ENVIRONMENTAL IMPACT ASSESSMENT FOR ESTABLISHMENT OF SEWER NETWORK AT

Aa.Ukulhas

Prepared by:

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January 2018

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بسم الله الرحمن الرحيم

Ministry of Environment and Energy
Male', Republic of Maldives.

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ފ.ގ، ދިވެހިރާއްޖެ.

Date: 24th January 2018

No: 438-WS/203/2018/14

Mr. Ibrahim Naeem

Director-General

Environmental Protection Agency

Male', Maldives

Dear Mr. Naeem,

Re: Declaration and Commitment to Undertake EIA for the Establishment of Sewerage System at A.A.Ukulhas.

As the proponent we confirm that we have read the report and to the best our knowledge, the information provided in the report are complete and accurate.

We would like to confirm our commitment to implement all post construction and mitigation measures as specified in the report.

Yours Sincerely

Mohamed Musthafa,
Director General

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DECLARATION OF CONSULTANTS

This EIA has been prepared in accordance with the EIA regulation 2012. We certify that the statements made in this EIA are true, complete and correct to the best of our knowledge and abilities.

Mahfooz Abdul Wahhab (EIA P22/2016)

Ibrahim Rashihu Adam (EIA P06/2017)

EXECUTIVE SUMMARY

1. The purpose of this EIA is to critically analyse and assess the potential environmental impacts associated with the establishment of a sewer network in AA.Ukulhas and expose the solutions and preferred alternatives as well as mitigation measures to minimize any negative impacts whilst trying to derive the maximum positive impacts from the project;

2. Existing sewer situation at the aforementioned island are not proper and are subject to cause ground water contamination.

3. In this sewer establishment project, sewer facilities are proposed to be constructed at a location whereby public nuisance could be minimised along with little disturbance to the natural setting of the proposed locations of sewer facility and allied pump stations for the network. All the components of the sewer network will be constructed according to EPA specification complying to both MEE and EPA regulations;

4. Additionally, this study also involved identification of several alternative locations for laying the outfall and selecting the most ideal location based on thorough study of the current patterns, proximity to the public recreational beaches and ease of design effectiveness. The preferred locations were selected based on best met design criteria of EPA and environmental options;

5. The construction works of sewer network presented in this report are not expected to adversely impact the environment if the mitigation measures mentioned in the report are followed. The most important mitigation measures are daily maintenance of machinery, following chemical handling procedures, waste segregation and storage in closed labelled containers until disposal to Thilafushi and most importantly following the EPA guidelines for operation of sewer system;

6. Potential groundwater contamination from damages to sewer network, potential impacts to marine life from discharge of sewerage from the outfall, excavation and dewatering are the most significant environmental impacts associated with the project. Therefore, it is extremely important to follow the proposed mitigation measure, relevant guidelines and regulations and the operation and maintenance manual of the sewer system during the operational phase.

7. Overall, the proposed project is expected to bring in positive outcomes. It is expected that the newly established sewer network will ensure safe sanitation services to island community in addition to greatly reducing further disturbance and contamination of the ground water and surrounding environment; and

8. Monitoring is essential to ensure that environmental thresholds are not exceeded and mitigation measures proposed are working. Ground water and marine water quality monitoring will be done according to the proposed monitoring schedule.

