scrubber wastewater	1	-1	3	2	1	-6	-A	B/E8	-1	N
B/E	7	Changes in live coral cover and water quality of Vandhoo due to the operation of brine and sewer outfall	1	-1	3	2	1	-7	-A	B/E9	-1	N
S/C	1	Changes in groundwater chemistry in islands of northern province due to better waste management practices	3	3	3	2	3	35	C	S/C1	3	-D
S/C	2	Changes in general hygiene and aesthetics of northern province islands due to better waste management practices	3	3	3	2	3	35	C	S/C2	3	-D
S/C	3	Changes in outburst of airborne and water borne diseases islands of northern province due to better waste management practices	3	3	3	2	3	35	C	S/C3	3	-D
S/C	4	Changes in smoke pollution and smoke related respiratory problems from household burning in the northern province	3	3	3	2	3	18	B	S/C4	2	-C
S/C	5	Changes in social attitudes about the need to live in harmony with nature	4	1	2	2	3	28	C	S/C5	3	-A
S/C	6	Changes in resource use from Vandhoo by the neighboring islands	3	-2	3	3	3	-15	-B	S/C6	-2	C
E/O	1	Changes in soil fertility due to composted material produced and distributed through this project	3	1	3	2	3	9	A	E/O1	1	N

E/O	2	Changes in family incomes provided by job-generating opportunities associated with the RWMF	3	3	3	2	3	14	B	E/O2	2	-B
E/O	3	Risks associated with bulk storage of waste oils	1	-1	3	3	3	-9	-A	E/O3	-1	N
E/O	4	Changes in air quality due to operation of heavy machinery and equipment	1	-1	3	2	3	-8	-A	E/O4	-1	N
E/O	5	Changes in ambient noise level due to operation of heavy machinery and equipment	1	-1	3	2	3	-8	-A	E/O5	-1	N

7.1 Summary of the potential changes with and without the proposed changes to existing RWMF

Significant negative changes identified in the RIAM analysis are described in the following subsections. Each significant change will not only require mitigation measures to minimize or eliminate a potential change (impact), each of these significant changes will also need to have a corresponding baseline that describes the social-cultural, economic and environmental conditions *before* any construction or operational activities, and a corresponding monitoring strategy for measuring the effectiveness of the mitigation measures proposed in the Environmental and Social Management Program (ESMP) presented in Chapter 9.

Based on this rationale, the present sub section lays the groundwork for focusing the impact analysis on significant changes that could be produced by the project, as well as identifying those parameters requiring a baseline and the mitigation measures and monitoring requirements, as outlined in the ESMP.

7.1.1 Summary of potential changes with the proposed changes to existing RWMF

As shown in Figure 42 and Table 25, there are ***5 moderate negative changes (-C)*** expected to occur if the ***RWMF*** is built and operated. There is only ***1 significant negative change (-D)*** associated with the operational phase. However, all of the negative changes associated with the construction and operation of the RWMF can either be reduced considerably or eliminated, provided that the applicant and its contractors apply the best practice measures described in the ESMP. Additionally, it is worth highlighting that there are ***3 significantly positive (D) and 1 important positive (E) changes*** associated with operating the RWMF at Vandhoo. Each potential change that require a baseline and mitigation measures will be described later in this section. Overall this option scored 12 positive changes and 16 negative changes (Figure 42 and Table 25).

7.1.2 Summary of potential changes without the proposed changes to existing RWMF

The analysis of Scenario 2, the situation ***without the project***, indicates that there are ***6 potentially significant negative changes*** that would seriously affect the Maldives and its people. Only 1 positive change was identified for Option 2 which was just moderately positive.

Although it should be evident that no construction impacts would be expected if the RWMF is not built, it is noteworthy that the RIAM analysis identified a total of ***6 significant negative changes*** both inside and outside of the immediate project area if the RWMF is not built and made operational. The results of the analysis highlight the critical situation that is developing without immediate solutions to the solid waste issues facing the Maldives.

Overall this option scored 1 positive change, 17 neutral and 10 negative changes (Figure 42 and Table 25).

7.2 Results of analysis of the scenario with the proposed changes to existing RWMF

7.2.1 Potential impacts associated with the construction phase

There are 9 changes identified during the construction phase of the project all of which are negative (Table 26). The 2 moderate negative, 1 significant negative and 1 negative impact require a baseline and mitigation measure prior to project commencement.

Table 26. Summary of changes during construction phase of the project

P/C	1	Changes in landscapes due to clearing of vegetation for construction operations
P/C	3	Changes in hydrocarbon concentrations on the island due to spills associated with motorized construction vehicles
B/E	1	Changes in endemic terrestrial flora due to construction site clearing
B/E	2	Changes in littoral flora and fauna due to construction operations
B/E	3	Changes in vegetation cover due to clearing for construction and guest accomodation
B/E	4	Changes in turtle nesting patterns due to disturbance
B/E	5	Impacts on marine habitat due to sewer and brine outfall pipe laying activities
E/O	4	Changes in air quality due to operation of heavy machinery and equipment
E/O	5	Changes in ambient noise level due to operation of heavy machinery and equipment

Physical-chemical impacts and baselines

There are 2 changes identified under this category and are discussed below: -

P/C	1	Changes in landscapes due to clearing of vegetation for construction operations

Changes in landscape including flora and vegetation due to construction activities (excluding site clearance at construction plots and roads) are expected to be minimal.

P/C	3	Changes in hydrocarbon concentrations on the island due to spills associated with motorized construction vehicles

All of the mechanized equipment associated with the project requires refined fossil-fuel products oils and greases, combustible fuels, etc.) and storage tanks that are required to store and dispense these products during both the construction and operational phase of the project. As a result, the RIAM analysis has flagged the potential spillage of hydrocarbons onto the island and into groundwater supplies, unless proper mitigation measures are taken (see Section 9 for the measures specified under the ESMP). The permeability of the soils on Vandhoo would make it easy for any accidentally spilled hydrocarbons to enter the underlying groundwater readily and this potential impact raises serious concerns about the contamination of groundwater supplies by hydrocarbons, because this would likely render the groundwater unusable as a potable water source. Consequently, PC3 has been pointed out as being potentially negative change. These have been flagged under the precautionary principle. It follows that both components require a baseline to establish existing anthropogenic hydrocarbons in groundwater, as well as mitigation measures and follow-up monitoring.

The baseline for hydrocarbons were not tested during this ESIA survey as this was not specified under the ToR for this ESIA. However, groundwater was tested for other physical and chemical components results of which are presented in Table 16 and Table 17. It is recommended to test water quality for hydrocarbons during the monitoring process.

Biological ecological impacts and baselines

The impact identified under this category is discussed below: -

B/E	5	Impacts on marine habitat due to sewer and brine outfall pipe laying activities

Changes in live coral cover due to construction of brine and sewer outfalls are predicted to have moderate negative impacts as it may lead to loss of marine habitats.

The baseline conditions of marine environment including coral cover, fish abundance as well as seawater quality was already established prior to the development of RWMF at Vandhoo (Riyan and NIRAS, 2012). Current conditions were compared with the initial ESIA and the results are presented in section 5 of this report.

B/E	1	Changes in endemic terrestrial flora due to construction site clearing
B/E	2	Changes in littoral flora and fauna due to construction operations
B/E	3	Changes in vegetation cover due to clearing for construction

The island having a thick vegetation, vegetation clearance was identified as the impact with highest significance (B/E3). Moreover, most building plots were proposed at areas with a thick coconut grove. In addition to heavy vegetation, changes in endemic terrestrial flora and fauna due to construction and operation phase are also identified. Few protected banyan trees were identified, one of which falls on a construction plot (Figure 44).

Terrestrial fauna and vegetation cover which falls on the building plots and road areas were identified and are presented in Figure 33 and Table 14.

B/E	4	Changes in turtle nesting patterns due to disturbance

Even though there were no evidence of turtle nesting identified during the initial ESIA (Riyan and NIRAS, 2012), at least 4 turtle nesting sites were identified during the field survey for preparation of this report. The nesting pits were not necessarily confined to the turtle conservation area identified in the Masterplan (Appendix 4), but rather, the nesting pits were observed all around the island.

Human exploitation of all the identified sites were also evident. Since the island is no longer available to the public, it is predicted that the exploitation could be from the staff working on the RWMF at Vandhoo.

Different forms of legislation have been in place over the years to provide protection for turtle species found in the Maldivian waters (discussed in turtle management plan on Appendix 15). A 10 year moratorium on turtle capture was initially passed in 2005 (under Section 10 of the Fisheries Law 5/87), which was again renewed for additional 10 years in 2006. The expiration of this ban in 2016 was followed by a blanket ban on turtle capture and egg harvesting under the Environmental Protection and Preservation Act (Law 4/93).

A Sea Turtle Management plan to be enforced during operation of the facility was formulated in 2014 and includes measures to minimize impact on sea turtles utilizing the beach at Vandhoo (Appendix 15). However, it should be noted that not all the measures identified in the Plan have been implemented to date at the RWMF. Hence the Consultant advises full implementation of the plan during the construction phase of the current project and future operations at the facility.

Economic operational impacts and baseline

E/O	4	Changes in air quality due to operation of heavy machinery and equipment
E/O	5	Changes in ambient noise level due to operation of heavy machinery and equipment

The two impacts identified under this category were only assumed to have a minimum negative impact on the environment. Inherent to any construction project, impacts on air quality and noise level is expected to arise from construction activities of the buildings proposed in this project. Since the project site is far from urban areas or communities impact on air and noise is negligible.

7.2.1 Potential impacts associated with the operational phase

There are 20 changes identified during the operational phase of the project, 6 of which are negative and 12 positive changes (Table 27).

Table 27. Summary of changes during operational phase of the project

P/C	2	Changes in hydrocarbon concentrations on the island due to storage facility leaks
P/C	4	Changes in groundwater chemistry of Vandhoo due to leachates from the waste facility
P/C	5	Changes in groundwater chemistry due to oil and waste oil leachate from power house and fuel farm
P/C	6	Changes in untreated daily waste volumes in the northern province
P/C	7	Changes in untreated clinical and e-waste volume in the northern province
P/C	8	Changes in pollutant concentration in the sea due to poor waste management practices
P/C	9	Changes in recyclable waste usage and availability
P/C	10	Changes in water quality for daily use to the workers due to provision of RO plant
B/E	4	Changes in turtle nesting patterns due to disturbance
B/E	6	Changes in flora and fauna of Vandhoo in response to pollutants released from inadequately treated scrubber wastewater
B/E	7	Changes in live coral cover and water quality of Vandhoo due to the operation of brine and sewer outfall
S/C	1	Changes in groundwater chemistry in islands of northern province due to better waste management practices
S/C	2	Changes in general hygiene and aesthetics of northern province islands due to better waste management practices
S/C	3	Changes in outburst of airborne and water borne diseases islands of northern province due to better waste management practices
S/C	4	Changes in smoke pollution and smoke related respiratory problems from household burning in the northern province
S/C	5	Changes in social attitudes about the need to live in harmony with nature
S/C	6	Changes in resource use from Vandhoo by the neighboring islands
E/O	1	Changes in soil fertility due to composted material produced and distributed through this project
E/O	2	Changes in family incomes provided by job-generating opportunities associated with the RWMF
E/O	3	Risks associated with bulk storage of waste oils

Physical chemical impacts and baseline

There are 8 changes associated with the proposed development under this category and are discussed below: -

P/C	2	Changes in hydrocarbon concentrations on the island due to storage facility leaks
P/C	4	Changes in groundwater chemistry of Vandhoo due to leachates from the waste facility
P/C	5	Changes in groundwater chemistry due to oil and waste oil leachate from power house and fuel farm

As mentioned in the previous subsection describing physical-chemical changes during the construction phase, refined fossil fuel leaks from mechanized project- support equipment and from fuel storage tanks are a serious concern and as a consequence, thereby P/C2, P/C4 and P/C5 have been flagged as moderate changes under the precautionary principle. These components require a baseline to establish existing anthropogenic hydrocarbon as well as chemical and physical groundwater chemistry, as well as mitigation measures and follow-up monitoring.

