Environmental Impact Assessment Report

Construction and Operation of Maniyafushi Field Station
Maniyafushi, Kaafu Atoll

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Prepared for: Ministry of Fisheries and Agriculture

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Land and Marine Environmental Resource Group Pvt Ltd, Maldives

Table of contents

Table of contents.....ii
List of Tables.....iv
Consultants Declaration vi
Details of consultants participate in preparation of EIA report vii
Proponents Declaration viii
1 Non-technical Summary ix
Background.....ix
Key impacts, mitigation measures and alternatives ix
ꋍꋬꋞꋍꋏ.....xi
ދިގުފަހުރުގެ ކުށްވަށް، ތަނާ ގުޅުންހުރި ކަންކަމާ ގުޅޭގޮތުން ކުރިއަށްގެންދާ ބަލަހައްޓާނެ ގޮތުގެ ސުރުޚީ xi
2 Introduction 2-13
2.1 Purpose of the report and need for the EIA 2-13
3 Terms of Reference (ToR).....3-15
4 Project Setting.....4-16
5 Project Description 5-20
5.1 Project Proponent.....5-20
5.2 The Project 5-20
5.2.1 Existing facilities 5-20
5.2.2 Construction phase 5-21
5.2.3 Operational phase 5-22
5.3 Need for the Project 5-25
5.4 Location and Extent of Site Boundaries 5-25
5.5 Project management.....5-26
5.5.1 Construction phase and schedule for implementation.....5-26
5.6 Major Inputs and Outputs 5-26
5.6.1 Inputs (description of the project in terms of raw materials, processes, equipment and work force)5-26
5.6.2 Power generation facility.....5-33
5.6.3 Waste management.....5-34
5.6.4 Wastewater 5-35
5.6.5 Safety measures during construction and operation 5-35
5.6.6 Outputs.....5-35
6 Methodology.....6-36
6.1 Physical surveys.....6-36
6.1.1 Marine Environment.....6-36
6.1.2 Shoreline survey 6-37
6.1.3 Bathymetric survey.....6-37
6.2 Water quality analysis.....6-37
7 Existing environment.....7-38
7.1 Geographic location of Maniyafushi 7-38
7.2 Geology and geomorphology.....7-38
7.2.1 Shoreline and vegetation 7-39
7.3 Bathymetric survey 7-41
7.4 Climate.....7-41
7.4.1 Wind Climate.....7-41
7.4.2 Tide.....7-46
7.4.3 Wave and Current.....7-47

7.5 Marine environment 7-48
7.5.1 Reef survey 7-48
7.5.2 Seawater quality 7-52
7.6 Groundwater quality 7-53
8 Stakeholder consultation 8-55
8.1 Consultation with EPA 8-55
8.2 Consultation with Health Protection Agency (HPA) 8-55
8.3 Consultation with Kaafu Atoll Council 8-55
9 Environmental Impacts 9-56
9.1 Impact Identification 9-56
9.2 Limitation or uncertainty of impact prediction 9-58
9.3 Constructional Impacts 9-58
9.3.1 Loss of marine habitat 9-58
9.3.2 Impact on shoreline/ shoreline and erosion 9-59
9.3.3 Impacts on seawater quality 9-59
9.3.4 Pollution of the natural environment 9-59
9.3.5 Impact on air quality and noise 9-59
9.3.6 Impacts on groundwater quality 9-59
9.3.7 Risk on health and safety 9-60
9.4 Operational impacts 9-60
9.4.1 Impact on seawater quality 9-60
9.4.2 Impact on marine environment 9-60
9.4.3 Impacts on landscape integrity and scenery 9-61
9.4.4 Socioeconomic impact 9-61
9.4.5 Risk of introduction of alien species 9-61
9.4.6 Impact Analysis 9-61
10 Alternatives 10-65
10.1 Considered alternatives 10-65
10.1.1 Location of seapen construction 10-65
10.1.2 The no-project scenario 10-65
11 Mitigation Plan 11-66
12 Monitoring Program 12-68
13 Conclusion and recommendation 13-70
Acknowledgements 13-71
References 13-72
Appendices 13-73
Appendix 1 List of abbreviations 13-74
Appendix 2 Terms of Reference (ToR) 13-75
Appendix 3 Land Use Plan of Maniyafushi 13-76
Appendix 4 Powerhouse building and distribution map 13-77
Appendix 5 Fuel tank design 13-78
Appendix 6 Lightening protection layout 13-79
Appendix 7 Environmental and Social Management Plan (ESMP) of Maniyafushi Field Station 13-80
Appendix 8 Island survey map of Maniyafushi (Oct 2017) 13-81
Appendix 9 Bathymetric survey map 13-82
Appendix 10 Water test results report 13-83
Appendix 11 List of stakeholders consulted 13-84

List of Tables

Table 1. Legislations pertaining to the project 4-16
Table 2. Work schedule for the proposed project....5-26
Table 3. Major inputs required for the proposed project and their outputs....5-27
Table 4. Building sizes of the facilities to be constructed under this project....5-30
Table 5. Estimated workforce required for the project....5-33
Table 6. GPS Coordinates of marine and groundwater sampling locations....6-37
Table 7. Summary of shoreline survey (taken from Land Area Registration Survey Report provided by Marine Research Centre) 7-39
Table 8. The four seasons experienced in the Maldives....7-42
Table 9. Hourly wind data from Hulhule Meteorological station 7-43
Table 10.The traditionally defined seasons experienced in Maldives compared with the current analysis of seasonal winds per month 7-44
Table 11. Summary of tide level at Ibrahim Nasir International Airport, Male Atoll 7-47
Table 12. Details of substrate composition at sites R1-R3, as observed on 23 December, 2017 7-49
Table 13. Results of seawater quality tests performed by MWSC (lab reports in Appendix 10) 7-53
Table 14. Results of seawater quality tests performed in-situ (using Hanna HI9828 probe)7-53
Table 15. Results of seawater quality tests performed in-situ (using Hanna HI9828 probe)7-54
Table 16. Impact prediction categorized 9-56
Table 17. Grading scales for the four impact evaluation criteria 9-57
Table 18. Assessment of Probability of impact from project activities 9-62
Table 19. Assessment of significance of impact from project activities....9-63
Table 20. Assessment of duration of impact due to project activities....9-63
Table 21. Assessment of magnitude of impact due to project activities 9-64
Table 22. Identified possible impacts and their relevant mitigation measures....11-67
Table 23. Monitoring programme for construction phase of the project 12-68

Table of Figures

Figure 1. Sites selected for grow-out pens (image sourced from project brief provided by client) 5-26
Figure 2. Proposed design of the sea cucumber grow-out pen....5-28
Figure 3. Off-bottom sea cucumber grow-out cage....5-29
Figure 4. Top view of grouper cage 5-29
Figure 5. Sea water intake system 5-30
Figure 6. Floor layout plan of broodstock holding facility 5-31
Figure 7. Floor layout plan of algae culture greenhouse 5-32
Figure 8. Sampling locations of marine environment and groundwater quality 6-36
Figure 9. Location of South Male Atoll in Maldives archipelago (A), location of the Maniyafushi at South Male Atoll (B) and Drone image of Maniyafushi (C) 7-38
Figure 10. Aerial and satellite images of Maniyafushi showing changes to the shoreline and island over the years 7-39
Figure 11. Drone image showing beach on the southeastern side of the island....7-40
Figure 12. Erosion prone areas observed at the island 7-40

Figure 13. Schematic showing Low Water Line (LWL), High Water Line (HWL) and Vegetation line (Veg) at Maniyafushi taken during survey for Land Area Registration and for EIA data collection (larger scaled drawing is provided in Appendix 8).....7-41
Figure 14. Wind rose plot for Hulhule' Meteorological station, based on mean daily wind data for the period of January 1998 to December 2015 (left) and maximum daily wind data (right) for the period of January 2008 to December 2015. 7-43
Figure 15. Monthly wind rose plots for Hulhule' Meteorological station, based on mean daily wind data for the period of January 1998 to December 2015 7-45
Figure 16. Monthly wind rose plots for Hulhule' Meteorological station, based on maximum daily wind data for the period of January 2008 to December 2015 7-46
Figure 17. Schematic showing anticipated wave and current regime at the reef system 7-48
Figure 18. Percentage composition of live cover at sites R1 – R3, as surveyed on 23 December, 2017.....7-50
Figure 19. Representative photographs of site R1, as surveyed on 23 December, 2017 7-51
Figure 20. Representative photographs of site R2, as surveyed on 23 December, 2017 7-51
Figure 21. Representative photographs of site R3, as surveyed on 23 December, 2017 7-52

Consultants Declaration

I certify that to best of my knowledge the statements made in this Environmental Impact Assessment report for "Construction and Operation of Maniyafushi Field Station" are true, complete and correct.

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Consultant Registration Number: EIA P04-2007

Signature:

Company Name: Land and Marine Environmental Resource Group Pvt Ltd

Date: 14th January 2018

Details of consultants participate in preparation of EIA report

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Project description	Hussein Zahir Mariyam Shujaath	P04-2007	
Project setting	Mariyam Shujaath		
Existing Environment	Hussein Zahir Mariyam Shujaath	P04-2007	
Impact, alternatives and Mitigation	Hussein Zahir Mariyam Shujaath	P04-2007	
Stakeholder consultation	Hussein Zahir Mariyam Shujaath	P04-2007	
Monitoring	Hussein Zahir	P04-2007	
Recommendation and Conclusion	Hussein Zahir	P04-2007	

Proponents Declaration

بسم الله الرحمن الرحيم

" ދިވެހިންގެ ކަނޑުގެ ދަތުރުތައް - ދިރިހުރި ދުވަހުގެ ގަސްދުން "

MARINE RESEARCH CENTRE
Ministry of Fisheries and Agriculture
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ފިޝަރީސް ޔުނިވަރސިޓީ ކެމްޕަސް
ފ - ފިލަދެއްދޫ

Ref: 30-MRC-ADM/203/2018/1

11 January 2018

Ibrahim Naeem
Director General
Environmental Protection Agency
Green Building
Male', Maldives

Subject: Proponents declaration and letter of commitment

Dear Sir,

As proponent of the project "Construction and Operation of Maniyafushi Field Station", 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 EIA report are true.

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

Sincerely,

Shafiya Naeem
Aquatic Pathologist

1 Non-technical Summary

Background

The proposed project is a continuous project implemented by the MRC and executed by MOFA, which will seek funds for its continuation. The project is an extension of an existing mariculture research and development operation, focusing on research and development of mariculture techniques for the brown marbled grouper, milkfish, sandfish and local varieties of sea cucumbers such as the white teatfish. In addition, the project will target on establishing research and capacity for coral reef studies and reef fisheries.

In the immediate term, mariculture research and development capacity will be established to facilitate the establishment and development of a mariculture industry in the country. The project aims at establishing production capacity for approximately 25,000 pieces of fingerling size groupers per production cycle to pilot viability of grow out operations. Further, the project aims at developing research capacity for sea cucumber hatchery technology as well as the production of milkfish.

Key impacts, mitigation measures and alternatives

Impacts on the environment from various activities of the construction work and during the operation of the facility have been identified through interviews with the project management team, field data collection and surveys are also based on past experience of consultant in similar development projects. The impacts identified are also described according to their location, extent and characteristics. Mitigation measures have also been identified for impacts which are irreversible in nature.

Impact analysis was done using the Leopold matrix. Impact analysis showed that impact of highest significance is on seawater quality as majority of the project is established in the lagoon and sea.

The proposed development is expected to bring significant socioeconomic impacts on the locals, especially the island communities as the project will mainly focus on training Atoll communities interested in grouper and sea cucumber farming on a large scale. Since there is a high demand for export business of these two species, it will bring high economic benefits to the local communities. Moreover, it will create many job opportunities especially for the unskilled workers.

Mitigation measures are discussed in the report for potential impacts, including measures to minimize the impacts on seawater quality, such as regular change of water (by 25%) of the closed

hatchery system and avoiding trampling outside project boundary. Detailed mitigation measures are discussed in Section 11 of the report.

Alternatives have been considered for the specific location of the grow-out pens. The ‘no project’ alternative is also considered. If this alternative was to be chosen, this would mean that all negative environmental impacts which would arise due to construction would not be there. However, the ‘no-project’ scenario would take away an opportunity the local communities to explore a highly rewarding economic venture.

1. ޚުލާޞާ

ތައާރަފު

މި ޚުލާޞާއިން ދައްކައިދެނީ ކ. މަނިއަދޫފަރުގައި އުޅުމަށް ހަމަޖެހިފައިވާ ޔާއްމުންނަށް ފޯރާ އާއި ތަނުގެ އާލާކުރުމުގެ ދަރަސްކުރާ ކޯސް ހަދައިދިނުމުގެ ގޮތުން ހަދާ މެނުކަލްޗާ ފްލެޓްސް އުޅުމުގެ ކުރިން ތަޢައްޚުރުކޮށްފައިވާ ބިމާފައްޓަން އަސަރު ފޮރާން މިންވަރު ބަޔާންކުރާ ރިޕޯޓުގެ ހުލާސާކަމުގެ ޚުލާޞާއެކެވެ. މިމަޝްރޫޢުގެ އުފާއްދަކަމަށް މިނިސްޓްރީ އޮފް ފިޝަރީޒް އެންޑް އެގްރިކަލްޗާ އާއި މުރިން ރިސޯޓް ސަންރައިޒް ފުޅުގެން ފޯރާ އާއި ތަނުގެ އާލާކުރުމުގެ ރިސޯޓް މާލޭފުޅަ މަނިއަދޫފަރުގައި ދަނީ ކުރުފުޅުންނެވެ. މި ޕްރޮޖެކްޓްގެ ދަށުން މަސައްކަތް ކުރާނެދުވަސް ފުންޏާއި ފާސްފުޅު ހަދަފު ކުރުން ހިމެނެއެވެ.

ބިމާފައްޓަން ކޮންފަށް އަސަރު، އަދި މިއަސަރު ކުޑަކުރުމަށް އެޅިދާނެ ފިޔަވަޅުތަކާއި ބަދަލުގައި ކުރެވިދާނެ ކަންތައް

މިމަޝްރޫޢުގެ ސަބަބުން ބިމާފައްޓަން ކޮންފަށް އަސަރުގެ ބޮޑުބައެއް މައްޗަށް ހިފައިހިފުން މަޝްރޫޢު ހިންގާ ފަރާތްތަކުގެ ވޯކަ ދެކެވިގެންނާއި، ފިޔުރެ މަސައްކަތަށް އެއްކަރުވެން މައްސަލަތަކުގެ މައްޗަށް ބަލާކުރިވެގެންނާއި، މިގޮ ކުރިން ކުރިވިފައިވާ މިފަދަ މަސައްކަތްތަކަން ކޮންސަލްޓަންޓަން ލިބިފައިވާ ތަޖުރިބާގެ މައްޗަށް ބަލާކުރެވޭ. މިގޮތަށް ހިފުފައިވާ އަސަރުތައްވެސް އަސަރުކުރާ ސަރަހައްދު، އަސަރުގެ ކުޑަ/ބޮޑުމިން އަދި އުމުރުމުން ސިފަތަކުގެ މައްޗަށް ބަލާކުރިވެއެވެ. އަދި މިއަސަރުތައް ކުޑަކުރުމަށް އެޅިދާނެ ފިޔަވަޅުތައްވެސް ބަޔާންކުރިވިފައިވާނެއެވެ.

މިމަޝްރޫޢުގެ ސަބަބުން ކޮންފަށް އަސަރުކުރާނެ ހިފައިހިފުން ފިއްޓާލާ މަޤުރިބްސަށާއެއްގެ އެހިގައެވެ. މިމަޝްރޫޢުގެ ސަބަބުން ކުރަން އެންމެ ބޮޑުވާ އަސަރަކީ ކަނޑުގައި ފެންނަކުނު ފަށްފަރުގެ ކޮޅިޖަށް ކޮންފަށް އަސަރުވެކަމެވެ. އޭގެ ފޯރާ އާއި ތަނުގެ އާލާކުރަން ހަދާ ކޮރިޖަށް ހުންނަނީ މުދުގައި ކަމަށްވާތީއެވެ.

މިމަޝްރޫޢުގެ ސަބަބުން ކުރާނެ ބަޔަކު އަސަރުތަކުގެ ތެރެއާގައި އެންމެ ފައިދާ ބޮޑު އަސަރެއްކަމަށް ފެންނަނީ އާއްމުންނަށް ފޯރާ އާއި ތަނުގެ ބޮޑުކުރުގެ ވިޔަފާރި ފުރުސަތުއިތުރުކުރާއެއްގައި ކަން ބަޔަކު އުމުރީހާއެއް ހުރިހުރި ފުރުސަތުތަކު ހުރިމިވެން ދިއުމެވެ. މީގެ އިތުރުން މީގެ ސަބަބުން މަޤާ ތަޢުލީމު ދާއިރާކުރުގެ ފުރުސަތުތަކެއް ލިބޭފައިސާ އެތައް ފަރުތަތްކަކަން ބަޔަކު އާމްދަނީއެއް ހުރުމުގެ މަގު ފަހިވެގެންދާނެއެވެ.

މަޝްރޫޢުގެ ސަބަބުން ކޮންފަށް އަސަރުތައް ކުޑަކުރުމަށް އެޅިދާނެ ފިޔަވަޅުތަކަކަށްވެސް މިރިޕޯޓުގައި ބަލާލާފައިވާނެއެވެ. މިގޮތުން މިމަޝްރޫޢު ފުރުމަތިކަރު ބޭނުމާ ފެނަކަ ކޮންފަށް ނުރުކު އަސަރު ކުޑަކުރުމަށް ހެދޭނީ ފެންގަނޑުގެ 25% ކޮންމެ

ދުވަހަކުވެސް ބަދަލުކުރަން ހިމެނެއެވެ. ތިމާވެއްޓަށް ކުރާ އަސަރު ކުޑަކުރުމުގެ ގޮތުން އެޅިދާނެ އިތުރު ފިޔަވަޅުތަކުގެ ތަފްސީލު މިރިޕޯޓުގެ ސެކްޝަން 11 ގައި ބަޔާންކުރެވިފައިވާނެއެވެ.

މިމަޝްރޫޢުގައި މަސައްކަތް ކުރިއަށް ގެންދިއުމަށް ޚަރަދުވާ ގޮތުގެ ބަދަލުގައި ކުރެވިދާނެ ކަންތައްތަކުގެ ތަފްސީލުގައި ބަޔާންކުރެވިފައި ވަނީ ޗާޓަ އާއި ޤަނޫނާ އާލާތަކާ ކުރިމަތި ބަދަލުކޮށްފައި އެކަން ދިމާވެދާނެތީއެވެ.

މަޝްރޫޢު ކުރިއަށް ނުގެންދިއުންވެސް އިޚްތިޔާރެއްގޮތެވެ. މިގޮތުން ހިއާރުކޮށްފިނަމަ މިމަޝްރޫޢުގެ ސަރަޙައްދު ތިމާވެއްޓަށް ކުރާނެ އަސަރުތަކެއް ނުކުރާނެއެވެ. އެހެންނަމަވެސް މިމަޝްރޫޢުގެ ސަރަޙައްދު ލިބޭނީ ފައިދާތަކެއް ބޭރުވުމުގެ ސަރަޙައްދުން މިދެ ކަމުދާ ގެއްލުންކަމުގައި ފެނެއެވެ.

2 Introduction

The livelihood of Maldivians is highly dependent on tuna fisheries. The decline in tuna fisheries in the Maldives, has, over the past years, been affecting the livelihood of many island communities who were highly dependent on the income generated from this industry. To improve the situation, the Government of Maldives has initiated development of aquaculture or mariculture as an alternative source of livelihood which would reduce the pressure on natural stocks of tuna and reef related fishery activities.

Mariculture, however, is a new field in the Maldives and development of mariculture in the country requires transfer of technology from other countries and capacity building in research, biosecurity, aquatic animal health and provision of training and extensive services.

To initiate mariculture development in the country, some pilot activities have been carried out by the Marine Research Centre (MRC) of Ministry of Fisheries and Agriculture (MOFA). These activities include pilot scale half-round pearl culture, grouper culture, ornamental fish culture and seaweed culture. Efforts are being made to commercialize these activities. Currently, sea cucumber (sandfish) culture is being carried out on a commercial scale by the private sector.

To facilitate mariculture development and increase research capacity of MRC in fisheries and coral reef, a field station is being developed on Maniyafushi Island in South Male' Atoll. Currently the station has very limited facilities. With the available facilities some small scale research activities are being carried out in the station. The project "Construction and Operation of Maniyafushi Field Station" will establish the basic facilities of the station, which will improve the research capacities of MRC.

The estimated investment cost of the proposed project is MVR 31,317,925.00 Funding for the infrastructure component of the project will come from the Public Sector Investment Program (PSIP) implemented by the Government, and external sources. Funding for the operational phase research and development activities and mariculture activities is expected from the annual recurrent budget of the government and external sources.

2.1 Purpose of the report and need for the EIA

This document presents the findings of an Environmental Impact Assessment (EIA) for the construction and operation of Maniyafushi field station. Developers of such development projects are required to carry out EIA studies under the Environmental Act of Maldives. The

developer is required to obtain approval of the Environmental Protection Agency (EPA), prior to the implementation of any development activities on the island.

Land and Marine Environmental Resource Group Pvt Ltd won the bid for the project to prepare the EIA and to provide assistance in other environmental related activities. This EIA is prepared in accordance with Environmental Impact Assessment Regulations 2012 and the environmental policy and guidelines of the Government of Maldives.

3 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 EIA based on the impacts associated with the project.

In accordance with the regulations of Ministry of Environment and Energy, an EIA application form and project brief was sent stating the nature of the project and likely impacts associated with the environment. The scoping meeting was held at the Environmental Protection Agency (EPA) on the 14th of December 2017 with the project proponent, consultant and EPA officials. Based on the discussions at the meeting, draft TOR which had been submitted was finalized and approved by EPA on the 14th of December 2017 (see Appendix 2).

The EIA report is prepared as per the TOR given by EPA. All efforts have been made to address the requirements identified in the TOR.

4 Project Setting

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. Furthermore, it adheres to the principles underlined in the regulations, action plans, programs and policies of the following Ministries of the Government of Maldives.

- Ministry of Environment and Energy (MEE)
- Ministry of Fisheries and Agriculture (MOFA)

These are discussed in detail in Table 1 below.

Table 1. Legislations pertaining to the project

Legislation	How does current project conform to legislation
Environmental Protection and Preservation Act (Law 4/93)	EIA undertaken as stipulated in the Act, which states that any developmental project which has a potential impact on the environment should have an EIA done prior to commencement of the project. List of such projects are given in the EIA Regulations 2012
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. The proposed project will conform to the regulation, by first submitting an application to carry out dewatering within the project site. The proponent will also carry out all the additional measures necessary to obtain the approval for EPA and to abide by the regulation.
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 (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 and MWSC fuel tanks have a capacity of 200 tonnes (approximately 6350 gallons) which as per the regulation means that there should be a distance of 15ft between the bund wall of the tank and other residential areas adjacent to the plot. There should

	also be a distance of 5ft between the bund wall and other properties within own plot. 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.
Third National Environment Action Plan (2009 – 2013) (NEAP III)	This guide developed by the Ministry of Housing and Urban Development (MHUD, 2005) classifies islands into 5 different categories. Lh.Naifaru is classified as a Category B island, which includes inhabited islands that are not developed as Urban Centres. It states that the preparation of land use plans for such islands shall be supervised by the relevant government office, in this case, Ministry of Home Affairs, with the advice of Urban Development Department of MHI. When planning these islands, the relevant government office shall seek advice of MHI. The guidelines also refer to a minimum of 20m wide Environmental Protection Zone (EPZ), consisting of vegetation to be provided around the outer periphery of the island between the beach and rest of the island. However, it also states the EPZ's can be excluded from areas where the land use is for harbor frontage or for commercial use.
National Biodiversity Strategy and Action Plan (NBSAP)	The objective of NBSAP was to *"achieve biodiversity conservation and sustainable utilization of biological resources in the Maldives"* by integration of biodiversity conservation into all areas of national planning, policy development and administration (MHAHE, 2002). To achieve this objective, one of the first actions listed is "formulation and adoption of suitable development planning procedures, land use plans and strengthening of the EIA process". The current project conforms to this policy, by carrying out the EIA prior to commencement of the project, so as to minimize impact on the environment and to incorporate ways of environmental monitoring and management during the project works.
Waste Management Regulation (R-58/2013)	This Regulation was gazetted on the 5th of August 2013 and came into effect 6 months from the date, on 5th of February 2014. The main objective of this regulation is to implement the national policy on waste management. Article 8 of the regulation addresses management of hazardous waste, where Section Raa specifies that transport of hazardous waste from one location to

	another should be in a manner where the waste is packed in tightly sealed containers so as to prevent leakage. The Article further specifies that hazardous waste should not be dumped or burnt under any circumstance. Hazardous waste has to be separated and stored separately in a manner which ensures no leakage of waste. As per the regulation, hazardous waste generated during the project will be collected and stored separately and as per the regulation. Transportation will also be as per the Regulation.

5 Project Description

5.1 Project Proponent

The proponent of the proposed project is the Ministry of Fisheries and Agriculture.

5.2 The Project

The proposed project is a continuous project implemented by MRC and executed by MOFA, which will seek funds for its continuation. The project is an extension of an existing mariculture research and development operation, focusing on research and development of mariculture techniques for the brown marbled grouper (*Epinephelus fuscoguttatus*), milkfish (*Chanos chanos*), sandfish (*Holothuria scabra*) and local varieties of sea cucumbers such as the white teatfish (*Holothuria fuscogiva*). In addition, the project will target on establishing research and capacity for coral reef studies and reef fisheries.

In the immediate term, mariculture research and development capacity will be established to facilitate the establishment and development of a mariculture industry in the country. The project aims at establishing production capacity for approximately 25,000 pieces of fingerling size groupers per production cycle to pilot viability of grow out operations. Further, the project aims at developing research capacity for sea cucumber hatchery technology as well as the production of milkfish.

Proposed project has the following components:-

- Mariculture research and demonstration facility;
- Coral reef and fisheries research; and
- Coral reef and fisheries training

Mariculture research and demonstration facility component is highly targeted for the establishment of the mariculture industry in the country. It includes mariculture research and development, training, extension and demonstration. It is the major component of the station. The other two components are more general and addresses the coral reef fishery issues as they arise.

5.2.1 Existing facilities

Maniyafushi is an already established island as a training and demonstration facility for sea cucumber and grouper hatchery facility. Therefore, power generation, RO plant, hatchery,

seawater intake wells, pump stations, water intake and outfall pipelines, hatchery discharge, STP with sewer discharge, mosque, staff headquarters and jetty already exist on the island.

However, extension of some of these facilities are included in the proposed development which include the following:-

- Extension of existing powerhouse,
- Demolish and construct a four storey staff headquarter
- Warehouse/workshop
- Demolish existing mosque and reconstruction
- Road paving

The Land Use Plan (LUP) of Maniyafushi is attached in Appendix 3 of this report.

5.2.2 Construction phase

The construction phase will involve demolition of some of the existing infrastructure and the construction of all infrastructure required to complete the mariculture research and development facility. The infrastructure development will be planned to minimize the cutting down of existing trees.

The scope of this phase include the following:-

a) Demolition of existing staff accommodation building;
b) Construction of a 4-storey staff accommodation building with all necessary support services (195 m^2);
c) Construction of broodstock unit (195 m^2);
    i. Round concrete tanks (121 tons x 2 nos);
    ii. Rectangular concrete tanks (37 tons x 2 nos);
d) Construction of live feed culture unit (198 m^2);
    i. Fiberglass tanks rectangular for algae culture (1.6 tons x 10 nos);
    ii. Fiberglass tanks round for algae culture (0.5 tons x 6 nos);
    iii. Fiberglass tanks round for algae culture (1.5 tons x 4 nos);
    iv. Fiberglass tanks rectangular for rotifer culture (1.6 tons x 4 nos);
    v. Fiberglass tanks round for rotifer culture (0.5 tons x 4 nos);
    vi. Fiberglass tanks for rotifer enrichment (0.6 tons x 5 nos);
    vii. Fiberglass tanks for brine shrimp culture (1.5 tons x 2 nos);
e) Construction of 4-storey laboratory unit (68 m^2);
f) Construction of warehouse (65 m^2);

g) Deployment of square, High Density Polyethylene (HDPE) floating cages for grouper grow-out pilot (8 unit of 8 cages; dimensions: 3m x 3m/cage; with UV protected HDPE cage nets);
h) Deployment of square, HDPE floating cages for milkfish grow-out pilot (1 unit of 8 cages; dimensions: 3m x 3m; with UV protected HDPE cage nets);
i) Deployment of square, HDPE floating cages for grouper broodstock conditioning (2 unit of 3m x 3m cages with UV protected HDPE cage nets); and
j) Deployment of round, HDPE floating cages for milkfish broodstock conditioning (2 unit of 10m diameter cages with UV protected HDPE cage nets);

5.2.3 Operational phase

The operation will involve the following components:-

a) Grouper culture;
    i. Scaling up of an existing pilot research on breeding the brown marbled grouper (*Epinephelus fuscoguttatus*) to obtain a production of approximately 25,000 fingerling-sized animals in the hatchery, and trailing their grow-out in sea cages;
    ii. 22 locally sourced grouper broodstock will be maintained in 3m x 3m x 4m floating cages at a stocking density of 4.3 kgm^{-3}, fed daily and monitored for their health and spawning behavior;
    iii. Grouper broodstock will be fed with dark meat usually discarded from tuna processing factories;
    iv. The broodstock will be monitored for natural breeding in captivity, the cages will be lined just before spawning occurs, in order to catch the fertilized eggs;
    v. In addition, broodstock conditioning in in-land tanks will be tested as a method to achieve a more reliable, regular production;
    vi. Fertilized eggs will be scooped from broodstock cages and transferred to hatchery for incubation;
    vii. Egg incubation stocking density range from 50-100 eggs/liter;
    viii. The hatched larvae are transferred to larval rearing tanks for larval rearing 7 tons tanks are used at an initial stocking density of 20-30 larvae/liter;
    ix. Rotifer (*Brachionus plicatilis*), enriched with mixed microalgae cultures, will be introduced as live food organisms to 3 day old larvae, at a density of 3-5 individuals/ml. The larvae will be fed on rotifers until 28 days post hatch;
    x. Cultures of rotifer will be maintained continuously in the live feed culture units at adequate quantities to feed the first feeding larvae;

xi. The brine shrimp (*Artemia salina*) will be introduced on day 17 post hatch, at a density of 2-3 individuals/ml, and will be continued until the larvae are weaned on to artificial feeds at day 8;

xii. Brine shrimp will be cultured from cysts available off the shelf;

xiii. The larvae will then be introduced to imported, factory made micro pellet feeds, the sizes of which will be gradually increased according to the growth of the animals. The animals will be maintained on pelletized feed until they are transferred to sea cages for grow out production;

xiv. 70-90 day old grouper juveniles will be transferred to sea cages at a density of 150-200 m^{-3} for grow out production to market size;

xv. The stocking density will be reduced to provide adequate space for the animals;

xvi. During grow out, the animals will be fed with an imported, ready-made grow out pallet feed 5-10 mm.

b) Research on sandfish breeding and rearing;

i. Broodstock obtained from a previous project will be maintained in in-land tanks designed for sandfish spawning;

ii. Spawning trials will be carried out by providing the animals with a temperature shock to cue the animals starting to spawn;

iii. The eggs will be scooped out of the broodstock tanks and a stocking density of 300 individuals per liter and fed with the diatom *Chaetoceros calcitrans* cultured on site;

iv. The hatched larvae will be transferred to larval rearing tanks at a stocking density of 300 individuals per liter and fed with diatom *Chaetoceros calcitrans* cultures on site;

v. When the larvae start to settle, substrate coated with the benthic diatom *Navicula* sp. will be introduced to the tanks to provide the settling larvae with food, as well as settlement substrate;

vi. Sandfish larvae will be maintained in hatchery tanks for 60-70 days until they are ready to be transferred to grow out tanks and pens;

vii. Experiments will be carried out in land based tanks as well as the sea pens to optimize conditions of grow out. These will include experiments on feed (both types and ration sizes) as we as stocking densities to assess the best combinations for optimal growth.

c) Development of breeding technologies for local varieties of sea cucumber;

i. Locally sourced sea cucumber broodstock will be conditioned in in-land tanks as well as in the shallow lagoon area of the island;
ii. Experiments will be carried out to optimize breeding and rearing techniques.

d) Milkfish broodstock conditioning and rearing;
   i. Milkfish broodstock obtained locally will be maintained and conditioned in sea cages. Spawning is expected to occur naturally without any external interventions;
   ii. Fertilized eggs will be incubated in in-land tanks, and the hatched larvae transferred to larval rearing tanks in the hatchery;
   iii. The larvae will be fed on live feeds (microalgae, rotifer and artemia) produced on site during the hatchery phase;
   iv. Milkfish hatchery phase is expected to be completed in 21 days, at which point the animals will be transferred to nursery tanks with adjusted stocking densities;
   v. The nursery phase is expected to take 4-6 weeks until the milkfish fry reach bait-size;
   vi. The fry will be fed on artificial feeds during the nursery phase.

e) Live feed culture and management;
   i. The live feed culture facility will produce the following species on site and at adequate quantities to allow for smooth aquaculture operations:
      i. Microalgae, *Nanochloropsis oculata*
      ii. Microalgae, *Isochrysis galbana*
      iii. Microalgae, *Chaetoceros calcitrans*
      iv. Benthic microalgae, *Navicula* sp.
      v. Microalgae, *Brachionus plicatilis*
      vi. Super small rotifer, *Nanochloropsis oculata*
      vii. Brine shrimp, *Artemia salina* (obtained as cysts, and cultured as and when needed).

f) Power generation;
   i. Diesel power generation will be primarily used, especially at the initial stages of the project.
   ii. The option of solar power generation will be studied, with the aim of integrating solar and diesel power in the future.
g) Training and demonstration;

i. Maniyafushi will be developed as a center that provides training and demonstration on aquaculture techniques, best practices, and aquaculture management.
ii. Training and demonstration works will include sea cucumber and grouper culture training, live feed culture and maintenance targeting the private sector.
iii. The maximum number of trainees at any given time is not expected to exceed 20, and the trainings will be held for a duration of 14 days.