ސާދާ ހުލާސާ

1. މި ޕީ.އެޗް.ޑީ ދިރާސާގައި އެމް.އެލް.ޓީ.ގެ ޚާއްޞަކޮށް ހަމަޖެހިފައިވާ ނަޒަރިއްޔާ ނިޒާމުގެ ސަބަބުން ބިމާއްޓަން އަސާސީކޮށް މިންވަރު ބަލައި އެކަށީގެންވާ ހައްލު ދެނެގަތުމަށް އަދި މައްސަލަތަކުގެ ބާރުއަޅާ ގޮތުން ކުރިމަތިވެފައިވާ ނުރަފާ މައްސަލަތަށް މަދުކޮށް ދުރުހެޅުމަށްޓަކައި ދޭދެކޮޅަށް ހިއްސާކޮށް ހަމަ ކުރުމަށް ކުރުމަށް ކުރެވޭނެ ބަދަލުތަކާއި މަސައްކަތްތަކެއް ކުރުން;
2. މާލޭގައި ދަންނަވާލައިވާ ރަށްގެ ނިޒާމުގެ ހެދުމުގެ ވަނީ އެއްގެ ރަށްގޮތު ހެދުމެއްގެ ކަމުގައި ނުވާތީ މިކަމުގެ ސަބަބުން ބޮޑުވާ ފެންނަ ތިބައްޓަރު ވަރަށް ކަމުގެ ބޭނުން;
3. އެމް.އެލް.ޓީ.ގެ ނިޒާމާ ނިސްބަތްވާ އެކުލަވާ ފަސޭހަތަކަށް ޒާތުންކުރުމުގެ މިހާރު ހުރިހާކަމެއް ސަބަބަކަށް ވެވެއް އާރުކު ރަށްތެރޭގެ އަސާސީ ނިޒާމުތަކުގެ ސަބަބުން ގޮތުގެ ނިޒާމު ގޮތް ބައެއް ނުބައް ރަނގަޅުކަން ތަރުތީބުކުރަން މުސްތަޤުބަލަށް ހާއްސަ މިންބަރަކަށް ބޭނުމިނަ އަދި އަންނަނިވި އަދި ހަރަކާތްތަކަށް ފާހަގަކުރެވޭނެ އެކިއެކި އެއްމާއި އެއް ބަލައިގަންނަ އެސްޕަޝަލް އިކުރުވެ މަސައްކަތް ދިރާސާ ނިމުނުއުމަރު;
4. އަދި މި ރިޕޯޓުގައި އަރުހާލާ ހެދި އެކުލަވާލައި އަސާސީ އެކަކިގެނި ސަރުކާރުގެ ކަނޑައެޅުއްވުމުގައި ވަނީ ދިރާސާކުރުމުގެ މިގޮތުން އަރުހާލާ އެކުލަވާ ވޭރޯ ސަރުކާރުކުގެ ބައި އަދި މި ސަރުކާރުކުގެ ކަނޑައެޅިފައިވާ ޕީ.އެޗް.ޑީ ދިރާސާގެ ރިޕޯޓު ގައި ބިރުވެރި މައްސަލައާ ރައްޔިތުންނާ.
5. ނިޒާމު ނިޒާމު ގެހުރިތަކުގެ ދައުރު، މިރިޕޯޓުގައި ބަހައްސަރުވާ ބިރުވެރިކަން ފިޔަވަޅުން ކުރެވޭ ފިކުރުތަކެއް އަލަގެން ރިޔާސީ ނަމަ ބިރުވެރިކަން ދިމާވަނީ ރަސްމީގެ ކުރެވޭނެ، އަދި ދެރަކަން ދެރަކަން ކުރަންޖެހޭ މަސައްކަތް ކުރުމުގައި ކަމުގެ އަދި އޮފީސް ނިސްބަތްދާއިރާގެ އަދާކުރި ރައްޔިތުންގެ ރާއްޖެރަށް ބިލުކޮށް ކަނި ގިނަދުވަސްދަން ބަރުދަކަން ޕީ.އެޗް.ޑީ ގެ މިނިސްޓްރީ އޮފީސް ގޮތުގެމިން އަރަފަކުރުން.