As previously noted, the baseline for hydrocarbons were not tested during this ESIA survey as this was not specified under the ToR for this ESIA. However, groundwater was tested for other physical and chemical components results of which are presented on Table 16 and Table 17. It is recommended to test water quality for hydrocarbons during the monitoring process.

P/C	6	Changes in untreated daily waste volumes in the northern province
P/C	7	Changes in untreated clinical and e-waste volume in the northern province
P/C	8	Changes in pollutant concentration in the sea due to poor waste management practices
P/C	9	Changes in recyclable waste usage and availability

Major positive changes due to better waste management and treatment are expected from the proposed development, which is the ultimate goal of the project. Proper treatment and disposal of waste from the source points in the islands will contribute to reduce the amount waste which make their way into the oceans as well. With the introduction of recyclable waste storage facilities, recyclables such as metals, glass, plastics etc, will be made available for the public.

P/C	10	Changes in water quality for daily use to the workers due to provision of RO plant

With the development of the RO plant, the workers residing on the island will be provided with clean water for daily use.

Biological ecological impacts and baseline

The 3 changes associated under this category are discussed below: -

B/E	4	Changes in turtle nesting patterns due to disturbance

As discussed in the previous subsection, changes in turtle nesting patterns are also expected during the operational phase as well. These include disturbance from lights, noise and trespassing. Refer to the previous sub-section for further details on B/E4.

B/E	6	Changes in flora and fauna of Vandhoo in response to pollutants released from inadequately treated scrubber wastewater

Inadequately treated scrubber wastewater, if released into the ground could have negative impacts on island's flora and fauna.

B/E	7	Changes in live coral cover and water quality of Vandhoo due to the operation of brine and sewer outfall

Wastewater and brine released from the sewer and brine outfalls are expected to impact negatively on the marine ecosystem. However, since sewer outfall will be extended beyond the reef edge and the area where outfalls are constructed is a high mixing zone, B/E7 is classified as a minimal negative change.

Social cultural impacts and baseline

There are 6 impacts identified under this category, 1 of which is negative: -

S/C	1	Changes in groundwater chemistry in islands of northern province due to better waste management practices
S/C	2	Changes in general hygiene and aesthetics of northern province islands due to better waste management practices
S/C	3	Changes in outburst of airborne and water borne diseases islands of northern province due to better waste management practices
S/C	4	Changes in smoke pollution and smoke related respiratory problems from household burning in the northern province
S/C	5	Changes in social attitudes about the need to live in harmony with nature

Although an indirect impact, the proposed development will bring about several positive impacts as a result of better management practices on the islands on northern province. It will put an end to the need to burn accumulated waste on the islands thereby preventing respiratory problems. Moreover, a lot of airborne and water borne disease outburst which commonly occur

in the islands of Maldives are due to accumulation of waste on the islands. Occurrence of such incidents are expected to lower due to the proposed upgrade to the RWMF. In addition to this, groundwater chemistry of the island is expected to improve as chemical leachate from waste will be prevented. Overall, islands with proper waste management practices are aesthetically more pleasing, more hygienic and as result people's attitude will change towards waste disposal practices and realize the importance of living in harmony with nature.

S/C	6	Changes in resource use from Vandhoo by the neighboring islands

The island was previously used by the neighboring islands (specifically Rasmaadhoo and Innamaadhoo) to source natural resources such as coconuts and dry coconut leaves. Dry coconut leaves were extensively farmed from Vandhoo by Rasmaadhoo inhabitants for thatching. There is a high demand for weaved thatches from nearby resorts and a large income is generated by selling these to the resorts. Since the development of RWMF at Vandhoo, local access has been banned to Vandhoo. This issue is discussed in further detail in the social assessment section of this report.

The possible socio-cultural impacts mentioned in the TOR for this report which includes the impact on the natural features and landscape of the project also ties with S/C6. Vegetation clearance would change the natural landscape and also would limit the availability of forest resources which could potentially still can be sourced to the locals interested as proposed in the mitigation measures of this ESIA. Alternatives are proposed in section 8 to minimize the area of vegetation that needs to be cleared.

No significant impact is envisaged to the visual amenity of the island as the thick buffer zone still remains.

Economic operational impacts and baseline

E/O	1	Changes in soil fertility due to composted material produced and distributed through this project

During public consultations it was identified that even though composting is possible at the islands, sales and distribution is difficult. Therefore, compost produced at the islands will be brought to the RWMF at Vandhoo, for packing and distribution.

E/O	2	Changes in family incomes provided by job-generating opportunities associated with the RWMF

The proposed facility will generate several job opportunities for the locals.

E/O	3	Risks associated with bulk storage of waste oils

Bulk storage of waste oils, if not properly handled, may lead to a disastrous incident, however, since the design of waste storage oil tanks and the fuel farm is very stringent, this component is classified as a minimal negative impact.

7.3 Potential risks of the project

7.3.1 Construction phase risks

The construction work may generate *dust and noise* causing a health hazard to the workers. This risk, however, can easily be minimized by using appropriate equipment (masks, earmuffs). Occupational accidents represent another risk and protocols and guidelines outlined in the ESMP will help minimize these risks to the workers during the construction phase.

7.3.2 Operational phase risks

The most serious risks to eliminate and/or reduce will occur in the operational phase. These include respiratory and other pollution-related diseases in workers associated with the incinerators. However, since any works related to the incinerator is not in the scope of proposed upgrade, these will not be discussed in further detail. Other risks include risks of fire associated with the fuel farm, health hazards to workers due to handling of waste. As a risk reduction measure, the occupational health and safety procedure formulated by WAMCO (attached in Appendix 10) should be strictly followed by the workers.

8 Project alternatives

The proposed project involves upgrade of RWMF at R. Vandhoo. Location of the project has been identified by the proponent after carrying out intensive analyses of the islands in the northern province. Since the island already has an acceptable facility on this island, the location is ideal for this project as this will be an extension of the current facility and the proponent will be able to well-establish the current resources under the available budget. To change the project location means having to construct all the resources which is neither environmentally, nor economically feasible.

Nevertheless, specific options related to different components of the project are discussed below: -

8.1 Considered alternatives

8.1.1 Guest accommodation blocks

Proposed: The proponent proposes to construct beach front accommodation blocks for guests and consultants who visit the RWMF.

Alternate: Allocate single rooms for consultants within the proposed staff accommodation blocks.

Recommended option: *Key impact due to the project is due to vegetation clearance. Construction of beach front rooms for the Consultants requires additional vegetation clearance for the room footprint as well as that for the access roads to the area. Consultation team does not see the need for constructing beach front accommodation for visitors in a waste management facility, rather, rooms within the proposed staff accommodation facilities are considered to be sufficient. Selection of this alternative means that the vegetation within the proposed guest accommodation areas as well as access roads to the areas will be retained. In addition to negative environmental impacts, the beach front accommodation blocks are economically not feasible.*

8.1.1 Road network

Proposed road network: Highlighted in yellow in Figure 43.

Alternate road network: Indicated in magenta in Figure 43.

Figure 43. Proposed road network (yellow highlight) and alternate road network (red) for RWMF at Vandhoo

Selected road network: *a total of 17.7% of vegetation clearance is required for all building footprint area and road development. Approximately 19.5% of this area is contributed to by the area to be cleared for road development (which encompasses a total of 188 significant trees and coconut palms). Thus the Consultant feels that an alternate route which requires less vegetation clearance would be more feasible in terms of environmental impacts. Alternate route for road development (with width 10m) is given in Figure 43 and total area which requires to be cleared for proposed development with this route is approximately 16.6%, while 14% of this total is accounted for by road clearance (Approximate number of significant vegetation required to be cleared is 60). Furthermore, the proposed route provides access to guest blocks to be developed on the beach side, which as discussed in Section 8.1.3 are considered unnecessary and thus there is no reason to develop roads providing access to the area. Hence based on the area of clearance required, the Consultant considers the alternative route to be feasible and is selected for in the report.* Table 28 *compares the vegetation clearance required for the proposed road network with that of the alternative network.*

Table 28. Vegetation clearance required for different road widths and network

Route	Width (m)	Area to be cleared (m^2)	% of total vegetation clearance (m^2)
Proposed	12	10,400	19.5
Proposed	10	9,400	17.9
Alternative	10	7,330	14.5

8.1.2 Road widths

Proposed width: 12 m

Alternate width: 10 m

Selected width: *vegetation clearance is the most significant negative impact due to the proposed project. Hence it is crucial to minimize this impact to the greatest extent possible. Road construction with a width of 12m contributes approximately 19.5% of the area to be cleared for the proposed works. Although these routes will be used by heavy vehicles on a regular basis, the Consultant feels that narrowing of the road widths is a feasible option, especially with the decreased impact on the environment due to this option. Hence we propose to decrease the road width to the minimum required width for industrial zones, which is 10m. A consequence of this would be decreased area of vegetation clearance (16.6% total with contribution of 14.5% by road clearance work) and thus decreased impact on the environment.*

8.1.3 Number of boreholes

Proposed: The proponent proposes to establish one borehole at the RO facility.

Alternate: Establish 2 boreholes adjacent to each other

Selected option: *The alternate option of establishing 2 boreholes in case one of them fails.*

8.1.4 The no-project scenario

The no-project scenario is also an available option. If this option is selected, the environmental impacts due to the project will be avoided. Impacts during construction phase are minor, although impacts due to operation of the proposed facility are envisaged to be moderate (based on literature). The socio-economic benefits due to the project is also envisaged to be high. The status of the existing facility and why it has failed to serve its goal is discussed in the previous subsections of this report. Moreover, since the RWMF facility is already established at Vandhoo, major environmental impacts are already addressed and discussed during the initial development of this project. Therefore, it will be economically, environmentally and socially more feasible to upgrade an already existing facility to its full potential.

9 Environmental and social management plan

The Environmental and Social Management Program (ESMP) described herein has been developed in order to mitigate the priority list of potential impacts described in Section 7, which are expected during the construction and operational phase of the proposed RWMF at Vandhoo Island. The ESMP recognizes fine different types of mitigation, which include the following: -

1. **Prevention** – involves total prevention of a potential impact;
2. **Minimization** – minimizes potential impacts by limiting the magnitude of action and its implementation;
3. **Restoration** – this requires repair or rehabilitation of the component that is affected by the project;
4. **Maintenance** – reduces or eliminates the impact through operations designed to preserve the status quo during the activity;
5. **Compensation –** compensates affected party(ies) or the environment by replacing lost goods or service that has been changed by the activity.

The ESIA has focused on measures 1 and 2, while aiming to avoid the other types of mitigation measures. Following subsections describe the proposed measures and monitoring requirements for those issues that were highlighted within the biological-ecological, physical-chemical, social-cultural and economic-operational dimensions.

9.1 Summary of mitigation and risk reduction measures during construction and operational phase

Mitigation measures that are explored below (Table 29) emerged out of the discussions and consultations during work on this report with the project proponent and based on literature. Mitigation measures are proposed to reduce or eliminate the severity of any predicted adverse environmental effects and improve the overall social and environmental performance of the project.

Mitigation measures are discussed both for the construction and operation stage of the project. As described in Section 7, most of the potential changes produced during construction phase are short-lived, of low intensity and consequently with very low significance. Some, however, are irreversible, including intensive vegetation clearance. During the construction stage it is also important to take measures to minimize impact on environment due to methods used.