5.3 Need for the Project

The livelihoods of Maldivians have always depended on the country's marine resources. These resources are shared by both fisheries and tourism sectors, the two main pillars of the country's economy. Tuna fishery has been the traditional fishery in the Maldives for years. However, reef fishery has recently become popular due to the demand created by the tourism industry. Today, the key fisheries are pole-and-line skip jack tuna fisheries, hand-line yellowfin tuna fisheries, grouper and other reef fish fisheries and lobster and sea cucumber fisheries.

The tuna fishery, which has traditionally been the main source of livelihood for the people, has declined in recent years. Some reef fisheries such as sea cucumber and grouper fisheries that serve as an additional source of livelihood have also declined, while the market for the living reef resources has widened due to the expansion of tourism in the country.

The declining fisheries have been affecting the livelihood of the island communities. To improve the situation, the government has started to develop marine aquaculture or mariculture in the country, which is seen as an alternative source of livelihood that reduces fishing pressure on natural stocks and contributes to the sustainability of reef related fisheries. However, mariculture is a new field in the Maldives.

5.4 Location and Extent of Site Boundaries

The locations proposed for the new grow-out pens are at the areas where existing grow-out pens are located. The proposed pens are larger than the existing pens. The locations are shown on Figure 1 below.

Figure 1. Sites selected for grow-out pens (image sourced from project brief provided by client)

5.5 Project management

5.5.1 Construction phase and schedule for implementation

The project duration for the construction and establishment of grow-out pens is estimated to last about 10 months. Listed below are the construction phases and detailed work schedule.

Table 2. Work schedule for the proposed project

Activity/Month	1	2	3	4	5	6	7	8	9	10
Preparation of land use plan										
Preparation of architectural drawings										
Refurbishment of hatchery										
Construction of powerhouse										
Preparation of electrical design study										
Construction of new infrastructure										

5.6 Major Inputs and Outputs

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

5.6.1.1 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 jetty. Sea pen construction will be carried out at the areas allocated for construction of the pens.

5.6.1.2 **Construction work**

Project inputs and outputs

Project inputs and source, as well as outputs and management is shown in Table 3.

Table 3. Major inputs required for the proposed project and their outputs

Inputs	Source	Outputs	Management
Cement	• Imported material, contractor may purchase locally or import directly	Building structure and walls	MRC
River sand	• Imported material, contractor may purchase locally or import directly	Building structure and walls	MRC
Aggregate	• Imported material, contractor may purchase locally or import directly	Building structure and walls	MRC
Gypsum board	• Imported material, contractor may purchase locally or import directly	Building ceiling	MRC
Wood	• Imported material, contractor may purchase locally or import directly	Building ceiling	MRC
GI pipes	• Imported material, contractor may purchase locally or import directly	Building ceiling	MRC
Corrugated sheets	• Imported material, contractor may purchase locally or import directly	Building ceiling	MRC

Construction methodology

- Flexy Type Floating Fish Cage

AquaTec Flexy Type Floating Fish Cage is the fourth generation of AquaTec floating fish cage. It is designed to be both strong and elastic to withstand 1.5 m high waves. Made of prime grade High Density Polyethelene (HDPE) with anti-UV. The cylindrical floating device is hydrodynamic, therefore, making the water circulation easier, which helps oxygen circulation and fish growth.

Each of AquaTec Floating Fish Cage components can be assembled and dismantled easily with simple tools. The connections between floating device and floating device joint use Stainless Steel grade 304 bolt equipped with ring and nylon lock nut.

Since the pens are proposed to be constructed in deeper areas of the lagoon, dredging of the lagoon for deepening will not be required.

Floating Device

The function is to use as a place where fish farming activity takes place. The cylindrical floating device is hydrodynamic, therefore making the water circulation easier, which helps oxygen circulation. The side wall thickness is 10-12 mm with a gross buoyancy of 100 kg/m in sea water. Both ends of the floating device are sealed with double waterproof layer. There are walking tracks with anti-slip patterns above the floating device. The walking tracks are fused to floating device.

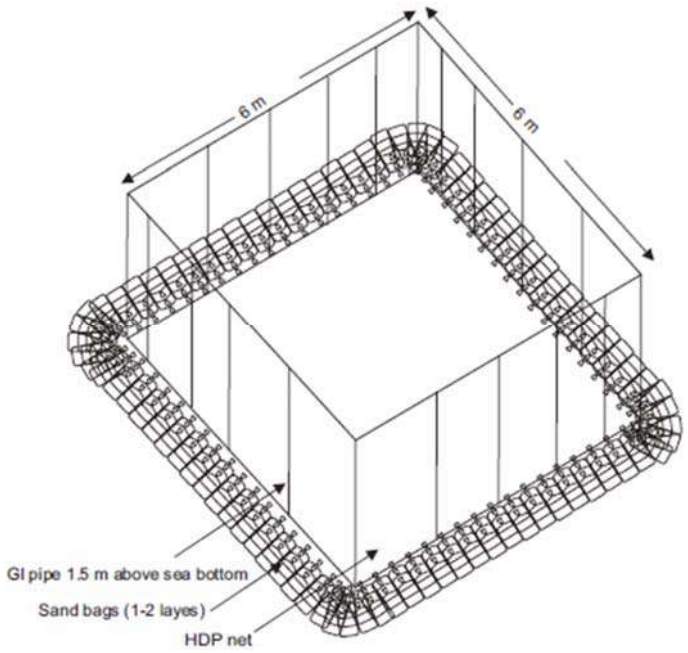


Figure 2. Proposed design of the sea cucumber grow-out pen

Sand for the filling of sandbags at the bottom of sea cucumber grow-out pens will sourced from local sand miners operating in Male'. The amount of sand will be minimal as only small scale experiments will be carried when the need arises.

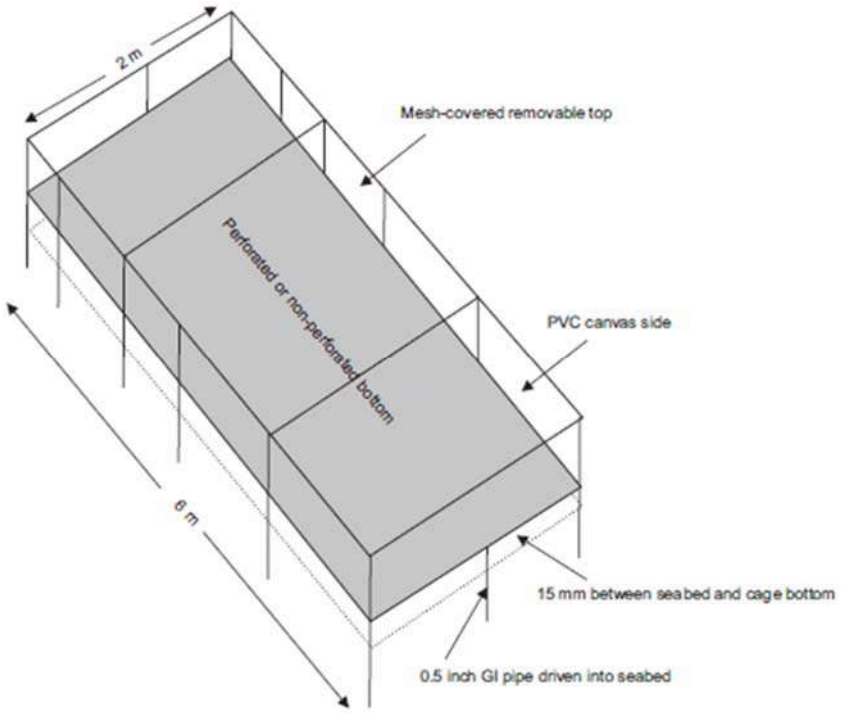


Figure 3. Off-bottom sea cucumber grow-out cage

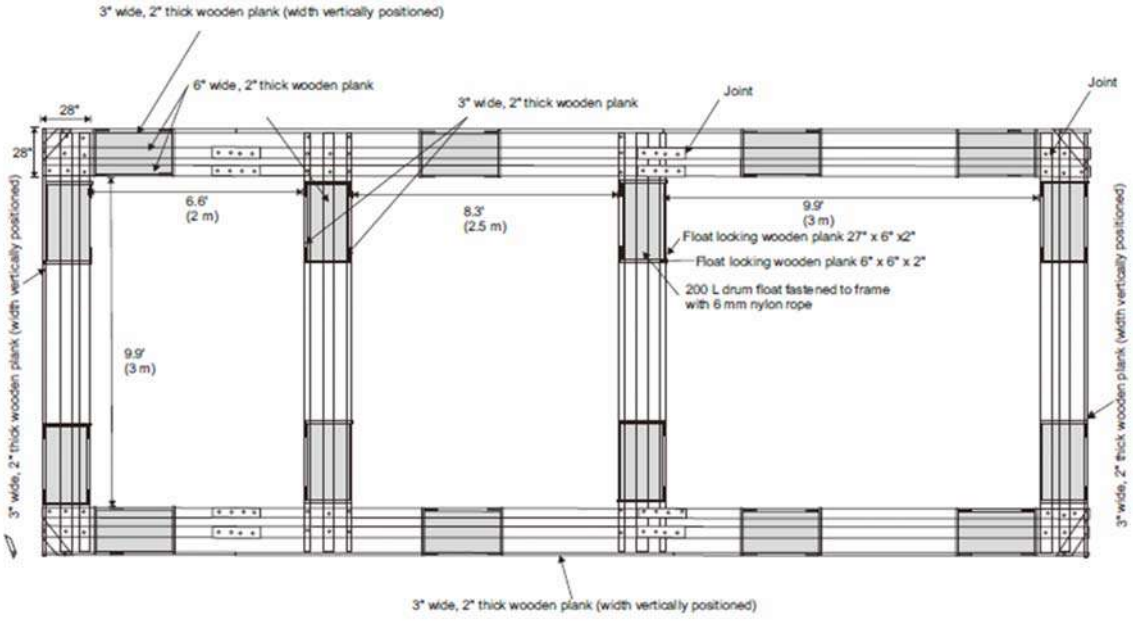


Figure 4. Top view of grouper cage

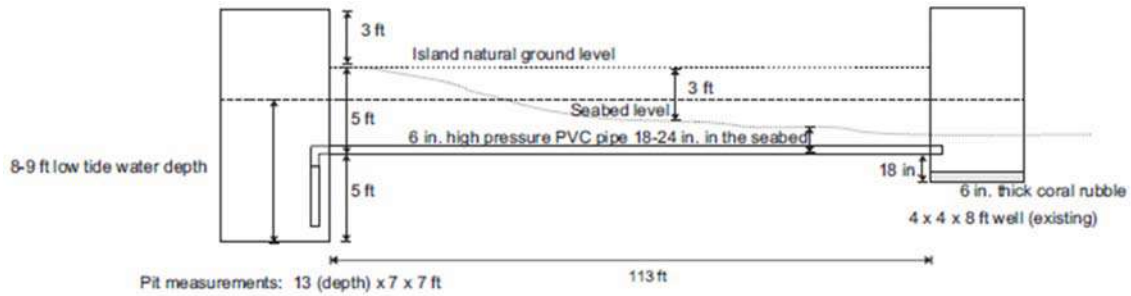


Figure 5. Sea water intake system

- Building construction

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 on Table 4 below. 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 (groundwater is too saline for construction use).

Table 4. Building sizes of the facilities to be constructed under this project

Building	**No. of storeys**
Broodstock holding facility	Single
Live feed culture facility (FL area: 7.75 x 13.4 m = 104 m^2)	Single
Laboratory	Four
Hatchery/nursery	Single
Trainee/staff quarters	Four
Warehouse	Single
Powerhouse	Single

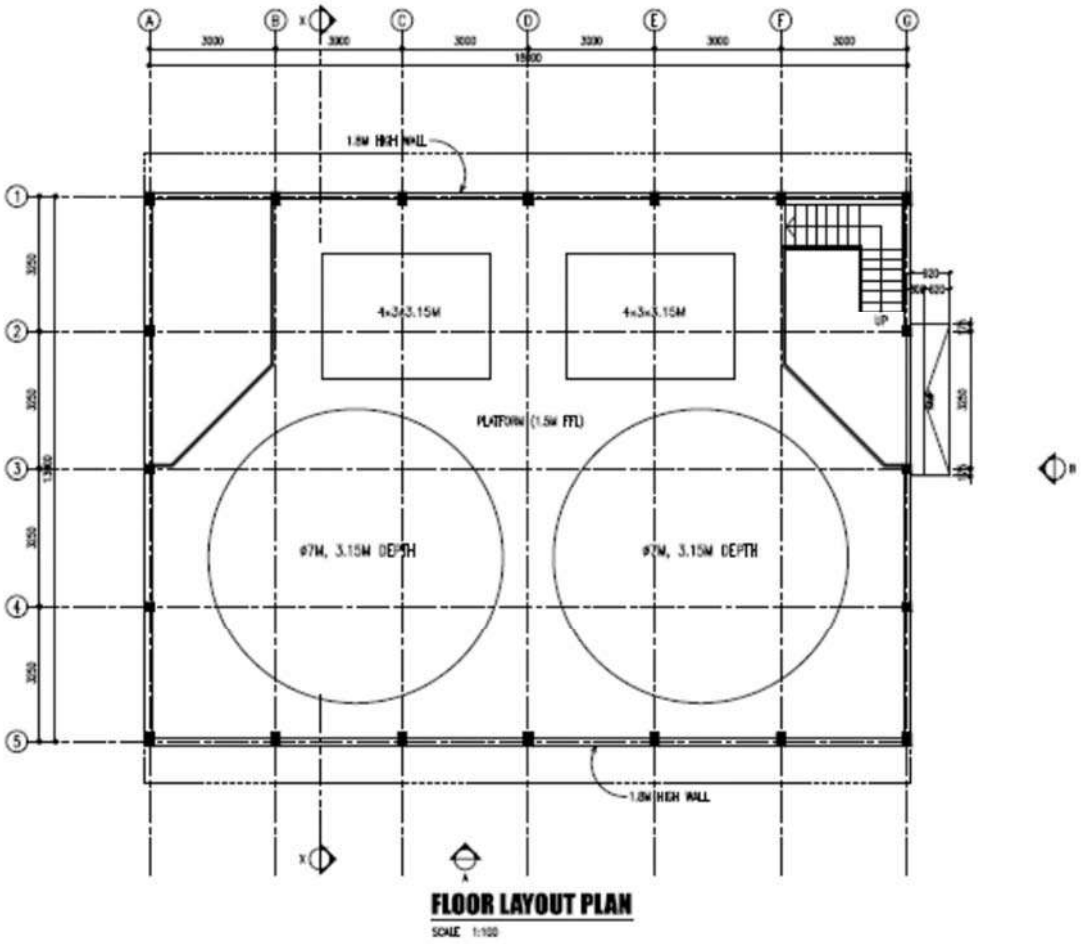


Figure 6. Floor layout plan of broodstock holding facility

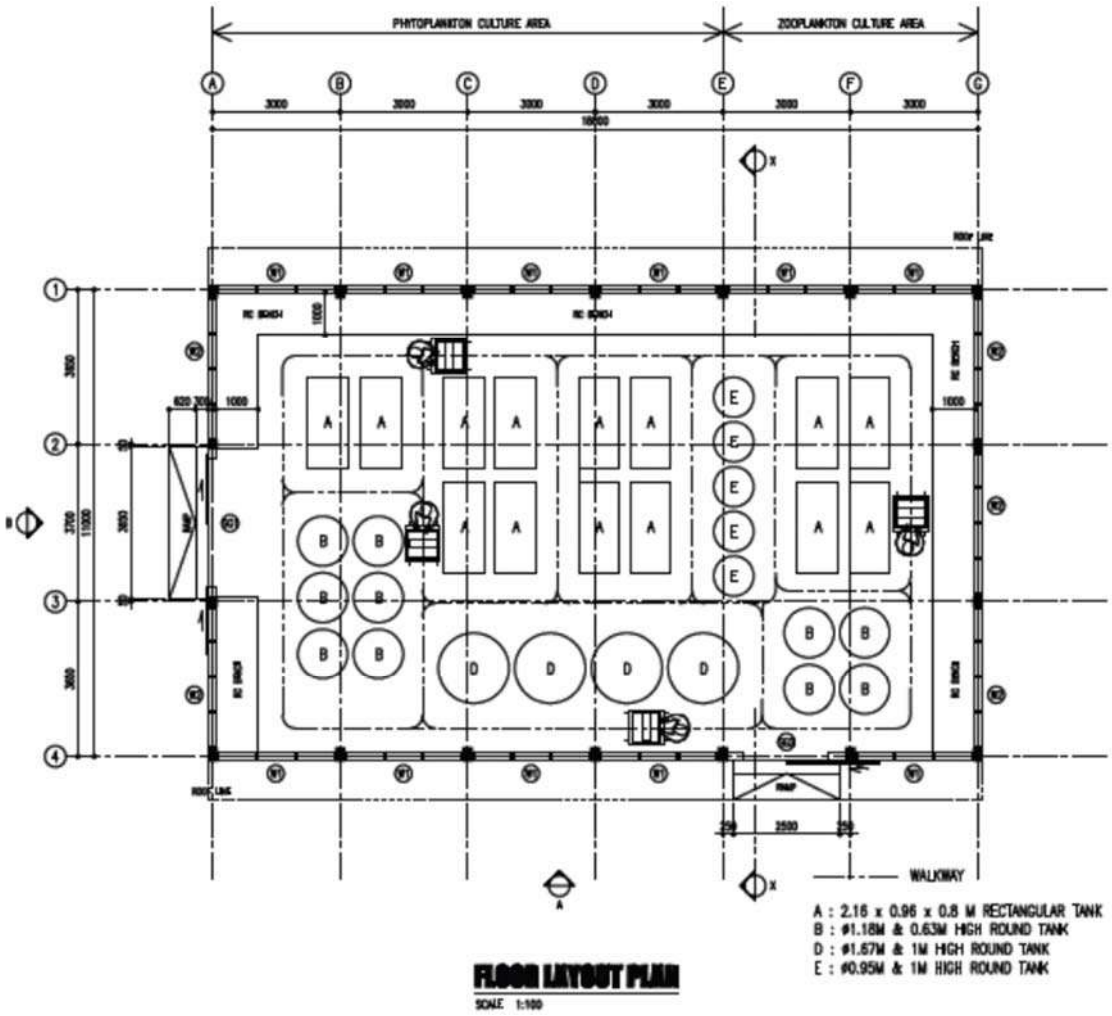


Figure 7. Floor layout plan of algae culture greenhouse

- Training

The main purpose of the facility is conduct demonstration activities for mariculture projects, providing training opportunities to Maldivians who are eager to engage in mariculture work.

In addition to the training programs, the facility will also produce fingerlings for prospective local farmers. Grouper and sand fish fingerlings will be reared at the facility.

5.6.1.3 **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 5 based on the scale of the work needed for the construction of the field station. Temporary accommodation facilities will be made on land not used for

construction to station the workforce required for the project. Utilities will be provided by existing facilities on the island.

Table 5. Estimated workforce required for the project

Designation	Numbers
Project manager	1
Works manager	1
Project administrator	1
QA/QC/HSES officer	1
Dredging superintendent	0
Chief surveyor	1
Project engineer	1
Laborers: Mobilization and site preparation	10
Construction	40
Site cleanup	10

5.6.2 Power generation facility

Under the proposed project, the power generation facility will be upgraded as the existing electric power system is insufficient for its full operation as well as for the planned upgrading works. The load forecasts for staff accommodation and hatchery and other such infrastructure areas are developed for 10 years but for street light and lighting for public spaces are considered constant.

With the commissioning of the upgraded power system, reliable and cost effective power will be delivered throughout the day. Generating capacity of the power station would be further upgraded only on demand. With this strategy, the consumers on the island will benefit from low cost and reliable power for their consumption.

This project, if implemented as planned, will consolidate the infrastructure of the island and is an important means for developing K. Maniyafushi further. Stable, reliable and cost-effective electricity to this island will improve the life span of the general electrical appliance and as well as the most expensive machineries used in the island.

- Generator set sizing and main control panel board

For continuous operation of power system, minimum four generator sets, with total capacity of 97kW (1x35kW, 1x28kW, 2x17kW) shall be installed. The power house and control panel shall be large enough to accommodate the diesel generator sets sizes for the 10 year period. The panel board is a synchronizing panel board with automatic load sharing for two generator sets.

- Voltage drop

Main distribution cables are selected to limit the voltage drop to maximum 5% for the 10 year period and up to 2% for the consumer cables. Existing consumer and road light cables shall be used where possible and make joints where necessary to connect new/ existing distribution boxes.

- Powerhouse building

Existing power house is insufficient for the installation of additional generators and control panel thus a new powerhouse building is designed and constructed. The new powerhouse will be equipped with sound attenuators and rockwool insulated roofs to minimize noise. Refer to Appendix 4 for basic design of a new power house and distribution map.

- Fuel tank

A fuel storage tank with a capacity of 3,600 liters shall be constructed within the powerhouse premises. Refer to Appendix 5 for fuel tank and fuel line designs.

- Fire system and lightening protection

Fire extinguishers shall be installed at suitable locations of the powerhouse and in the premises. A fire alarm system with smoke and heat detectors shall be installed within the powerhouse.

The powerhouse will be facilitated with lightning protection terminals. Refer to Appendix 6 for lightning protection layout.

- Power distribution network

New power distribution network will be laid as part of proposed project. Trenching works will be done manually since the island is very small and buildings are closely stacked together. Cables will be laid 600mm below ground level. No dewatering will be required for the cable laying works.

5.6.3 Waste management

An area is designated as a waste yard where waste will be sorted and safely stored prior to transportation to Thilafushi for final disposal. The proposed site is indicated on the LUP given in Appendix 3 of this report. Waste will be transported to Thilafushi once a month.

5.6.4 Wastewater

Grey and black water from toilets and kitchen is connected to a septic tank (three chambers septic tank), the effluent is disposed at the northern side lagoon (existing system). Since the estimated population of the island is very small even at peak capacity (staff and trainees during training programs), sewage treatment is not necessary. The effluent disposal pipe line does not meet the wastewater disposal regulation; hence mitigation is provided for this component.

5.6.5 Safety measures during construction and operation

The safety measures to be followed during construction and operation phase of the project are outlined in Environmental and Social Management Plan (ESMP) attached in Appendix 7 of this report.

5.6.6 Outputs

Key outputs of the project include:

- sea-cucumber and grouper grow-out pens,
- research facilities including laboratory
- accommodation facilities and;
- upgraded powerhouse and power distribution network.

Secondary outputs as a result of the operation of the facility include venue for conducting mariculture related training for development of mariculture industry in the country and produce fingerling for prospective maricultural projects (mariculture development projects carried out by Ministry of Fisheries and Agriculture).

6 Methodology

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 EIA 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 December 2017. General information on the existing environment was based on available secondary data, such as climatic data from the meteorological center at Hulhumale' Airport.

6.1 Physical surveys

6.1.1 Marine Environment

Figure 8. Sampling locations of marine environment and groundwater quality

Table 6. GPS Coordinates of marine and groundwater sampling locations

Name (sampling sites)	Latitude	Longitude
S1 (Marine survey)	4° 3'17.84"N	73°24'34.63"E
S2 (Marine survey)	4° 3'25.36"N	73°24'23.85"E
S3 (Marine survey)	4° 3'27.14"N	73°24'42.20"E
GW (Groundwater)	4° 3'20.34"N	73°24'39.65"E

6.1.2 Shoreline survey

Shoreline survey was carried out using Trimble Geo explorer 7 system; high tide, low tide, vegetation line and erosion line was mapped.

6.1.3 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 Hulhule.

6.2 Water quality analysis

Samples for sea water quality were collected at the same locations surveyed for the reef environment analysis (Figure 8 and Table 6). General parameters were tested in situ using a Hanna multi probe water test meter (HI 9828) and the rest tested at MWSC Water Quality Assurance Laboratory.

Groundwater sample was collected from a well located at the project area (Figure 8 and Table 6) and tested in-situ using Hanna multi probe water test meter (HI 9828).

7 Existing environment

7.1 Geographic location of Maniyafushi

Maniyafushi is located at South Male' on the western side approximately 3.4km from the western peripheral reef. The island lies at coordinates of N 04° 03'21.05", E 73°24'39.54", approximately 15.9km south west of Capital Male' City. Nearest resort or island to Maniyafushi is Jumeirah Vittaveli Maldives (Bolifushi) located on the northwestern side approximately 4.3km away (see Figure 9).

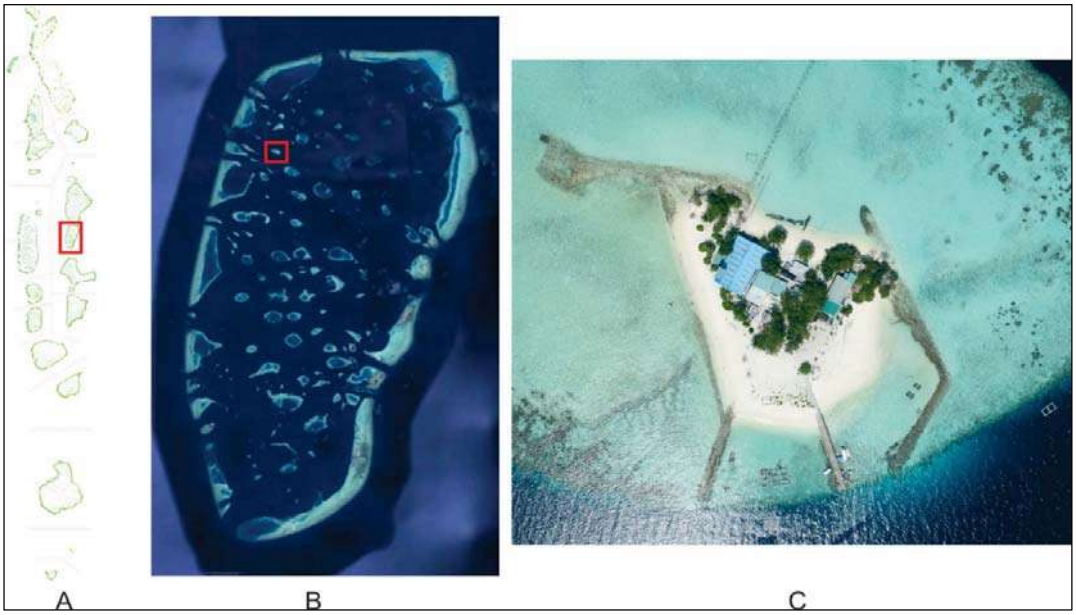


Figure 9. Location of South Male Atoll in Maldives archipelago (A), location of the Maniyafushi at South Male Atoll (B) and Drone image of Maniyafushi (C)

7.2 Geology and geomorphology

Earliest aerial image available of Maniyafushi is from 1969. The image shows the island is very small with distinct extending northwest and southwestwards, while the island is very narrow and elongated oriented northwest to south east wards. Aerial images taken during 1999 by Government of Maldives (Construction Ministry) shows the island has undergone significant coastal modifications. These include several coral rock breakwaters/revetments and small-scale reclamation. At present most of these breakwaters/revetments are gone with only low remnants remaining, a new access jetty is constructed by Marine Research Centre at old access jetty/rock mound. Beach rock formations are not observed, while erosion is observed at the northern and north eastern side of the island (mainly due to poor condition of the revetment structures).

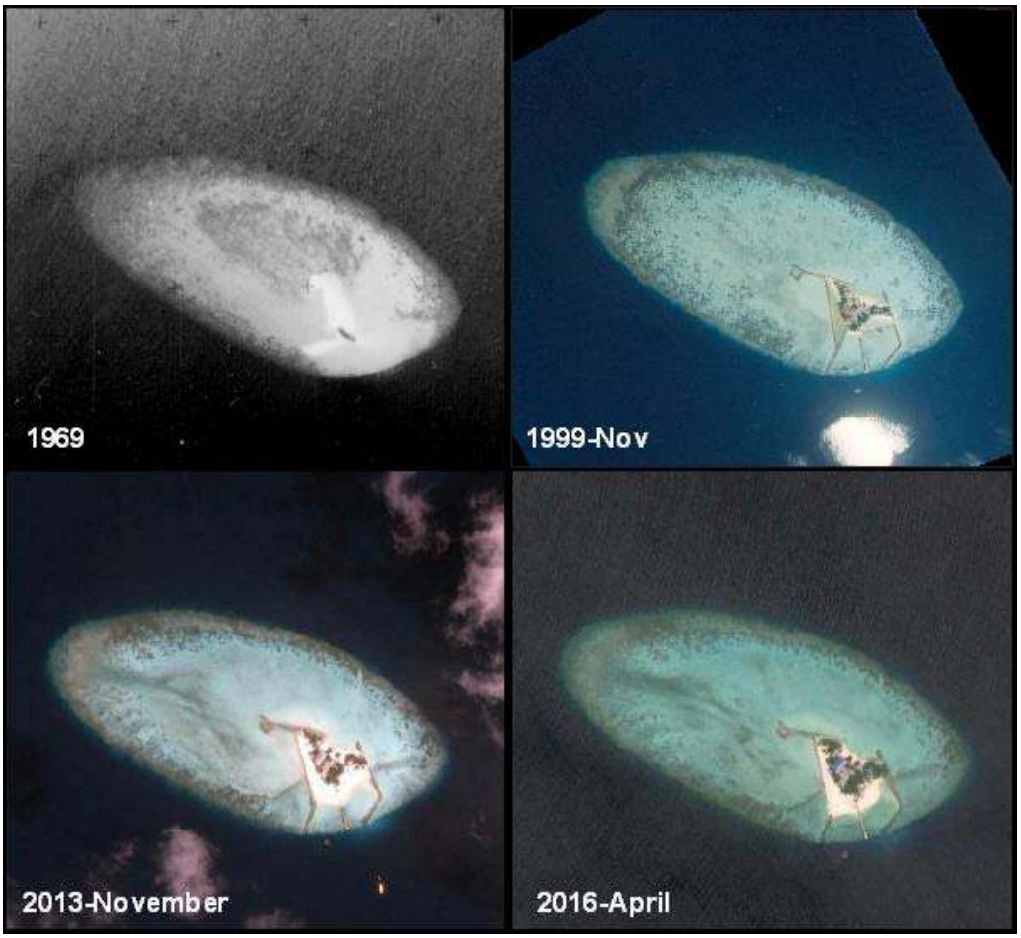


Figure 10. Aerial and satellite images of Maniyafushi showing changes to the shoreline and island over the years

7.2.1 Shoreline and vegetation

The island is largely reclaimed, with mostly replanted vegetation. Vegetation on the island are mostly Sea Hibiscus and Sea lettuce, and Coconut palms (11 Coconut palms). The island is void of proper vegetation buffer since it is largely reclaimed island. The high tide line at some areas are very close to building footprint (Hatchery south west corner).

Table 7. Summary of shoreline survey (taken from Land Area Registration Survey Report provided by Marine Research Centre)

Shoreline category	Perimeter (m)	Area (sqm)	Area under MSL (sqm) (average area under HWL and LWL)
High Water line	4,334	313,342	333,447
Low Water line	4,650	353,551	
Vegetation line	5,137	267,399	
Reef line	1,940	241,301	

Figure 11. Drone image showing beach on the southeastern side of the island

Figure 12. Erosion prone areas observed at the island

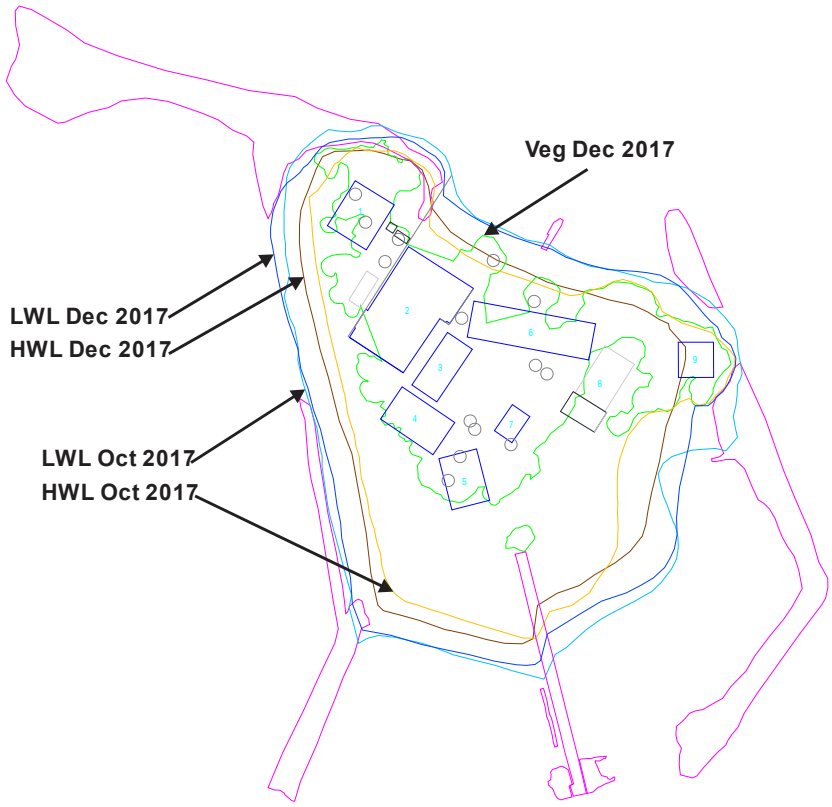


Figure 13. Schematic showing Low Water Line (LWL), High Water Line (HWL) and Vegetation line (Veg) at Maniyafushi taken during survey for Land Area Registration and for EIA data collection (larger scaled drawing is provided in Appendix 8)

7.3 Bathymetric survey

Bathymetric survey at Maniyafushi reef was done at project area (eastern segment of the reef including reef slope. The bathymetric survey shows that lagoon area at the southern side of the island is on average -1.4m MSL while the northern side is -1.6m MSL. The lagoon area where shallow pens are located has an average depth of -1.6m MSL. The deep water pen or cage location is near reef slope with a gradual reef slope (see Appendix 9 for bathymetric survey map).

7.4 Climate

7.4.1 Wind Climate

Wind climate in the Maldives is dominated by the Indian Ocean monsoon climate, with the 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. 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*. *Iruvai halha* lasts from October to November (Table 8). 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).

Table 8. The four seasons experienced in the Maldives

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

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 K. Hulhule, approximately 20 km North of Maniyafushi. An analysis of the wind climate was done using hourly wind data

between the periods of May 2008 to December 2015 from the Hulhule 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 14) 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.