6. ކޮރަޕްޝަން ބިލުން ފެން ނުލުމުގެ (ޖިޔޮޕޮލިޓިކް) ސަރަޙައްދު ފިޔަ ގެއްލުންތަކުގެ ސަރަޙައްދުތައް، ނިޒާމު ހިންގާ ބެލުމަށްގެންދާއިރު ނިޒާމުގެ ނިޒާމާއި ފިޔަ ގެއްލުންތަކުގެ ސަރަޙައްދު ބިލުގެ ފެން ތަރައްޤީކުރުމައި، އަރުހާލާ އަދި ފިޔަ ގެއްލުންތަކުގެ ސަރަޙައްދު ކަނޑައެޅި ދިރާސާން ފިޔަވަޅުން ގެއްލުންތަކުގެ މި ޖުމްހޫރިއްޔާގެ ދަރަނި ދިރާވާ ބިމާއްޓަން ގެޔަނުލުމަ އެއްގެ ބަޖެޓަ މައްސަލަތަކާ. އަދި މިރިޕޯޓުގައި ބަހައްސަރުވާ ފަރުބަދު ފިޔަވަޅުން ކުރެވޭނެ ހަރަކާތްތަކުގެ ރަނގަޅުކަމަށް އެކުލަވައި، ހޯދުމަށް ގަވާއިދުތަކުގައި އިސްތިސްނާއަށް އަސާސީ މަސައްކަތު ގަނޑުއެޅުމާއި، ނިޒާމު ހިންގާ ބެލުމަށް، އާބާދީ އަނެއް ދިރުން ބޭނުންފުން މަނާ އޮގެ އާސާސީ ކުރިއަށް ގެންދިއުން މަޝްރޫޢުގެ ސަރަޙައްދު ފަރުބަދު ފިޔަ ރައްކާ ގެއްލުންބަން ކުރެވި، ދުލުހަލުވި ގޮތުގައި މިނިސްޓްރީގެ ހިދުމަތް ރަށްތެރޭގެ ނިޒާމުތަކުގައި ފިޔަދެނުމަށް މަޖުބޫރު.
7. ޖުމުލަކޮށްލާގައި މި ޕްރޮޖެކްޓްތަކުގެ ސަރަޙައްދު ރަނގަޅު ނިޒާމުގެ ބަދަލުތަކުން ކަމަށް ބެލެވޭ. މިގޮތުން މި ޕްރޮޖެކްޓްތަކުގެ ދަށުން ޒާތުންކުރުމުގެ ހަމަޖެހިފައިވާ ނިޒާމާ ނިސްބަތްވާ ރައްޔިތުން ރާއްޖެ ނިޒާމުގެ ހިދުމަތް ފިޔަވަޅުތައް. އަދި މި ނިޒާމުގެ ޒާތުންކުރުމުން ބިލުގެ ފެން ވެރިކަން މިންވަރު ބަލައި ތަރައްޤީކުރުމުގެ ޖުމްހޫރީ ކުރެވޭނެގޮތްތައް.
8. ހުރިހާ ކަމެއްގައި ރައްޔިތުން މަޤާމުތައް ކުރުން ފަރާތް މުއައްސަސާ. އެއީ ޕްރޮޖެކްޓް ކުރިއަށްދާ މިންވަރަށް ފުޅާކުރުން ގޮތުގެ އަޒުނާބަށް ދަށުގެ ރާއްޖޭގެ އިސްލާހީ ދަރަނިވަރު. އަދި ރަށްތަކުގެ ރިޔާސީ ކަނޑައެޅުން ޖުމްހޫރީ މަޤާމު ކުރެވޭނެ. އަޅުގަނޑު ބިލުގެ މަސަލާ ފެންގެ ކައުންސިލް މަޤާމު ކުރުން ދަރަނި މަޤާމުތައް ޝަރީޢަތް އާ އަސާސީގެ.