During operational phase, even though the significance of impacts is less, the impacts are more long term, permanent and irreversible. Therefore, best practice methods are well recommended once the proposed changes to the existing facility at Vandhoo become operational. It is also of noteworthy that operational impacts bring about several social economic positive impacts.

Table 29 summarizes the proposed mitigation measures for potential impacts that could be produced during both construction and operational phase. However, the ESMP will focus only on those potential changes that were flagged by the RIAM process and described for each dimension. Additionally, Table 29 identifies the most serious risks and it summarizes steps to be taken to address them. Table 29 summarizes monitoring requirements as well. Table 29 also includes some additional, non-significant and minor impacts that are flagged in order to ensure that even the most responsible contractors and facility operators are reminded that it is essential to take necessary precautions to eliminate these impacts and risks.

Commitment from the proponent for carrying out the proposed mitigation and monitoring plan is given in the declaration of the proponent.

Table 29. Measures to mitigate/monitor potential impacts and occupational health risks during the construction and operational phase of the project

Activity	No.	Potential impacts	Mitigation Measures	Location/ Time frame	Monitoring*	Responsibility
CONSTRUCTION PHASE						
Fuel storage and fuel dispersal to vehicles	PC2	Accidental spills of hydrocarbon on the island due to storage facility leaks	Construct concrete berms around the tank and fueling areas, install sumps to pump out spilled products, emergency warning spill alert equipment.	Fuel storage tank site/ Prior, during and after construction phase	Groundwater quality as specified in Table 30	ME, WAMCO, RWMF supervisor
Maintenance and refueling of project support vehicles	PC3	Accidental spills of hydrocarbon on and under the island associated with motorized support-vehicles	Construct concrete line maintenance areas with capacity to collect and use-recycle used hydrocarbons. Ensure proper maintenance of machinery, appropriate workshop facilities, appropriate handling of all waste (store in a safe place for later removal / incineration in the incinerator).	Maintenance areas/ Prior, during and after construction phase	Groundwater quality as specified in Table 30	Construction supervisor, WAMCO, RWMF supervisor
Laying of brine and sewer outfalls	BE1	Changes in live coral cover and contamination of seawater	Avoid trampling on areas outside of project boundary. Outfall pipes should be properly anchored to prevent pipeline movement, especially to prevent the pipes from drifting to the turtle conservation area.	Reef flat on southside/ during construction phase	Marine environment and seawater quality as specified in Table 30	ME, WAMCO, RWMF supervisor
Construction activities	EO4 EO5	Air pollution and noise impacts	Avoid unnecessary operation of machinery and equipment. Limit use of heavy machinery to project site only. Regular maintenance of machinery	Whole islands/ during construction phase		ME, Construction supervisor
Clearing of vegetation in the project area and guest accommodation	BE5	Vegetation removed from most of the site	Erosion and dust control devices in place prior to construction. Ensure protection of the vegetation buffer zone along the coast (50 m wide) and around the wetland. The buffer should be 70 m in the area where the wetland is found. Coconut palms, if possible, to be moved from the cleared area to the buffer area. Vegetation falling outside project boundary shall not be	RWMF site/ During construction	None	ME and Construction supervisor

			harmed in any way. Coconut palms removed from the construction sites, if not replanted, should be taken to a nearby island and rehabilitated. An alternative option for road widths are described in section 8 in order to minimize the no. of coconut palms to be removed. Plant some of the cleared vegetation on either side of the roads as well as the areas shown on Figure 44. Beach front guest accommodation blocks are not recommended, instead, allocate guest rooms at the proposed staff accommodation block as discussed under project alternatives section. Few protected banyan trees were identified, one of which falls on a construction plot (Figure 44). It is recommended to shift the block to avoid the banyan tree. All banyan should be conserved during and operation of the facility.			
Overall construction and operation of the project	BE6	Changes in turtle nesting patterns due to changes in beach areas due to construction, noise and lights	Document the relative importance of the beaches as nesting areas for each turtle species, if considered important, take measures such as infrared lights at night, turtle protection measures. No trespassing signs shall be enacted at the turtle conservation area and the area should not be disturbed by any means. Any exploitation, if reported shall be punished.	Turtle conservation area	None	ME, EPA, Construction supervisor
OCCUPATIONAL HEALTH AND SAFETY RISKS DURING CONSTRUCTION						
Dust generated during construction		Worker's health may be affected	Provide masks to the worker where dust is prone in the work area	Site specific	During construction	Construction supervisor
Noise from machinery / construction		Worker's health may be affected	Workers should have protective gear including earmuffs.	Site specific	During construction	Construction supervisor

Work accidents		Worker's health may be affected	Establish and enforce appropriate safety rules and work routines and compulsory use of safety equipment (helmets, protective wear). First aid kit accessible on site, routines for emergencies established and known to all.	Site specific	During construction	Construction supervisor
OPERATIONAL PHASE						
Fuel storage and fuel dispersal to vehicles	PC5	Changes in hydrocarbon concentrations on the island due to possible leaks from storage facilities during operational phase	Construct concrete berms around the tank and fueling areas, install sumps to pump out spilled products, emergency warning spill alert equipment to alert o	Fuel storage tank site/ Prior to, and during operational phase		EPA, WAMCO RWMF supervisor
Maintenance and refueling of project support vehicles	PC5	Changes in hydrocarbon concentrations on the island due to possible motor vehicle leaks and maintenance during operational phase	Construct concrete line maintenance areas with capacity to collect and use-recycle used hydrocarbons. Ensure proper maintenance of machinery, appropriate workshop facilities, appropriate handling of all waste /store in a safe place for later removal / incineration in the incinerator	Maintenance areas/ prior to, and during operational phase		WAMCO RWMF supervisor
Leaching from land-fill to ground water and / or the marine environment	PC4	Changes in groundwater chemistry due to leachates from the waste facility; Impact to the soil and potential groundwater/coastal water contamination	Adhere to the regular monitoring of soil and groundwater for leachates	Soil, groundwater and coastal waters/ During operation		WAMCO
Leakage / overflows from wastewater treatment	BE8	Changes in groundwater chemistry/ flora and fauna due to leachates and effluents from the waste facility	Maintain sufficient storage capacity; Regular monitoring of soil and groundwater for leachates, emergency procedures pre-defined in case of leakage. Maintain scrubbers of the RWMF	Soil, groundwater and coastal waters/ During operation		WAMCO
Wastewater treatment. Leakage from plant or insufficient cleaning of wastewater.	BE8	Contamination of soil, groundwater, seawater causing harm to people, flora, fauna.	Wastewater treatment plant designed to treat sanitary and other waste.	Soil, groundwater and coastal waters/ During operation		WAMCO

Release of brine and sewer wastewater into the lagoon	BE9	Loss of marine habitat, contamination of seawater quality	Treatment of wastewater prior to releasing into the lagoon. Ensure outfall pipes are intact and in place with rigid anchoring. Monitor water quality at the outfall areas and check for optimal range of parameters	During operation	Marine environment and seawater quality as specified in Table 30	EPA, WAMCO
Operation of fuel farm and power house	PC5	Changes in groundwater chemistry. Risk of accidents.	Construct concrete berms around the tank and fueling areas, install sumps to pump out spilled products, emergency warning spill alert equipment. Follow MNDF's fuel handling procedure. Have emergency oil spill cleanup equipment available.	During operation	Groundwater quality as specified in Table 30	EPA, WAMCO
Bulk storage of oils and waste oils	EO3	Changes in groundwater chemistry. Risk of accidents.	Construct concrete berms around the tank and fueling areas, install sumps to pump out spilled products, emergency warning spill alert equipment. Follow MNDF's fuel handling procedure. Have emergency oil spill cleanup equipment available.	During operation	Groundwater quality as specified in Table 30	EPA, WAMCO
Changes in resource use from Vandhoo by neighboring islands	SC6	Impacts on livelihood of locals as an income generating facility was no longer available	WAMCO to collect and sell resources such as dry coconut leaves to potential buyers	During operation	NONE	WAMCO
Overall operation of the project	BE6	Changes in turtle nesting patterns due to changes in beach areas due to construction, noise and lights	Implement turtle management plan attached on Appendix 15 of this report. Restrict entry to turtle conservation area indicated through clear sign boards. Demarcate boundaries through fencing. Conduct regular briefing sessions to the staff at the facility. Regular monitoring through environmental officer recruited by the operator, WAMCO. Any exploitation, if reported shall be punished.	Turtle conservation area	NONE	WAMCO
Waste lost into the sea during transport		Visual impact (affecting tourism, people in general); impact on marine flora/fauna	Custom-built vessels with protective shields, preventing movement of light fractions. Vessels to follow existing regulations regarding transport vessels. Compulsory logbooks of all waste loaded and unloaded	Marine environment / sea- During transport	NONE	Vessel operators and WAMCO

Waste lost into the sea during loading / unloading of waste		Visual impact (affecting tourism, people in general); impact on marine flora/fauna	Mesh fence and green belt towards the seaside, preventing movement of light fractions. Custom-built vessels such as landing crafts, truck loads and compactors ensuring effective operation of the facility	Transfer area between facility and sea/ During operation	NONE	Vessel operators and WAMCO
Visual impact of facility		Visual impact affecting tourist impression	Replanting and green belts, camouflaging the facility from distance, comply with the recommendation for vegetation buffer-zone, ensure area light is concealed (as far as possible) from the surroundings.	Surroundings of Vandhoo Island/throughout operation	NONE	Design engineers; Facility operators
Operation of RO plant		Risk of distribution of improperly treated water	Properties of product water quality produced from the RO plant should be in compliance with EPA's guideline for drinking water quality. Prior to RO plant becoming operational, RO plant shall be registered at EPA and monitoring of product water shall be carried out as per the operating license. EPA to monitor whether reporting is being done by the operator.	During operation	As per operating license	WAMCO, EPA
OCCUPATIONAL HEALTH AND SAFETY RISKS DURING OPERATION						
Waste unload and waste storage		Workers health may be affected	Reduce speed of vehicles, provide masks to the worker where dust is prone in the work area	Site specific	During operation	Facility operator / safety officer
Waste recycling activities (removing recyclables, toxic and hazardous waste)		Workers health may be affected	Workers should have protective gear including earmuffs.	Site specific	During operation	Facility operator / safety officer
Waste handling (from storage to incinerator)		Workers health may be affected	Establish and enforce appropriate safety rules and work routines and compulsory use of safety equipment (helmets, protective wear). First aid kit accessible on site, routines for emergencies established and known to all.	Site specific	During operation	Facility operator / safety officer

Landfill		Unpleasant working environment, potentially harmful (pathogens, toxics)	Protective equipment that ensures no direct contact between workers and waste	On site	During operation	Facility operators
Noise from operation of machinery for waste handling and power house		Unpleasant working environment	Appropriate earmuffs, protecting against noise	On site	During operation	Facility operators
Handling of waste (sorting of waste, handling for recyclables and hazardous materials, work on the landfill)		Health hazard to the workers (pathogens, toxic / hazardous waste)	Protective equipment that ensures no direct contact between workers and waste.	On site	During operation	Facility operator / safety officer
Accidents in the processes		Injury due to poor handling or malfunctioning machinery and equipment	Well-developed and well enforced safety guidelines and streamlined processes for operation; compulsory safety training for all employees; compulsory use of adequate protective equipment. Access to first aid kit on site.	On site	During operation	Facility operator / safety officer

**Please refer to the monitoring table on Table 30 for the complete monitoring plan proposed for the project*

Figure 44. Area proposed for relocation of some of the removed coconut palms (left). Locations of Banyan trees (right).