Table 9. Hourly wind data from Hulhule 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%

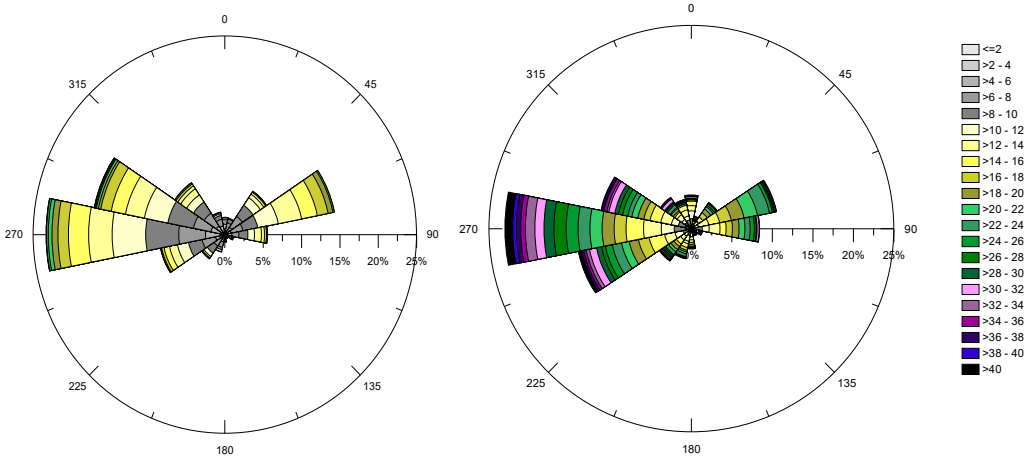


Figure 14. Wind rose plot for Hulhule' Meteorological station, based on mean daily wind data for the period of January 1998 to December 2015 (left) and maximum daily wind data (right) for the period of January 2008 to December 2015.

With regards to mean wind speeds per month, results from this analysis were contradicting with the traditionally defined monsoonal months. It is evident from Figure 14 that the SW monsoon lasts from April to October whereas it is traditionally defined that the SW monsoon of the Maldives commences in May and ends in September and the months March to April and October to November are transition periods. But clearly, during April, transition from NE to SW monsoon had already occurred as the winds were predominantly coming from the west, and NE winds were almost zero to negligible. Likewise, in October, the transition from SW to NE has not commenced yet as the winds was not only predominantly coming from the westerly direction but also at a strong speed. March and November can, however, be taken as the transition periods (Table 10).

Table 10.The traditionally defined seasons experienced in Maldives compared with the current analysis of seasonal winds per month

<table>
<tr><th>Month</th><th>Traditionally defined seasons</th><th>Seasons as per our analysis</th></tr>
<tr><td>December</td><td rowspan="3">NE monsoon</td><td rowspan="3">NE monsoon</td></tr>
<tr><td>January</td></tr>
<tr><td>February</td></tr>
<tr><td>March</td><td rowspan="2">Transition period 1</td><td>Transition period 1</td></tr>
<tr><td>April</td><td rowspan="6">Winds predominantly from the west</td></tr>
<tr><td>May</td><td rowspan="4">SW monsoon</td></tr>
<tr><td>June</td></tr>
<tr><td>July</td></tr>
<tr><td>September</td></tr>
<tr><td>October</td><td rowspan="2">Transition period 2</td></tr>
<tr><td>November</td><td>Transition period 2</td></tr>
</table>

Additionally, during the SW monsoon, winds are known to occur dominantly from the SW direction, however the results indicate that the strongest and most dominant winds occur from the west and the second most dominant frequency fluctuates between WSW and WNW directions. As for the NE monsoon, winds predominantly occur form the NE direction, agreeing with the traditional definition (Figure 15).

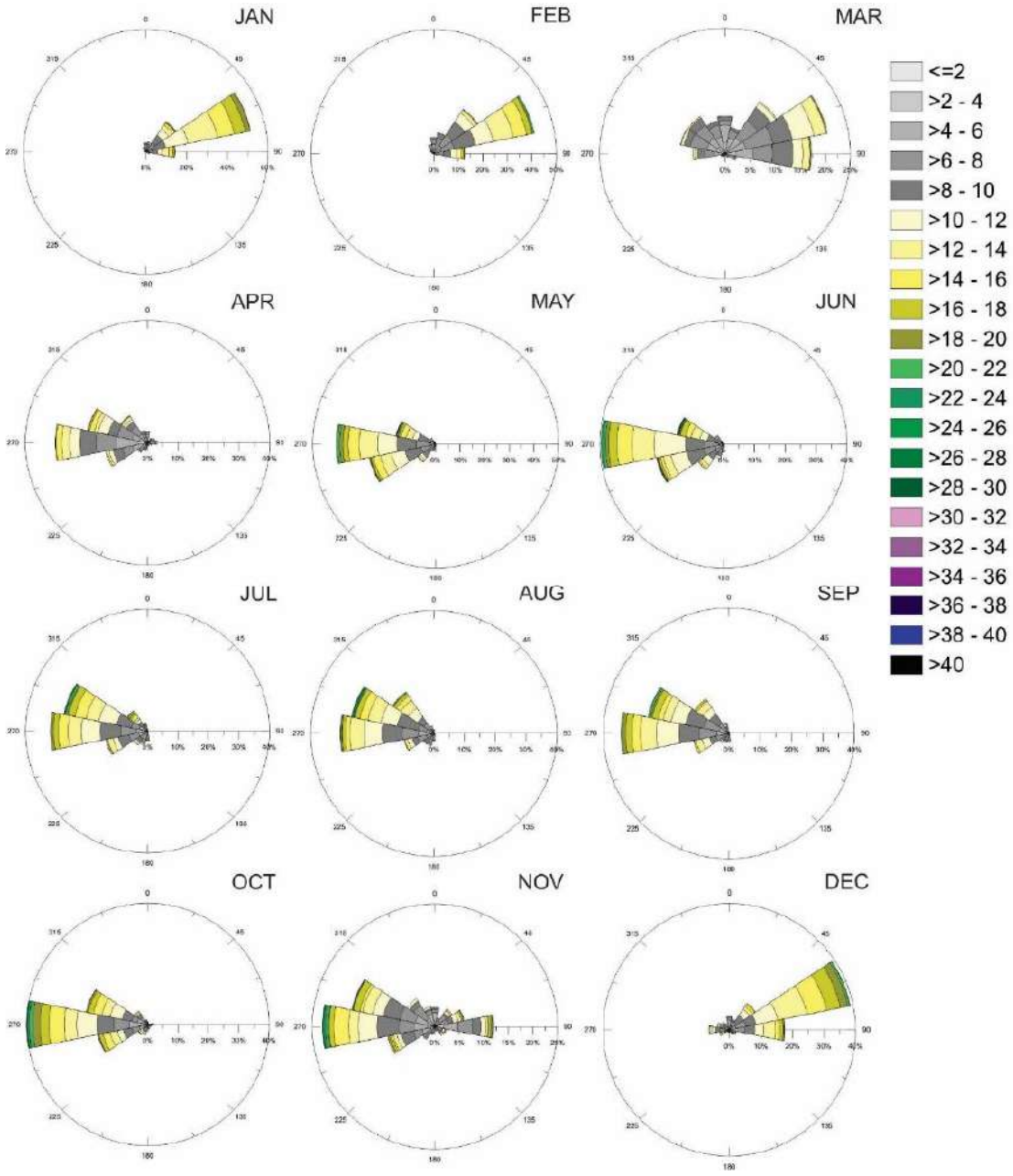


Figure 15. Monthly wind rose plots for Hulhule' Meteorological station, based on mean daily wind data for the period of January 1998 to December 2015

With reference to monthly maximum wind speeds, unlike the mean monthly winds speeds, only one transition period was observed from the wind rose analysis. A wind direction change abruptly from NE to W on April and a clear transition period from W to NE monsoon is observed in November which extends to December as well. The highest maximum wind speeds occur during July and January to March are generally the calmer months (Figure 16).

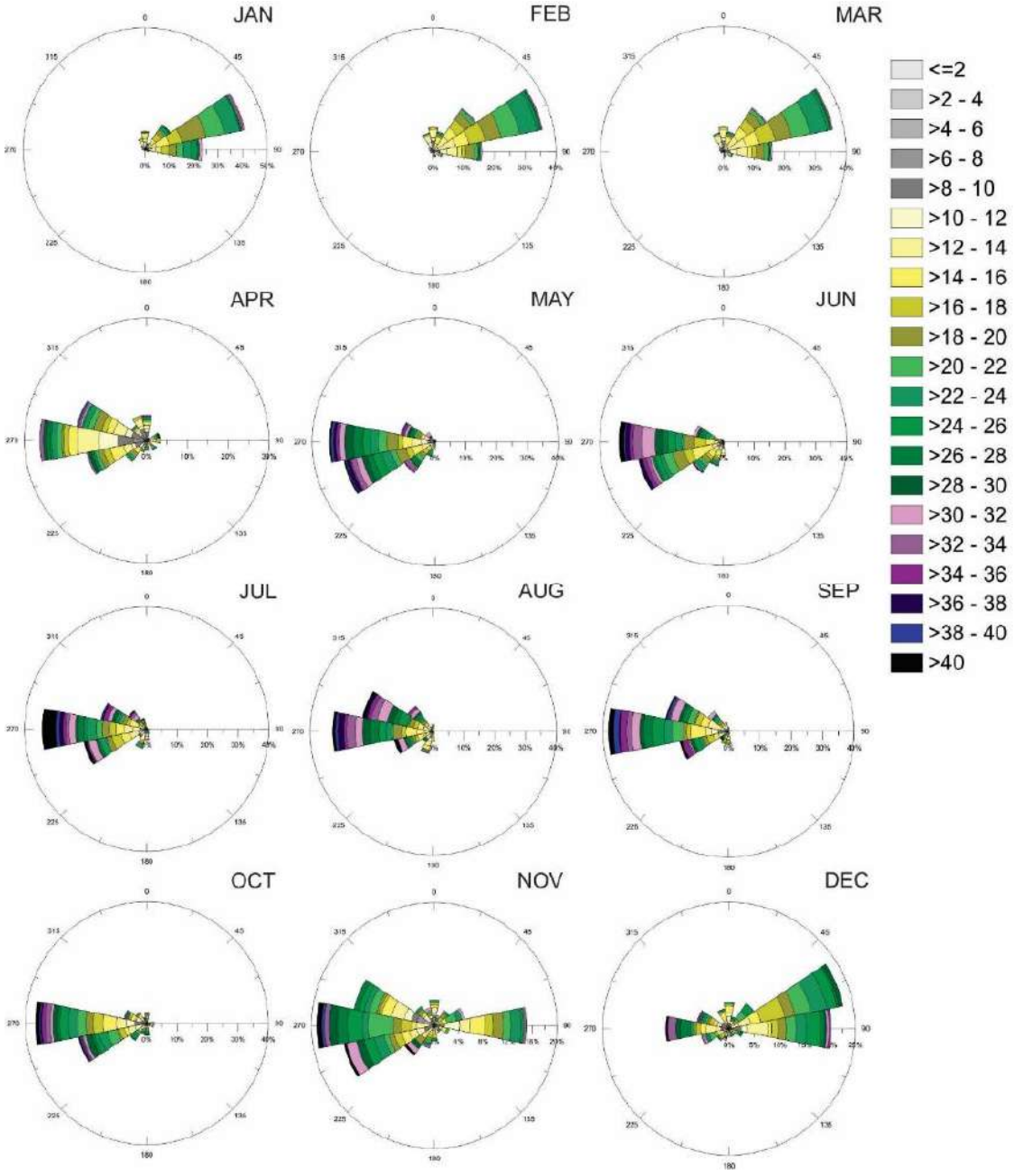


Figure 16. Monthly wind rose plots for Hulhule' Meteorological station, based on maximum daily wind data for the period of January 2008 to December 2015

7.4.2 Tide

Tides experienced in the Maldives are mixed semi-diurnal and diurnal with a strong diurnal inequality. A tide station at Ibrahim Nasir International Airport has continuous records of tide for over the past 30 years. The maximum tidal range recorded at this tide station is 1.20m. The

highest astronomical tide level is +0.64m (MSL) and the lowest astronomical tide level is -0.56m (MSL) (Table 11).

Table 11. Summary of tide level at Ibrahim Nasir International Airport, Male Atoll

Tide level	Water level referred to Mean Sea Level (MSL) (m)
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.0
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

7.4.3 Wave and Current

Information on the deep water waves for Maldives is limited (Kench and Brander, 2006), but wave climate data for the Indian Ocean region surrounding the Maldives reported by Young (1999) indicate that the dominant swell approaches the Maldives from southerly quarters. Young (1999) reported that on a seasonal basis, swell reaching Maldives is from the south-southwest from April to November with a peak significant wave height (Hs) of 1.8 m in July, and from the southeast from December to March with a minimum mean Hs of 0.75 m in March.

General wave and current pattern around the Maniyafushi reef is assessed using available wind data. The dominant wind direction during NE monsoon for Male' atoll is from the eastern quadrant and from the western quadrant during the SW monsoon. The reef system also receives refracted swell waves from western and southern side (lesser extent). The main hydrodynamic factors affecting the currents at Maniyafushi reef system are wind wave induced currents and tidal currents (Figure 17).

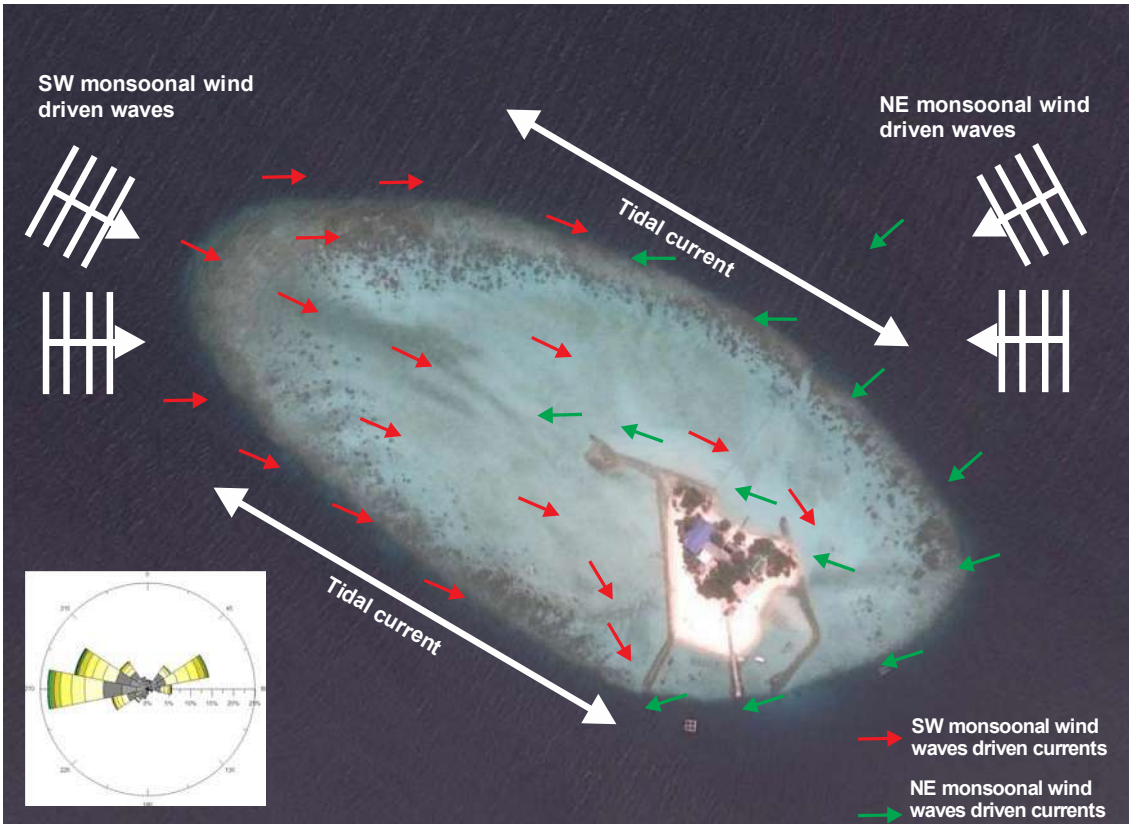


Figure 17. Schematic showing anticipated wave and current regime at the reef system

7.5 Marine environment

The proposed habitats for the grow-out pens are located at the deep lagoon area where smaller grow-out pens already exist. Under the proposed project the grow-out pens will be extended to a larger area as shown on Figure 1.

7.5.1 Reef survey

Following section describes the reef condition at the project location. Quantitative reef surveys were conducted at four sites (R1-R3) which will act as baselines in future reef monitoring. Refer to Figure 8 for aerial map of surveyed locations and Table 6 for their GPS Coordinates.

Figure 18 and Table 12 show the percentage composition of substrate forms at the three quantitative survey locations (R1-R3). Coral rock was noted as the most dominant substrate at all sites with a percentage cover ranging from 68.71% to 52.51%. Highest live cover was observed at location R1 with 14% coral cover, which comprised of Porites spp. and other

branching and encrusting coral forms. Live coral cover at R2 and R3 was comparatively low, with 2.35% and 0.34% respectively. A significant presence of dead coral covered in algae and coralline algal cover were recorded at all surveyed locations. Moreover, forms of macroalgae such as Halimeda were also recorded in significant numbers at R3.

Table 12. Details of substrate composition at sites R1-R3, as observed on 23 December, 2017

Substrate Categories	R1			R2			R3		
	Mean	±	Std. Error	Mean	±	Std. Error	Mean	±	Std. Error
Algae	1.67	±	1.67	1.02	±	0.59	1.01	±	0.58
Coral	14.00	±	7.51	2.35	±	1.88	0.34	±	0.34
Halomitra	-			0.34	±	0.34	-		
Other coral branching	0.33	±	0.33	-			-		
Other coral encrusting	0.33	±	0.33	0.34	±	0.34	0.34	±	0.34
Porites	11.33	±	7.54	1.68	±	1.21	-		
Sponges	1.00	±	0.58	0.33	±	0.33	-		
Macroalgae	0.67	±	0.67	2.03	±	1.17	6.04	±	2.68
Halimeda	-			0.34	±	0.34	5.70	±	2.36
Other macro algae	0.67	±	0.67	1.69	±	0.89	0.34	±	0.34
Ascidian	-			0.34	±	0.34	-		
Other live	-			1.69	±	1.21	-		
Dead coral covered with algae	8.00	±	2.52	9.06	±	3.81	27.07	±	3.98
Coralline algae	9.33	±	2.19	8.75	±	2.87	7.35	±	2.96
Rock, rubble, sand	65.33	±	6.06	74.43	±	4.10	58.20	±	0.76
Coral rock	55.00	±	7.57	68.71	±	3.43	52.51	±	1.26
Rubble	6.67	±	0.33	5.39	±	0.67	4.69	±	0.69
Sand	3.67	±	1.33	0.33	±	0.33	1.00	±	1.00

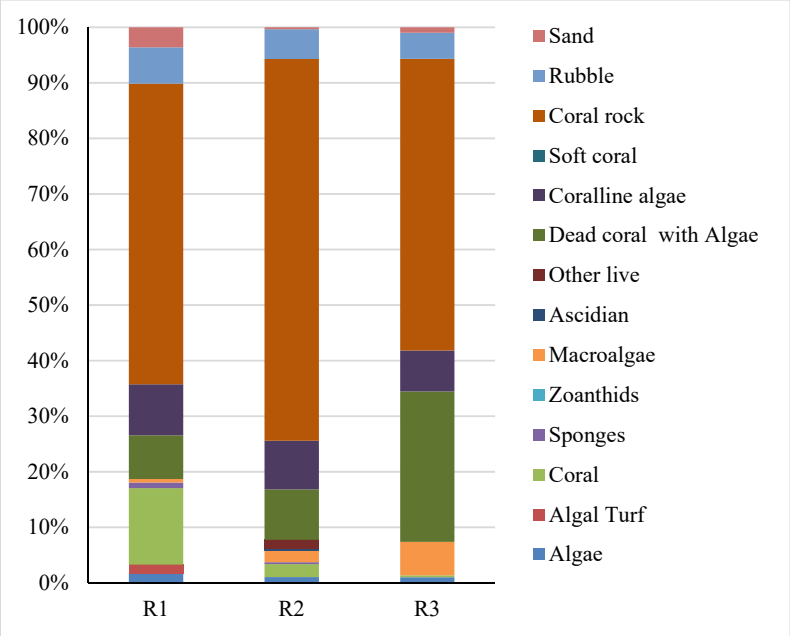
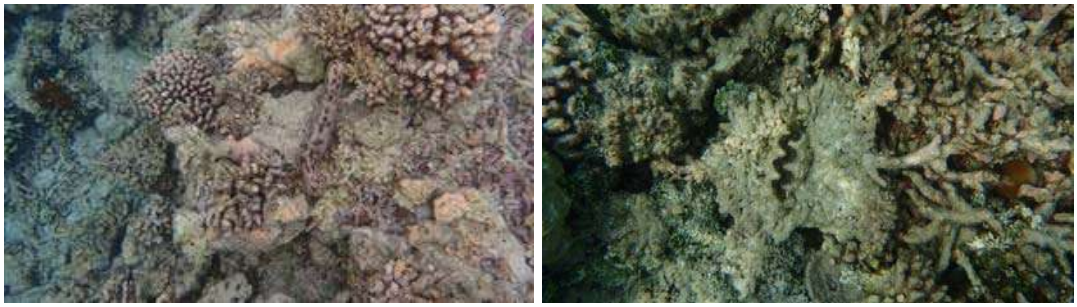


Figure 18. Percentage composition of live cover at sites R1 – R3, as surveyed on 23 December, 2017

7.5.1.1 **Site 1**

Location R1 was located on the southern side of the reef system. This site hosted the highest live coral cover accounting for 14% of the transect. This comprised of colonies of Porites spp. (11.33%) and other branching and encrusting hard coral forms. A significant presence of coralline algal cover (9.33%) were also recorded, followed by dead coral covered in algae, which accounted for 8% of the sampled area. Additionally, low occurrences of rubble (6.67%), sand (3.67%), macroalgae (0.67%) and sponges (1%) were also recorded (Refer to Figure 8 for aerial map of surveyed locations and Table 6 for their GPS Coordinates. and Figure 19 for representative photos of the site).



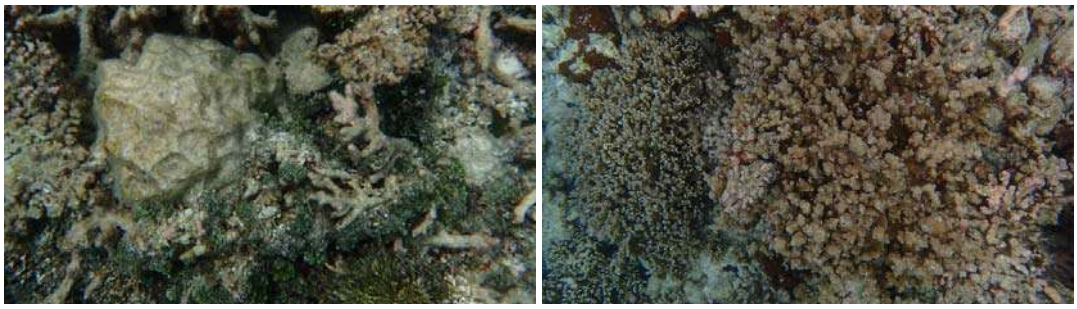


Figure 19. Representative photographs of site R1, as surveyed on 23 December, 2017

7.5.1.2 **Site 2 (Control)**

Location R2 was established as a control for comparison in future monitoring efforts. This site showed a similar dominance of rock as the main substrate with 68.71%, followed by dead coral covered in algae (9.06%) and coralline algae (8.75%). Low occurrences of live coral were also recorded, which comprised of Halomitra spp. (0.34%), Porites spp. (1.68%) and other encrusting coral forms. Additionally, macro algal cover, sponges and ascidian forms were also recorded (Refer to Figure 8 for aerial map of surveyed locations and Table 6 for their GPS Coordinates. and Figure 20 for representative photos of the site).

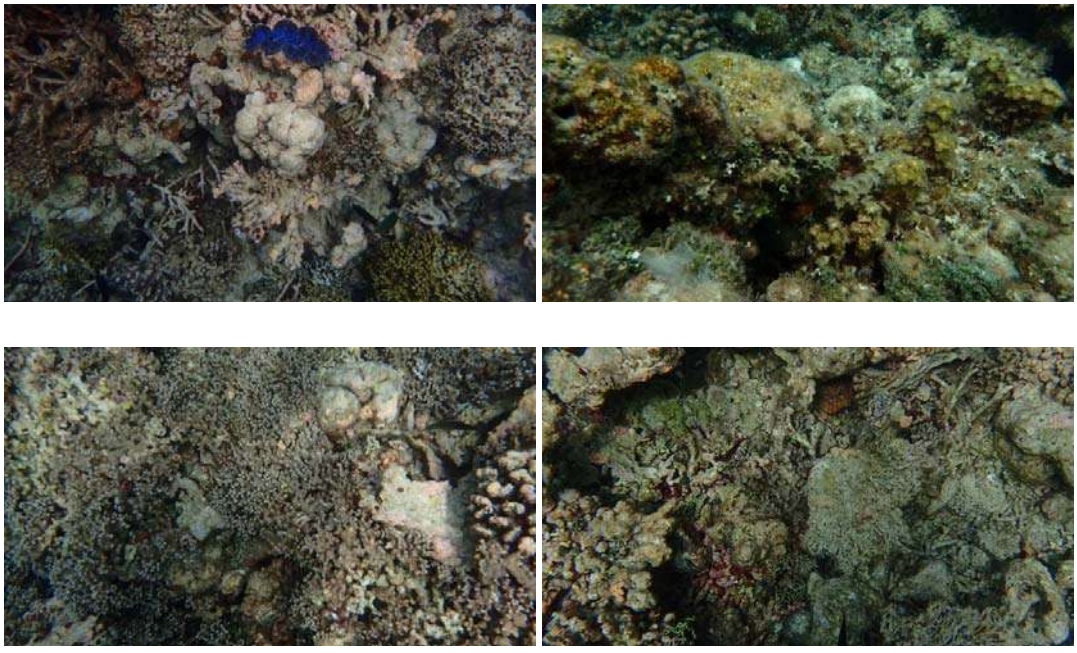


Figure 20. Representative photographs of site R2, as surveyed on 23 December, 2017

7.5.1.3 **Site 3**

Location R3 was located on the north eastern side of the island. This site showed a higher presence of dead coral covered in algae (27.07%) than the previous sites, with a comparatively lower presence of coral rock (52.51%). Also, higher occurrences in macro algal cover and Halimeda spp. (5.70%) were recorded at this location. In addition to these, comparable presence of coralline algae (7.35%) were recorded as well (Refer to Figure 8 for aerial map of surveyed locations and Table 6 for their GPS Coordinates and Figure 21 for representative photos of the site).

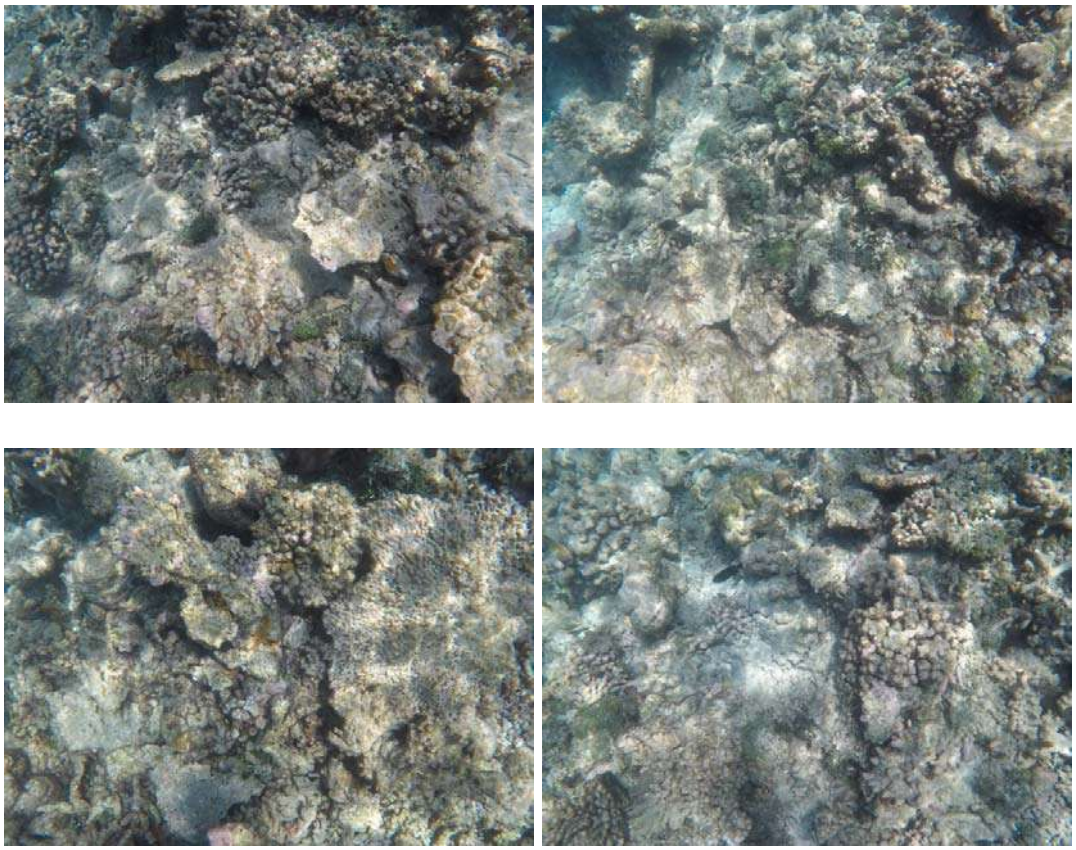


Figure 21. Representative photographs of site R3, as surveyed on 23 December, 2017

7.5.2 Seawater quality

The condition or quality of coastal water is important for ecological functioning of the organisms living in the habitat, for health and safety reasons and also for visual and aesthetic impacts. The water quality is generally determined by the level of nutrients. There are several sources that can lead to increased nutrients in coastal waters, e.g. sewage effluents and terrestrial storm water runoff. Sediment stir-up can also lead to release of nutrients within the sediments especially when there is excavation and dredging involved.

The most important nutrients of concern in coastal waters are nitrates and phosphates. In excessive quantities these can cause rapid growth of phytoplankton and result in algal blooms. Visual quality of the water is also important; a beach environment is much more attractive when the water is clean and one can see the sea bottom. However, even clear waters may sometimes be polluted.

It is worthwhile to note here that there is no direct input source of nutrients in the coastal waters during the construction phase. However, the operational phase and associated activities (grouper and sea cucumber rearing) has the potential to release a number of nutrients into waters. Moreover, sewerage discharge pipelines are already established on the island. Therefore, the purpose of the assessment of water quality is to establish a baseline for the seawater quality, taken as a standard to compare with any future water quality assessments. A list of parameters tested and their values for the three locations are given in Table 13 (test results from MWSC) and Table 14 (in-situ water testing done using Hanna HI9828 probe).

Table 13. Results of seawater quality tests performed by MWSC (lab reports in Appendix 10)

Parameter	Site 1	Site 2	Site 3
Physical appearance	Clear with particles	Clear with particles	Clear with particles
Nitrate (mg/l)	3.7	3.1	3.0
Nitrogen Ammonia (mg/l)	0.03	<0.02	<0.02
Phosphate (mg/l)	<0.05	<0.05	<0.05

Table 14. Results of seawater quality tests performed in-situ (using Hanna HI9828 probe)

Parameter	Site 1	Site 2	Site 3
Temperature	27.23	27.44	27.04
pH	8.06	8.11	8.09
Salinity (‰)	32.51	32.62	32.64
Turbidity (FTU)	0.00	0.10	0.00

7.6 Groundwater quality

Groundwater sample was analyzed in order to establish the baseline groundwater characteristic of the island. The groundwater quality was found to be highly saline with a salinity of 18.01 ‰ and a conductivity of 29.19 mS/cm. Water quality test results from the groundwater table on the island is shown on Table 15 below.

Table 15. Results of seawater quality tests performed in-situ (using Hanna HI9828 probe)

Parameter	Site 1
Temperature	27.04
pH	7.22
Salinity ($^{o}/_{oo}$)	18.01
Turbidity (FTU)	0.02
Conductivity (mS/cm)	29.19

8 Stakeholder consultation

8.1 Consultation with EPA

Consultation with EPA was held at the agency on the 3rd of January 2018 at 10am. Participants of the meeting are listed in Appendix 11. The representatives from EPA agree that the proposed project will benefit the community. Major concerns highlighted at the consultation meeting are listed below:-

- Existing sewer discharge is directly on the reef system, it is recommended to extend this out into the ocean.
- The corner of the hatchery building is very close High Water Line (HWL) on the north western side. Coastal protection measures are recommended.
- A landing craft shall be used in order to transfer any heavy equipment (if any) to the project site.
- Concerns about the size of the island being too small for such a facility was raised. This will limit the number of participants which could be accommodated at a time.
- Since there is very less vegetation on the island, they should be retained as much as possible.
- Waste should not be burnt or dumped to the sea.

8.2 Consultation with Health Protection Agency (HPA)

Consultation with HPA was held at the agency on the 3rd of January 2018. Participants of the meeting are listed in Appendix 11. Representative from HPA was consulted via telephone conversation and a project brief was emailed for comments. They had no concerns regarding the construction and operation of the field station at Maniyafushi as of now.

8.3 Consultation with Kaafu Atoll Council

The Vice president of the Kaafu Atoll council was consulted over the phone on the 3rd of Janyary 2018 and the following were highlighted:-

- During a recent tour around the Atoll, many parties interested in grouper and sea cucumber fishery came forward requesting for a similar facility.
- They would like to know when the facility will be open for enrolment.

NOTE: the TOR specifies consultation with Maldives Food and Drug Authority. However, MFDA stated that Consultation for this project should be carried out with HPA and not MFDA.

9 Environmental Impacts

9.1 Impact Identification

Various methods are available to categorize impacts and identify the magnitude and significance of the impact, such as checklists, matrices, expert opinion, modelling etc. Impacts on the environment from various activities of the project construction work (constructional impacts) and post construction (operational impacts) have been identified through interviews with the project management team, field data collection surveys and based on past experience in similar development projects. Data collected during field surveys can be used to predict outcomes of various operational and construction activities on the various related environmental components. This data can also be used as a baseline for future monitoring of the environment.

Possible impacts arising from the construction and operation works are described according to their location, extent (magnitude) and characteristics. They are also further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories.