1. INTRODUCTION

1.1. Structure of the EIA

This Environmental Impact Assessment (EIA) addresses the potential impacts of the proposed development on the physical, biological, environmental and socio-economic aspects of the development area in addition to providing safeguards to reduce any environmental effects.

In addition to forming a basis for the assessment and approval of the proposed changes, this EIA provides the community and government authorities with information on all aspects of the proposal. The EIA has been divided into following sections:-

- **Section 1**: INTRODUCTION- Provides an outline of the structure and purpose of the EIA as well as objectives of the proposed development;
- **Section 2**: STATUTORY REQUIREMENTS- Outlines the relevant legislative requirements pertaining to the proposed project;
- **Section 3**: PROJECT DESCRIPTION- Described the proposed development in detail;
- **Section 4**: METHODOLOGY- Describes the detailed methods used for data collection on the existing environment and baseline conditions;
- **Section 5**: EXISITING ENVIRONMENT- Describes the present conditions of the physical components of the study area and sets baseline conditions;
- **Section 6**: STAKEHOLDER CONSULTATION- Provides details on the consultation process and parties consulted for this study;
- **Section 7:** OPTIONS ASSESSMENT- Discusses all the available alternatives for the project and justifies the preferred option;
- **Section 8**: POTENTIAL IMPACT ANALYSIS- Describes the prevailing environmental characteristics and constraints of the site and locality being investigated and an assessment of the potential environmental impacts associated with the proposed changes. Mitigation measures that would be implemented to reduce any potentially adverse impacts are also identified;
- **Section 9**: ENVIRONMENTAL MANAGEMENT- Outlines the environmental management plans which would be used to mitigate/monitor the changes;
- **Section 10**: JUSTIFICATION AND CONCLUSION- The conclusions drawn from the proposed project and impact analysis with the justification of the preferred options;
- **Section 11**: ACKNOWLEDGEMENTS; and
- **Section 12**: REFERENCES

Supporting documents are provided as appendices to this EIA.

1.2. Project background

The proposed project involves establishment of sewerage networks, pump stations and sea outfall at Aa.Ukulhas.

1.3. Need for the project

The outer islands of Maldives lack a proper sanitation system due to which the groundwater quality on these islands are severely affected. In majority of the islands, wastewater management is through establishment of septic tanks at household levels and discharging into the sea at the nearest location to the household. Even though septic tanks maybe sufficient in the past due to the low population size, nowadays due to high population densities

The rate at which sewerage is discharged into the groundwater lens would be at a higher rate than the rate at which natural system can decompose all the organic matter, this causes the contamination of groundwater lens.

Up until the recent development of whole island sewerage facilities in the outer islands of Maldives, Septic tanks have been used for sewerage disposal including the project island of Aa.Ukulhas. The said septic tanks are usually at a close proximity to the groundwater wells which are more often than not contaminated due to wastewater leachate. Use of this contaminated groundwater could be linked to water borne diseases as well as dermal diseases.

In order to provide clean sanitation facilities to the outer islands of Maldives, the Government of Maldives has proposed to establish sewerage network facilities with pumping stations and wastewater outfall at the island of Aa.Ukulhas.

1.4. Project objectives

The primary objective of the proposed project is to provide proper sanitation facilities to the residents of Aa.Ukulhas.

1.5. The EIA process

The EIA process in the Maldives is coordinated by the Environmental Protection Agency (EPA) of the Maldives in order to ensure that environmental considerations are included in decisions regarding projects which may have an adverse impact on the environment.

The first step in the process involves screening of the project to determine whether a particular project warrants preparation of an EIA. Based on this decision, the EPA then decides the scope of the EIA which is conferred to the project proponents, the consultants as well as any relevant stakeholders to the project at a scoping meeting. A document ideally encompassing the issues and impacts that have been identified during the scoping meeting will then be issued known as the Terms of Reference (ToR). The consultant then prepares the EIA in accordance with the ToR and/or the range of issues identified during the scoping process. Once the findings of the EIA has been reported to the EPA, it gets reviewed following which an EIA Decision Note (DN) is issued to the proponent who is responsible for implementing the

project according to the DN and undertake appropriate environmental monitoring if required and report to the EPA.

1.6. Purpose of this EIA

As per article 5 (a) of the Environmental Protection and Preservation Act of the Maldives (Law No. 4/93) and the EIA Regulation 2012 of the Maldives, any development projects/activities that may have a significant impact on the environment are required to have an EIA submitted to the EPA prior to implementation.