9.2 Environmental monitoring plan

The natural environment of Maldives has been regarded as sensitive to both natural and human related environmental changes. Solid waste disposal and management has been one of the most concerned issues with regard to the negative environmental changes resulting from improper waste disposal to human health, and natural environment. RWMF is the first modern waste management facility that was designed with due consideration given to the socioeconomic and environmental concerns at local level.

Primary basis of modern waste management is to maximize environmentally sound waste disposal to minimize the quantity of municipal solid disposed to landfill. This is normally accomplished by reducing the quantity of waste initially produced; and diverting waste material to beneficial reuse, recycling, composting, incineration and landfills. Engineered lined landfill systems are constructed to contain residual waste material in an environmentally secure manner. Similarly, incinerators have the capacity to reduce harmful emission to acceptable standards through high temperature combustion.

Environmental standards are often set to address the siting, design, construction, operation of waste management facilities, to substantially reduce and mitigate adverse environmental impacts associated with management of waste material. These impacts may include: dust, odour or impaired air quality, noise, leachate, and hazardous material spills, explosions or fire. Effective operations management and good housekeeping practices are always required, in addition to properly trained staff, and current Operations Management/Maintenance manuals/plans, and Environmental Health and Safety Contingency Plans.

Innovative planning and design are encouraged to maximize safe, efficient and productive use of the property that is dedicated to waste management over the life of a facility.

As such an appropriate environmental monitoring program shall be developed for all waste management facilities at Vandhoo. The operator shall prepare and propose a program which satisfactorily addresses emission, storm water management, groundwater monitoring, leachate collection/management, and landfill management. Environmental monitoring requirements also shall include air quality and nuisance factors such as litter and rodents with respect to problem prevention and control.

It is proposed that the operator is required to submit an annual report outlining the results of the environmental monitoring programs and providing an assessment of compliance and impact. If monitoring indicates that there are negative environmental impacts as a result of the

operation, then corrective measures must be put in place and appropriate authority shall be notified. It is proposed that the report be prepared by a professional.

The following is proposed as part of the overall environmental management plan for the waste management facility in the context of various components of the project and their impacts to natural and human environment. The outcome of the monitoring is used to prepare an annual report based on the specific monitoring programs.

- Air Quality
- Groundwater Monitoring
- Leachate Management
- Reef quality
- Shoreline
- Vector Control
- Load and off-load of waste (log-book)

A very exhaustive air quality monitoring had been specified under the initial ESIA of the proposed development (Riyan and NIRAS, 2012) due to the development of incinerators. However, the scope of the proposed upgrade works does not include any incinerator related works, therefore, air quality monitoring will be limited to those associated with operation of powerhouse.

Following table (Table 30) provide a schedule for the impact monitoring that shall be followed as part of the overall environmental monitoring.

Table 30. Environmental monitoring program proposed for the waste management facility at Vandhoo.

Component	Parameter	Monitoring location	Frequency	Responsible agency	Estimated yearly cost (USD)
Air quality	Particulate Matter (PM_{10}) Carbon Monoxide (CO) NOx SO2	Direct emission measurement at powerhouse chimney	3 months after the start-up of powerhouse. Hereafter annually.	WAMCO	5,000
Effluents (Leachates)	BOD5; pH; TSS Ammonia; Zinc Benzoic acid; Phenols	At the landfill cells	Bi annually	WAMCO	1000

Ground-water	Temperature; pH; Electrical conductivity; TDS; TSS; DO; Ammonia; Phosphate; Sulfate; Zinc; Benzoic acid, Phenols, hydrocarbons	Borewell east Borewell west Well	quarterly	WAMCO	500.00
Reef	Coral cover (diversity) Algal cover Fish community (abundance and trophic groups)	SW1 SW2 SW3 SW4	Bi annual	WAMCO	1200.00
Seawater	Temperature; pH; Salinity Electrical conductivity; TDS; TSS; Turbidity Ammonia; Phosphate; Sulfate	SW1 SW2 SW3 SW4	Bi annual	WAMCO	500.00
Shoreline	High tideline; Low tideline Vegetation line	Shoreline of the island	Bi annual	WAMCO	1000.00
Human health	Vectors; Noise; Dust	At the facility, Systematic records according to the monitoring plans	As in the monitoring plans	Operator staff/ safety officer	NA
Waste	Waste loaded (from sources) and unloaded (at Vandhoo)	Tonnes of waste	Continuous	Waste provider; facility operator EPA controlling (samples)	

9.3 Capacity development and training

There are ongoing capacity development and training programs currently in place for the personnel working in the RWMF of Vandhoo. Moreover, a 12-month training program is planned for technical training by bringing technicians from abroad.

It is understood from the consultation with the current operator of the facility, WAMCO and the field report (Mostafa, 2018) that lack of technical capacity in the existing facility is a major issue which needs to be overcome in order to proper functioning and to achieve the desired goals of the project. At present there is a quality engineer/ technician on site upkeeping the incinerator, however, lack of supporting staff is a major concern.

The roles of government agencies and institutions responsible for carrying out particular mitigation, monitoring and enforcing agencies are specified for each component in the mitigation (Table 29) and monitoring (Table 30) tables for ease of reference.

10 Conclusion and recommendations

This ESIA supports and recommends the upgrade facilities proposed for the existing RWMF at Vandhoo. In light of the stakeholder consultations and field investigation report (Mostafa, 2018), it is evident that the existing facility neither has the capacity or facilities to cater to manage waste of the zone II islands. In other words, at present the facility does not meet its purpose. Consultation team also understood that the proposed upgrades will only address part of the many problems identified in the existing facility. However, due to financial limitations, only the proposed facilities could be established at the RWMF. Addressing other identified issues to complete the loop is highly recommended.

As part of the impact identification process, impact with the highest negative impact was identified to be vegetation clearance. It was estimated that about 17.7% of vegetation will need to be cleared in order to accommodate the proposed development. Alternative road designs and narrowing of road widths are thus selected alternatives and are highly recommended to limit the extent of vegetation clearance. Selection of the alternative route also reduces the number of significant which needs to be cleared for road construction. Given that majority of that to be cleared are Coconut palms, this is a significant incentive for selection of the alternative. These options are discussed under project alternatives of this report. Other mitigation measures include rehabilitation of some removed coconut palms within the plot areas and at either side of the road. All the coconut palms removed under this project should be relocated to another island and rehabilitated. Mitigation measures are discussed in more detail in section 9 and Table 29.

The consultation team also observed that the RWMF has a large catchment area for rainwater. However, as rainwater harvesting is not recommended health wise, catchment pits for proper drainage should be well incorporated at the buildings to prevent flooding. As such, groundwater enhancement is expected on this island.

Even though air pollution due to incinerator operation is a major significant impact expected from a project of this nature, this ESIA does not discuss air pollution in much detail since no incinerator related works were part of the scope of this project. A very thorough investigation of impacts due to incinerator operation was carried out in the initial ESIA of the project (Riyan and NIRAS, 2012). The only significant source of air pollution is expected to be generated from the operation of powerhouse and heavy vehicles.

Major positive impacts due to the proposed facility were identified. Analysis of the two options, a: changes with the proposed upgrade to RWMF and b: changes without the proposed upgrades revealed that that even though the latter option avoids the negative impacts due to the

proposed works, the socio-economic benefits due to the former option outweighs the negative impacts (Figure 42).

In conclusion, and based on the information available, the consultation team finds that the proposed upgrade to the RWMF is absolutely critical, and that the social and environmental benefits of a properly functioning facility which meets its requirement clearly outweighs the negative, residual impacts from the project. The benefits may be further strengthened by using the entire process as a learning experience for all involved parties.

Acknowledgements

The consultation team acknowledges the contribution provided by the team members in this report for the valuable contribution to the report and at the field. The consultant also acknowledges the assistance provided by ME and WAMCO.

CVs of team members are given below.

Curriculum Vitae

Position	Environmental Consultant
Name	Shahaama Abdul Sattar
Address	G. Helengeli, Lily Magu Male', Rep. of Maldives
Contact	Mobile: +9607904985 Email: shahaama.abdulsattar@lamer.com.mv shahaama.sattar@gmail.com
Date of Birth	30 September 1980
Nationality	Maldivian
Education	**Master of Science (MSc)** in Fisheries Biology and Fisheries Management, University of Bergen. Bergen, Norway, 2004 - 2006 **Bachelor of Science (BSc.),** The Flinders University of South Australia, Adelaide, South Australia, 1999 - 2001
Membership of Professional Associations	Small Island Research Group (SIRG) Maldives, Vice President
Countries of Work Experience	Maldives
Languages	**Dhivehi** Mother tongue **English** Fluent

Employment Record

From: 2008 - 2011
Employer: Marine Research Centre, Ministry of Fisheries and Agriculture, Male', Maldives.
Position: Fisheries Biologist

From: 2006 to 2008
Employer: Marine Research Centre, Ministry of Fisheries Agriculture and Marine Resources, Male', Maldives.
Position: Senior Research Officer

From: 2002 – 2004
Employer: Marine Research Centre, Ministry of Fisheries Agriculture and Marine Resources, Male', Maldives.
Position: Research Officer

Line of work at MRC included:
Assessment of the reef and grouper fisheries of Maldives, with surveys to monitor fisheries and fish species behavior. Compilation and analysis of data, for regular reviews and reporting and formation of management recommendations. Key role in the formulation of the Grouper Fisheries Management Plan / Grouper Fisheries and Export Regulation

Focal point for the IUCN funded project on identification of reef fish spawning aggregations in the Maldives through fishermen interviews (2007)

Secretariat and key organizer – Indian Ocean Cetacean Symposium 2009

Project Partner for Maldives for the Darwin Initiative Coral Reef Fish Project, Maldives

MRC Focal Point for the Atoll Ecosystem Conservation Programme, Ministry of Housing and Environment (2009 – 2011)

Participated in the Biodiversity Valuation survey of Baa Atoll Maldives carried out by AEC project and IUCN

From: May 2011 – Dec 2012
Employer: Darwin Reef Fish Project / Marine Research Centre (Maldives) and Marine Conservation Society (UK)
Position: Consultant, Darwin Reef Fish Project (4 year joint collaboration between MRC and MCS, UK)
Assess the various reef fisheries (grouper, aquarium and food fisheries) of the Maldives and aims to establish management plans for these fisheries. Provision of technical support and assistance to the project staff and MRC in implementing the project and formulation of the management plans.

From: July 2011 – Dec 2011
Employer: Bay of Bengal Large Marine Ecosystem Project
Position: BOBLME Sharks Working Group Coordinator
Coordinator for the Sharks WG of BOBLME project, and work with the focal points in the member countries, to assist in the formulation and implementation of their National Plans of Action for Sharks.

From: June 2011 to Present
Employer: Land and Marine Environmental Resource Group Pvt Ltd
Position: Environmental Consultant

Workshops/Seminars Participated

15-21 March 2003 - Training Workshop on the Implementation of Multilateral Agreements in the Conservation of Biodiversity with special focus on Marine Biodiversity. Kushiro, Japan

14-16 November 2006 – Sixth William R. and Lenore Mote International Symposium – Life history in Fisheries Ecology and Management. Sarasota, Florida

03-05 March 2008 – Olhugiri and Dhigalihaa Protected Areas Management Planning Workshop. Eydhafushi, Maldives

11 March 2008 – Applying the Ecosystem Approach to managing Atoll Ecosystems in the Maldives. Hulhule Island Hotel, Maldives

24-26 March 2008 – Regional Consultation on Preparation of Management Plans for Shark Fisheries. Beruwela, Sri Lanka

17-19 June 2008 – Workshop on Assessment and Management of the Offshore Resources of

South and Southeast Asia. Bangkok, Thailand
22-23 March 2009 – BOBP-IGO National Workshop on Monitoring, Control and Surveillance in Marine Fisheries. Male', Maldives

18 – 20 July 2009 – Indian Ocean Cetacean Symposium 2009. Paradise Island Resort and Spa, Maldives.