Table 16. Impact prediction categorized

Impact category	Description	Reversible/ irreversible	Cumulative impacts
Negligible	The impact has no significant risk to environment either short term or long term	Reversible	No
Minor	The impact is short term and cause very limited risk to the environment	Reversible	No
Moderate	Impacts give rise to some concern, may cause long term environmental problems but are likely short term and acceptable	Reversible	May or may not
Major	Impact is long term, large scale environmental risk	Reversible and Irreversible	Yes, mitigation measures has to be addressed

The concept of the Leopold Matrix (Leopold et. al., 1971) has been used to classify the magnitude and importance of possible impacts which may arise during the constructional and post constructional stage of the proposed project. This is one of the best known matrix methodology used for identifying the impact of a project on the environment. It is a two dimensional matrix which cross references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected.

The matrix has the actions which may cause an impact on the horizontal axis and the environmental conditions which may be impacted on the vertical axis. While the original Leopold matrix lists 100 such actions and 88 environmental conditions, not all are applicable to all projects. Hence the matrix used in the current assessment is a modified matrix customized to this project.

Each action which is evaluated is done so in terms of magnitude of impact on the environmental condition and significance of this impact. In addition to this probability of impact as well as duration of impact is also assessed and shown separately. All probable and significant actions, their magnitude of impact and duration of impact are further described in the text.

This version of the Leopold Matrix has been adopted from Josimovic et. al (2014) and the EIA adopts the grading scales used in the paper referred. Listing of these grading scales are shown in Table 17 below.

Table 17. Grading scales for the four impact evaluation criteria

Evaluation criteria	Designation	Scale
Impact Probability	M	Impact is possible (probability <50%)
	V	Impact is probable (probability >50%)
	I	Impact is certain (probability = 100%)
Impact Magnitude	0	no observable effect
	1	low effect
	2	tolerable effect
	3	medium high effect
	4	high effect
	5	very high effect
Impact significance	P	limited impact on project site (immediate site)
	I	Impact of importance at Island level
	A	Impact of importance at Atoll level
	N	Impact of national character
	M	Impact of cross-border character
Impact duration	P	Occasional/temporary
	D	Long term/permanent

The proposed project involves construction of grow-out pens for sea cucumber and grouper rearing at K. Maniyafushi. Development of the field station on the island is also included in the project. Both the constructional phase and operational phase of the project are expected to have impacts on the environment, especially the marine environment.

The severity of impacts is predicted by reviewing the design plans and construction methodologies. Mitigation measures are formulated in light of the information revealed by the project engineers.

9.2 Limitation or uncertainty of impact prediction

Uncertainty of impact prediction are mainly due to the lack of long term data, inherent complexity of ecosystem and lack of coordinated monitoring programs with consistent methodologies which can be used to predict outcomes or reliability of predictions of previous projects.

The impacts are predicted by reviewing the survey data collected during field visits and information revealed by the designers and engineers. The data collected during field visit is limited in terms of number of days to a week or few more, which limits the overall understanding of even the short term environmental conditions.

The time limitation of EIA field data collection and report preparation is also a hindrance to properly understanding the environmental factors dictating the conditions of the habitat.

9.3 Constructional Impacts

In any development project major direct impacts to the environment (either short term or long term) occur mainly during the construction phase. Potential direct or indirect impacts on the environment from the proposed works include:

- Loss of marine habitat
- Impact on shoreline
- Impact on seawater quality
- Pollution of the natural environment
- Impacts on groundwater

9.3.1 Loss of marine habitat

Sewer outfall, hatchery discharge and seawater intake well are already established at the project site. Therefore, pipeline laying work will not be required on this project. As such, constructional impacts on marine environment from outfalls is not anticipated.

As for the establishment of grow-out pens, the pens will be placed at deeper area of the lagoon which does not require deepening of the lagoon nor dredging by any means. Moreover,

the pens will be constructed from buoyant material, thus they will not touch the sea bottom. Therefore, impacts on marine environment due to construction of grow-out pens is expected to be very low. According to the impact analysis, this component scored an average value of 0.21 (Table 21).

9.3.2 Impact on shoreline/ shoreline and erosion

Maniyafushi is observed with sparse vegetation and void of proper shoreline vegetation belt. The project has been designed in such a way that limited vegetation need to be cleared from the site, any mature tree/palm that needs to be removed will be transplanted elsewhere on the island. The corner of the hatchery is very close the high tide line of the island, in the event of erosion building structure may be compromised. Although it not included in current project, it is recommended to place coastal protection measures on this side of the island.

9.3.3 Impacts on seawater quality

The construction phase of the project will have minor impact on seawater quality (due to stir up some sediment during construction of pens and transportation of pens from lagoon to reef slope area). However, average value of impact is envisaged to be 1.25 with impact being restricted to project site and for the construction period (hence short term).

9.3.4 Pollution of the natural environment

Such development projects have the potential to pollute the environment during the construction phase, through improper disposal of waste. All construction waste will be collected and transported to Thilafushi for proper disposal. Hence the impact potential for pollution is negligible to minor, with an average impact value of 0.14 being felt at the project site.

9.3.5 Impact on air quality and noise

Inherent to any construction project, impacts on air quality and noise level is expected to arise from constructional and demolishing 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.

9.3.6 Impacts on groundwater quality

As there is a four storey building proposed to be built on site, dewatering will be required from this location (minor dewatering). Dewatering will lead to thinning of freshwater lens of islands, however, groundwater on Maniyafushi is already brackish with high salinity and conductivity. Groundwater extracted during dewatering will disposed at nearby areas on the island.

9.3.7 Risk on health and safety

Health and safety risks are associated with any construction project such as this. There is a robust health and safety guideline highlighted in the ESMP (attached in Appendix 7) formulated for this project. Given that the ESMP is followed, it is expected to minimize the risks of accidents and jeopardizing the health and safety of the workers.

9.4 Operational impacts

9.4.1 Impact on seawater quality

No research was found on the impacts of intensive sea cucumber or grouper farming on seawater quality. Aqua culture, in general, is expected to increase the particulate organic matter produced at the grow-out pen areas which will eventually increase the concentrations of chlorophyll a and daytime dissolved oxygen in the bottom layers. It is also expected that the ammonia and phosphate levels may increase in the farming area than in the control area (Huang, 2005). It is important to monitor potential changes to seawater quality at the area through implementation of a scheduled monitoring programme identified in Section 12 of the report.

Moreover, the hatchery discharge is an open system therefore the chances of contamination is minor. Algae and feed production will be a closed system but the water will be changed by up to 25% per day in order to minimise contamination of marine environment.

9.4.2 Impact on marine environment

Very little research has been done on the impacts of sea cucumber culture on the environment. Plotieau et. al. (2013) conducted a study on impacts of intensive sea cucumber farming on sediment. Results of this study shows that two years of intensive farming had an effect on the composition and grain size of the sediment, whereby fine fraction of the sediment and its carbonate proportion was reduced after two years of intensive farming. Furthermore, the study suggested that the number of bacteria and the concentration of microscopic organisms decreased significantly in the pens where intensive farming was carried out. Hence they

recommend a method whereby the pen areas are left unused for culture for a period of time between culture cycles.

In terms of marine habitat, the sites monitored in Maniyafushi were in general composed of low coral cover. Most dominant substrate at all sites was coral rock ranging from 68.71% to 52.51%. Site R1 at the southern side of the island had the highest live coral cover at 14 %. Control site had a live coral cover of 2.35 % whereas at site R3 where the sewer and hatchery discharge is located had the lowest live coral of 0.34 %. Site R3 also consisted of forms of macroalgae such as Halimeda. This could be attributed to the presence of effluent discharge at this location.

The location anticipated to have the highest significant impact is site R3 where the hatchery and sewer effluent is diposed off. However, it is not anticipated to cause any more significant impacts than already is from the already established discharge outfalls.

9.4.3 Impacts on landscape integrity and scenery

The island is already being used by the MRC as a mariculture island and most of facilities are already established on the island. Additionally, no vegetation will be removed under the proposed development. Therefore, it is not expected cause further impacts on landscape integrity and scenery of the island.

9.4.4 Socioeconomic impact

The proposed project is envisaged to have a high positive impact on the socioeconomic environment as it is targeted for the local communities with the interest of sea cucumber and grouper farming as a source of income. There is a huge demand for grouper and sea cucumber export industry and this project will open opportunities for a new means of income for interested parties. Moreover, this will also create job opportunities for many, particularly for those who are unskilled. Therefore, expected average value of impact is 1.

9.4.5 Risk of introduction of alien species

The only non-native species to be used in the project is the sandfish species to be harvested in the project. However, sandfish had already been introduced to the Maldives and can no longer be considered an alien species. Therefore, there is no risk of introduction of alien species associated with the proposed project.

9.4.6 Impact Analysis

An analysis of the impacts due to the project was done using the Leopold matrix. Impacts are assessed according to probability of impact, significance of impact, magnitude of impact and duration of impact. Tables 18 to 21 gives the assessment for the impacts, and these are further discussed above with their scoring.

As evident from Tables below, most impacts envisaged during the construction phase have a low impact on the environment, while impact envisaged during operational phase is envisaged to be moderate to high, based on literature review. Key impact is the changes to the ecosystem due to long term use of the hatchery system at the given areas. High impact is also envisaged on the economy nationwide.

Table 18. Assessment of Probability of impact from project activities

	Envisaged impact factors	Construction phase					Operational phase
		Trampling by workers	Construction of sea-pens	Solid waste disposal	Building(s) construction/ demolition	Dewatering	Grow-outs
Physical components	Seawater quality	V	V	M	M		V
	Land			M	I	I	
	Coastal zone	V	V		I		
	Erosion				V		
	Air				M		
	Noise				M		
	Groundwater quality					I	
Biological components	Ecosystem quality	I	I	M			I
	Diversity of flora		I		M		
	Diversity of fauna						
Socio-cultural components	Landscape				I		
	Land use				I		
	Economy						I
	Cultural heritage						
	Accidents	V	M	M	M		M

Table 19. Assessment of significance of impact from project activities

	Envisaged impact factors	Construction phase					Operational phase
		Trampling by workers	Construction of sea-pens	Solid waste disposal	Building(s) construction/ demolition	Dewatering	Grow-outs
Physical components	Seawater quality	P	P	P	P		P
	Land				I	P	
	Coastal zone	P	P		I		
	Erosion				I		
	Air				P		
	Noise				P		
	Groundwater quality					I	
Biological components	Ecosystem quality	P	P	P			P
	Diversity of flora		P		I		
	Diversity of fauna						
Socio-cultural components	Landscape				I		
	Land use				I		
	Economy						N
	Cultural heritage						
	Accidents						

Table 20. Assessment of duration of impact due to project activities

	Envisaged impact factors	Construction phase					Operational phase
		Trampling by workers	Construction of sea-pens	Solid waste disposal	Building(s) construction/ demolition	Dewatering	Grow-outs
Physical components	Seawater quality	P	P	P	P		D
	Land				L	L	
	Coastal zone	P	D		L		
	Erosion				L		
	Air				P		
	Noise				P		
	Groundwater quality					L	
Biological components	Ecosystem quality	P	D	P			D
	Diversity of flora		D		L		
	Diversity of fauna						
Socio-cultural components	Landscape				L		
	Land use				L		
	Economy						D
	Cultural heritage						
	Accidents						

Table 21. Assessment of magnitude of impact due to project activities

	Envisaged impact factors	Construction phase					Operational phase	Sum	Average
		Trampling by workers	Construction of sea-pens	Solid waste disposal	Building(s) construction/ demolition	Dewatering	Grow-outs		
Physical components	Seawater quality	1	1	1	1	0	2	6	1.00
	Land	0	0	0	2	2	0	4	0.67
	Coastal zone	1	0	0	3	0	0	4	0.67
	Erosion	0	0	0	3	0	0	3	0.50
	Air	0	0	0	1	0	0	1	0.17
	Noise	0	0	0	1	0	0	1	0.17
	Groundwater quality	0	0	0	0	3	0	3	0.50
Biological components	Ecosystem quality	2	1	1	0	0	3	7	1.17
	Diversity of flora	0	1	0	1	0	0	2	0.33
	Diversity of fauna	0	0	0	0	0	0	0	0.00
Socio-cultural components	Landscape	0	0	0	2	0	0	2	0.33
	Land use	0	0	0	2	0	0	2	0.33
	Economy	0	0	0	0	0	4	4	0.67
	Cultural heritage	0	0	0	0	0	0	0	0.00
	Accidents	0	0	0	2	0	0	2	0.33
Cumulative values of IF according to environmental factors		4	3	2	18	5	9	41	6.83
Average		0.27	0.20	0.13	1.20	0.33	0.60		

10 Alternatives

The proposed project involves the construction and establishment of a research and demonstration facility of sea-cucumber and grouper hatchery at Maniyafushi of Kaafu Atoll. The location of the project has been identified by the proponent. Since the island already has an acceptable facility on this island, the location is ideal for this project as this will as 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 locations for construction of grow-out pens in the island lagoon is a considerable option.

10.1 Considered alternatives

10.1.1 Location of seapen construction

Proposed locations: two pens on the southeastern lagoon and two more on the southeast side outside the reef flat

Alternate locations: Anywhere on the northwestern side of the lagoon

Selected type: The jetty to access the island is located at the southeastern side of the lagoon which will make it easier for the transfer boats to move the pens back and forth

10.1.2 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 economic impact due to the project is also envisaged to be high, as the project has a high success rate and all income earned will go to the individual community groups trained during each project. Due to this, and given that environmental impacts due to farming although envisaged to be moderate are not too clear, the continuation of the project is considered feasible. However, it is crucial that the monitoring programme given in the report is followed to identify impacts to the environment and to initiate mitigation measures necessary to decrease these impacts.

11 Mitigation Plan

Mitigation measures that are explored below (Table 22) 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. During the construction stage it is important to take measures to minimize impact on environment due to methods used.

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

Table 22. Identified possible impacts and their relevant mitigation measures

Possible Impacts	Mitigation measures	Location	Time frame (Phase)	Impact intensity	Institutional responsibility	Cost (MRF)
Noise and air pollution	• Avoid unnecessary operation of machinery and equipment • Limit use of heavy machinery to project site only	Project development plot	During construction	Minor, short term impact	Project proponent/ contractor	N/A
Oil spills from power house	• Follow fuel handling regulation of MNDF. • Have emergency clean-up gear on standby	Powerhouse area	During construction and operation	Moderate, long term	Project proponent/ contractor	N/A
Risk of accidents and health and safety of workers	• Strictly follow the ESMP in Appendix 7 of this report • Have emergency vessels on standby to transfer injured staff to Male' in case of accidents	Project development plot	During construction	Minor, short term impact	Project proponent/ contractor	N/A
Contamination of seawater	• Follow regular water change routines of closed hatchery system • Extend sewer outfall beyond the reef system	Sea outfall	During construction and operation	Moderate, long term	Project proponent/ contractor	N/A
Physical damage to reef habitat	• Avoid trampling on areas outside of project boundary	Project development plot	During construction	Minor, short term impact	Project proponent/ contractor	N/A
Sedimentation / siltation on the reef and lagoon	• Avoid trampling on areas outside of project boundary	Project development plot	During construction	Minor, short term impact	Project proponent/ contractor	N/A
Impact on sediment and seawater quality due to intensive farming	• Carry out monitoring programme as scheduled and review results • Implement mitigation measures identified then based on results of monitoring programme	Project development plot	During operation	Moderate, long term	Project proponent/ contractor	N/A

12 Monitoring Program

Monitoring is the systematic collection of information over a long period of time. It involves the measuring and recording of environmental variables associated with the development impacts. Monitoring is needed to;

- Compare predicted and actual impacts
- Test the efficiency of mitigation measures
- Obtain information about responses of receptors to impacts
- Enforce conditions and standards associated with approvals
- Prevent environmental problems resulting from inaccurate predictions
- Minimize errors in future assessments and impact predictions
- Make future assessments more efficient
- Provide ongoing management information
- Improve EIA and monitoring process

Impact and mitigation monitoring is carried out to compare predicted and actual impacts occurring from project activities to determine the efficiency of the mitigation measures. This type of monitoring is targeted at assessing human impacts on the natural environment. Impact monitoring is supported by an expectation that at some level anthropogenic impacts become unacceptable and action will be taken to either prevent further impacts or re-mediate affected systems. Mitigation monitoring aims to compare predicted and actual (residual) impacts so that effectiveness of mitigation measures can be determined.

Monitoring works have been identified for the operational phase of the project, due to the small scope of the construction phase. Monitoring works during the operational phase will be carried out according to the monitoring programme in Table 23. Cost for the monitoring (data collection) activities will be covered by the proponent (commitment to carrying out and financing the mitigation and monitoring work is given in the Proponents Declaration on Page vi).

Table 23. Monitoring programme for construction phase of the project

Monitoring parameter	Frequency or timing	Cost
Shoreline mapping using precision GPS (high tide line and Low tide line)	Every six months (this would give a clear picture of shoreline changes over long term and seasonal shifts) for two years	MRF 10,000 per survey
Seawater quality tested for • Nitrates • pH	Every six months for the duration of the project	MRF 10,000.00

• Dissolved Oxygen • Nitrogen Ammonia • Salinity • Temperature • Total Dissolved Solids • Turbidity		

The EIA monitoring report structure provided in the EIA report bylaw 2012 (2012/R-27) shall be used for the monitoring report preparation. Monitoring reports will be submitted at the intervals as specified in Table 23 for monitoring work during operational phase of the project.

13 Conclusion and recommendation

The environmental impacts associated with proposed project are considered minor to moderate. This conclusion is based on the evaluation of various components of the proposed project. The proposed project site for grow-out pens is located at the sout eastern side of the island where smaller pens are already established. The island has very few vegetation which will be retained during construction of buildings on the island.

The project consists of construction of 2 four storey buildings, therefore, dewatering would be required for foundation works. However, groundwater characteristic analysis of Maniyafushi shows that the groundwater lens is highly saline on this island.

As the size of the island is considerably small, one of the buildings is close to high tide line of the island. Therefore, it is highly recommended to put in coastal protection structures on this side of the island to prevent erosion and damage to the building. The proponent states that under the currently available budget, such structures cannot be accommodated, however, the consultant recommends arrangement of funding for shore protection measures as soon as possible.

The impacts of proposed activities on sea water quality once the project becomes operational has to be closely monitored as outlined in Table 23 of this report.

While the no project scenario has been considered, the option was concluded to be not feasible as it will take away the opportunity for the island communities to venture into a highly economically rewarding field.

Therefore, with due consideration to the environmental components identified above and the extent of the project activities and their likely and predicted impacts identified, the consultant concludes that the project components and designs are feasible and appropriate mitigation measures have been considered to correct and minimize unfavorable environmental changes.

Acknowledgements

The consultant 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 MRC.

CVs of team members are given below.

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

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

LANGUAGES AND DEGREE OF PROFICIENCY

Divehi- mother tongue
English- fluent

COUNTRIES OF WORK EXPERIENCE

Maldives
Australia

EMPLOYMENT RECORD

2016 to present- 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.
- Overseeing 29 desalination plants and 32 sewerage systems registered under FENAKA Corporation
- Overseeing water and sewerage related projects operated under the company.
- Project management of sewerage 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: 7774602

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: 7782866

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.

- 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

2015 (Casual) Barista/ waitress- Donut King, Mustang Avenue, Majura Park, ACT 2609, Australia.

- Serving customers
- Taking orders and handling cash
- Often took up the manager's position at the absence of the manager
    - Referee
        - Mark
            - Area manager
            - Telephone: +61 407 616 784

DETAILED TASKS

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

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 new 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 the this study.

Environment consultancy for reclamation of Enboodhoo Lagoon to artificially create new islands for resort development, Maldives

Location: Enboodhoo Lagoon
Year : 2016
Client: Dream Islands Development Pvt. Ltd.
Position Held: Environment Officer
Duties Rendered: Part of the project management team to advice the client on island designs 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: Deputy Manager (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.

Environmental Impact Assessment Report for water production and distribution facility at HA. Hoarafushi, HDh. Hanimaadhoo and GA. Villingili
Location: HA. Hoarafushi, HDh. Hanimaadhoo 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.

Project management for design and built basis for sewerage collection network, 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
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 sewerage facilities in Hithadhoo (central area), Addu city
Location: S. Hithadhoo
Year: 2016 (ongoing)

Client: Ministry of Environment and Energy
Position held: Project Manager
Duties rendered: Monitoring project progress and responsible for overseeing project activities and solve issues. Arrange inspection trips to review project activities. Arrange resources for the project and resolve issues.

Project management for consultancy services for survey, design of sewerage facilities in F. Biledhoo, GDh. Madaveli, R. Innamaadhoo and Sh. Feevah, Maldives
Location: F. Biledhoo, GDh. Madaveli, R. Innamaadhoo and Sh. Feevah
Year: 2017 (ongoing)
Client: Ministry of Environment and Energy
Position held: Project Manager
Duties rendered: Monitoring project progress and responsible for overseeing project activities and solve issues. Assign tasks to the technical and team and arrange resources. Communicate with the client and report work progress.

CURRICULUM VITAE

Name:	**Fathimath Farah Amjad (Ms)**
Address:	G. Male' Hiya 2 (11-04), Ameenee Magu, Male' 20082, Rep. of Maldives
Telephone:	+ (960) 768-8861
E-mail:	fara.a@outlook.com
Nationality:	Maldivian
Date of Birth:	April 30th, 1990

ACADEMIC QUALIFICATION

Maldives National University, Male', Maldives	**Bachelor of Environmental Management** (June, 2015 - Present)
Maps College, Male', Maldives	**The Association of Business Executives, UK- Diploma in Marketing Management Level 4** (January 2013 – June 2013)
UCSI University, Kuala Lumpur, Malaysia	**Foundation in Built Environment** (January 2010 – April 2011)
Male' Centre of Technology, Male', Maldives	**Advanced Certificate in Residential Drafting** (January 2007 – August 2007) **Certificate in Autocad 3D** (July 2007 – August 2007)
Aminiya School, Male; Maldives	**Cambridge GCE & GCSE O' Levels** (2003 – 2005)

EMPLOYMENT

Maldives Energy and Environmental Company, Malé, Maldives

Research Assistant (October, 2015 – Present)

Duties:

- Conducting marine, terrestrial and socio-economic surveys for EIA reports, with the assistance of the EIA consultant.
- Design of layouts, maps and other data for reports.
- Input and sectional writings for EIA reports.
- Communication with government authorities, island and atoll councils and other relevant parties regarding ongoing projects at the company.

Renewable Energy Maldives, Male', Maldives

Project/Monitoring Assistant, Draftsperson (March, 2014 – September, 2015)

Duties:

- Regular monitoring and data management of all installed PV solar systems.
- Designing and drafting of technical and electrical layouts. I. e. Roof layouts, Waste-to-energy incinerator design, etc.
- Regular communication with suppliers regarding equipment for PV installations and various DC products.
- Communication with customers, government authorities and

other relevant establishments on various matters regarding PV systems, equipment clearance and site installations.
- Drafting proposals and bid documents.
- Designing promotional materials such as brochures and banners.
- Assisting the engineer in the preparation of energy audit reports, data collection, analysis and site surveying.

[Independent Projects]

Freelancing (2012 – 2012)
- Designing and digital drafting of residential and small scale commercial structures.

Arcade Pvt Ltd,
Male', Maldives

Draftsperson (January, 2009 – May, 2009)
Duties:
- Designing exterior and interior layouts of buildings.
- Drafting of architectural, structural, plumbing and electrical drawing sets for a number of residential and commercial buildings under guidelines from the civil engineer.
- Preparation of digital 3d models on request.

Hulhumale' Development Corperation,
Malé, Maldives

Customer Services and Data Collection (3 month contract; August, 2008 – November 2008)
Duties:
- Collecting and processing data.
- Communication with customers.

Gedor Consultancy,
Malé, Maldives

Draftsperson (January, 2008 – July, 2008)
Duties:
- Drafting architectural and structural drawings with the guidance of the head architect and engineer.
- Worked in the designing and drafting phase of a number of resort projects, residential, commercial and government buildings.

Design House Pvt Ltd,
Malé, Maldives

Draftsperson Trainee (June, 2007 – September, 2007)
Duties:
- Draftsperson training while undergoing the residential drafting course at Male' Centre of Technology.

COMMUNICATION

Languages: English, Dhivehi.

- Good oral and written communication skills.
- Good in scientific and formal report writing.

OTHER QUALIFICATIONS AND SKILLS

Scuba Diving

- Emergency First-Aid Responder (Pending)
- PADI Advanced Open Water Diver, 2014
- PADI Open Water Diver, 2014
  (80+ logged dives)

AFFILIATIONS AND TRAININGS

Memberships

- **Assessor** at **Green Fins**, an initiative by UNEP, internationally coordinated by Reef-World Foundation, UK which aims to protect and conserve coral reefs by establishing and implementing a comprehensive management approach to promote a sustainable diving and snorkelling tourism industry.
- **Certified Eco-Diver** at **Reef Check Foundation,** an international non-governmental organization dedicated to the conservation of reefs by collecting data from volunteer/citizen scuba diver teams in over 90 countries.

Voluntary work

- Citizen-Scientist at **IUCN Maldives - Project Regenerate**, aimed at regenerating and sustainably managing the coral reef eco systems of Maldives.
- Marine cleaner at **NGO Save the Beach** and **'Project Damage Control'**, working at coastal and marine clean up events at Villimale' and Male' area, conducting community awareness programs, litter audits and reef monitoring programs.

Workshops & Trainings

- **'Turtle Watch Maldives'** protocol trainings conducted by **Marine Research Centre Maldives**; for survey conduction and data submission guidelines.
- **Maldives Coral Bleaching Protocol** trainings conducted by **Marine Research Centre Maldives** and **IUCN-Maldives**, recording base line data and the extent of bleaching damage.

Participations & Events

- **'Kill the COTS'**; an event organised by **Divers Association of the Maldives** and several dive schools in the central region to tackle the nation-wide outbreak of Crown of Thorns starfishes.

REPORTS

- Saleem, A., **Amjad, F.**, Hammadh, A. and Naeem, S. (2015). Environmental Monitoring Report: L. Mahakanfushi & Baresdhoo Integrated Resort Project Phase: Mahakanfushi Harbour, Entrance Channel and Causeway Works. Monitoring Report No.1.

REFEREES

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References

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Naseer, A. and Hatcher, B. G., 2004. Inventory of the Maldives coral reefs using morphometrics generated from Landsat ETM+ imagery. *Coral Reefs* 23(1),*pp 161-168*.

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Appendices

Appendix 1 List of abbreviations

CBD – Convention on Biological Diversity
EIA – Environmental Impact Assessment
ESMP - Environmental and Social Management Plan
EPA – Environmental Protection Agency
HPA- Health Protection Agency
MEE – Ministry of Environment and Energy
MRC- Marine Research Center
MoFA – Ministry of Fisheries and Agriculture
NBSAP - National Biodiversity Strategy and Action Plan
NEAP III – Third National Environment Action Plan
ToR – Terms of Reference
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme

Appendix 2 Terms of Reference (ToR)

NO: 203-EIARES/30/2017/28

Terms of Reference for the Environmental Impact Assessment for the Construction and Operation of Maniyafushi Field Station at Maniyafushi, Kaafu Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on *14/12/2017* for undertaking the EIA of the Construction and Operation of Maniyafushi Field Station at Maniyafushi, Kaafu Atoll. **The proponent of the Project is Ministry of Fisheries and Agriculture.**

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.

1. **Introduction to the project** – Describe the purpose of the project and, if applicable, the background of the project and the tasks already completed. Clearly identify the rationale and objectives to enable the formulation of alternatives. Define the arrangements required for the environmental assessment and if relevant, including how work carried out under this contract is linked and sequenced with other projects executed by other consultants, and how coordination between other consultants, contractors and government institutions will be carried out. List the donors and the institutions the consultant will be coordinating with and the methodologies used.

2. **Study area** – Submit an A3 size scaled plan with indications of all the proposed land infrastructures. Specify the boundaries of the study area for the environmental impact assessment highlighting the location and size of the proposed construction. The study area should include nearby environmentally sensitive areas. Justification for site selection is required. Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3. **Scope of work** – The report should be categorized into the following components.

   Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the project, using maps at appropriate scales where necessary. The following should be provided (all inputs and outputs related to the proposed activities shall be justified):

   The main activities of the project development components shall cover but not limited to:

   1. Construction of various infrastructure components, to include all land based and shore based facilities, structures such as service related infrastructure (e.g. power generation, water supply, waste disposal),
   2. Duration of construction related activities,
   3. Estimated number, types and sources of materials
   4. Labor requirements and (local) labor availability;
   5. Housing of construction workforce,
   6. Operational aspects of the facility,
   7. Description of safety measures during the construction and operation.

Environmental Protection Agency
Green Building, 3rd Floor, HandhuvareeHingun
Male', Rep. of Maldives, 20392
Tel: [+960] 333 5949 [+960] 333 5951
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Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

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ގްރީން ބިލްޑިންގ، 3ވަނަ ފަންގިފިލާ، ހަނދުވަރީހިނގުން
މާލެ، ދިވެހިރާއްޖެ، 20392
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Task 2. Description of the existing environment – Assemble, evaluate and present the environmental baseline studies/data regarding the *study area and timing of the project* (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring.

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

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

Climate/hydrology/hydrodynamics

- Wind, waves patterns associated with project location in the context of available secondary data.
- Tidal information relevant to site, including tidal ranges and currents;
- Wave climate and wave induced current based on available climatic data;
- Wind induced (seasonal) currents;

Geology and geomorphology

- Description of land/island characteristics of the proposed development site (use maps); this should include shoreline maps showing vegetation line, low tide line, high tideline, areas of coastal erosion and accretion and reef line,
- Characteristics of infrastructure as access to the facility (e.g. harbor and access channel)

Ecology

- Description of existing landscape setting and changes to the existing setting because of the proposed development,
- Description of marine environment in terms of reef benthic community, fish community
- Seawater quality measuring these parameters: temperature, pH, salinity, turbidity (SS), phosphate, nitrate, ammonia from points of all types of waste water discharge from the facility
- Groundwater characteristics of the island.

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. Include permits and approvals from the relevant institutions (where applicable).

Task 4. Potential impacts of the proposed project– The EIA report should identify all the impacts (direct, indirect and cumulative) and evaluate the magnitude and significance, this shall include:

1. Impacts on surrounding habitats where the effluents from the facility are disposed
2. Impacts on landscape integrity/scenery.
3. Impacts on employment and income, potential for local people to have (temporary or long term) job opportunities;
4. Pollution of the natural environment (e.g. oil spills, discharge of waste during the construction and operation of the facility

5. Health and safety risks associated with the proposed works.
6. Impact associated with the introduction of aliens species (if any).

The methods used to identify the significance of the impacts shall be outlined. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts.

Task 5. Alternatives to proposed project – Describe alternatives including the *"no action option"* should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This should include alternatives for environmental, social and economic considerations. The report should highlight how the location for the outfall was determined. All alternatives must be compared according to commonly accepted standards as much as possible.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. Mitigation measures must also be identified for both construction and operation phase. Cost of the mitigation measures, equipment and resources required to implement those measures should be specified. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included.

Task 7. Environmental monitoring plan - Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present environmental impact management and monitoring plan for coastal modification and sediment movement around the island. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided.

Task 8. Stakeholder consultation – EIA report should include a list of people consulted and what were the major outcomes. Identify appropriate mechanisms to supply stakeholders and the public with information about the development proposal and its progress. Major stakeholder consultation shall include Environmental Protection Agency, Kaafu Atoll Council, Maldives Food and Drugs Authority and Health Protection Agency and other relevant Authorities/Parties/NGO.

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

Relevant documentation, references for consultants – Include publicly available studies or references relevant to the current project to be used by the consultant.

***Timeframe for submitting the EIA report** – The developer must submit the completed EIA report within 06 months from the date of this Term of Reference.*

ENVIRONMENTAL PROTECTION AGENCY
Rep of Maldives
14.12.2017

Environmental Protection Agency
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Male', Rep. of Maldives, 20392
Tel: [+960] 333 5949 [+960] 333 5951
Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv
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ގްރީން ބިލްޑިންގ، 3 ވަނަ ފަންގިފިލާ، ހަނދުވަރީހިނގުން
މާލެ، ދިވެހިރާއްޖެ، 20392
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Appendix 3 Land Use Plan of Maniyafushi

LEGEND :

- Open / Green Space
- Accomodation Block
- Warehouse
- Powerhouse
- Waste yard
- Brood Stock Facility
- Mosque
- Vegetation (Existing)
- Jetty
- Laboratory
- Green House
- Toilets
- Sewerage Junction Box
- Hatchery (Existing)
- Road / Paved area
- Beach
- High tide line
- Low tide line

- Seawater intake pipeline
- Waste seawater discharge pipeline
- RO intake pipeline
- RO discharge pipeline
- Sewage discharge pipeline

Appendix 4 Powerhouse building and distribution map

K.MANIYAFUSHI POWER SYSTEM UPGRADING PROJECT

BASIC DESIGN STUDY REPORT

May 2017

STATE ELECTRIC COMAPANY LIMITED
MALE'
MALDIVES

TABLE OF CONTENTS

1 INTRODUCTION 3
2 BASIC CONCEPT OF THE PROJECT 4
3 OUTLINE OF THE BASIC PLAN 4
3.1 Load Forecast 4
3.2 Generator Set Sizing and main Control Panel Board 4
3.3 Voltage Drop 5
3.4 Power House Building 5
3.5 Fuel tank 5
3.6 Fire System 5
4 PROJECT EFFECTS 6

ANNEX 1: Site Plan
ANNEX 2: Build up area and unit load
ANNEX 3: Distribution Map
ANNEX 4: Schematic Diagram
ANNEX 5: Feeder Voltage drop calculations
ANNEX 6: DB load calculations
ANNEX 7: Control Panel details
ANNEX 8: Fuel tank and fuel lines.
ANNEX 9: Lightning protection
ANNEX 10: Powerhouse Layout

1 INTRODUCTION

K.Maniyafushi Island located 17 kilometers SW from the Capital City Male' with just over one hectare of land area is used by the Ministry of Fisheries and Agriculture as a mariculture island.
The island already consists of the necessary infra-structure which allows it to function as its core establishment.
However the existing electric power system is insufficient for its full operation and also for the planned upgrading works.
This document includes the power consumption for the future buildings and its equipment's which are anticipated to come in a near future by the Ministry.

2 BASIC CONCEPT OF THE PROJECT

Based on the data provided by the ministry and through analysis of the data, the basic concept of the proposal is to construct a new power plant along with a suitable and reliable distribution system that can cater for the existing and future demands at an optimum cost. The concept also emphasizes on providing reliable and cost effective power to the island. With this concept in mind, the capital investment is brought to a minimum.