09-11 August 2009 – Second Regional Consultation on Preparation of Management Plans for Shark Fisheries. Kulhudhuffushi, Maldives

24-25 February 2010 – BOBLME Project – National Inception Workshop, Male', Maldives

2-3 June 2010 – BOBP-IGO Technical Advisory Committee – 5th Meeting, Male', Maldives

13-14 September 2010 – BOBLME Fisheries Assessment Working Group – 1st Meeting, Bangkok, Thailand

14-16 December 2010 – EWS-WWF 2nd Marine Conservation Forum for the Gulf Region In partnership with the Pew Environment Group – Local Actions for Global Challenges, Abu Dhabi, United Arab Emirates

18-19 January 2011 – Bay of Bengal Large Marine Ecosystem Project – Workshop on the Status of Marine Managed Areas in the Bay of Bengal, Penang, Malaysia

5-7 July 2011 –Bay of Bengal Large Marine Ecosystem Project – First meeting of the BOBLME Sharks Working Group, Male', Maldives

7-8 September 2011 – Workshop to formulate the Grouper Fisheries Management Plan, DRFP/MRC, Male', Maldives

15-17 September 2011 – SEAFDEC Special Meeting on Sharks Information Collection in Southeast Asia, Bangkok, Thailand

10 April 2014 - Stakeholder Consultation to present the National Plan of Action on the Conservation and Management of Sharks (NPOA-Sharks), Male', Maldives

Publications

Sattar, S. A., Najeeb, A., Islam, F., Afzal, M. S. and Wood, E. (2012) Management of the grouper fishery of the Maldives, *Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia*, *9-13 July 2012, Session 13E* (in press)

Ushan, M., Wood, E., Saleem, M. and Sattar, S. A (2012) Maldives Sharkwatch Report for 2009 - 2010, *Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia*, *9-13 July 2012, Session 13D* (in press)

Sattar, S. A., Andréfouët, S., Ahsan, M., Adam, M. S., Anderson, C. R. and Scott, L (2012) Status of the Coral Reef Fishery in an Atoll under tourism development: the case of Central Maldives, *Atoll Research Bulletin 590*: 163-186

Sattar, S. A., Amir, H. and Adam, M. S. (2012) Reef fish tagging programme – Baa Atoll Pilot project, *Atoll Research Bulletin 590*: 187-200

BOBLME (2011) Report of the BOBLME Sharks Working Group, 5-7 July 2011, Male' Maldives,

Prepared for the Bay of Bengal Large Marine Ecosystem Project by Sattar, S. A. and Anderson, R. C.
Saleem, M., Sattar, S. A. (2009) Study on post-tsunami restoration and conservation projects in Maldives, *Prepared for the International Union for Conservation of Nature*.

Tamelander, J., Sattar, S., Campbell, S., Hoon, V., Arthur, R., Patterson E. J.K., Satapoomin, U., Chandi, M., Rajasuriya, A. and Samoilys, M. (2009) Reef fish spawning aggregation in the Bay of Bengal: Awareness and Occurrence, *Proceedings of the 11th International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008,* Session 22

Sattar, S. A., Jørgensen, C., Fiksen, Ø. (2008) Fisheries Induced Evolution of Energy and Sex Allocation. *Bulletin of Marine Science*, 83(1): 235-250

Sattar, S. A. (2008) Review of the Reef fishery of the Maldives, Marine Research Centre, Male', Maldives. 62 pp

Sattar, S. A. and M. S. Adam (2005) Review of the Grouper fishery of the Maldives with additional notes on the Faafu Atoll fishery. Marine Research Centre, Male', Maldives. 54 pp

Environmental Impact Assessments Reports and other studies

The following are a selected list of the projects I have been involved in as an environmental consultant at LaMer Group Pvt Ltd.

Name of assignment or project	EIA for development of domestic airport facility at Funadhoo, Shaviyani Atoll
Year	2018
Location	Funadhoo, Shaviyani Atoll, Maldives
Client	Regional Airports, Ministry of Tourism
Project features	Development of domestic airport facility at Funadhoo
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA for agricultural development project at Hulhidhoo, Vaavu Atoll
Year	2017
Location	Hulhidhoo, Vaavu Atoll, Maldives
Client	Aarah Investments Pvt Ltd
Project features	Development of Hulhidhoo as a mix-use island with an agricultural (hydroponics) and tourism component
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA for development of 100 bed hospital at Addu City
Year	2017
Location	Addu City, Maldives
Client	Ministry of Housing and Infrastructure
Project features	Redevelopment of Equatorial Convention Centre as a 100 bed tertiary level hospital
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA for relocation of sewer outfalls at IGMH and Westpark area, Male' City
Year	2017
Location	Male', Maldives
Client	MWSC Pvt Ltd
Project features	Relocation of sewer outfalls at IGMH and Westpark area to industrial village area of Male'
Positions held	EIA team member

Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA for resort development at Islands I and E of Emboodhoofalhu Finolhu Development project
Year	2017
Location	Emboodhoofalhu Finolhu, Maldives
Client	Dream Islands Development Project
Project features	Development of reclaimed islands I and E of Emboodhoofalhu Finolhu as tourist resorts
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	Environmental Impact Assessment Report for aquatic animal quarantine facility at Hulhumale'
Year	2016
Location	Hulhule, Maldives
Client	Ministry of Fisheries and Agriculture
Project features	Setting up an animal quarantine facility within plant quarantine service area in Hulhule
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	Environmental Impact Assessment report for relocation of Male' Submarine cable landing
Year	2016
Location	Male', Maldives
Client	Dhiraagu
Project features	EIA related to relocation of the submarine cable from existing location to a new location
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	Socioeconomic Situation analysis of selected fishing communities as part of formulation of Master Plan for Sustainable Fisheries (MASPLAN)
Year	2015
Location	ADh. Mahibadhoo, F. Bilehdhoo, GA. Villingili, HA. Ihavandhoo, L. Gan, L. Maamendhoo, Lh. Naifaru, S. Maradhoo, Maldives, Maldives
Client	Ministry of Fisheries and Agriculture
Project features	Socioeconomic survey of selected islands, to undertake a situational analysis of the island communities
Positions held	Fisheries Management Consultant
Responsibilities	Carryout socioeconomic surveys in forms of group discussions and household surveys. Data collection and analysis and report formulation (trip reports and overall situational analysis).
Name of assignment or project	Development of Training material for project staff on mainstreaming and increasing awareness on climate change adaptation and mitigation measures in tourism operation
Year	2015
Location	Male', Maldives
Client	Ministry of Tourism
Project features	Mainstreaming and increasing awareness on climate change adaptation and mitigation measures in tourism operation
Positions held	Team member
Responsibilities	Material development and presentation
Name of assignment or project	Development of water supply and a sewerage system at Fuvahmulah
Year	2015
Location	Fuvahmulah, Gnaviyani atoll. Maldives
Client	Ministry of Environment and Energy
Project features	Setting up a water supply and a sewerage facility
Positions held	EIA team member

Responsibilities	Preparation of the EIA report
Name of assignment or project	Environmental Impact Assessment for soft coastal protection works at GDh. Thinadhoo
Year	2014
Location	GDh. Thinadhoo, Maldives
Client	Ministry of Environment and Energy
Project features	Beach Nourishment and Coastal protection
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	Beach Nourishment and Coastal Protection works at a private land at Praslin, Seychelles
Year	2014
Location	Praslin, Seychelles
Client	Ahmed Didi
Project features	Beach Nourishment and Coastal protection at Praslin, Seychelles
Positions held	Environmental assessment team member
Responsibilities	Preparation of the report submitted to the client
Name of assignment or project	1500 Housing Unit construction Project Maldives
Year	2014
Location	Fuvahmulah, Gadhdhoo, Hoadedhdhoo, Hithadhoo, Holhudhoo, Madaveli, Thinadhoo, Maldives
Client	Ministry of Housing and Infrastructure
Project features	Construction of Housing Units at the specified Islands
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Coastal modification at Robinson Club Maldives
Year	2013
Location	Ga. Funamaudua, Maldives
Client	Robinson Club Maldives, Maldives
Project features	Coastal modification at the NW side of the island, construction of geo-bag revetment and harbor basin maintenance dredging works
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for construction of gravity type waste water collection system at ADh Omadhoo
Year	2013
Location	ADh Omadhoo, Maldives
Client	ADh Omadhoo Island Council Office
Project features	Construction of gravity type waste water collection system and sea outfall pumping system
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for upgrading of Maldive Gas Pvt Ltd Gas jetty
Year	2013
Location	Thilafushi, Maldives
Client	Maldive Gas Pvt Ltd
Project features	Reconstruction of existing gas jetty head and expansion of jetty head
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Resort development at GDh Havvodaa
Year	2013
Location	GDh Havvodaa, Maldives
Client	Crystal Plaza Pvt Ltd, Maldives
Project features	Construction of a resort hotel and all the related amenities
Positions held	EIA team member
Responsibilities	Preparation of the EIA report

Name of assignment or project	EIA report for Coastal protection, coastal modification, beach nourishment, coral nursery setup and entrance channel maintenance dredging work
Year	2013
Location	Gili Lankanfushi, Maldives
Client	Gili Lankanfushi, Maldives
Project features	Coastal protection, coastal modification, beach nourishment, coral nursery setup and entrance channel maintenance dredging work
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Harbor development project at Dh. Maaenboodhoo
Year	2013
Location	Dh. Maaenboodhoo, Maldives
Client	Ministry of Housing and Infrastructure
Project features	Development of harbor facility (dredging of harbor basin, construction of wharfs and breakwater)
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Flood mitigation and reclamation work at Faresmaathoda
Year	2013
Location	GDh. Faresmaathodaa, Maldives
Client	United Nations Office for Project Services (UNOPS)
Project features	Construction of breakwater and reclamation of land
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Development of Domestic Airport Facility
Year	2012
Location	Th. Thimarafushi, Maldives
Client	Maldives Airports Company Limited
Project features	Construction of runway apron
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Wharf reconstruction and upgrading of existing berthing facility and slipway
Year	2012
Location	Thilafushi, Maldives
Client	Fuel Supply Maldives Pvt Ltd, Maldives
Project features	Reconstruction of wharf and upgrading of existing berthing facility and slipway
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Resort development at B. Kanifinolhu
Year	2012
Location	B. Kanifushi, Maldives
Client	Coastline Hotels and Resorts Pvt Ltd, Maldives
Project features	Construction of a resort hotel and all the related amenities
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for Borehole construction at Cyprea Mrine Food Fish Factory
Year	2012
Location	K. Himmafushi, Maldives
Client	Cyprea Marine Food Pvt Ltd, Maldives
Project features	Construction of a 8 inch borehole at factory premise
Positions held	EIA team member
Responsibilities	Preparation of the EIA report

Name of assignment or project	EIA report for resort development at K. Kudavilligili, Maldives
Year	2011
Location	K. Kudavilingili, Maldives
Client	Yacht Tours Pvt Ltd, Maldives
Project features	Construction of resort hotels and all the related amenities. In addition a large reclamation of the shoreline as additional land as part of the resort development is also part of the project
Positions held	EIA team member
Responsibilities	Preparation of the EIA report
Name of assignment or project	EIA report for development of city hotel, hospitality institute and resort development at Gasfinolhu and Bodufinolhu, L. Atoll
Year	2011
Location	L. Gan, Bodufinolhu and Gasfinolhu, Maldives
Client	Premier Equities Pvt Ltd, Maldives
Project features	Construction of a resort hotel and required amenities including a training hotel for hospitality industry
Positions held	EIA team member
Responsibilities	Preparation of the EIA report

Referees

Dr. Mohamed Shiham Adam, PhD
Marine Research Centre
Ministry of Fisheries and Agriculture
Male', Republic of Maldives
Tel. No: +960 331 3681
Email: msadam@mrc.gov.mv

Dr. Charles Anderson
anderson@dhivehinet.net.mv
charles.anderson11@btinternet.com

Certification

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

Shahaama A. Sattar Date: October 2018

CURRICULUM VITAE

NAME:	Aishath Abdulla
DATE OF BIRTH:	10th September 1986
NATIONALITY:	Maldivian
PERSONAL ADDRESS:	H.Regalge, MajeedheeMagu Male' Rep. of Maldives
EDUCATION:	2012 Masters in Environment & Development, University of Melbourne, Australia 2010 BA (Hons) in Urban and Regional Planning, International Islamic University Malaysia, Malaysia
LANGUAGE AND DEGREE OF PROFICIENCY:	
	English – Fluent Dhivehi – Mother tongue
COUNTRIES OF WORK EXPERIENCE:	
	Maldives Malaysia

EMPLOYMENT RECORD:

February 2013- Present	Environmental Planner LAMER Group Pte Ltd Male' Maldives
November 2010 – January 2011	Urban Planner/ Acting business development Manager Riyan Pte.Ltd Male' Maldives
May 2009 - July 2009	Trainee ANZ PLANNERS SDN. BHD Selangor Malaysia
August 2005 - October 2005	Surveyor Ministry of Fisheries and Agriculture Male' Maldives
December 2003	Surveyor Ministry of Planning and National Development Male' Maldives
May 2003-August 2003	Volunteer UNICEF Male' Maldives

OTHER MEMBERSHIPS:	Secretary of the NGO, Small Island Research Group, Maldives

CONFERENCES & EXPERT GROUP MEETINGS	Attended the Expert Group Meeting (EGM) on: Urbanization in Small Island Developing States as a planner from the Maldives; at the United Nations in New York (June 2016)
ADEQUACY FOR THE ASSIGNMENT	
DETAILED TASKS ASSIGNED:	**WORK UNDERTAKEN THAT BEST ILLUSTRATES CAPABILITY TO HANDLE THE TASKS ASSIGNED**
Provision of input on the environmental components of the project **Ensure the integration of the component of the climate change adaptation project in the training materials and training sessions**	**ENVIRONMENTAL PROJECTS** **Assessment of Climate Sensitive Natural Resources in Laamu Atoll and Preparation of Resources Maps** Year: Ongoing Client: UNDP Position Held: Project Coordinator Duties Rendered: Overall coordination of the project which includes project planning, keeping PMU updated on the progress of the project, facilitate the project team in addressing the issues, delays etc during the project **Preparation of Environmental Impact Assessments (EIAs) for IDB-Sanitation Project in Five Islands** Year: 2016-2017 Client: Ministry of Environment and Energy Duties Rendered: Data analysis and preparation of the report for the EIAs conducted on the proposed project of establishing sewerage systems in Th. Veymandoo and Lh. Naifaru based on the inputs from the environmental consultants. **Developing a Handbook to Enhance the Capacity of Trainers to Increase the Resilience of People with Disabilities to DRR and CCA** Year : Ongoing Client: National Disaster Management Center Position Held: Consultant Duties Rendered: Review and analyze existing; provide input in relevant stakeholder consultations; Preparation of the handbook **Tool Kit and Training Materials for Increasing Awareness on Climate Change Adaptation & Mitigation Measures in Tourism Sector (Kaaf, Alif Alif, Alif Dhaal, Baa & Lhaviyani Atoll)** Year : 2015 Client: Ministry of Tourism Position Held: Project manager Duties Rendered: Preparation of Materials, Conducting workshops **Tool Kit and Training Materials for Increasing Awareness on Climate Change Adaptation & Mitigation Measures in Tourism Sector (For Tourism Staff)** Year : 2015 Client: Ministry of Tourism

	Position Held: Project manager Duties Rendered: Preparation of Materials, Conducting workshops **Situation Analysis for the formulation of Master Plan for Sustainable fisheries (MASPLAN)** Year : 2015 Client: JICA Position Held: Consultant Duties Rendered: Community Consultations, Analysis and reporting **Integration of Climate Change Risk Resilience into Land Use Planning** Location: Maldives Year: 2011 Client: Ministry of Housing and Environment Position Held: Planner/Project Coordinator Duties Rendered: Provide input in planning perspective and also over all coordination of the project inclusive of conducting a workshop to present the findings **<u>URBAN PLANNING</u>** **Preparation of AA. Feridhoo Land use plan** Year : 2016 Client: Feridhoo Island Council Position Held: Planner Duties Rendered: Community Consultations, land use planning and reporting **Preparation of K. Himmafushi Land use plan** Year : 2016 Client: Himmafushi Island Council Position Held: Planner Duties Rendered: Community Consultations, land use planning and reporting **Preparation of AA. Bodufolhudhoo Land use plan** Year : 2015 Client: Bodufolhudhoo Island Council Position Held: Planner Duties Rendered: Community Consultations, land use planning and reporting **Formulation of Coastal Protection Regulation, ICCRRIP Project** Client: Ministry of Environment & Energy Position Held: Project Coordinator Duties Rendered: Consultations, Input in formulation of Regulation and reporting **Preparation of AA. Mathiveri Land Use Plan** Year : 2014 Client: Mathiveri Island Council Position Held: Planner

	Duties Rendered: Community Consultations, land use planning and reporting **Development of a National Framework/plan on managing IDP's (internally displaced) persons/population caused by crises, emergencies and climate change** Year : May 2014 –Dec 2014 Client: UNDP/NDMC Position Held: Team Leader Duties Rendered: Overall project coordination and delivery **Preparation of Disaster Management Plan for a Guest House** Year : 2014 Client: Sea Side Lodge Guesthouse Manager, Hulhumale' Position Held: Planner Duties Rendered: Preparation of the disaster management plan according to the guidelines set by **Perceptions and understandings of climate change and migration survey (K.Guraidhoo and R.Dhuvaafaru) carried out by a Norwegian Research Institute** Year : 2013 Client: CICERO - Center for Climate and Environmental Research – Oslo ; Norwegian Academic Institution Position Held: Local Consultant Duties Rendered: Assisted (CICERO to carry out the household survey, focus group discussions and the key informant interviews **Review and Update the Detailed Island Risk Assessment in the Maldives prepared for HDh. Kulhudhuffushi and GDh. Thinadhoo** Year: 2013 Client: Ministry of Environment and Energy Position Held: Social Planner/Project Coordinator Duties Rendered: Review all relevant documents related to DIRAM study, study the social aspects impacting the risks of the islands and overall management of the project. **Preparation of Heritage Action Plan and Preliminary Inventory** Year: 2011 Client: Department of National Heritage Position Held: Team Leader Duties Rendered: Proposed action plan for the protection and safeguarding of national heritage. Prepared a preliminary inventory of the existing tangible and intangible heritage of Maldives **Preparation of Atoll and Island Development Plans for AA. Atoll** Year: 2011 Client: Secretariat of AA Atoll council Position Held: Planner/ Project Manager Duties: Manage and prepare the development plans **Reviewing the Third Tourism Master Plan 2005-2011** Year : 2011

	Client: Ministry of Tourism Arts and Culture Position Held: Planner/Project Coordinator Duties Rendered: Provide input in planning perspective and also over all coordination of the project inclusive of conducting a workshop to present the findings **Preparation of a detailed Layout Plan for Tourism Zone (Asseyri Project)** Year :2011 Client: Ministry of Tourism Arts and Culture Position Held: Planner/Project Coordinator Duties Rendered: Provide input in planning perspective through preparing the layout plan and also over all coordination of the project inclusive of conducting a workshop to present the findings **Appraisal of Hithadhoo Regional Hospital Development** **Location:** S. Hithadhoo, Maldives **Year :**2010 **Client:** OPEC Fund for International Development (OFID) **Position Held:** Socio Assessment Specialist/Project Coordinator **Duties Rendered:** Overall Coordination of the project and carry out social Impact assessment study. **Mapping study of infrastructure and resources for Youth** **Location:** **Year :** 2010 **Client:** UNDP **Position Held:** Assistant project coordinator **Duties Rendered:** Assisting in overall coordination of the project ***Draf RancanganTempatan* DAERAH KUALA LANGAT (*Draft Local Plan* for Kuala Langat District)** **Location:** Kuala Langat, Selangor, Malaysia **Year :**2009 **Client:** JPBD (Town and country planning department, Selangor) **Position Held:** Support consultant **Duties Rendered:** Assisting in the planning process including the report writing, consultations, preparing layout plans and 3D sketch-up models **Reviewing the Master Plan of** Badra and Sweirra, Iraq **Location:** Badra and Sweirra, Iraq **Year :**2009 **Client:**City council, Badra and Sweirra **Position Held:** Support consultant **Duties Rendered:** Providing consultancy on the master plan. Reviewing the EIA and preparing SIA for the master plan of Badra and Sweirra. **HELIPAD Development; PRINCE COURT Hospital** **Location:** Ampang, Kuala Lumpur, Malaysia **Year :**2009 **Client:** **Position Held:** Support Consultant **Duties Rendered:** Reviewing the guidelines for HELIPAD development, preparing proposal presentations for the development

Professional Referees

Name: Najfa Shaheem Raazee
Position: Project Manager of ICCRRIP Project
Email Address: najfa.raazee@environment.gov.mv

Name: Ilan Celman
Position: Former project manager for Perceptions and understandings of climate change and migration survey (K.Guraidhoo and R.Dhuvaafaru)
Email Address: ilan_kelman@hotmail.com

CERTIFICATION

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

Aishath Abdulla
03 July 2017
Contact Number: + (960) 7987809 Email: ayshath.abdulla@gmail.com.

Mariyam Shujaa-ath Abdul Fathah
Musaafaa, Lh. Naifaru
Mobile: 9696169
Email: mariyam.shujaath@gmail.com

EDUCATION

2015
Bachelor of applied science (Honours) - University of Canberra, Australia.

- Title: Metal contamination and mercury speciation in fish of the Maldives.
- First class honours.
- Course GPA: 7.0 out of 7.0.

2012-2014
Bachelor of Environmental science - University of Canberra, Australia.

- Majored in Environmental Chemistry and Analytical Chemistry.
- Course GPA: 5.833 out of 7.0.

2008-2010
College – Edexcel General Certificate of Education.

2005-2007
University of Cambridge general certificate of Education (GCE).

1998-2004:
Primary Education-Madhrasathul Ifthithaah (Maldives).

IELTS overall band score: 8.0 out of 9.0

OTHER TRAININGS

Certificate in Practical Use of FIDIC Contracts, 2018.

Participated in training course on Managed Aquifer Recharge (MAR) under the Enhance Climate Resiliency and Water Security in the Maldives (Maldives GCC) Project funded by USAID.

Course work on Project Management, Cyrix College, Maldives.

WORKSHOPS

Consultant from FENAKA Corporation Ltd. for the formulation of Global Analysis and Assessment of Sanitation and Drinking‐Water (GLAAS) for the Maldives, 2016.

Consultant from FENAKA Corporation Ltd. for workshop to formulate the national strategic action plan and indicator framework for water and sewerage for the Maldives, 2017.

LANGUAGES AND DEGREE OF PROFICIENCY

Divehi- mother tongue
English- fluent

COUNTRIES OF WORK EXPERIENCE

Maldives
Australia

EMPLOYMENT RECORD

2017 to present – Project Manager, Land and Marine Environmental Resource Group Pvt. Ltd., Male', Maldives.