3 OUTLINE OF THE BASIC PLAN

3.1 Load Forecast

The load forecasts for staff accommodation and hatchery and other such infrastructure areas are developed for 10 years but for street light and lighting for public spaces are considered constant. Refer Annex 2 for detailed calculations.

3.2 Generator Set Sizing and main Control Panel Board

For continuous operation of power system minimum four generator sets shall be installed. The power house and control panel shall be large enough to accommodate the diesel generator sets sizes for the 10 year period. The panel board is a synchronizing panel board with automatic load sharing for two generator sets.

3.3 Voltage Drop

Main distribution cables are selected to limit the voltage drop to maximum 5% for the 10 year period and up to 2% for the consumer cables. Existing consumer and road light cables shall be used where possible and make joints where necessary to connect new/ existing distribution boxes. Refer Annex 5 for detail calculations.

3.4 Power House Building

Existing power house insufficient for the installation of additional generators and control panel thus a new powerhouse building is designed and constructed. The new powerhouse will be equipped with sound attenuators and rockwool insulated roofs to minimize noise. Refer Annex 10 for basic design of a new power house.

3.5 Fuel tank

A fuel storage tank with a capacity of 3,600 liters shall be constructed within the powerhouse premises. Refer Annex 8.

3.6 Fire System

Fire extinguishers shall be installed at suitable locations of the powerhouse and in the premises. A fire alarm system with smoke and heat detectors shall be installed within the powerhouse.

4 PROJECT EFFECTS

With the commissioning of the upgraded power system, reliable and cost effective power will be delivered to the consumers throughout the day. Generating capacity of the power station would be further upgraded only on demand. With this strategy, the consumers on the island will benefit from low cost and reliable power for their consumption.

This project, if implemented as planned, will consolidate the infrastructure of the island and is an important means for developing K.Maniyafushi further. Stable, reliable and cost-effective electricity to this island will improve the life span of the general electrical appliance and as well as the most expensive machineries used in the island. .

ANNEX 1:

Site Plan

Key

A Accommodation/office block
- a Reception
- b Office
- c Mess room
- d Kitchen
- e Classroom

B Mosque (Existing)

C Store

D Microalgae mass culture

E Microalgae stock culture

F Zooplankton culture/Enrichment

G Wetlab/aquariums/Ground floor On-farm feed preparation station

H Larvae nursing/incubation Packing station

I Quarantine room

J Pump station

K Broodstock maintenance

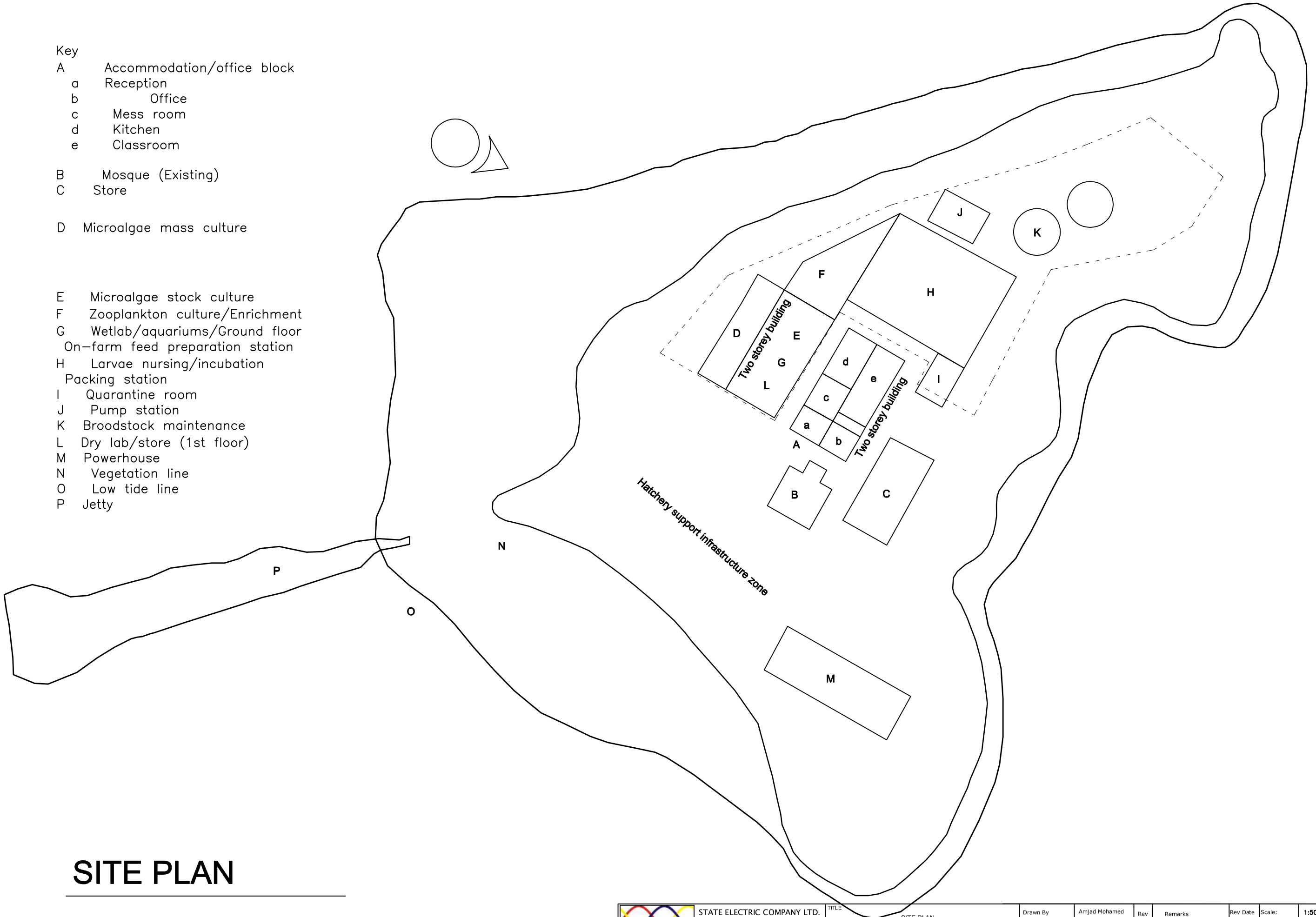
L Dry lab/store (1st floor)

M Powerhouse

N Vegetation line

O Low tide line

P Jetty



SITE PLAN

STATE ELECTRIC COMPANY LTD.
Amaeenee Magu, Male', Maldives.
Phone : 332 0982
Fax : 332 7036
E-mail : admin@stelco.com.mv

TITLE: SITE PLAN	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	1:500
	Checked By	Ahmed Shafeeu	00		-	Drawing No	NA
PROJECT: MANIYAFUSHI POWER SYSTEM	MEA Licence No.	MTIL/97/0016				Date	03/05/2016
	Signature					Sht No	01 of 01 Next Sht 0

ANNEX 2:

Build up Area and Unit Load

Build Up Area & Unit Load

Maniyafushi

Kaafu Atoll, Maldives

ITEM	BUILDING / FACILITY	NO	UNIT	kW	TOTAL kW	UNIT AREA (sqm)	TOTAL AREA (sqm)
1	Staff Accomodation	1	units	14	14	152.50	153
2	Reception	1	units	2	2		
3	Office	1	units	1.95	1.95		
4	Mess room	1	units	3.5	3.5		
5	Kitchen	1	units	6.35	6.35		
6	Class room	1	units	3.58	3.58		
7	Laundary	1	units	4.4	4.4		
8	Mosque	1	units	1.08	1.08	50.60	51
9	Store	1	units	0.62	0.62	96.00	96
10	Micro algae mass culture	1	units	65.15	65.15	299.50	300
11	Micro stock culture						
12	Zooplankton culture / Enritchment						
13	Wetlab / Aquariums						
14	Dry lab / store	1	units	13	13		
15	Larvae nursing / incubation / Packing	1	units	10	10	279.60	280
16	Quarantine Room	1	units	4	4	27.60	28
17	Pump station	1	units	6	6	36.20	36
18	Broodstock Maintenance	1	units	1.5	1.5	69.20	69
19	Powerhouse / desalination plant	1	units	23.5	23.5	141.00	141
	TOTAL	**16**	***units***	**160.63**	**160.63**	**1152.2**	**1152**
	TOTAL BUILT UP AREA						**1,152.20**
	TOTAL LAND AREA						**9,715.00**
	TOTAL BUILT UP PERCENTAGE						**11.86%**

ANNEX 3:

Distribution Map

Key

A Accommodation/office block
- a Reception
- b Office
- c Mess room
- d Kitchen
- e Classroom

B Mosque (Existing)

C Store

D Microalgae mass culture

E Microalgae stock culture

F Zooplankton culture/Enrichment

G Wetlab/aquariums/Ground floor
On-farm feed preparation station

H Larvae nursing/incubation
Packing station

I Quarantine room

J Pump station

K Broodstock maintenance

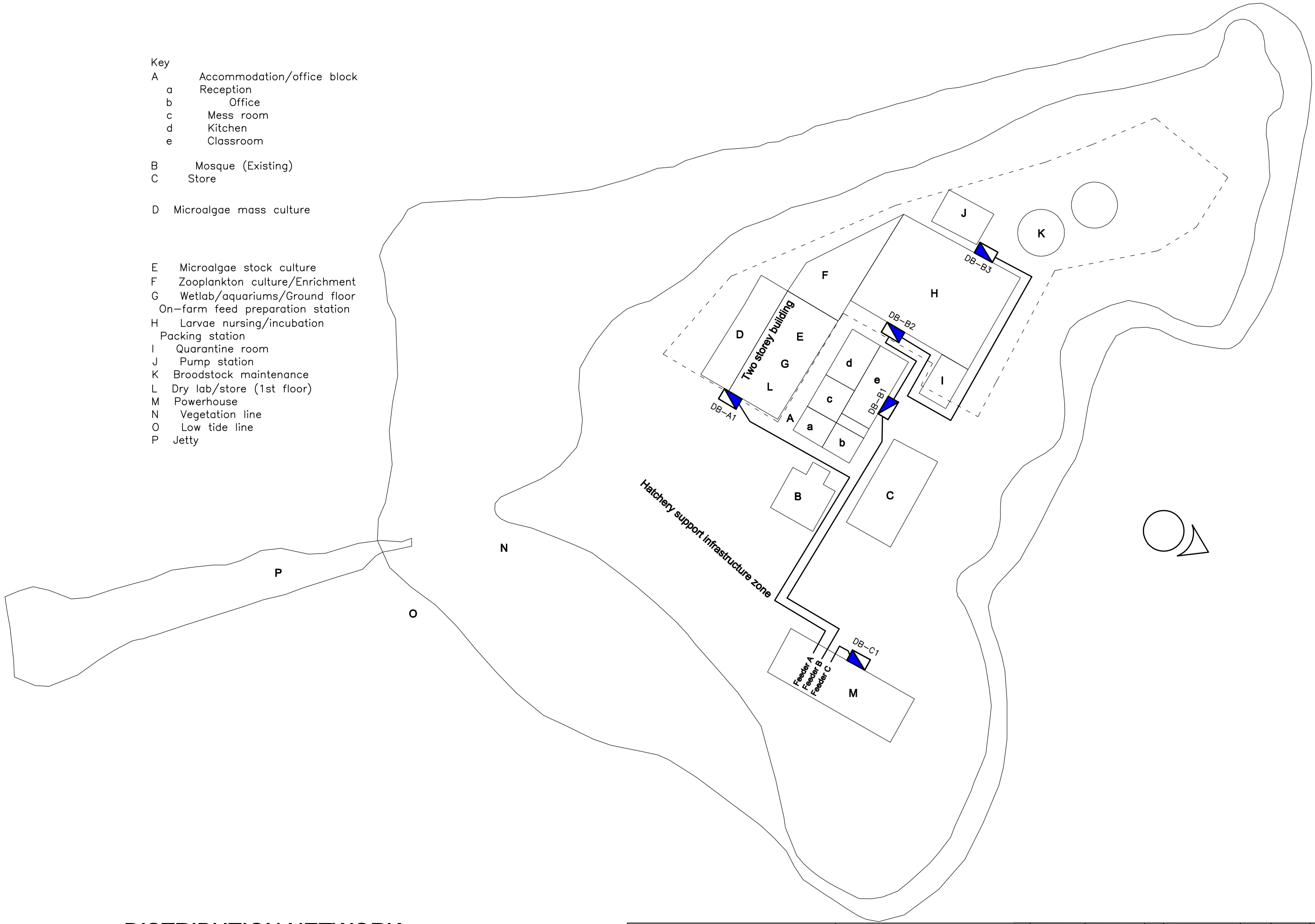
L Dry lab/store (1st floor)

M Powerhouse

N Vegetation line

O Low tide line

P Jetty



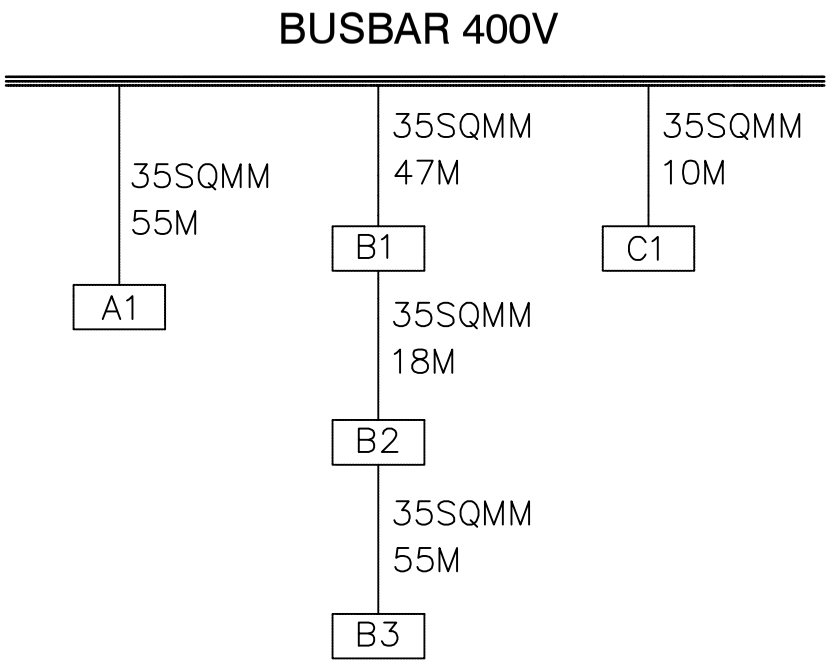
DISTRIBUTION NETWORK

STATE ELECTRIC COMPANY LTD.
Amaeenee Magu, Male', Maldives.
Phone : 332 0982
Fax : 332 7036
E-mail : admin@stelco.com.mv

TITLE: DISTRIBUTION MAP	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	1:500
	Checked By	Ahmed Shafeeu	01	added DB, added 2 gensets	5/10/17	Drawing No	NA
PROJECT: MANIYAFUSHI POWER SYSTEM	MEA Licence No.	MTIL/97/0016				Date	03/05/2016
	Signature					Sht No	01 of 01 Next Sht 0

ANNEX 4:

Distribution Schematic Diagram



STELCO
STATE ELECTRIC COMPANY LIMITED
STATE ELECTRIC COMPANY LTD.
Amaeenee Magu, Male', Maldives.
Phone : 332 0982
Fax : 332 7036
E-mail : admin@stelco.com.mv

TITLE: DISTRIBUTION SCHEMATIC DIAGRAM

PROJECT: MANIYAFUSHI POWER SYSTEM

Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	NA
Checked By	Ahmed SHafeeu	01	added DB, added 2 gensets	5/10/17	Drawing No	NA
MEA Licence No.	MITL/97/0016				Date	03/05/2016
Signature					Sht No	01 of 01 Next Sht 0

ANNEX 5:

Feeder Voltage Drop Calculations

VOLTAGE DROP CALCULATION

Feeder A

Voltage Drop Calculation sheet for Underground LV Copper Cables.(BS 6346)

Distance															PH-A1	Voltdrop	%
Sections			13	12	11	10	9	8	7	6	5	4	3	2	1	400 Volts	
Length (km)			**0**	**0**	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.055**		
Cab.size	16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.43		
Cab.size	25		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.26		
Cab.size	35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**8.99**	**8.99**	**2.25**
Cab.size	50		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.62		
Cab.size	70		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.66		
Cab.size	95		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51		
Cab.size	120		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86		
Cab.size	150		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.37		
Cab.size	185		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04		
Cab.size	240		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.72		
Cab.size	300		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55		
Cab.size	400		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31		
Kilowatts			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**78.15**		

Section No.	KVA drop Per Km.	Terminal Voltage		Terminal Amps. Section	Load
1	5.37	V1	380.00	I1	148.60
2	0.00	V2	400.00	I2	148.60
3	0.00	V3	400.00	I3	148.60
4	0.00	V4	400.00	I4	148.60
5	0.00	V5	400.00	I5	148.60
6	0.00	V6	400.00	I6	148.60
7	0.00	V7	400.00	I7	148.60
8	0.00	V8	400.00	I8	148.60
9	0.00	V9	400.00	I9	148.60
10	0.00	V10	400.00	I10	148.60
11	0.00	V11	400.00	I11	148.60
12	0.00	V12	400.00	I12	148.60
13	0.00	V13	400.00	I13	148.60
14	0.00	V14	400.00	I14	148.60
15	0.00	V15	400.00	I15	148.60
		V16	400.00		
Total	5.37				

VOLTAGE DROP CALCULATION

Feeder B

Voltage Drop Calculation sheet for Underground LV Copper Cables.(BS 6346)

Distance													B2-B3	B1-B2	PH-B1	Voltdrop	%
Sections			13	12	11	10	9	8	7	6	5	4	3	2	1	400 Volts	
Length (km)			**0**	**0**	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.055**	**0.018**	**0.047**		
Cab.size	16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.99	1.85	8.37		
Cab.size	25		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.13	2.42	5.02		
Cab.size	35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.69	1.77	3.68		
Cab.size	50		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.93**	**1.31**	**2.71**	**8.95**	**2.24**
Cab.size	70		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47	0.92	1.91		
Cab.size	95		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.62	0.69	1.44		
Cab.size	120		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.56	1.17		
Cab.size	150		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.76	0.47	0.97		
Cab.size	185		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	0.40	0.84		
Cab.size	240		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.34	0.70		
Cab.size	300		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	0.31	0.64		
Cab.size	400		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.26	0.54		
Kilowatts			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11.5**	**10**	**37.48**		

Section No.	KVA drop Per Km.	Terminal Voltage		Terminal Amps. Section	Load
1	2.20	V1	380.00	I1	71.27
2	0.23	V2	393.69	I2	89.62
3	0.79	V3	395.09	I3	110.65
4	0.00	V4	400.00	I4	110.65
5	0.00	V5	400.00	I5	110.65
6	0.00	V6	400.00	I6	110.65
7	0.00	V7	400.00	I7	110.65
8	0.00	V8	400.00	I8	110.65
9	0.00	V9	400.00	I9	110.65
10	0.00	V10	400.00	I10	110.65
11	0.00	V11	400.00	I11	110.65
12	0.00	V12	400.00	I12	110.65
13	0.00	V13	400.00	I13	110.65
14	0.00	V14	400.00	I14	110.65
15	0.00	V15	400.00	I15	110.65
		V16	400.00		
Total	3.22				

VOLTAGE DROP CALCULATION

Feeder C

Voltage Drop Calculation sheet for Underground LV Copper Cables.(BS 6346)

Distance															PH-A1	Voltdrop	%
Sections			13	12	11	10	9	8	7	6	5	4	3	2	1	400 Volts	
Length (km)			**0**	**0**	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.010**		
Cab.size	16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12		
Cab.size	25		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67		
Cab.size	35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.49**	**0.49**	**0.12**
Cab.size	50		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36		
Cab.size	70		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25		
Cab.size	95		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19		
Cab.size	120		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16		
Cab.size	150		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13		
Cab.size	185		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11		
Cab.size	240		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09		
Cab.size	300		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08		
Cab.size	400		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07		
Kilowatts			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**23.5**		

Section No.	KVA drop Per Km.	Terminal Voltage		Terminal Amps. Section	Load
1	0.29	V1	380.00	I1	44.68
2	0.00	V2	400.00	I2	44.68
3	0.00	V3	400.00	I3	44.68
4	0.00	V4	400.00	I4	44.68
5	0.00	V5	400.00	I5	44.68
6	0.00	V6	400.00	I6	44.68
7	0.00	V7	400.00	I7	44.68
8	0.00	V8	400.00	I8	44.68
9	0.00	V9	400.00	I9	44.68
10	0.00	V10	400.00	I10	44.68
11	0.00	V11	400.00	I11	44.68
12	0.00	V12	400.00	I12	44.68
13	0.00	V13	400.00	I13	44.68
14	0.00	V14	400.00	I14	44.68
15	0.00	V15	400.00	I15	44.68
		V16	400.00		
Total	0.29				

ANNEX 6:

DB Load Calculations

Feeder A

DB REF	DB-A1
MAIN INCOMING SWITCH RATING	100A TPN
SIZE OF INCOMING CABLE	1x 4C x 35sqmm XLPE/SWA/PVC

S/N	Item	Unit Load (kW)	Units	Total Con P(kW)	Demand Factor	Diversity Factor	Total Act P(kW)	Total Load (A)
1	Micro algae mass culture	1	1	65.15	1.00	0.70	45.61	82
2	Micro stock Culture							
3	Zooplankton culture / enrichment							
4	Wetlab / aquarium							
5	Dry lab / store	1	1	13	1.00	0.70	9.10	16
				78.15			**55**	**99**

MAIN CABLE LENGTH
55

Feeder B

DB REF	DB-B1
MAIN INCOMING SWITCH RATING	80A TPN
SIZE OF INCOMING CABLE	1x 4C x 50sqmm XLPE/SWA/PVC

S/N	Item	Unit Load (kW)	Units	Total Con P(kW)	Demand Factor	Diversity Factor	Total Act P(kW)	Total Load (A)	MAIN CABLE LENGTH
1	Staff Accomodation	14	1	14	1.00	0.70	9.80	18	**47**
2	Reception	2	1	2	1.00	0.70	1.40	3	
3	office	1.95	1	1.95	1.00	0.70	1.37	2	
4	Mess room	3.5	1	3.5	1.00	0.70	2.45	4	
5	Kitchen	6.35	1	6.35	1.00	0.70	4.45	8	
6	Class room	3.58	1	3.58	1.00	0.70	2.51	5	
7	Laundary	4.4	1	4.4	1.00	0.70	3.08	6	
8	Mosque	1.08	1	1.08	1.00	0.70	0.76	1	
9	Store	0.62	1	0.62	1.00	0.70	0.43	1	
				37.48			**26**	**47**	

DB REF	DB-B2
MAIN INCOMING SWITCH RATING	63A TPN
SIZE OF INCOMING CABLE	1x 4C x 50sqmm XLPE/SWA/PVC

S/N	Item	Unit Load (kW)	Units	Total Con P(kW)	Demand Factor	Diversity Factor	Total Act P(kW)	Total Load (A)	MAIN CABLE LENGTH
1	Lavae nurse / incubation / packing	10	1	10	1.00	0.70	7.00	13	**18**
				10.00			**7**	**13**	

Feeder B

DB REF	DB-B3
MAIN INCOMING SWITCH RATING	63A TPN
SIZE OF INCOMING CABLE	1x 4C x 50sqmm XLPE/SWA/PVC

S/N	Item	Unit Load (kW)	Units	Total Con P(kW)	Demand Factor	Diversity Factor	Total Act P(kW)	Total Load (A)	MAIN CABLE LENGTH
1	Quarantine Room	4	1	4	1.00	0.70	2.80	5	**55**
2	Pump station	6	1	6	1.00	0.70	4.20	8	
3	Brood stock maintenance	1.5	1	1.5	1.00	0.70	1.05	2	
				11.50			**8**	**15**	

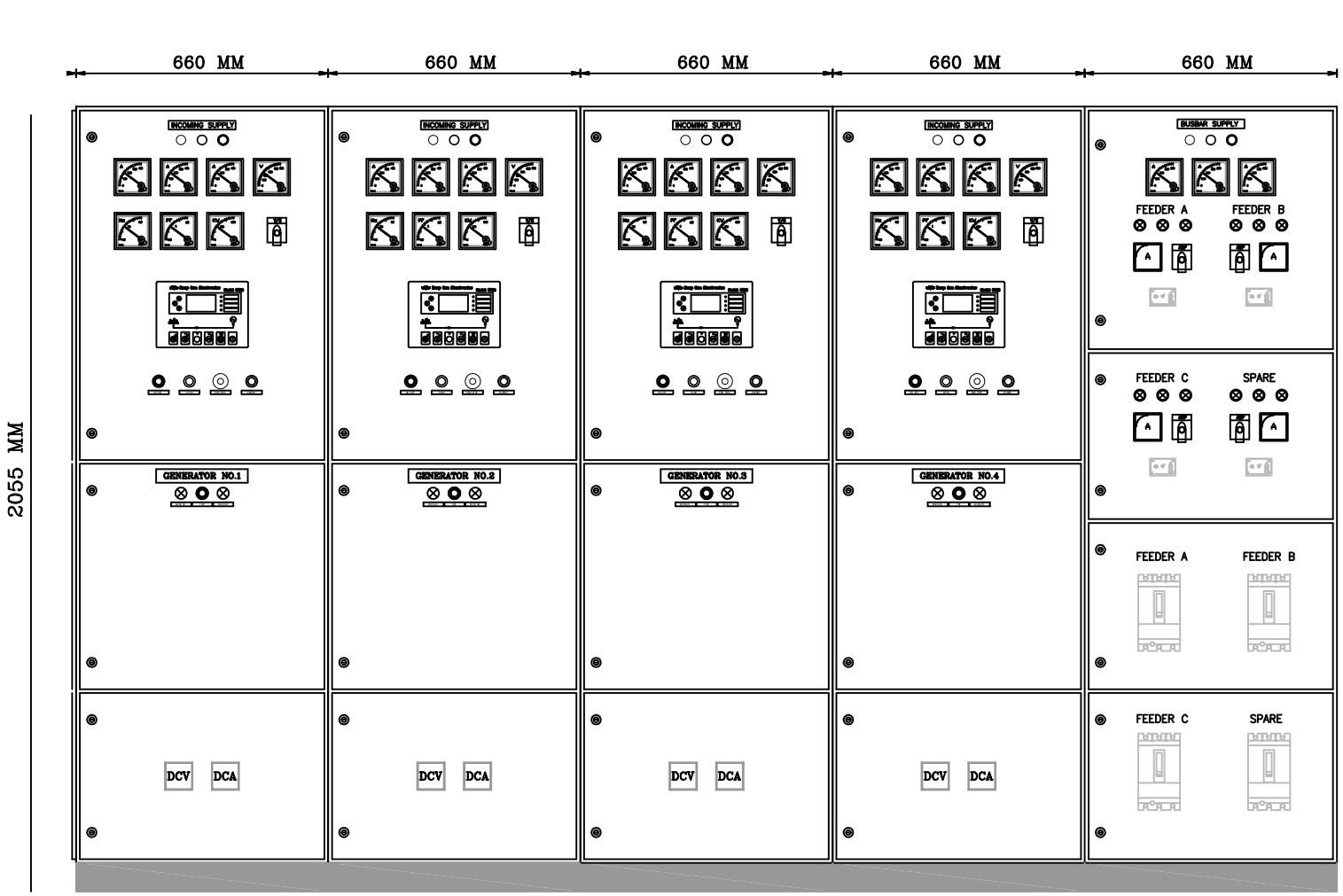
Feeder C

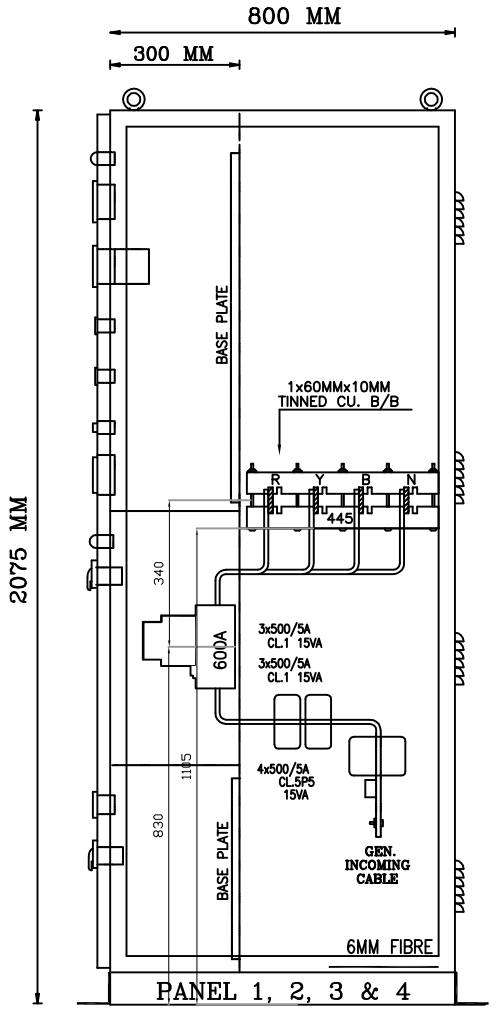
DB REF	DB-C1
MAIN INCOMING SWITCH RATING	63A TPN
SIZE OF INCOMING CABLE	1x 4C x 50sqmm XLPE/SWA/PVC

S/N	Item	Unit Load (kW)	Units	Total Con P(kW)	Demand Factor	Diversity Factor	Total Act P(kW)	Total Load (A)	MAIN CABLE LENGTH
1	Powerhouse	23.5	1	23.5	1.00	0.70	16.45	30	**10**
				23.50			**16**	**30**	

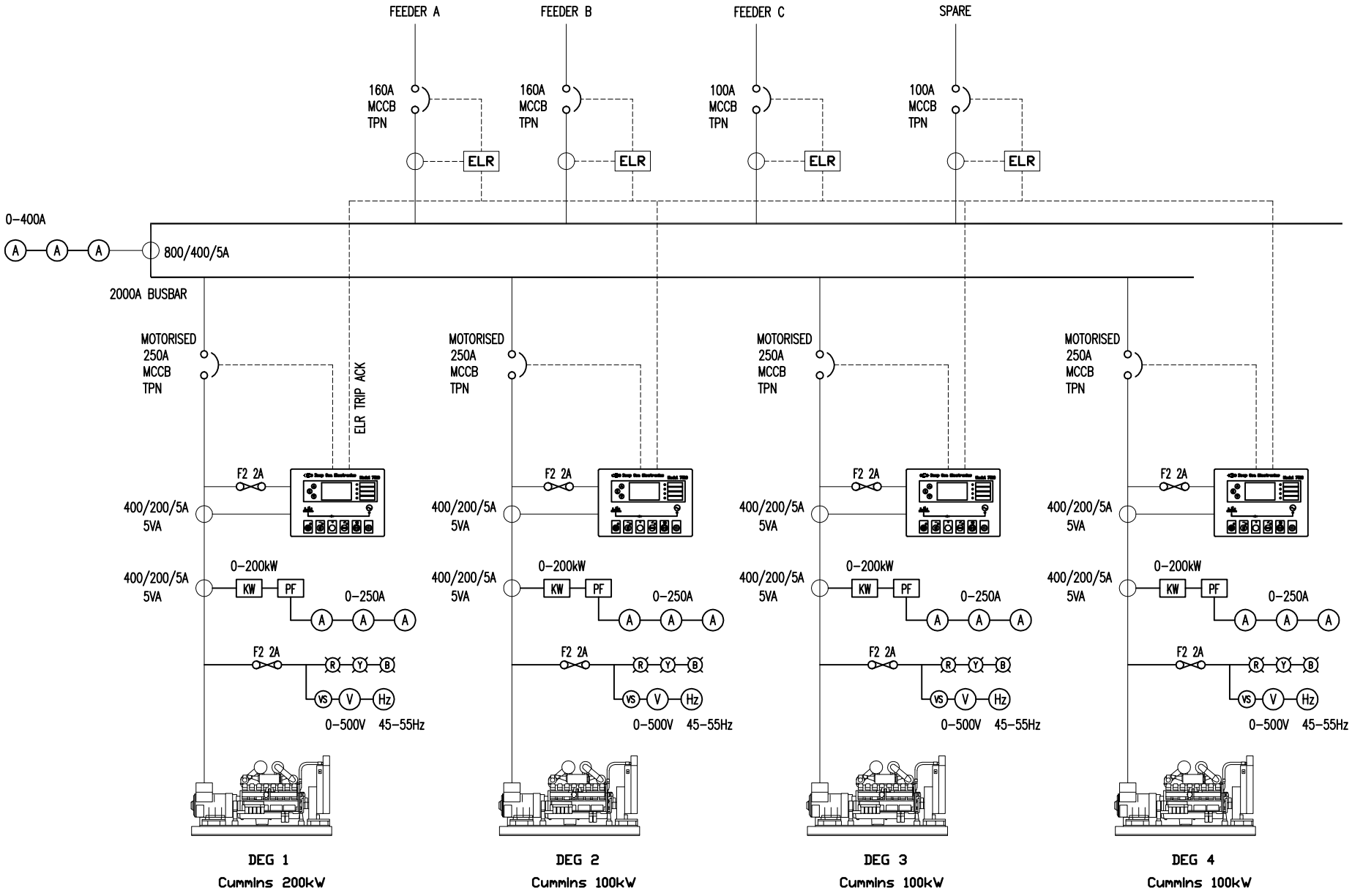
ANNEX 7:

Control Panel Details





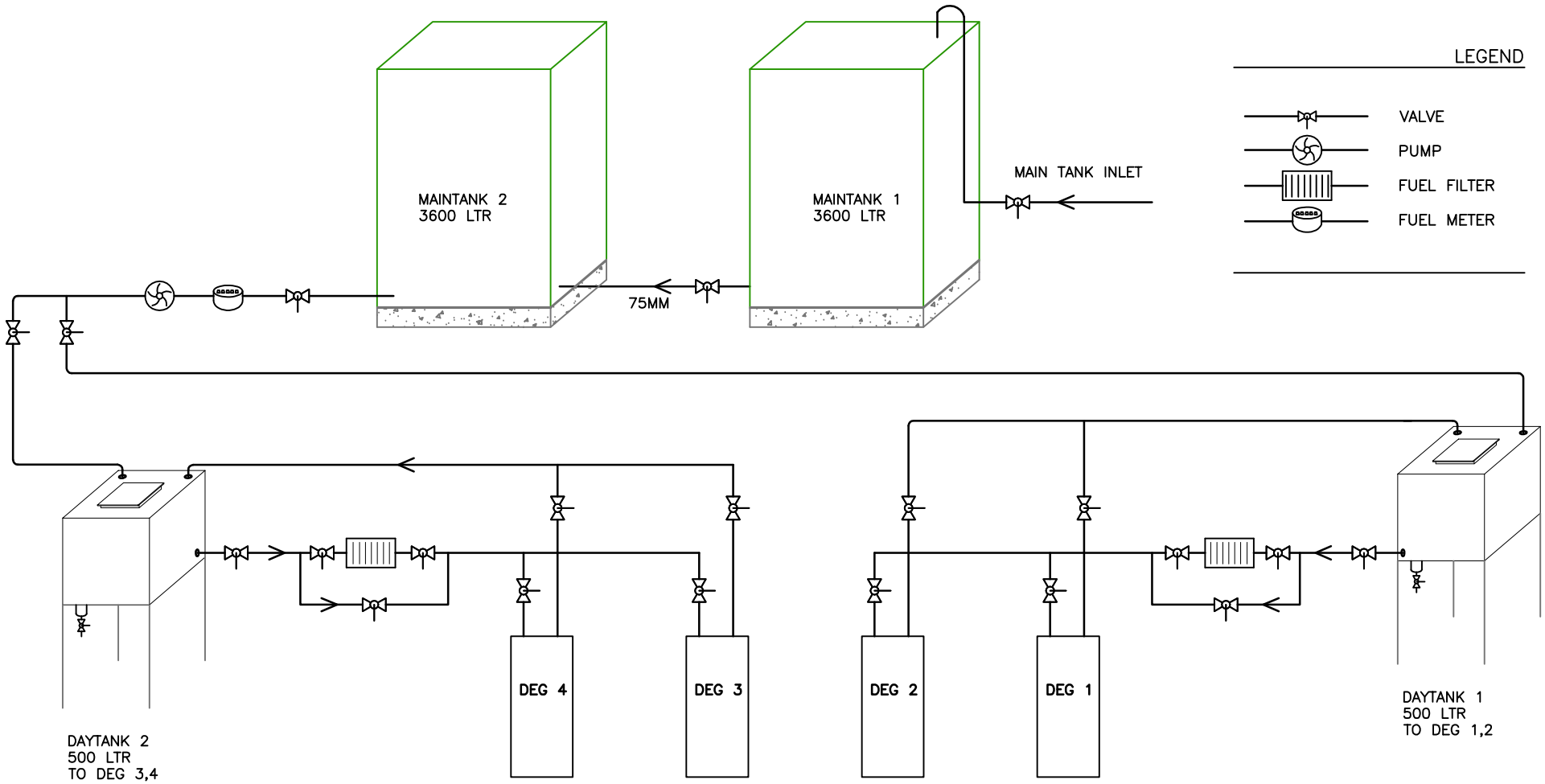
STATE ELECTRIC COMPANY LTD. Amaeenee Magu, Male', Maldives. Phone : 332 0982 Fax : 332 7036 E-mail : admin@stelco.com.mv	TITLE PANEL FRONT VIEW PANEL SECTION VIEW PROJECT MANIYAFUSHI POWER SYSTEM	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	NA
		Checked By	Ahmed Saif	01	added DB, added 2 gensets	5/10/17	Drawing No	NA
		MEA Licence No.	MEB/2004/385				Date	03/05/2016
		Signature					Sht No	02 of 02 Next Sht 0



STATE ELECTRIC COMPANY LTD. Amaeenee Magu, Male', Maldives. Phone : 332 0982 Fax : 332 7036 E-mail : admin@stelco.com.mv	TITLE: PANEL SINGLE LINE DIAGRAM PROJECT: MANIYAFUSHI POWER SYSTEM	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	NA
		Checked By	Ahmed Shafeeu	01	added DB, added 2 gensets	5/10/17	Drawing No	NA
		MEA Licence No.	MTIL/97/0016				Date	03/05/2016
		Signature					Sht No	01 of 02 Next Sht 2

ANNEX 8:

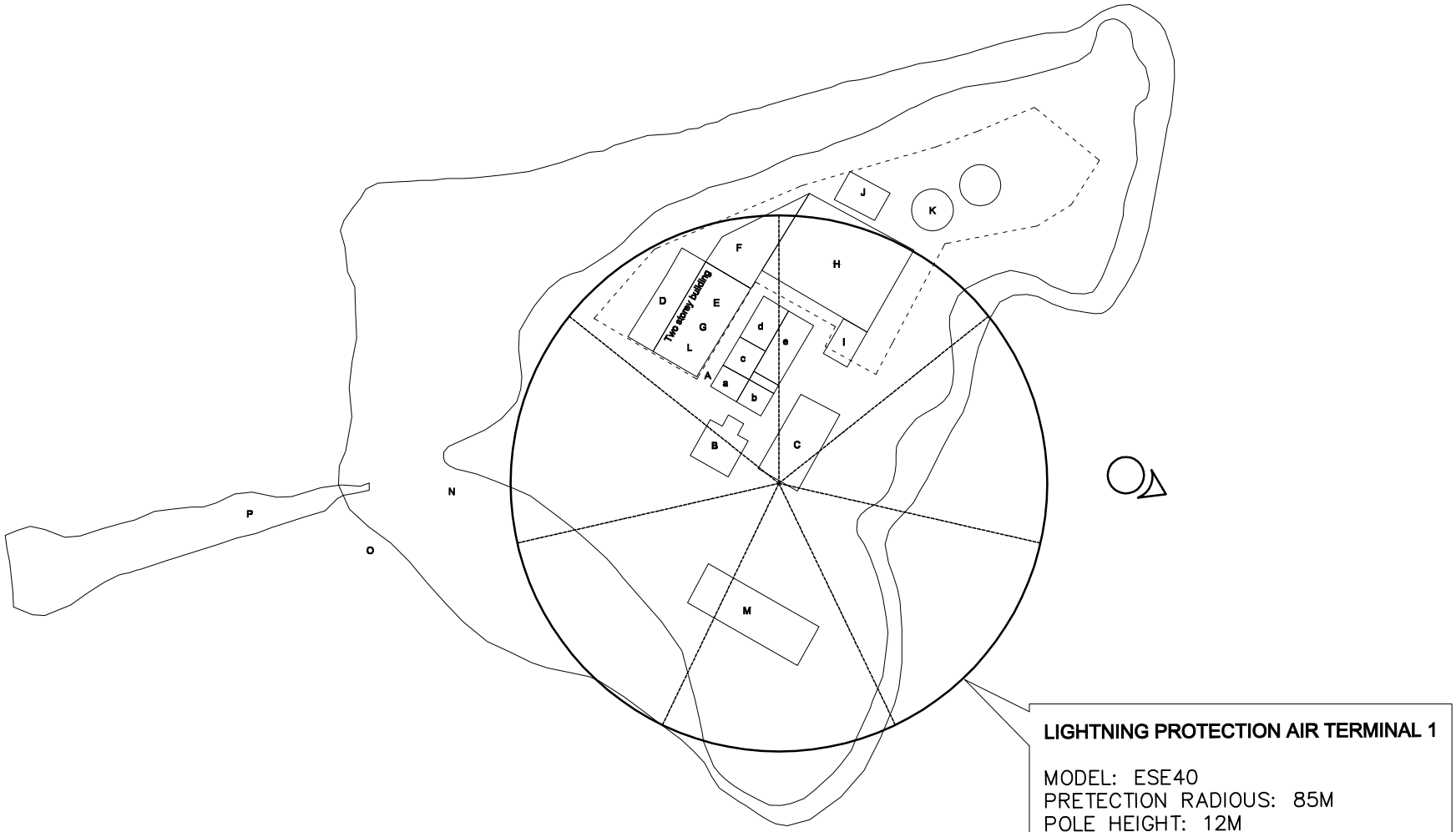
Fuel Tank and Fuel Lines



STATE ELECTRIC COMPANY LTD. Amaeenee Magu, Male', Maldives. Phone : 332 0982 Fax : 332 7036 E-mail : admin@stelco.com.mv	TITLE: FUEL SYSTEM SCHEMATIC DIAGRAM PROJECT: MANIYAFUSHI POWER SYSTEM	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	NA
		Checked By	Ahmed Shafeeu	01	added DB, added 2 gensets		Drawing No	NA
		MEA Licence No.	MTIL/97/0016				Date	03/05/2016
		Signature					Sht No	01 of 01 Next Sht 0

ANNEX 9:

Lightning Protection Layout



LIGHTNING PROTECTION AIR TERMINAL 1

MODEL: ESE40
PRETECTION RADIOUS: 85M
POLE HEIGHT: 12M
LOCATION: FREE STANDING MAST

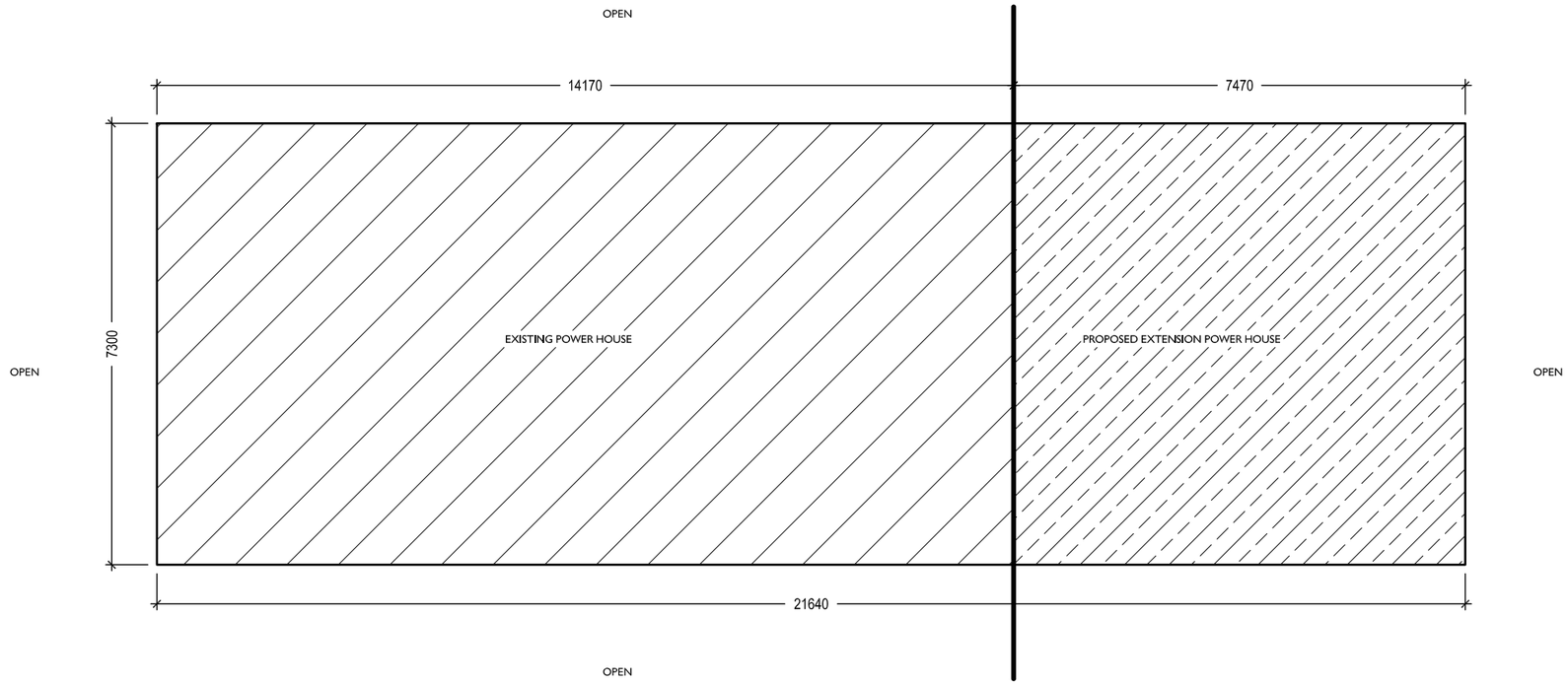
LIGHTNING PROTECTION LAYOUT

STATE ELECTRIC COMPANY LTD.
Amaeenee Magu, Male', Maldives.
Phone : 332 0982
Fax : 332 7036
E-mail : admin@stelco.com.mv

TITLE: LIGHTNING PROTECTION LAYOUT	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	1:1000
	Checked By	Ahmed Shafeeu	00		-	Drawing No	NA
PROJECT: MANIYAFUSHI POWER SYSTEM	MEA Licence No.	MTIL/97/0016				Date	03/05/2016
	Signature					Sht No	01 of 01 Next Sht 0

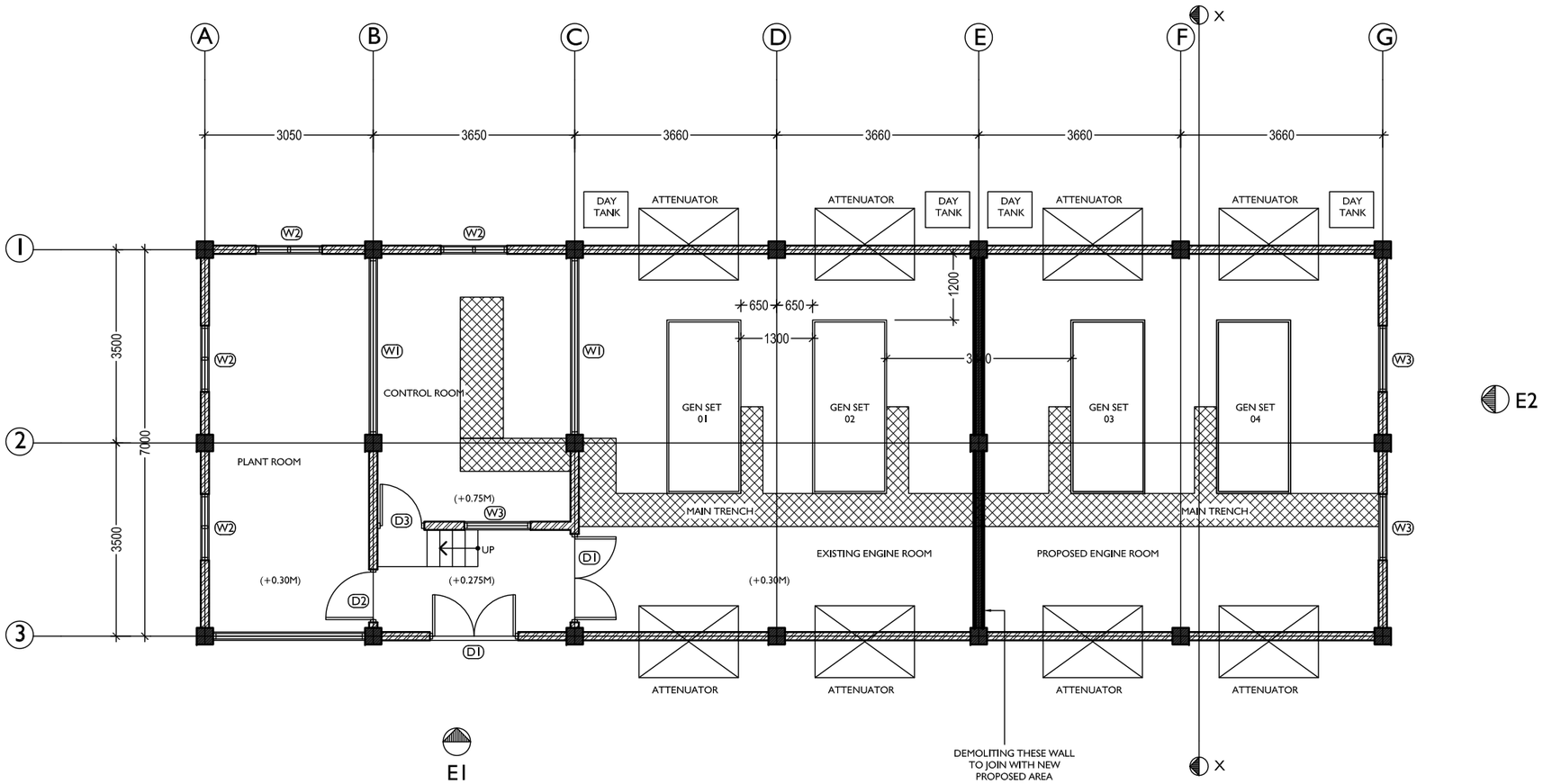
ANNEX 10:

Powerhouse Layouts



SITE PLAN 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS	DRAWING TITLE: 01- SITE PLAN
			1		SCALE : 1:100 / DATE : 31 AUGUST 2017
			2		



DEMOLITION PLAN 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS	DRAWING TITLE: 02- DEMOLITION PLAN
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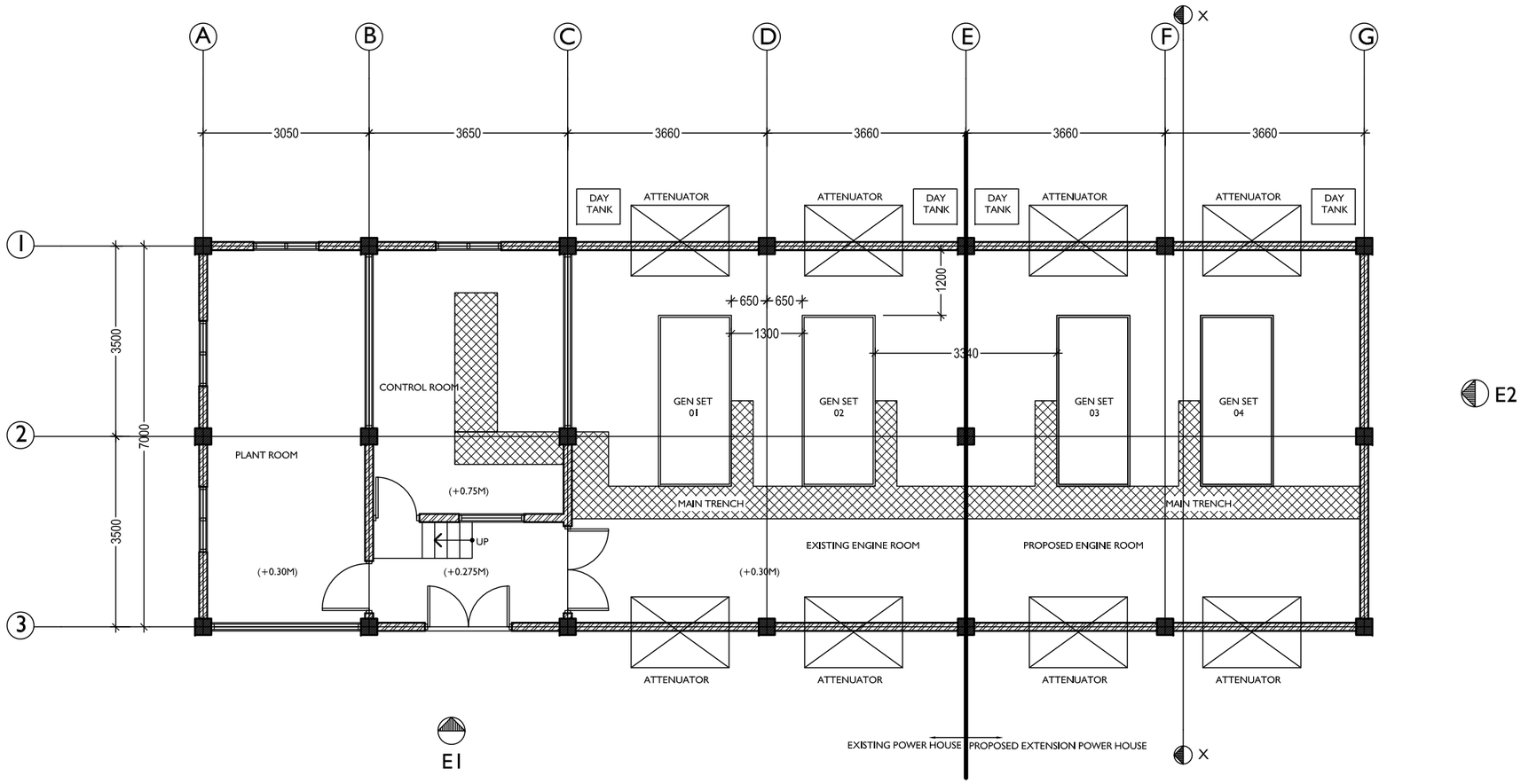
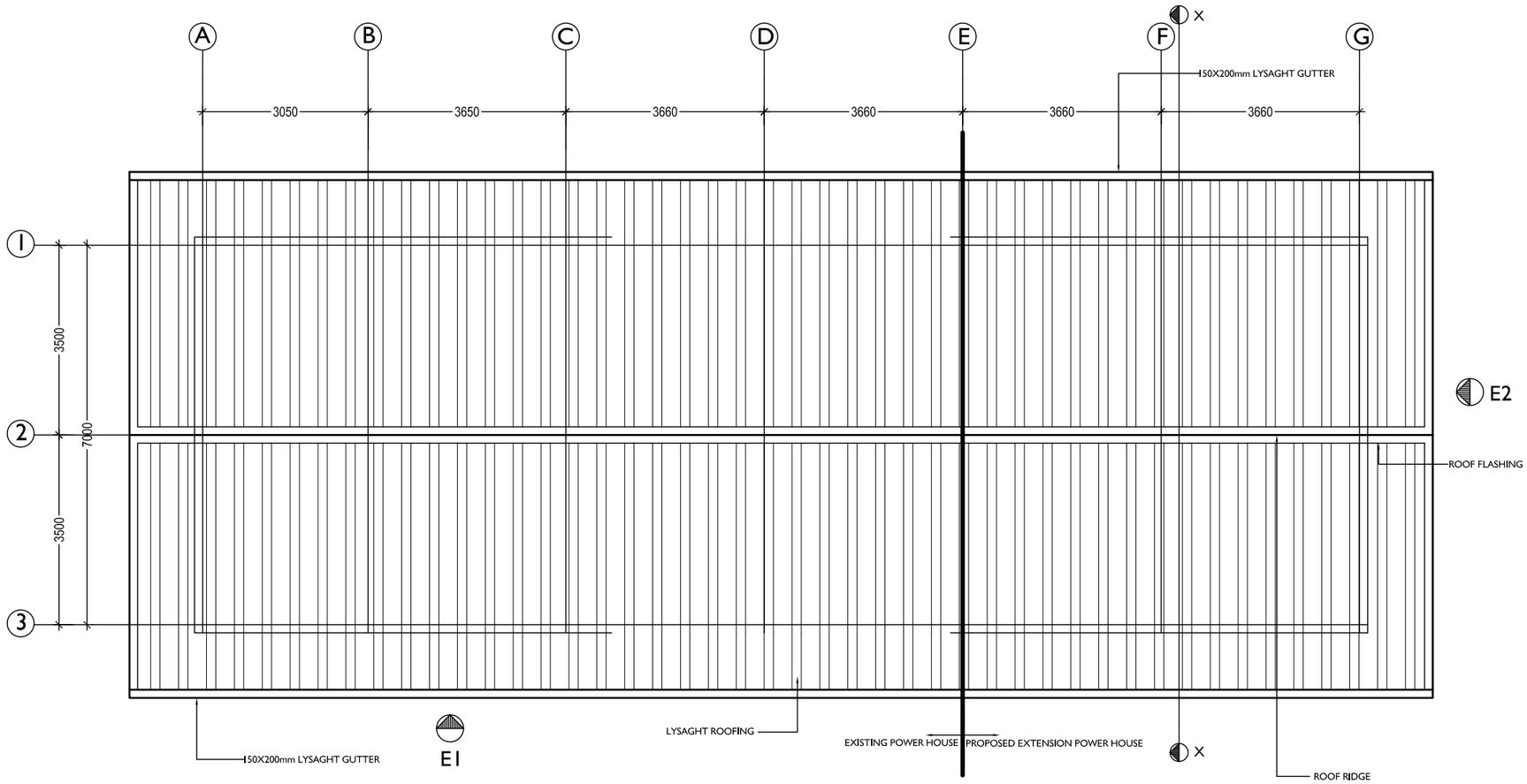
			2		



GROUND FLOOR PLAN 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS	DRAWING TITLE: 03- GROUND FLOOR PLAN
			1		SCALE : 1:100 DATE : 31 AUGUST 2017
			2		



ROOF PLAN 1:100

NOVEA ENGINEERING
PO Box 3013
Male
Maldives
m : +9609999413

CLIENT :
MINISTRY OF FISHERIES & AGRICULTURE

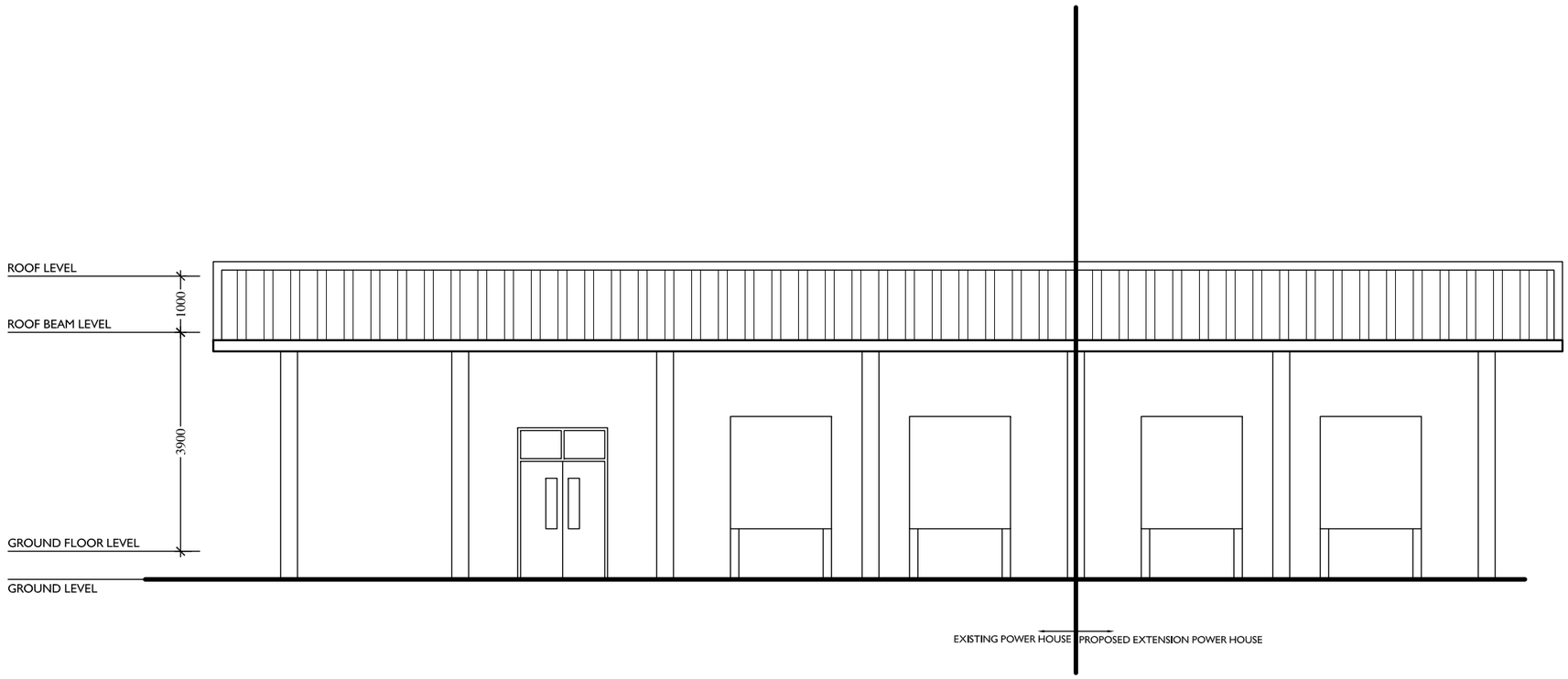
PROJECT :
EXTENSION OF K. MANIYAFARU POWER HOUSE

	REVISIONS	
1		
2		

DRAWING TITLE:
04 - ROOF PLAN

SCALE : 1:100

DATE : 31 AUGUST 2017



FRONT ELEVATION (E1) 1:100

NOVEA ENGINEERING
PO Box 3013
Male
Maldives
m : +9609999413

CLIENT :
MINISTRY OF FISHERIES & AGRICULTURE

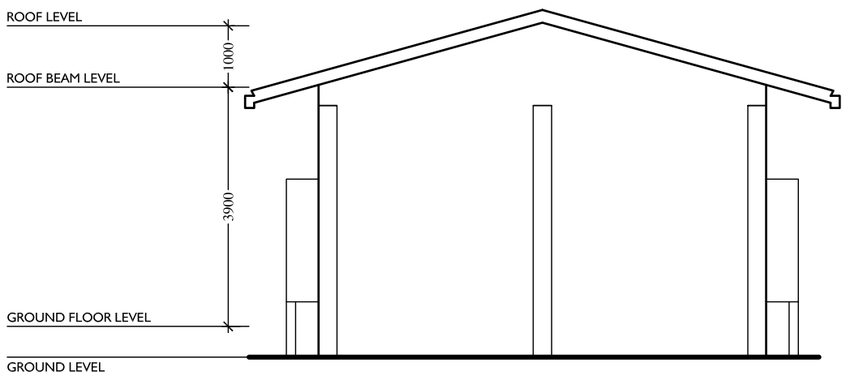
PROJECT :
EXTENSION OF K. MANIYAFARU POWER HOUSE

	REVISIONS	
1		
2		

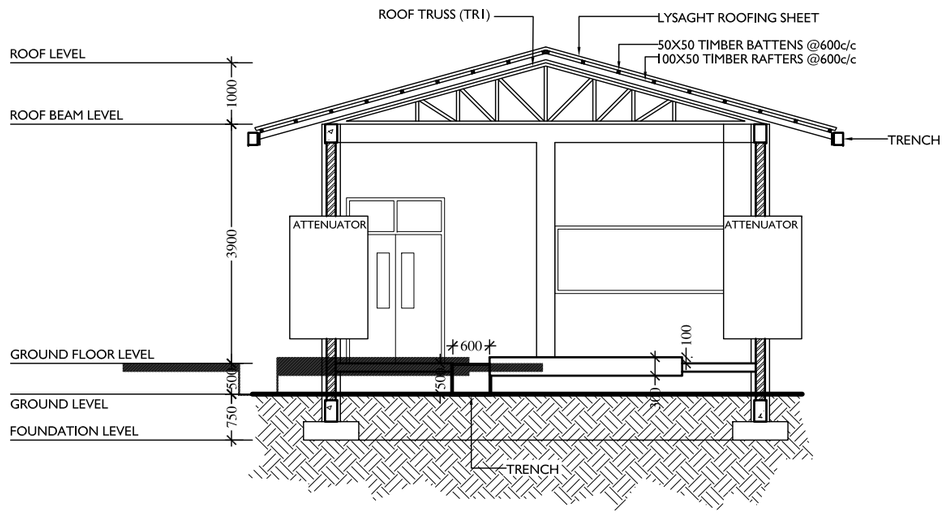
DRAWING TITLE:
05 - FRONT ELEVATION

SCALE : 1:100

DATE : 31 AUGUST 2017



SIDE ELEVATION (E2) 1:100



SECTION X-X 1:100

NOVEA ENGINEERING
PO Box 3013
Male
Maldives
m : +9609999413

CLIENT :
MINISTRY OF FISHERIES & AGRICULTURE

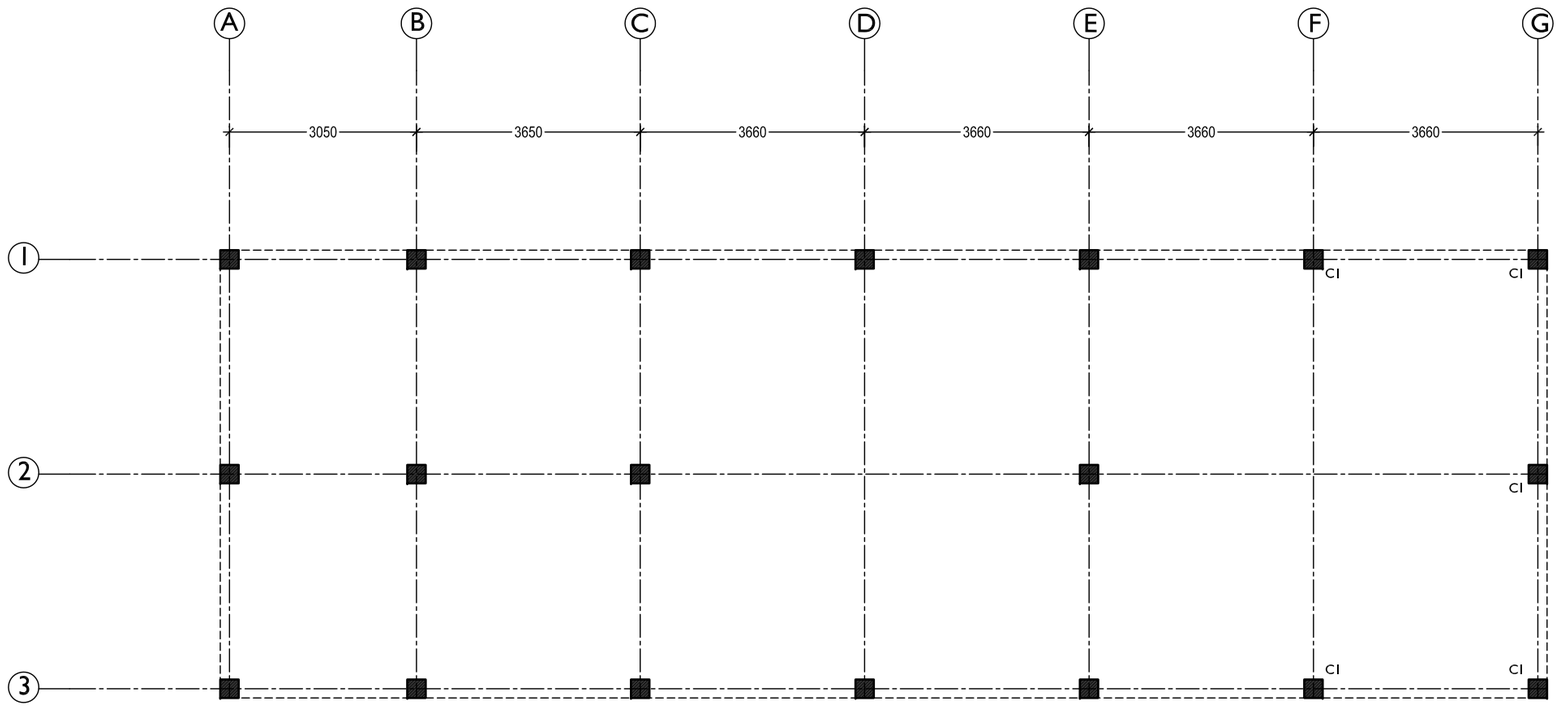
PROJECT :
EXTENSION OF K. MANIYAFARU POWER HOUSE

	REVISIONS	
1		
2		

DRAWING TITLE:
06 - SIDE ELEVATION & SECTION

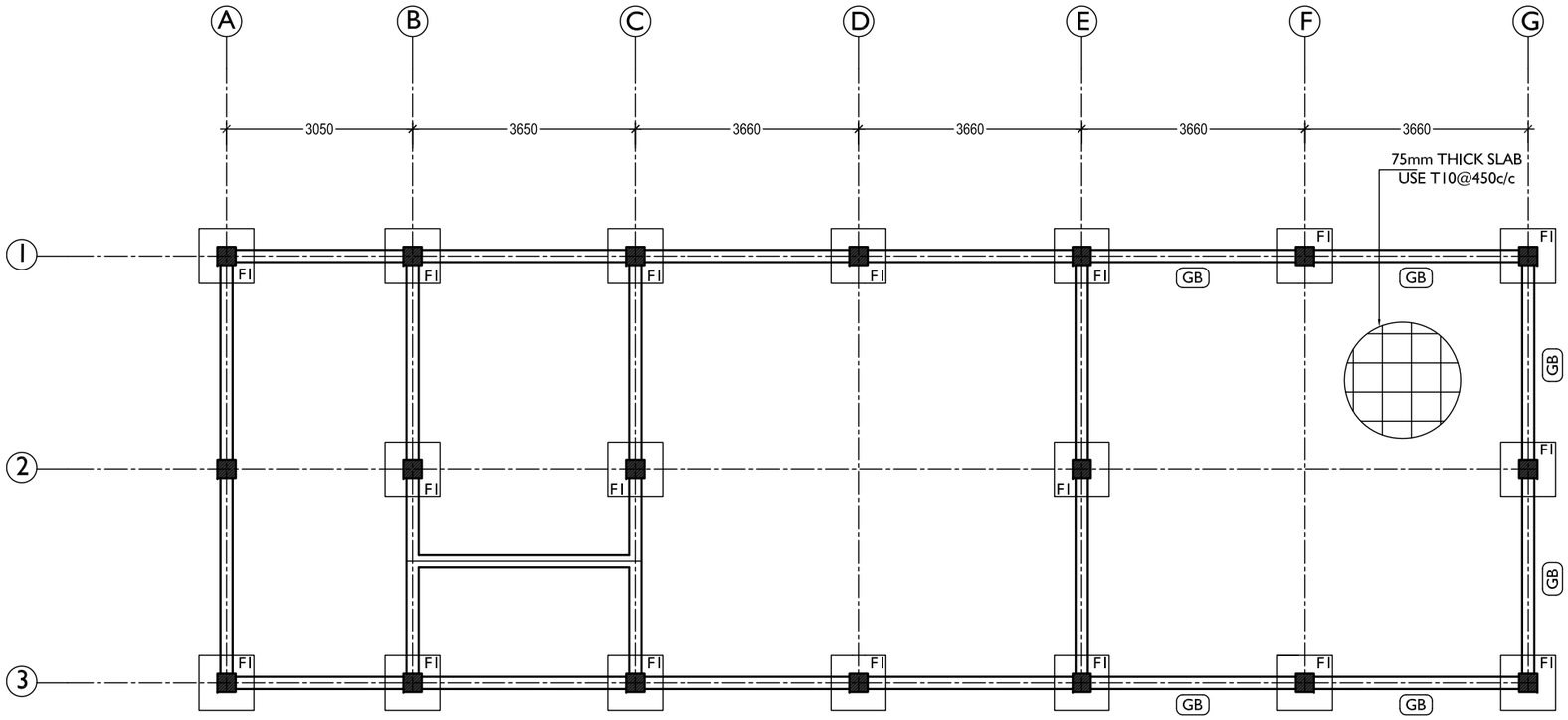
SCALE : 1:100

DATE : 31 AUGUST 2017



COLUMN LOCATION PLAN 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS	DRAWING TITLE: 07 - NEW COLUMN LOCATION PLAN
			1		SCALE : 1:100 / DATE : 31 AUGUST 2017
			2		