- Project management for the dredging, reclamation and shore protection works for reclamation of 9 islands for resort development purpose at Emboodhoo Lagoon, South Male' Atoll, Maldives.
- Provide the most feasible and environmentally sound advice to the client.
- Field survey to collect data for EIA.
    - Referee
        - Mohamed Aslam
            - Director
            - Land and Marine Environmental Resource Group Pvt. Ltd.
            - Email: mohamed.aslam@lamer.com.mv
            - Telephone: +960 7782 866

2016 to 2017 – Assistant Director, Utilities Services Division, FENAKA Corporation Ltd., Male, Maldives.

- Water quality monitoring for water and sewer branches registered under FENAKA.
- Providing Environmental consultancy for the Company.
- Compiling Environment Impact Assessment reports for projects carried out by the company.
- Head of 29 desalination plants and 32 sewerage systems registered under FENAKA Corporation.
- Overseeing water and sewerage related projects operated under the company.
- Project management of water and waste water related projects of the company.
- Conduct environmental research, environmental surveys and environmental monitoring for the company.
    - Referee
        - Hussein Hameez
            - Director
            - Utilities Services Division, FENAKA Corporation Ltd.
            - Email: hussein.hameez@fenaka.com.mv

- Telephone: +960 7774 602

March 2016 to June 2016- Land and Marine Environmental Resource Group Pvt. Ltd., Male', Maldives.

- Providing environmental consultation to developing and developed resort hotels.
- Compilation of Environment Impact Assessment reports for Government and private development projects
- Assisting in environmental research, environmental surveys and environmental monitoring
- Field survey to collect data for EIA.
    - Referee
        - Mohamed Aslam
            - Director
            - Land and Marine Environmental Resource Group Pvt. Ltd.
            - Email: mohamed.aslam@lamer.com.mv
            - Telephone: +960 7782 866

2015- Research student-Eco chemistry laboratory, University of Canberra Australia.

- Completed honours project on metals and mercury speciation in fish of the Maldives.
- Experienced analytical methods in sampling metals of the fish.
- Mercury speciation analysis techniques.
- Data analysis and statistical methods.
- Web based research work and literature reviews about metals in fish of the Maldives.
- Did research on health related issues on eating fish of the Maldives and able to give consumption advisories about which fish and how much to consume.
- Currently preparing research papers on metals in fish of the Maldives
    - Referees
        - Professor Bill Maher (primary supervisor)
            - Professor in Applied Science
            - University of Canberra, Australia
            - Email: Bill.Maher@canberra.edu.au
            - Telephone: (02) 6201 2531
        - Dr. Simon Foster (secondary supervisor)
            - Assistant professor in Environmental Sciences
            - University of Canberra, Australia
            - Email: Simon.Foster@canberra.edu.au
            - Telephone: (02) 6201 2540

2014- Volunteer research student - Fresh water laboratory-University of Canberra, Australia.

- Report preparation for biological response to flow downstream of Corin, Bendora, Cotter and Googong dams, ACT, Australia.
- Field work to Corin, Bendora, cotter and Googong Rivers.
- Experienced fresh water biological assessment methods and water sampling.
- Sorting macroinvertibrates.
- Processing macroinvertibrates and algae in the laboratory.
- Writing scientific reports.Writing scientific reports.
- Writing scientific reports.
    - Referee
        - Dr. Evan Harrison
            - Technical officer and project manager
            - Institute for Applied Ecology, University of Canberra, Australia
            - Email: Evan.Harrison@canberra.edu.au
            - Telephone: (02) 6201 2400

August 2010 to December 2011- Assisstant cashier, Bank of Maldives

- Handling cash
- Interacting with consumers face-to-face.
- Providing information to customers face-to-face.
    - Referee
        - Mrs. Dheena Mohamed
            - Assistant manager
            - Bank of Maldives, Lh, Naifaru
            - Telephone: 6620319

DETAILED TASKS

Work undertaken that best illustrates capability to handle the tasks assigned: -

PROJECT MANAGEMENT

Project management for the dredging, reclamation and shore protection works for reclamation of 9 islands for resort development purpose at Emboodhoo Lagoon, South Male' Atoll, Maldives.

Location: Emboodhoo Lagoon, South Male' Atoll
Year : 2016 to present
Client: Dream Islands Development Ltd.
Position Held: Project manager
Project Summary: The project involves reclamation of 9 islands, totaling up to a land area of approximately 63 ha which requires about 2.1 million cum of dredged material. This fill material was dredged from a deeper lagoon at North male' Atoll via a Trailer Suction Hopper Dredger. Coastal protection works include construction of revetments and groynes. A marina of depth -4 m is underway as well.
Duties Rendered: Lead the technical teams to deliver the project objectives on time. Providing feasible and sound environmental advice to the client when faced with diverse engineering and technical challenges with a sense of purpose and urgency. Routine site inspections to ensure project works are going smoothly and as per the design. Conduct weekly progress meetings with the Contractor to ensure the work is on schedule and to resolve any issues related to work. Communicate between the Client and the Contractor to ensure project deliverables are smooth and on schedule. Execute all duties of the Engineer as per the FIDIC blue book forms of contract.
Project value: USD 34 Million.

Project management for design and built basis for sewerage collection networks, sewage pumping stations and sea outfall pumping station and allied work in the island of L. Maamendhoo.

Location: L. Maamendhoo
Year : 2016-2017
Client: Ministry of Environment and Energy.
Position Held: Project manager
Project Summary: The project involved design and built of wastewater collection and disposal of a gravity system. The sewer network as designed and built for the entire island of Maamendhoo. Project also involved design and built of pump stations and sea outfall at the most environmentally and socially feasible locations.
Duties Rendered: Monitoring project progress and responsible for overseeing project activities and solve issues. Arrange inspection trips to review project activities.

Project management for provision of sewage facilities in Hithadhoo (central area), Addu City.
Location: S, Hithadhoo
Year : 2016-2017
Client: Ministry of Environment and Energy.
Position Held: Project manager
Project Summary: The project involved all construction works of the waste water collection and disposal of a vacuum system in the central area of Hithadhoo. Provision of house connections, construction of pump stations and sea outfall were part of the project.
Duties Rendered: Monitoring project progress and responsible for overseeing project activities and solve issues. Site inspection of project activities.
Project value: MVR 12 Million.

Project management for consultancy services for survey, design of seweage facilities in F. Biledhoo, GDh. Madaveli, R. Innamaadhoo and Sh. Feevah, Maldives.
Location: F. Biledhoo, GDh. Madaveli, R. Innamaadhoo and Sh. Feevah
Year : 2017
Client: Ministry of Environment and Energy.
Position Held: Project manager
Project Summary: The project involved design of gravity wastewater collection networks for the 4 islands based on the projected population for the coming 30 years. The most environmentally and socially feasible locations for the pump stations and sea outfall were identified via field surveys.
Duties Rendered: Monitoring project progress and responsible for overseeing project activities and solve issues. Assign tasks to the technical team and arrange resources. Identification of most environmentally and socially feasible options. Communicate with the client and report work progress.

ENVIRONMENT CONSULTANCY PROJECTS AND REPORTS

Report preparation for biological response to flows downstream of Corin, Bendora, Cotter and Googong Dams.
Location: ACT, Australia
Year :2014
Client: ACTEW Water, Australia
Position Held: Researcher/surveyor (intern)
Duties Rendered: Assisted in field work to rivers and in processing macroinvertebrates and algae in the laboratory. Data analysis and writing scientific reports.

Environment Impact Assessment report for resort development works at GDh. Havoddaa, Maldives
Location: GDh. Havoddaa
Year : 2016
Client: Crystal Plaza Resorts Pvt. Ltd.

Position Held: Environment Officer
Duties Rendered: Assessment of beach environment of the project site and assisted in compilation of the EIA report.

Environment Impact Assessment report for harbour extension works at GDh. Fares-Maadhoda, Maldives
Location: GDh. Fares-Maathoda
Year : 2016
Client: Ministry of Housing and Infrastructure
Position Held: Environment Officer
Duties Rendered: Assessment of beach environment of the project site and assisted in compilation of the EIA report.

Environment Impact Assessment report for backfilling of lake and boundary wall reconstruction at K. Funadhoo, Maldives
Location: K. Funadhoo
Year : 2016
Client: State Trading Organization Plc. (STO)
Position Held: Environment Officer
Duties Rendered: The study involved groundwater analysis at the backfill area and identification of potential environmental impact areas related to the proposed project boundary area. As such, a mitigation plan was proposed to decrease the identified impacts.

Environment Impact Assessment report for retrofitting of berthing facility and fuel storage capacity at K. Funadhoo, Maldives
Location: K. Funadhoo
Year : 2016
Client: State Trading Organization Plc. (STO)
Position Held: Environment Officer
Duties Rendered: The study involved identification of potential environmental impacts expected to arise from the project and proposing the most cost effective and environmentally less destructive methodologies of implementing the project.

Environment Impact Assessment report for development of sewerage system at Lh. Naifaru, Maldives
Location: Lh. Naifaru
Year : 2016
Client: Ministry of Environment and Energy
Position Held: Environment Officer
Duties Rendered: Preparation of the EIA report based on baseline data, survey data and design methodology as well as proposing the mitigation plan to minimize the identified environmental impacts.

Environment Impact Assessment report for reclamation of Enboodhoo Lagoon to artificially create islands for resort development, Maldives
Location: Enboodhoo Lagoon
Year : 2016
Client: Dream islands development Pvt. Ltd.
Position Held: Environment Officer
Duties Rendered: The study involved thorough surveying of the Lagoon to identify potential reclamation and burrow areas for the creation of new islands using the bathymetric data as well as proposing the most suitable dredging methodologies based on the depths of burrow areas. Identifying methodologies with the least adverse impacts on the environment in addition to being the most cost effective were major components of this study.

Environmental consultancy for reclamation of Enboodhoo Lagoon to artificially create islands for resort development, Maldives
Location: Enboodhoo Lagoon
Year : 2016-2017
Client: Dream islands development Pvt. Ltd.
Position Held: Environment Officer
Duties Rendered: Part of the project management team to advice the client on island design and coastal protection based on existing oceanographic conditions, island modeling and bathymetry as well as to ensure ways of least environmental impacts and that the design conforms to EPA guidelines.

Environment Impact Assessment report for relocation of powerhouses at Th. Omadhoo, Sh. Lhaimagu, Dh. Hulhudheli, R. Rasmaadhoo, HA. Maarandhoo, HA. Uligamu and Sh. Bileffahi, Maldives.
Location: Th. Omadhoo, Sh. Lhaimagu, Dh. Hulhudheli, R. Rasmaadhoo, HA. Maarandhoo, HA. Uligamu and Sh. Bileffahi.
Year : 2016
Client: FENAKA Corporation Ltd.
Position Held: EIA Consultant (Deputy Manager)
Duties Rendered: Preparation of the EIA report based on baseline data, survey data and design methodology as well as proposing the mitigation plan to minimize the identified environmental impacts.

Environment Impact Assessment report for water production and distribution facility at HA. Hoarafushi, HDh. Hanimaadhoo, R. Ungoofaaru, Lh. naifaru, Dh. Kudahuvadhoo. Sh. Milandhoo, Th. Guraidhoo and GA. Villingili, Maldives.
Location: HA. Hoarafushi, HDh. Hanimaadhoo, R. Ungoofaaru, Lh. naifaru, Dh. Kudahuvadhoo. Sh. Milandhoo, Th. Guraidhoo and GA. Villingili.
Year : 2016
Client: Ministry of Environment and Energy
Position Held: EIA Consultant

Duties Rendered: Preparation of the EIA report based on baseline data, survey data and design methodology as well as proposing the mitigation plan to minimize the identified environmental impacts.

Environment Management Plan for the proposed bottling plant at HDh. Kulhudhuffushi.
Location: HDh. Kulhudhuffushi.
Year : 2017
Client: Island Beverages Maldives Pvt. Ltd.
Position Held: EIA Consultant
Duties Rendered: Conduct environmental and social surveys to ensure environmental and social values are preserved during the construction and operation of the project. Preparation of the EMP report based on baseline data, survey data and design methodology as well as proposing the mitigation plan to minimize the identified environmental and social impacts.

Environment Impact Assessment report for Constuction and Operation of Maniyafushi Field Station.
Location: K. Maniyafushi.
Year : 2017
Client: Ministry of Fisheries and Agriculture
Position Held: EIA Consultant
Duties Rendered: Preparation of the EIA report based on baseline data, survey data and design methodology as well as proposing the mitigation plan to minimize the identified environmental impacts.

CURRICULUM VITAE

1. POSITION: Environment Analyst

2. NAME OF FIRM: LaMER Group Pvt.Ltd

3. NAME: Azim Musthag

4. DATE OF BIRTH: 13th December 1985

5. NATIONALITY: Maldivian

6. PERSONAL ADDRESS: M. Anthias, Fulooniya Magu, Malé, Maldives

7. EDUCATION

Bachelor of Marine Science (Majoring in Marine Ecology), Griffith University, Queensland, Australia.

DELF (Diplôme d'études en langue française) Level A1 and Level A2

8. MEMBERSHIP OF PROFESSIONAL SOCIETIES: Master Instructor with the Scuba Schools International (SSI).

9. OTHER TRAINING:

Fish Watch Training Workshop conducted by Darwin Reef Fish Project initiated by the Marine Research Centre of Maldives in collaboration with Marine Conservation Society (UK) in 2009.

IUCN Manta Ray Workshop in 2013.

National Coral Reef Monitoring Framework monitoring protocols training in 2014 conducted by IUCN Maldives.

10. COUNTRIES OF WORK EXPERIENCE: Maldives and Australia

11. LANGUAGE AND DEGREE OF PROFICIENCY:

English - Native or bilingual proficiency
Dhivehi - Native or bilingual proficiency
French - Limited working proficiency

12. EMPLOYMENT RECORD:

2005 - 2011	Dive Instructor, Maldivers Diving Centre, Malé.
2012 – 2014	Dive Instructor, Diveoceanus Dive Centre at Paradise Island Resort
2017 - 2017	Research Assistant Griffith University, Gold Coast, Australia.
2018 (Present)	Environmental Analyst Lamer Pvt Ltd

13. DETAILED TASKS ASSIGNED: **WORK UNDERTAKEN THAT BEST ILLUSTRATES CAPABILITY TO HANDLE TASKS:**

Project: Ecological surveys for the proposed, potential UNESCO biosphere reserves.
Year: 2018

Location: Maldives
Client: IUCN Maldives
Main project features: Surveying of 5 reefs and 3 islands.
Position: Consultant.
Activities performed:
Conducted ecological (marine and terrestrial) surveys at the proposed sites
Data compilation and analysis
Assisted in the final report development.

Project: Environmental Monitoring Report for resort development
Year: 2018
Location: Maldives
Client: Pearl Atoll Pvt Ltd
Main project features: Survey for the Environmental Monitoring Report
Position: Environmental Analyst
Activities performed:
Conducted the marine component of the survey. The seawater quality analysis, sedimentation analysis, reef benthic surveys, and fish surveys.

Project: Environmental Impact Assessment Report for resort development
Year: 2018
Location: Bodufushi, Raa Atoll.
Client: Alibey Maldives Pvt Ltd
Main project features: EIA Survey for an addendum
Position: Environmental Analyst
Activities performed:
Conducted the marine component of the survey. The seawater quality analysis, reef benthic surveys, and fish surveys.

Project: Environmental Impact Assessment for Coastal Protection and Entrance Clearance.
Year: 2018
Location: Bandos Island Resort, Kaafu Atoll.
Client: Bandos Island Resort.
Main project features: EIA Survey
Position: Environmental Analyst
Activities performed:
Conducted the marine component of the survey. The seawater quality analysis, reef benthic surveys, and fish surveys.

Project: Third Addendum to the Environmental Impact Assessment Report
Year: 2018
Location: Enboodhoo Finolhu Lagoon
Client: Dream Islands Development Pvt Ltd
Main project features: Reclamation of Islands for Resort Development at Enboodhoo Finolhu Falhu, South Malé Atoll
Position: Environmental Analyst
Activities performed:
Conducted the marine component of the survey. The seawater quality analysis, reef benthic surveys, and fish surveys.

14. Certification:

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 wilful misstatement described herein may lead to my disqualification or dismissal, if engaged.

Date: 05th August 2018

[*Signature of staff member or authorized representative of the staff]* *Day/Month/Year*

Full name of staff member: Azim Musthag

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Appendices

Appendix 1 List of abbreviations

BPOE - Best Practicable Environmental Options
CPCe - Coral Point Count with Excel extension
DGPS - Differential Global Positioning System
DO – Dissolved oxygen
EPA - Environment Protection Agency
EPPA - Environmental Protection and Preservation Act
ESAMF - Environmental and Social Assessment and Management Framework
ESIA - Environmental and Social Impact Assessment
ESIA - Environmental Impact Assessment
ESMP - Environmental and Social Management Program
ESP - Electrostatic Precipitator
GPS - Global Positioning System
IDA - Development Association
IFD - Intensity Frequency Duration
IWMC - Island Waste Management Centers
MCEP - Maldives Clean Environment Project
ME - Ministry of Environment
MEMP – Maldives Environment Management Project
MNDF - Maldives National Defense Force
MSL – Mean Sea Level
PET - polyethylene terephthalate
RIAM - Rapid Impact Assessment Method
RO - Reverse Osmosis
RTK - Real Time Kinematic
RWMF - Regional Waste Management Facility
SWM - Solid Waste Management
TDS - Total Dissolved Solids
TOR - Terms of Reference
TSS – Total Suspended Solids
UTM - Universal Transverse Mercator
WAMCO - Waste Management Corporation

Appendix 2 Terms of Reference (ToR)

NO: 203-EIARES/438/2018/201

Terms of Reference for Environmental Impact Assessment Report for Upgrading of Infrastructure Regional Waste management Facility Zone 2, Raa Vandhoo

Background

The Regional Waste Management Facility (RWMF) at Vandhoo has been designed to provide long term environmentally sustainable solution for waste management in the North Province. The design of the RWMF has been done considering factors such as waste composition, quantity reaching RWMF, applicability in the local condition and regulatory compliance. Limitations of scarcity of land and the requirement to protect the fragile eco-system have also been considered during the design of RWMF.

The initial area allocated for the Regional Waste Management Facility is 15 hectares. Within these 15 hectares RWMF facility shall comprise of following components: Waste unloading and primary segregation platform, Temporary storage for recyclables, Incinération plant, Landfill cell, Leachate collection and management system, Coastal protection structure, Fencing, Berth and access channel, Administration building; and, Roads and storm water drains.

As major component of the facility, Incineration of the municipal waste, after recovery of recyclables and removal of inert materials, is proposed at the RWMF. Incineration will not only destroy the potentially harmful substances in the waste, but also reduce the volume of the waste for disposal in landfill. Incineration is also the most suitable processing technology for management of heterogeneous mixed waste, transported from islands and resorts.

The incinerator design capacity has been derived based on combustible fraction available in the waste. Primary level segregation / presorting has been proposed to avoid the incineration of wastes that contain

metals and metalloids, have potential to volatilize and are difficult to control through air emission technology (e.g., mercury and arsenic).

The incinerator is designed considering an average of 10 years of incoming waste quantities, with an operational life of 20 years. An incinerator of 40 TPD installed capacity have been proposed for managing the waste from 2012-2032.

This project was completed in 2015 and follow-up application for additional grant from WB under 'Maldives Clean Environment Project' became effective in September 2017. This project supports investment activities on going in Vandhoo as part of Zone 2 development activities.

The following is the terms of Reference for EIA for **Upgrading of Infrastructure Regional Waste Management Facility Zone 2, Raa Vandhoo**. This ToR is prepared on the basis of the scoping meeting held at EPA on **03/12/2018** in consultation with representatives from the proponent, **Ministry of Environment** and representatives from other institutions. The EIA consultant of the project is **Mr. Hussain Zahir (P04/2007).**

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

The components of the EIA report would be based on the discussion during the scoping meeting as follows:

1. **Introduction and rationale:** Description of the purpose of the project including the rational giving a brief history of the project describing how the project will improve waste management in the region.

Provide details of the proponent and institutional arrangements for the successful implementation of the project. Describe how the proposed project will improve waste management in the area.

2. **Study area:** Submit a scaled plan with indications of all the proposed. Specify the boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include:

- Location map (at a suitable scale) of the proposed development sites;
- Adjacent or remote areas including relevant developments and nearby environmentally sensitive sites (e.g. coral reef, mangroves, marine protected areas, turtle nesting area, bird nesting or roosting areas etc.); Relevant developments in the nearest areas and adjacent islands including residential areas, all economic ventures and cultural sites (if any in the immediate project area).
- Map delineating the waste catchment area of the facility.

3. **Scope of work:** the following components will be assessed and described as part of the scope of work.

Task 1. Description of the Proposed Project

Describe the RWMF infrastructure (fuel storage, water tanks etc.) proposed to be installed or upgraded including location, plant layout and its position in relation to surrounding land uses using maps and drawings where appropriate. Maps should also show the setting and precise location in relation to the relevant aspects of the project area, in particular:

- the location and boundaries of current or proposed land tenures that the project area will be subject to,
- the location and boundaries of the project footprint, including easement widths and access requirements,
- the location of any proposed buffers surrounding the working areas (for construction and operation),
- the location of natural features such as wetlands etc.
- Description of existing waste management arrangements in the RWMF should be outlined giving reference to the estimated type and quantity of waste received and processed at the facility, the present method of waste collection and management and the condition of existing

facilities such as the incinerator, leachate collection pond, waste storage cells / bunkers, fuel storage tanks, RO plant etc. Challenges and issues current faced by the waste operator should be also highlighted and corrective measures should be proposed.

- Identification of the emissions likely to be of concern and the environmental aspects of the project area which may potentially be impacted by the project.

Provide a full description and justification of the relevant parts of the proposed upgrading works, using maps at appropriate scale where necessary. All inputs and outputs related to the proposed activities shall be justified. The following should be provided.

- Construction of water tanks with extension of distribution network
  - Number of tanks, location and size, and the materials proposed for the construction of water tanks and network pipes.
  - Describe equipment needed and construction methods for laying the pipeline including handlining and transportation.
  - The route of the pipeline should be clearly indicated and marked on a map.
  - Details of vegetation clearance if any.
- Construction of new fuel storage tanks and relocation of existing fuel storage tanks
  - Number of fuel storage tanks, location and size.
  - Method and equipment used for tank construction.
  - The type of fuel that will be stored in the tank.
  - Location of inlet and outlet pipes.
  - Justification for the selected location and material from a fire safety perspective (such as not located close to highly flammable waste management areas, use of fireproof materials, firefighting equipment soured near tanks etc.)
  - Details of vegetation clearance if any.
- Rehabilitation of the existing ash disposal landfill and leachate pond (with pumps).
  - Proposed method for landfill rehabilitation and equipment to be used.
  - Details of the ash disposal cells including capacity, dimensions, design specifications and phased development plans.
  - Type and specifications of pumps proposed for leachate ponds.
- Upgrading / upscaling of the existing fire protection system
  - Type of firefighting equipment or system and locations.