NOTE:-

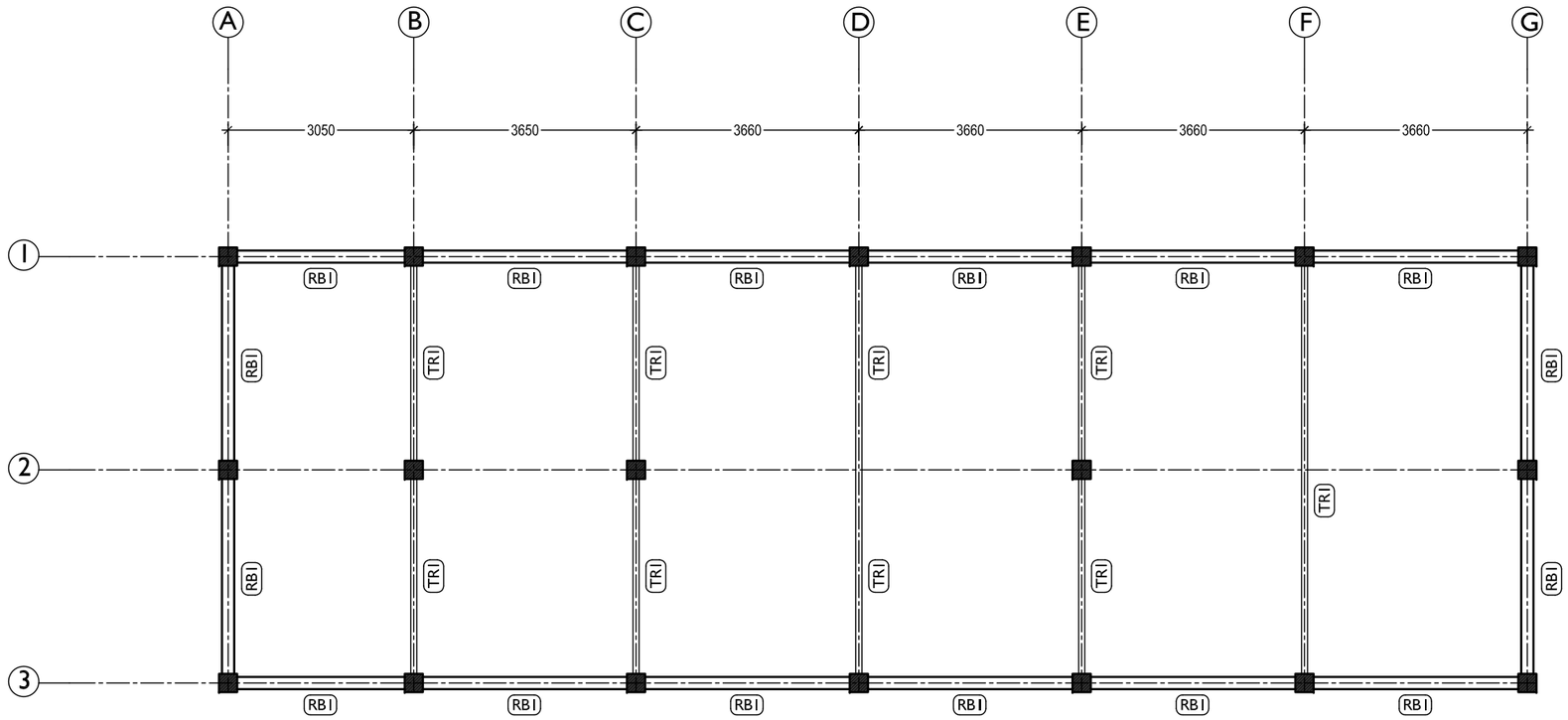
FOUNDATION DEPTH = 750mm

FOOTING DETAIL

#	SIZE	REINFORCEMENT
F1	900 X 900 X 300	T12@200c/c BW(B)

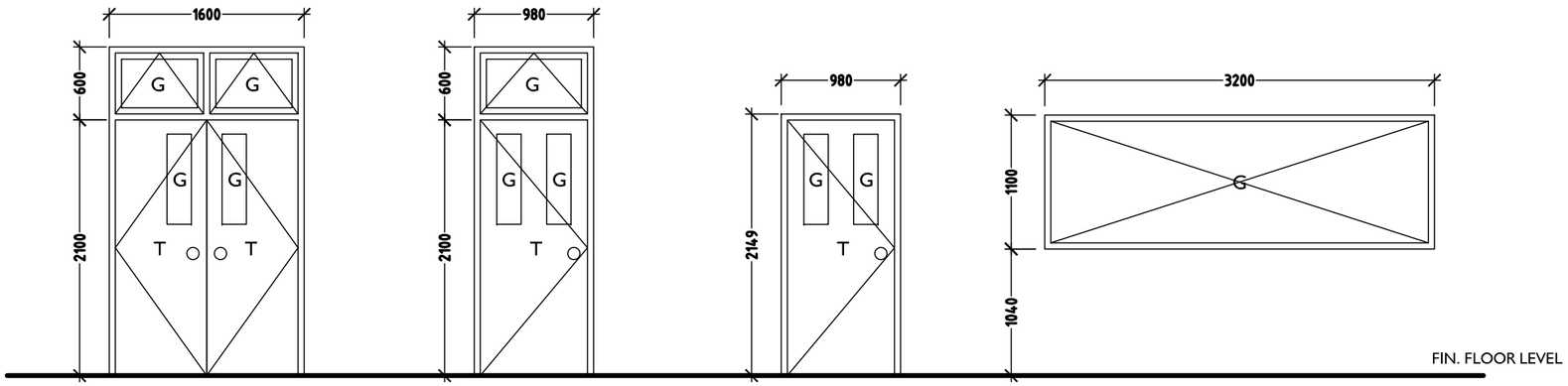
FOUNDATION PLAN 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS		DRAWING TITLE: 08 - FOUNDATION PLAN	
			1			SCALE : 1:100	DATE : 31 AUGUST 2017
			2				



ROOF BEAM/ TRUSS LAYOUT 1:100

NOVEA ENGINEERING PO Box 3013 Male Maldives m : +9609999413	CLIENT : MINISTRY OF FISHERIES & AGRICULTURE	PROJECT : EXTENSION OF K. MANIYAFARU POWER HOUSE		REVISIONS	DRAWING TITLE: 09 - ROOF BEAMS & TRUSS LAYOUT
			1		SCALE : 1:100 / DATE : 31 AUGUST 2017
			2		

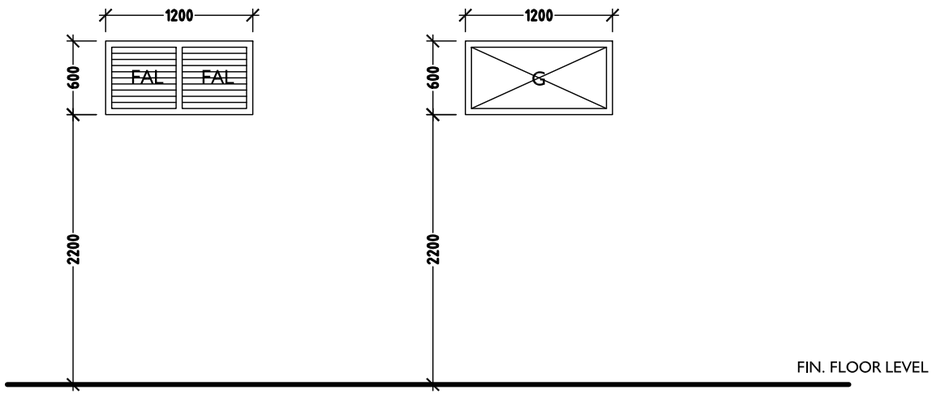


D1 OPEN AREA = 1.57 m²
TIMBER DOOR

D2 OPEN AREA = 1.57 m²
TIMBER DOOR

D3 OPEN AREA = 1.57 m²
TIMBER DOOR

W1 OPEN AREA = 1.57 m²
FIXED GLASS W/ ALUMINIUM FRAME



W2 OPEN AREA = 1.57 m²
FIXED ALUMINIUM LOUVERS

W3 OPEN AREA = 1.57 m²
FIXED GLASS W/ ALUMINIUM FRAME

- ALL DOORS/WINDOWS ARE ALUMINIUM (WHITE COLOUR POWDER COATED ALUMINIUM) UNLESS OTHERWISE STATED
- ALL DIMENSIONS TO BE CHECKED ON SITE PRIOR TO FABRICATION
- ALL DOOR/WINDOWS VIEWED FROM EXTERIOR
- FOR THE DOOR SWING REFER TO FLOOR PLANS

G - 6MM THK CLEAR GLASS
T - TIMBER
FAL - FIXED ALUMINIUM LOUVERS
PV - PVC

DOOR WINDOW DETAILS 1:50

NOVEA ENGINEERING
PO Box 3013
Male
Maldives
m : +9609999413

CLIENT :
MINISTRY OF FISHERIES & AGRICULTURE

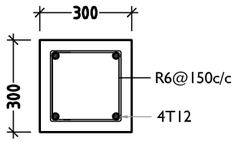
PROJECT :
EXTENSION OF K. MANIYAFARU POWER HOUSE

	REVISIONS	
1		
2		

DRAWING TITLE:
10 - DOORS & WINDOWS

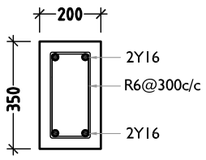
SCALE : 1:100

DATE : 31 AUGUST 2017

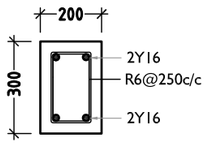


C1

COLUMN DETAILS 1:20



GB

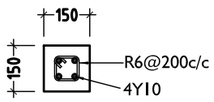


RB1

NOTES:

MINIMUM COVER TO REINFORCEMENT:

FOUNDATION	= 50MM
SLAB	= 25MM
BEAMS	= 35MM
COLUMNS	= 40MM
BEAMS BEND-UP BARS	= 12XDIA
ANCHOR BARS	= 55XDIA
LAPPING BARS	= 45XDIA
MID BARS	= 0.85 X SPAN
SUPPORT BARS	= 1/3 X SPAN



LINTEL BEAM

BEAM DETAILS 1:20

NOVEA ENGINEERING
PO Box 3013
Male
Maldives
m : +9609999413

CLIENT :
MINISTRY OF FISHERIES & AGRICULTURE

PROJECT :
EXTENSION OF K. MANIYAFARU POWER HOUSE

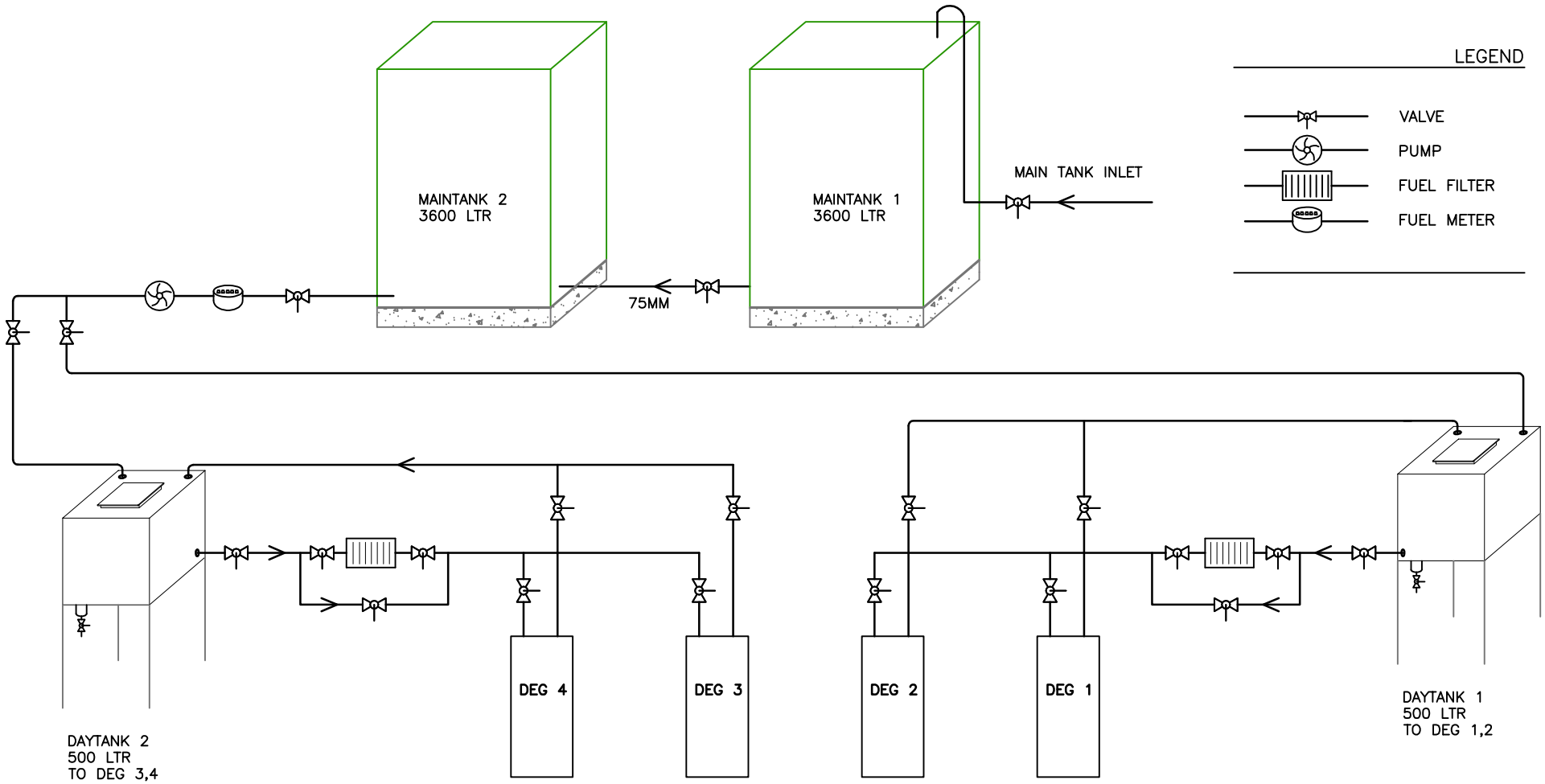
	REVISIONS	
1		
2		

DRAWING TITLE:
11 - STRUCTURAL DETAILS

SCALE : 1:20

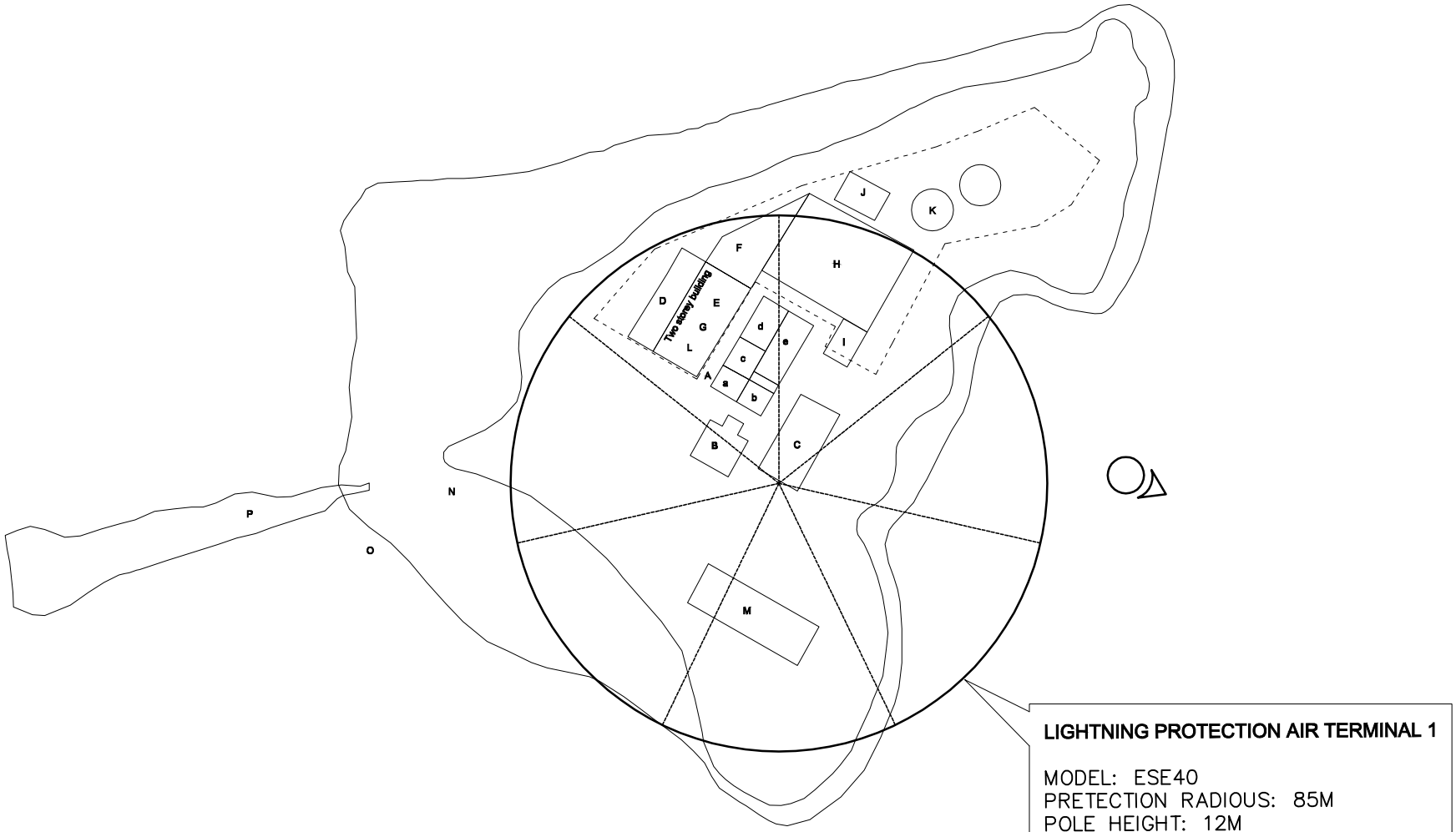
DATE : 31 AUGUST 2017

Appendix 5 Fuel tank design



STATE ELECTRIC COMPANY LTD. Amaeenee Magu, Male', Maldives. Phone : 332 0982 Fax : 332 7036 E-mail : admin@stelco.com.mv	TITLE: FUEL SYSTEM SCHEMATIC DIAGRAM PROJECT: MANIYAFUSHI POWER SYSTEM	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	NA
		Checked By	Ahmed Shafeeu	01	added DB, added 2 gensets		Drawing No	NA
		MEA Licence No.	MTIL/97/0016				Date	03/05/2016
		Signature					Sht No	01 of 01 Next Sht 0

Appendix 6 Lightening protection layout



LIGHTNING PROTECTION AIR TERMINAL 1

MODEL: ESE40
PRETECTION RADIOUS: 85M
POLE HEIGHT: 12M
LOCATION: FREE STANDING MAST

LIGHTNING PROTECTION LAYOUT

STATE ELECTRIC COMPANY LTD.
Amaeenee Magu, Male', Maldives.
Phone : 332 0982
Fax : 332 7036
E-mail : admin@stelco.com.mv

TITLE: LIGHTNING PROTECTION LAYOUT	Drawn By	Amjad Mohamed	Rev	Remarks	Rev Date	Scale:	1:1000
	Checked By	Ahmed Shafeeu	00		-	Drawing No	NA
PROJECT: MANIYAFUSHI POWER SYSTEM	MEA Licence No.	MTIL/97/0016				Date	03/05/2016
	Signature					Sht No	01 of 01 Next Sht 0

Appendix 7 Environmental and Social Management Plan (ESMP) of Maniyafushi Field Station

Environmental and Social Management Plan (ESMP) for the Construction Phase of Maniyafushi Research Development Facility
TO BE INCLUDED IN CONTRACTS

SUSTAINABLE FISHERIES RESOURCES DEVELOPMENT PROJECT

MINISTRY OF FISHERIES AND AGRICULTURE/WORLD BANK

REPUBLIC OF MALDIVES

2.1 EARTHWORK AND SOIL CONSERVATION

2.1.1 SITE CLEARANCE AND LAND DEVELOPMENT

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
Removal of palm trees	Throughout construction process	Flora and fauna impacts, land disturbance	Impact on terrestrial vegetation and species	Low	✓			Uprooting trees regulation 2005 5a	Avoid cutting of trees unless absolutely necessary. Trees that are of rare endemic should not be removed. During removing, attention maintain minimum disturbances to soil cover and care should be taken not to damage adjoining trees. Compensation for the trees removed should be conducted at a 1:2 ratio at least Water spraying should be done to avoid dust generation due to site clearance.	Contractor	MRC	

2.1.2 CONSERVATION AND REUSE OF TOP SOIL

Masonry and Construction	Within the project sites where topsoil from productive land to be removed	Soil and debris	Soil quality	Low					Top soil of the agricultural areas and any other productive areas where it has to be removed for this project shall be stripped to a specified depth of 150mm and stored in stockpiles of height not exceeding 2m, if directed by the engineer. If the contractor is in any doubt on whether to conserve the topsoil or not for any given area he shall obtain the direction from the engineer in writing	Contractor	MRC	Engineering Cost
	Site(s) identified for replantation program					✓			Removed top soil could be used as a productive soil when replanting/establishing vegetation			
	Locations where topsoil is stockpiled for reuse								Topsoil thus stockpiled for reuse shall not be surcharged or overburdened. As far as possible multiple handling of topsoil stockpiles should be kept to a minimum.			

2.1.3 PROTECTION OF GROUND COVER AND VEGETATION

Vehicle and machinery operation	Within the project areas/ new servicing yards developed by contractor for the project	Ground cover and vegetation	Soil quality, impact on terrestrial fauna	Low		✓			Vehicles, machinery and equipment shall be used and stationed only in the areas of work and designated sites approved by the engineer. Entry and exit of construction vehicles and machinery should be restricted to particular points as directed by the engineer. Sites used for maintenance and plant service should be restored back to its final status, and site restoration is considered as incidental to work.	Contractor	MRC	
									Do not destroy ground vegetation cover unnecessarily			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.1.4 DISPOSAL OF DEBRIS AND SOIL												
Masonry and Construction	Disposal sites to be identified by the contractor and approved by Engineer.	Land disturbance	Soil quality	Low			✓	Experienced Contractor	Precautions in excavation and construction	Contractor	MRC	
		Soil and debris	Soil quality						All debris and residual spoil material including any left earth shall be disposed only at locations approved by the engineer for such purpose and subjected to the clause **2.1.1**			Engineering Cost
			Ground and surface water						The contractor shall obtain the approval from EPA for disposal and spoil at the specified location, as directed by the Engineer			
									The debris and spoil shall be disposed in such a manner that; (i) waterways and drainage paths are not blocked (ii) the disposed material should not be washed away by runoff and (iii) should not be a nuisance to the public			
	All burrow sites (licensed sites) identified by contractor and approved by engineer.		Soil quality						The debris and residual spoil material including any left earth shall be used, to refill the burrow areas as directed by the engineer, subjected to laying of topsoil as per EMP clause **2.1.3.**			
	Applicable throughout the project sites		Ground and surface water						Excavated earth materials and all debris materials shall be disposed immediately without allowing to stockpile at identified locations for debris disposal, recommended by the engineer. During transportation, dispose materials should be covered with tarpaulin.			
	In identified filling sites subjected to the approval of engineer								If approved by the engineer, contractor can dispose the debris and spoil as a filling material provided that the contractor can ensure that such material is used for legally acceptable purposes with disposed in an environmentally acceptable manner.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.1.5 CONTAMINATION OF SOIL BY FUEL AND LUBRICANTS												
Vehicle and machinery operation	Servicing yards to be used for vehicle servicing	Spills and leaks	Surface water and ground water contaminatio n	Medium	✓			Experience d contractor to handle machinery and vehicle operation	Approval from Transport Authority or relevant authority in the form of a Licence should be secured by the contractor if he intends to prepare his own vehicle servicing yard	Contractor	MRC	Engineering Cost
									Vehicle/machinery and equipment servicing and maintenance work shall be carried out only in designated locations/ service stations approved by the engineer			
	Servicing yards to be used for vehicle servicing and locations where vehicles will be temporarily stationed								Waste oil, other petroleum products and untreated wastewater shall not be discharged on ground so that to avoid soil pollution. Adequate measures shall be taken against pollution of soil by spillage of petroleum/oil products from storage tanks and containers. All waste petroleum products shall be disposed of in accordance with the guidelines issued by the CEA or the engineer.			
	New servicing yards developed by the contractor for the project								Sites used for vehicle and plant service and maintenance shall be restored back to its initial status. Site restoration will be considered as incidental to work			
2.1.6 DISPOSAL OF HARMFUL CONSTRUCTION WASTES												
Disposal of construction wastes	Locations identified to store chemicals and waste disposal	Waste disposal chemicals and debris	Surface and ground water impact to marine life and human health	Medium	✓			Waste Manageme nt Regulation clause 1.4 Solid waste and hazardous materials will be transporte d to Thilafushi	Contractor prior to the commencement of work shall provide list of harmful, hazardous and risky chemicals/ material that will be used in the project work to the Engineer. Contractor shall also provide the list of places where such chemicals/materials or their containers or other harmful materials have been dumped as waste at the end of the project.	Contractor	MRC	Engineering Cost
									All disposal sites should be approved by the engineer and approved by EPA and relevant local authority.			
	All affected water bodies close to material storage and waste disposal sites								The contractor shall clean up any area including water-bodiesaffected/contaminated (if any) as directed by the engineer at his own cost.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.2 STORAGE AND HANDLING OF CONSTRUCTION MATERIAL												
2.2.1 EMISSION OF DUST												
Storage and handling of construction material	At all material storage locations (stock piles of sand, gravel and metal)	Emissions to air	Air quality and impact to human health	Medium		✓			Storage locations of sand, metal, soil should be located away from settlements and other sensitive receptors and covered (with artificial barriers or natural vegetation). Measures given under clauses **2.5.1** should be considered within material storage site to minimize dust during handling of material. All access roads within the storage site should be sprinkled with water for dust suspension.	Contractor	MRC	Engineering Cost
2.2.2 STORAGE OF FUEL, OIL, AND CHEMICALS (AVOID FUMES AND OFFENSIVE ODOUR)												
Chemicals and oil	At all material storage locations (cement, bitumen, fuel, oil and other chemicals used for construction activities)	Spills and leaks	Surface and ground water impact to marine life	Medium		✓			All cement, bitumen (barrels), oil and other chemicals should be stored and handled on an impervious surface (concrete slab) above ground level. Storage facility of cement, bitumen (barrels), oil and other chemicals should be an enclosed structure ensuring that no storm water flows in to the structure. A ridge should be placed around the storage facility to avoid runoff getting in to the structure.	Contractor	MRC	Engineering Cost
		Risks to labour	Impact to human health						Adequate ventilation should be kept to avoid accumulation of fumes and offensive odour that could be harmful to material handlers.Measures given under clause **2.9** should be considered to avoid any accidents and risks to worker population and public.	Contractor	MRC	
2.2.3 TRANSPORTATION OF MATERIAL												
Transportation of vehicles	Within the project locations and the vicinity	Air pollution, traffic congestion, public nuisance	Air quality, community impact	Low		✓			Avoid over- loaded trucks to transport material. During transportation, materials should be covered with tarpaulin. Minimize public nuisance due to dust, traffic, congestion, air pollution, etc., due to such haulage. Select routes based on the truck load; divide the load to prevent damages to local roads. If there are damages to local roads Contractor shall repair all damaged infrastructure/ roads.	Contractor	MRC	

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.3 PROTECTION OF WATER SOURCES AND QUALITY												
2.3.1 LOSS OF MINOR WATER SOURCES AND DISRUPTION TO WATER SOURCES												
Use of water	Project sites and worker camps	Water waste	Water conservation	Medium		✓		**Dewatering Regulation**	Contractor should make employees aware on water conservation and waste minimization in the construction process.	Contractor	MRC	Engineering Cost
		Conflict with community water	Impact on community water sources	Low		✓			Arrange adequate supply of water for the project throughout the construction period. Not obtain water for project purposes, including for labour camps, from public or community water supply schemes without a prior approval from the relevant authority. Not extract water from ground water or surface water bodies without the permission from engineer & EPA licence for dewatering.			
	Wells and other public water sources locations within the project sites	Conflict with community water	Impact on community water sources	Low	✓				Contractor shall protect sources of water (potable or otherwise) such as water sources used by the community so that continued use these water sources will not be disrupted by the work. In case the closer of such sources is required on temporary basis contractor shall provide alternative arrangement for supply. Alternative sources such as wells thus provided should be within acceptable distance to the original sources and accessible to the affected community.			
	Project sites	Effluents to water	Ground and surface water contaminati on	Low	✓				In case the contractors activities may adversely affect the quantity or quality of water, the contractor shall serve notice to the relevant authorities such as EPA and downstream users of water sufficiently in advance.			
	Construction sites, material and soil storage areas, and equipment and machinery service areas			Medium	✓				Apply best management practices to control contamination of run-off water during maintenance & operation of equipment.			
					✓				Maintain adequate distance between stockpiles & water bodies to control effects to natural drainage paths.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.3.2 SILTATION INTO WATER BODIES												
Masonry and Construction	All water bodies located around the project areas	Ground water contamination, discharge to waterways	Surface water and ground water contamination	Medium		✓				Contractor	MRC	Engineering Cost
Storage of construction materials									Construction materials containing small / fine particles shall be stored in places not subjected to flooding and in such a manner that these materials will not be washed away by runoff.			
Waste disposal									Temporary soil dumps should be placed at least 200m away from all water bodies			
Soil and debris									If temporary soil piles are left at the site for a long time those piles should be covered with thick polythene sheets			
									All fills, back fills and slopes should be compacted immediately to reach the specified degree of compaction and establishment of proper mulch			
2.3.4 CONTAMINATION OF WATER FROM CONSTRUCTION WASTE												
Masonry and Construction, Wastewater disposal	At all water courses located adjacent construction sites		Surface water and ground water contamination	Medium					The work shall be carried out in such a manner that pollution of lagoons, sea and other coastal water bodies paths located within construction areas or downstream. **Measures as given in 2.1.6., 2.3.2 and 2.3.6** clauses shall be taken to prevent the wastewater produced in construction from entering directly into water bodies or the irrigation systems.	Contractor	MRC	Engineering Cost
Masonry and Construction	At all water courses located adjacent construction sites								Avoid / minimize construction works near / at such drainage locations during heavy rainy seasons			
Waste disposal	At all water courses located adjacent construction sites and downstream							Waste Management Regulations 2013	All waste arising from the project is to be disposed in a manner that is acceptable to the engineer and as per the guidelines/instructions issued by the EPA.			Engineering Cost

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.3.5 CONTAMINATION FROM FUEL AND LUBRICANTS												
Wastewater disposal, Vehicles, machinery and plant servicing and maintenance	Vehicle and plant maintenance and servicing centres		Ground and surface water, Impact to marine life	Medium			✓		All vehicle and plant maintenance and servicing stations shall be located and operated as per the conditions and /or guidelines stipulated under the relevant local authority. In general these should be located at least 200m away from water bodies and wastewater shall not be disposed without meeting the disposal standards of the EPA.Wastewater from vehicle and plant maintenance and servicing stations shall be cleared of oil and grease and other contaminants to meet the relevant standards before discharging to the environment	Contractor	MRC	
	Yards, servicing centres								Vehicle, machinery and equipment maintenance and re-filling shall be done as required in EMP clause **2.1.6**. to prevent water pollution as well			
2.3.6 WASTAGE OF WATER AND WASTE MINIMISATION												
Use of water	Within project sites and labour camps	**Water waste**	Water conservation	Medium			✓		The contractor shall educate and made employees aware on water conservation, waste minimization and safe disposal of waste following guidelines.	Contractor	MRC	
2.3.7 EXTRACTION OF WATER												
Extraction of Water	Within project sites and labour camps	Conflict with community water	Impact on community water sources	Low	✓			Dewatering regulation	The contractor is responsible for arranging adequate supply of water for the project purpose throughout the construction period. Contractor shall not obtain water for his purposes including for labour camps from public or community water supplies without approval from the relevant authority. Such extraction (if approved) should be under direct supervision of the engineer	Contractor	MRC	Engineering Cost
	At all natural water sources used for construction works	Ground water contamination, discharge to waterways	Ground and surface water		✓				Extraction of water by the contractor for the project purposes shall comply with the guidelines and instructions issued by EPA The Contractor shall not extract water from groundwater or from surface water-bodies without permission from the Engineer.			
						✓			. The Contractor may use the natural sources of water subject to the provision that any claim arising out of conflicts with other users of the said natural sources			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.3.6 LOCATING, SANITATION AND WASTE DISPOSAL IN CONSTRUCTION CAMPS												
Sewage disposal	At all labour camps	Ground water contamination, discharge to waterways	Ground and surface water, Impact to marine life, impact to human health	High			✓		Locations selected for labour camps should be approved by engineer a Construction of labourer camps shall not be located within 200m from waterways or near to a site or premises of religious, cultural or archaeological importance and school.	Contractor	MRC	Engineering Cost
				High		✓		Direct disposal to sea	Labour camps shall be provided with adequate and appropriate facilities for disposal of sewerage. The sewage systems shall be properly designed, built and operated so that no pollution to ground or adjacent water bodies takes place. Compliance with the relevant regulations and guidelines issued by the EPA shall be strictly adhered to. There must also be sewage treatment, and frequent seawater quality monitoring			
Wastewater disposal				Medium	✓			Sand, cartridge, and UV filtered for final disposal to sea	Contractor shall adhere to the EPA recommendations on disposal of wastewater. Wastewater shall not be discharged to ground or waterways in a manner that will cause unacceptable surface or ground water pollution			
Solid waste disposal				High			✓	Waste Management Regulation, Solid waste and hazardous materials will be transported to Thilafushi	Labour camps shall be provided with adequate and appropriate facilities for disposal of solid waste. Garbage bins shall be provided the camps and regularly emptied. Waste segregation is highly encouraged. Garbage should be disposed of in a hygienic manner, to the satisfaction of the relevant norms.			
Labour camps		Outbreak of disease	Impact to human health	High	✓				All camps are kept clean and hygienic to prevent breeding of vectors			
				Medium			✓		Report any outbreak of infectious disease in a labour camp to the engineer , MRC, and Health Protection Agency immediately. Contractor shall carry out all instructions issued by the authorities. All relevant provisions and any other relevant regulations aimed at safety and health of workers shall be adhered to.			
					✓				Remove all labour camps fully after its need is over, empty septic tanks, remove all garbage, debris and clean and restore the area back to its former condition. A consent letter from the relevant local authority should be obtained that certifies the decommissioning has taken place to the level acceptable to the land owner			Engineering Cost

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.4 FLOOD PREVENTION												
2.4.1 BLOCKAGE OF DRAINAGE PATHS AND DRAINS												
Masonry and Construction	All construction work sites	Land disturbance	Impact to terrain and property	Low	✓			Experienced Contractor	Contractor's activities shall not lead to flooding conditions as a result of blocked drainage paths and drains. The contractor shall take all measures necessary or as directed by the Engineer to keep all drainage paths and drains clear of blockage at all times.. If flooding or stagnation of water is caused by contractor's activities, contractors shall provide suitable means to (a) prevent loss of access to any land or property and (b) prevent damage to land and property Contractor shall compensate for any loss of income or damage as a result.	Contractor	MRC	Engineering Cost
2.5 AIR POLLUTION												
2.5.1 ODOUR AND OFFENSIVE SMELLS												
Chemicals	Within construction and work sites including all sites used for store all chemicals and places where chemical reactions take place.)	Spills and leaks	Surface and ground water impact to marine life	Medium			✓	Experienced Contractor	Contractor shall take precautions such as storing all chemicals used for construction works in properly closed containers with good ventilations to prevent odour and offensive smell emanating from chemicals and processes applied in construction works or from labour camps. In a situation when/where odour or offensive smell does occur contractor shall take immediate action to rectify the situation. Contractor is responsible for any compensation involved with any health issue arisen out of bad odour and offensive smells	Contractor	MRC	Engineering Cost
Sewage	At all labour camps	Risks to workers	Impact to human health						Adequate ventilation should be kept to avoid accumulation of fumes and offensive odour that could be harmful to material handlers. The waste disposal and sewerage treatment system for the labour camps shall be properly designed, built and operated so that no odour is generated. Compliance with any existing regulations or guidelines.			
2.5.2 EMISSION FROM CONSTRUCTION VEHICLES, MACHINERY AND EQUIPMENT												
Vehicles, equipment and machinery operation	All plants, machinery and vehicles used for construction		Air quality from fuel combustion from vehicles and plant machinery	Medium	✓			EPA Vehicle Emissions standards Experienced Contractor	Comply with EPA Vehicle Emission Standards All vehicles, equipment and machinery used for construction shall be regularly serviced and well maintained to ensure that emission levels comply with the relevant standards. Fuel efficient vehicles and machinery	Contractor	MRC	Engineering Cost

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.5.3 GENERATION OF DUST												
Topsoil removal, transporting sand, rubble, cement, bitumen	Within the construction area where earth work will take place, storage locations of sand, rubble, bitumen, cement and all sub roads used for material transportation, paying special attention to sensitive locations.	Air emissions	Air quality and impact to human health	Medium			✓	Experienced Contractor	The contractor shall manage the dust generating activities such as topsoil removal, handling and transporting sand, rubble, bitumen, and cement during periods of high winds or during more stable conditions with winds directed towards adjacent residences and other facilities.	Contractor	MRC	Engineering Cost
									All stockpiles shall be located sufficiently away from sensitive receptors.			
									All vehicles delivering materials shall be covered to avoid spillage and dust emission.			
									The Contractor should avoid, and take suitable action to prevent dirt and mud being carried to the roadway (particularly following wet weather).			
									The contractor should enforce vehicle speed limits to minimize dust generation.			
									The Contractor shall employ a water truck to sprinkle water for dust suppression on all exposed areas as required (note: the use of waste water / waste oil for dust suppression is prohibited)			
									All cleared areas shall be rehabilitated progressively			
									All earthwork shall be protected in a manner acceptable to the minimize generation of dust.			
									All existing roads used by vehicles of the contractor, or any of his sub-contractor or supplies of materials or plant and similar roads which are part of the works shall be kept clean and clear of all dust/mud or other extraneous materials dropped by such vehicles or their tires.			
									Clearance shall be affected immediately by manual sweeping and removal of debris, or, if so directed by the Engineer, by mechanical sweeping and clearing equipment. Additionally, if so directed by the Engineer, the road surface will be hosed or sprinkled water using appropriate equipment.			
									Plants, machinery and equipment shall be handled (including dismantling) so as to minimize generation of dust.			
									The contractor shall take every precaution to reduce the level of dust emission from the hot mix plants and the batching plants up to the satisfaction of the Engineer in accordance with the relevant emission norms, and use a sprinkler system for dust suppression.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.6 NOISE PROTECTION AND VIBRATION												
2.6.1 NOISE FROM VEHICLES, PLANTS, AND EQUIPMENT												
Machinery, equipment and vehicle									All machinery and equipment should be well maintained and fitted with noise reduction devices.			
operation	Project sites and worker camps	Noise pollution	Impact to workers,	Low				Maniyafushi is not a locally inhabited island	In construction sites within 150 m of the nearest habitation, noisy construction work such as crushing, concrete mixing and batching, mechanical compaction, etc., will be stopped between 8 pm to 6 am. No construction shall take place within 100m around hospitals between 20.00 hours to 06.00 hours. Near noise sensitive sites, such as schools noisy equipment shall not be used during noise sensitive times of the day.	Contractor	MRC	Engineering Cost
	Wells and other public water sources locations within the project sites				✓				All vehicles and equipment used in construction shall be fitted with exhaust silences. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced. Notwithstanding any other conditions of contract, noise level from any item of plant(s) must comply with the relevant legislation for levels of sound emission. Non-compliant plant shall be removed from site.			
	All equipment, machinery and vehicles used for construction works								Noise limits for construction equipment used in this project (measured at one meter from the edge of the equipment in free field) such as compactors, rollers, front loaders, concrete mixers, cranes (moveable), vibrators, and saws shall not exceed 75 dB(A).			
									Maintenance of vehicles, equipment and machinery shall be regular and proper to keep noise from these at a minimum.			
	Construction sites, material and soil storage areas, and equipment and machinery service areas								Workers in vicinity of strong noise, and workers working with or in crushing, compaction, batching or concrete mixing operations shall be provided with Personal Protective Gear.			
	Within the construction sites and their vicinity					✓			Blasting shall be carried out during fixed hours (preferably during mid-day), as permitted by the Engineer. The timing should be made known to all the people within 500 m (200 m for pre-splitting) from the blasting site in all directions. People, except those who actually light the fuse shall be excluded from the area of 200 m (50 m for pre-splitting) from the blasting site in all directions at least 10m minutes before the blasting. Only chemical blasting where rocks have to be removed for landslide mitigation measures			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.7 IMPACTS TO FLORA												
2.7.1 LOSS OR DAMAGE TO TREES OR VEGETATION												
Removal of trees	All project sites	Flora and fauna, land disturbance	Impact to flora and habitat, and heritage				✓	Uprooting plants and trees Regulation 2006/ National Biodiversity Strategy Action Plan (NBSAP)	All works shall be carried out in a manner that the destruction to the flora and their habitats is minimised. Trees and vegetation shall be felled / removed only if that impinges directly on the permanent works or necessary temporary works. In all such cases contractor shall take prior approval from the Engineer.			
				Low			✓		Contractor shall adhere to the guidelines and recommendations made by the Environmental Protection Agency, if any with regard to felling of trees and removal of vegetation.	Contractor	MRC	Engineering
	Indicative number of trees plants and indicative number of planting structures necessary are to be identified by the contractor. Planting should take place as soon as the plant removal takes					✓			The contractor shall plant over 5 year old root-balled native trees suitable for the location as identified by the Engineer. The planting should take place in public land suitable for the purpose The contractor shall build hardy structures around the trees for protection. The contractor shall be responsible for ensuring the well-being of the trees/plants until the end of the contract			
						✓			Vegetation buffers and habitat corridors			
						✓			Contractor shall make every effort to avoid removal and/or destruction of trees of religious, cultural and aesthetic significance. If such action is unavoidable the Engineer shall be informed in advance and carry out public consultation and report on the same should be submitted to the Engineer.			
2.7.2 CHANCE FINDS OF IMPORTANT FLORA												
Land clearance, construction		Flora and fauna, land disturbance	Impact to flora and habitat	Low			✓	Uprooting Plants and Trees regulation 2006	During construction, if a rare/endangered flora species is found, it shall be immediately informed to the relevant agency by the contractor through the engineer. All activities that could destroy such flora and/or its habitat shall be stopped with immediate effect. Such activities shall be started only after obtaining the Engineer's or EPA's approval. Contractor shall carry out all activities and plans that the Engineer instructed him to undertake to conserve such flora and/or its habitat.	Contractor	MRC	

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.9 DISRUPTION TO PEOPLE												
2.9.1 LOSS OF ACCESS												
Masonry and Construction	All project sites	Public nuisance	Impact to community	Low	✓			Maniyafushi is not a locally inhabited island	At all times, the Contractor shall provide safe and convenient passage for vehicles and pedestrians. Work that affects the use of existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the Engineer.	Contractor	MRC	Engineering Cost
									The works shall not interfere unnecessarily or improperly and ensure convenience of public at all times			
						✓			On completion of the works, all temporary obstructions to access shall be cleared away, all rubbish and piles of debris that obstruct access be cleared to the satisfaction of the Engineer			
									Providing advance information to the public about the planned construction works and activities causing disruption to access and the temporary arrangements made to give relief to public in order to avoid any inconveniences due to the construction activities			Engineering Cost
2.9.2 TRAFFIC CONTROL AND SAFETY												
Vehicle operation	Road-side construction sites	Accidents, congestion	Impact to human safety	Low	✓			Maniyafushi is not a locally inhabited island	The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the street under improvement. The provision of traffic safety measures shall be considered incidental to work and follow	Contractor		
	Construction areas								Vehicles travelling in and out of the Project area should maintain low speeds when transporting material to avoid d the risk of accidents.		MRC	Engineering Cost

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.10 ACCIDENTS AND RISKS												
2.10.1 PUBLIC WORKER SAFETY												
Labour	Construction areas, material storage and worker camps	Accidents	Impact to worker health	Medium			✓	Maniyafushi is not a locally inhabited island	All reasonable precautions will be taken to prevent danger of the workers and the public from accidents such as fire, explosions, blasts, falling rocks, falling to excavated pits, chemical sprays, unsafe power supply lines etc.	Contractor	MRC	Engineering Cost
								Experienced Contractor	The Contractor shall comply with requirements for the safety of the workmen as per the international labour organization (ILO) convention No. 62 and Occupational Health and Safety of the Maldives Association of Construction Industry (MACI) to the extent that those are applicable to this contract. The contractor shall supply all necessary safety appliances and personal protective equipment (PPE) for eye and face, head, hearing, foot, hand, body and leg, and respiratory protection such as safety goggles, helmets, masks, boots, etc., to the workers and staff. The contractor has to comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, excavations, trenches and safe means of entry and egress.			
									Construction activities on existing facilities where operation is underway should be conducted post times of operation, post operational hours of the centre if on the same site.			
									The Contractor shall comply with requirements for the safety of the workmen as per the international labour organization (ILO) convention No. 62 , guidelines of the Health Protection Agency , MACI, and Labour Authority of the Maldives to the extent that those are applicable to this contract. The contractor has to comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, excavations, trenches and safe means of entry and egress.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.10.2 PREVENTION OF RISKS AND ELECTROCUTION												
Labour	Construction areas, material storage and worker camps	OHS	Impact to worker safety	Medium			✓		All electrical wiring and supply related work should confirm to **British Standards (BS) or relevant Maldivian Standards**. Adequate precautions will be taken to prevent danger of electrocuting from electrical equipment and power supply lines including distribution boards, transformers, etc. Measures such as danger signboards, danger lights, fencing and lights will be provided to protect the public and workers. All electric power driven machines to be used in the construction shall be free from defect, be properly maintained and kept in good working order, be regularly inspected and as per BS provisions and to the satisfaction of the Engineer.	Contractor	MRC	Engineering Cost
2.10.3 RISK AT HAZARDOUS ACTIVITY												
Labour	Construction areas, material storage and worker camps	OHS	Impact to Worker health	High			✓		All workers employed in hazardous activities shall be provided with necessary protective gear. These activities include mixing asphalt material, cement, lime mortars, concrete etc., welding work, work at crushing plants, blasting work, operators of machinery and equipment such as power saws, etc.	Contractor	MRC	Engineering Cost
							✓		Substitute harmful chemicals for less harmful chemicals. The use of any toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be notified of toxic chemicals that are planned to be used in all contract related activities. A register of all toxic chemicals delivered to the site shall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product			
									Materials Safety Data Sheets MSDS) and International Chemical Safety Cards (ICSC) should be visible for workers to see in their language			
2.10.4 LEAD POLLUTION												
Labour	Workshops, yards where spray painting is done	OHS	Impact to Worker health	Medium		✓			The Contractor shall at all times take every possible precaution and shall comply with relevant laws and regulations relating to the importation, handling, transportation, storage and use of explosives. Contractor shall obtain **MNDF** approval for importing and handling explosives	Contractor	MRC	Engineering Cost

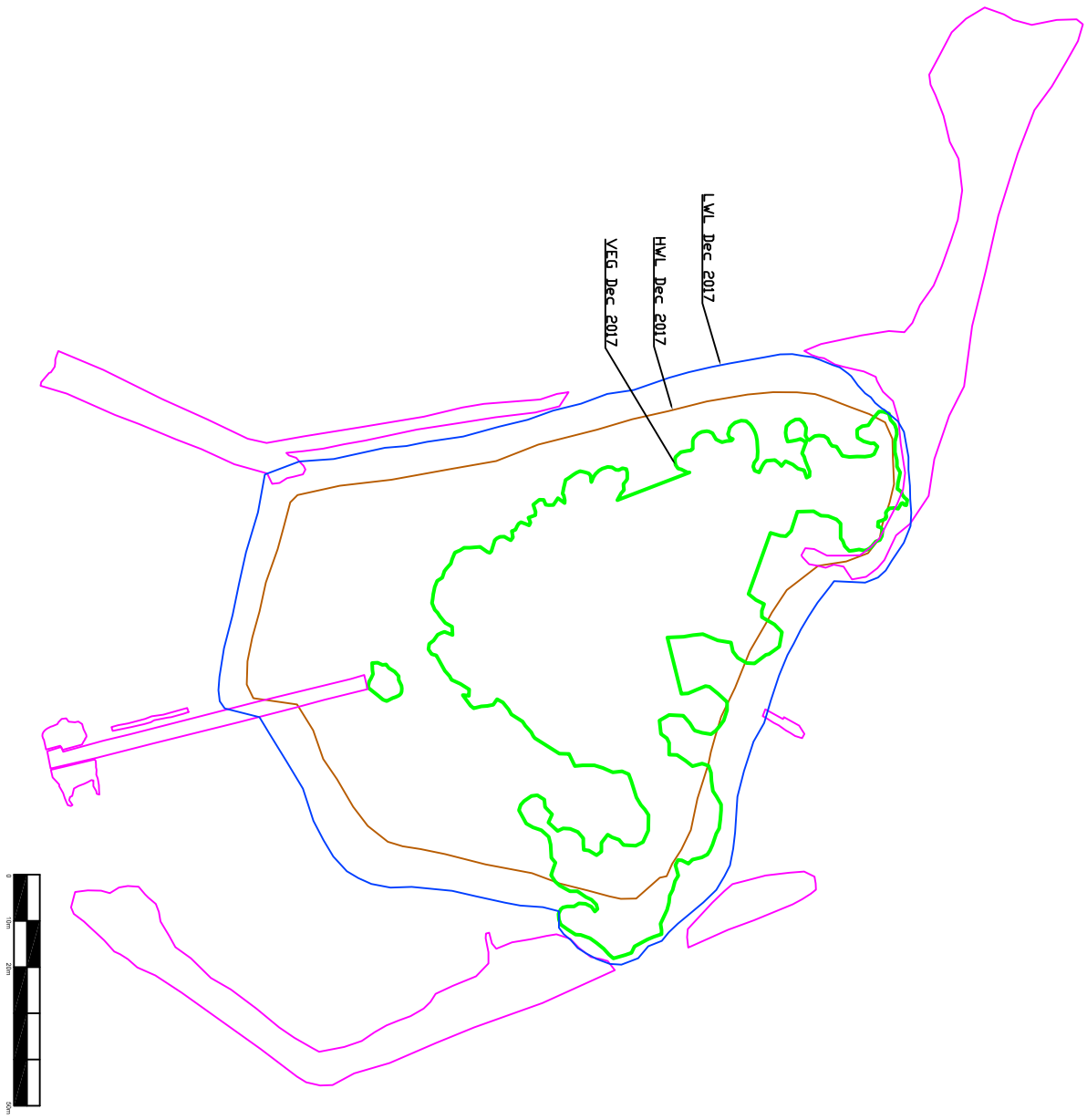
Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.11 HEALTH AND SAFETY												
2.11.1 PREVENTION OF VECTOR BASED DISEASES												
Disease	At worker camps, stores, yards	OHS	Impact to Worker health	Medium		✓			Contractor shall take necessary actions to prevent breeding of mosquitoes at places of work, labour camps, plus office and store buildings. Stagnation of water in all areas including gutters, used and empty cans, containers, tires, etc. shall be prevented. Approved chemicals to destroy mosquitoes and larvae should be regularly applied. All burrow sites should be rehabilitated at the end of their use by the contractor in accordance with the requirements/guidelines issued by the relevant local authorities Contractor shall keep all places of work, labour camps, plus office and store buildings clean devoid of garbage to prevent breeding of rats and other vectors such as flies.	Contractor	MRC	Engineering Cost
2.11.2 WORKERS HEALTH AND SAFETY												
Labour	Within construction sites, workshops and worker camps	OHS	Impact to Worker health and safety	Medium			✓		Contractor shall comply with the provisions in Health Protection Agency Protocols with regard to provision of health and safety measures and amenities at work place(s).	Contractor	MRC	
2.11.3 FIRST AID												
Labour	Within construction sites, quarry, crusher, concrete batching plants, workshops and worker camps	OHS	Impact to Worker health and safety	Medium			✓		At every workplace, first aid kit shall be provided as per the regulations. At every workplace an ambulance room containing the prescribed equipment and nursing staff shall be provided.	Contractor	MRC	Engineering Cost
2.11.4 POTABLE WATER												
Drinking water	Within construction sites, quarry, crusher, concrete batching plants, workshops and worker camps	OHS	Impact to Worker health and safety	Low	✓				In every workplace and labour camps portable water shall be available throughout the day in sufficient quantities.	Contractor	MRC	Engineering Cost

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.11.5 HYGEINE												
Labour	Worker camps and temporary sheds at work sites	OHS	Impact to Worker health and safety Impact to Worker health and safety	Low		✓			The contractor shall provide and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scale approved by the engineer.	Contractor	MRC	Engineering Cost
									At every workplace and labour camps sufficient number of bathing facilities, latrines and urinals shall be provided in accordance with the Health and Safety regulations and/or as directed by the Engineer. These bathroom and toilet facilities shall be suitably located within the workplace/buildings. Latrines shall be cleaned at least three times daily in the morning, midday and evening and kept in a strict sanitary condition. If women are employed, separate latrines and urinals, screened from those for men and marked in the vernacular shall be provided. There shall be adequate supply of water, within and close to latrines and urinals			
				Medium		✓		Open disposal to sea	The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place.			
				Medium			✓	Waste Regulations	Garbage bins must be provided in the camp, work sites and regularly emptied and the garbage disposed of in a hygienic manner. Construction camps shall have a clean hygienic environment and adequate health care shall be provided for the work force.			
				Medium	✓			Waste Regulations	Unless otherwise arranged for by the relevant local authority such as local level or atoll councils, the contractor shall arrange proper disposal of sludge from septic tanks. The contractor shall obtain approval for such disposal from the EPA.			
2.12 PROTECTION OF ARCHAELOGICAL, CULTURAL, AND RELIGIOUS PLACES AND PROPERTIES												
2.11.1 PREVENTION OF DAMAGE TO CULTURAL AND RELIGIOUS PLACES AND PROPERTIES												
Masonry and Construction, topsoil removal, site clearance	Near physical cultural resources	Loss of heritage	Impact to community	Low	✓				During construction activities the contractor should take all necessary and adequate care to minimize impacts on cultural properties which includes cultural sites and remains, places of worship. Workers should not be allowed to trespass in to such areas.	Contractor	MRC	

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.12.2 CHANCE FINDS OF ARCHAELOGICAL PROPERTY												
Masonry and Construction, topsoil removal, site clearance	In all project sites	Loss of heritage	Impact to community	Low		✓			All fossils, coins, articles of value of antiquity and structures and other remains or things of geological or archaeological interest etc. discovered on the site and/or during construction work shall be the property of the government of Maldives. The contractor shall take reasonable precaution to prevent his workmen or any other persons from removing and damaging any such article or thing and shall, immediately upon discovery thereof and before removal acquaint the Engineer of such discovery and carry out the Engineer's instructions for dealing with the same, awaiting which all work shall be stopped within 100m in all directions from the site of discovery. If directed by the Engineers the Contractor shall obtain advice and assistance from the relevant local authorities such as Department of Heritage and Ministry of Tourism on conservation measures to be taken with regard to the artefacts prior to recommencement of work in the area.	Contractor	MRC	
2.13 ENVIRONMENTAL ENHANCEMENT												
2.13.1 LANDSCAPING												
Revegetation, landscaping, replanting	All project sites and associated sites			Medium	✓		✓	National Biodiversity Strategy Action Plan (NBSAP)	Landscape plantation, re-vegetation etc, shall be taken up as per either detailed design or typical design guidelines given as part of the Bid Documents. The contactor also shall remove all debris, piles of unwanted earth, spoil material, away from the roadsides and from other work places and disposed at locations designated or acceptable to the Engineer or as per Clause 2.1.1. On completion of the works, the temporary structures shall be cleared away in full, all rubbish burnt, waste dumps and septic tank shall be filled and closed and roadsides, workplaces and labour camps, cleared and cleaned.	Contractor	MRC	Engineering Cost
					✓			Waste Management Regulations 2013	In case of an inadvertent damage cause to a utility, the contractor shall immediately inform the service provider and help to restore the service without delay.			

Activity	Location/Project Phase	Aspect	Impact	Risk Rating	Control in Place			Method	Proposed Protective and Preventative Measures	Institutional Responsibility		Mitigation Cost
					Yes	No	Planned			Implementation	Supervision	
2.13.3 HANDLING ENVIRONMENTAL ISSUES DURING CONSTRUCTION												
Management of environmental and social issues	Relevant construction sites during the construction period	Environmental and social issues	Implementation of the EMP	Medium		✓			For large contracts, the Contractor will appoint a qualified Environmental Officer following the award of the contract. The Environmental Officer will be the primary point of contact for assistance with all environmental issues during the pre-construction and construction phases, and will be responsible for ensuring the implementation of EMP	Contractor	MRC	Engineering Cost
			Implementation of the ESMP			✓			The Contractor shall appoint a person responsible for community liaison and to handle public complaints regarding environmental/ social related matters. All public complaints will be entered into the Complaints Register. The Environmental Officer will promptly investigate and review environmental complaints and implement the appropriate corrective actions to arrest or mitigate the cause of the complaints. A register of all complaints is to be passed to the Engineer within 24 hrs. They are received, with the action taken by the Environmental Officer on complains thereof			
		Grievance and redress	Transparency and established feedback mechanism between project and stakeholders			✓			Contractor shall develop suitable method to receive complaints. The complaint register shall be placed at a convenient place, easily accessible by the public.			
		Environmental and social issues	Implementation of EMP			✓			Contractor shall prepare detailed Environmental Method Statement (EMS) clearly stating the approach, actions and manner in which the EMP is implemented. It is required from the contractor to prepare the EMS for each work site, if work will be carried out at more than one site at once and time plan for implementation. The EMS shall be updated regularly and submit for Engineers review.			

Appendix 8 Island survey map of Maniyafushi (Oct 2017)



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Maniyafushi
Client: MOFA
Project Number: -
Date: -

Architect :-
Engineer : -
Drawn by : -
Services : -
Interior : -

Rev no	Date
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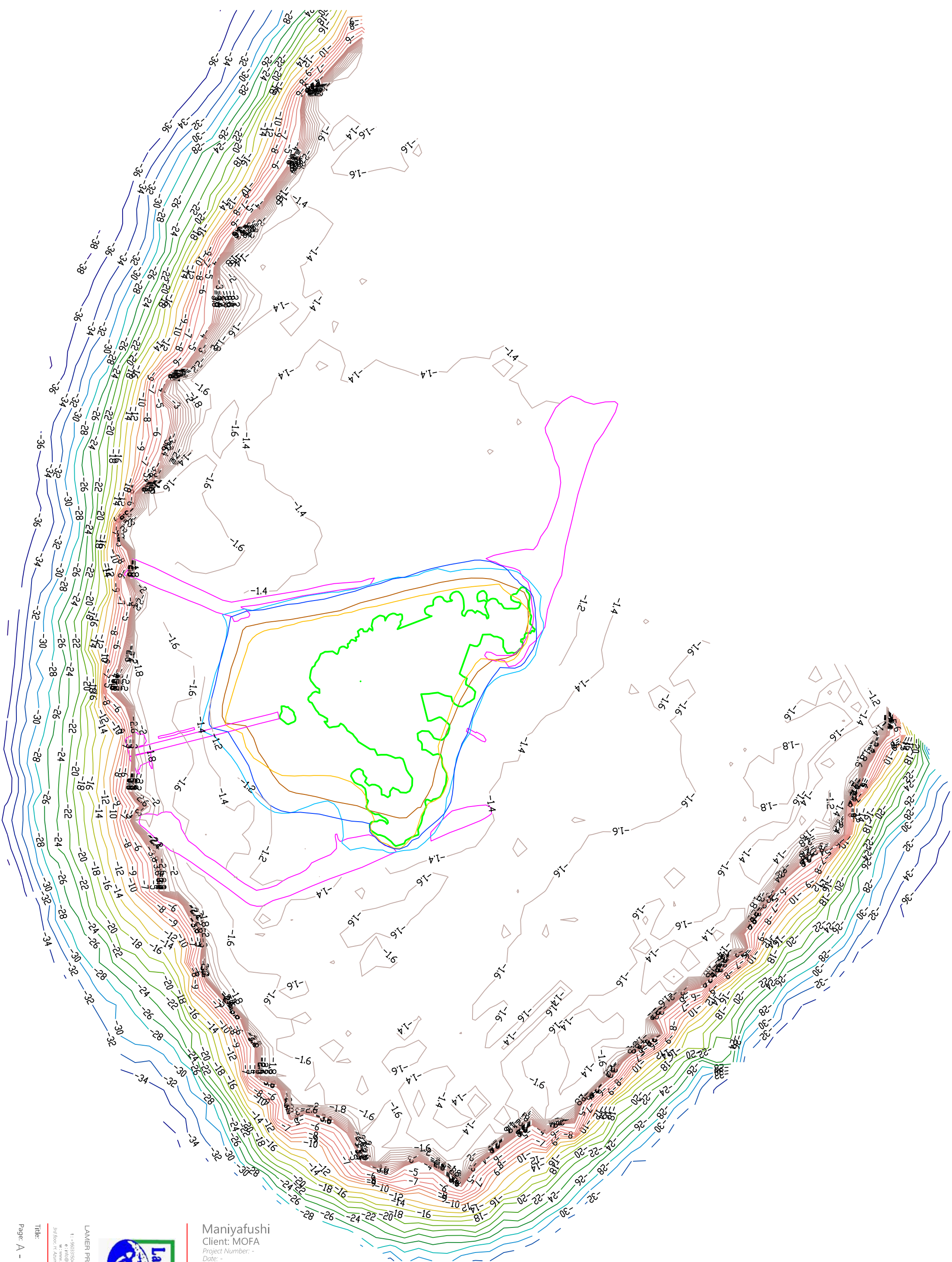
Title:

Appendix 9 Bathymetric survey map



Maniyafushi

Client: MOFA

Project Number: -

Date: -

Architect :-
Engineer : -
Drawn by : -
Services : -
Interior : -

Rev no	Date
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Page: A - 01/01

Appendix 10 Water test results report

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building 5th Floor, Machangoalhi, Ameenee Magu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

WATER QUALITY TEST REPORT

Report No: 500178079

Report date: **27/12/2017**
Test Requisition Form No: **900182740**
Sample(s) Recieved Date: **25/12/2017**
Date of Analysis: **25/12/2017 - 25/12/2017**

Customer Information:
Land & Marine Environment Resources
H.Azum
Ameeneemagu
Male' MALE

S2

Sample Description	Control (Maniyafushi)	Site 1 (S1,Maniyafushi)	Site 2 (S2,Maniyafushi)	**TEST METHOD**	**UNIT**
Sample Type	Sea Water	Sea Water	Sea Water		
Sample No	83195666	83195667	83195668		
Sampled Date	23/12/2017	23/12/2017	23/12/2017		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
Nitrate	3.1	3.7	3.0	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Nitrogen Ammonia	<0.02 (LoQ 0.02 mg/L)	0.03	<0.02 (LoQ 0.02 mg/L)	Method 8038 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Phosphate	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L

Keys: mg/L : Milligram Per Liter

Checked by

Aminath Sofa
Assistant Laboratory Executive

Approved by

Adam Rasheed
Manager, Quality

Notes: Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced except in full, without written approval of MWSC
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information provided by the customer

********** END OF REPORT **********

Appendix 11 List of stakeholders consulted

Office	Name	Designation	Contact
Environmental Protection Agency	Adam Mubeen	Assistant Engineer	7588930
	Ahmed Afrah Ismail	Engineer	9690600
	Aminath Mohamed	Environment Analyst	7504494
	Riffath Naeem	Senior Environment Analyst	3335949
Health Protection Agency	Moosa Haneef	Senior Public Health Program Officer	7423180
Kaafu Atoll Council	Abdul Waris	Vice president	7955002