The EPA of the Maldives has identified establishment of sewerage network in the island of Aa.Ukulhas as likely to have negative impacts on the surrounding natural environment. As such, a scoping application was provided to the EPA by the consultant and this EIA has been completed as per the requirements outlined within the approved ToR (Refer to Appendix B).

The purpose of this EIA is to critically analyze the environmental and socio-economic impacts which may arise due to the construction and operation of the proposed project. After analyzing the impacts it would be then possible to suggest proper mitigation measures to prevent/reduce any negative impacts and to enhance any positive impacts. The study involves evaluation of baseline conditions, prediction of the likely impacts, stakeholder consultation and design mitigation measures.

1.7. Terms of reference (ToR)

As part of the EIA process, a scoping meeting for the proposed project was held at the EPA on 19th December 2017. The project proponent, EIA consultant and representatives from AA Atoll council, AA.Ukulhas island council. The scope of the meeting as discussed at the meeting were approved and the ToR issued on the 24th December 2017 (the approved ToR is attached in Appendix B of this report).

1.8. EIA implementation

This EIA has been prepared by registered consultant as per EIA Regulation 2012 of the Maldives. The team members were:-

- Mahfooz Abdul Wahhab (EIA P22/2016)
- Ibrahim Rashihu Adam (EIA P06/2017)

1.9. The proponent

The proponent of this project is the Ministry of Environment and Energy (MEE). MEE is the ministry mandated in delivering governments policies regarding environment, energy, waste and sanitation.

2. STATUTORY REQUIREMENTS

All statutory requirements pertaining to this project have been considered in the concept development and assessment of this proposal. It is considered that all matters have been addressed where applicable and that the proposal fully complies with the objectives and requirements of all relevant statutory instruments. National legislations, existing policies and guidelines as well as international conventions relevant to the proposed project are outlined below:-

2.1. Law on general public services (4/96)

Under this law, the general public services are electricity, telephone, water and sewerage services. Relevant articles under this law pertaining to the proposed project are:-

- Article 3 states that any party can provide general public services only after getting registered in the competent authority and according to its regulations;
- Article 4 states that any public service must be provided after a contract agreement has been made between the service provider and the customer. The agreement must be made according to the regulations put forward by the competent authority;
- Article 5 states that a transfer of service between customers must be made only after a contract has been made between the customers according to the service providers regulations. If the customer fails to comply with the agreement, the service provider can discontinue service only after approval from competent authority;
- Article 7 states that the service provider can permanently discontinue its services according to regulation mentioned in article 3 of this law. However temporary discontinuation can be made after giving prior notification to the customers and according to the agreement made between the service provider and the customer;
- Article 8 states that the tariffs for the services must be approved from the competent authority prior to implementation. Further, any amendments to tariff structure also must be approved from the competent authority before implementation; and
- Article 9 states that any damage made to service provider's facilities by anyone, he can be charged with 10 prison penalty or banishment. Further, any action against this law (excluding what is mentioned in article 9 (a) of this law) can be charged between MVR 100 to MVR 5000 by the competent authority.

2.2. Environmental Protection and Preservation Act (4/93)

The Environmental protection and Preservation Act of the Maldives was enacted to protect the environment and its resources for the current and future generations. Relevant articles under this law pertaining to the proposed project are:-

- Article 2 states that the instructions for environmental protection will be given from the competent authority and everyone must respectfully follow these instructions;

- Article 3 states that all matters relating to environmental protection and preservation must be handled by the Ministry of Planning, Human Resource and Environment (MPHRE);
- Article 4 states that MPHRE must declare protected sites and species and formulate the regulations to manage them. If any other party wants to declare a protected site or species they must be registered in the MPHRE and managed according to regulations made by the Ministry;
- Article 5 states that any projects which pose significant impacts to the environment, an EIA report has to be made and submitted to the MPHRE. The projects which require an EIA and the regulation must be made by MPHRE;
- Article 6 states that if any project is found to cause significant adverse impacts, MPHRE have the right to stop the project;
- Article 7 states that any waste, oil or hazardous gas must not be dumped into any part of the Maldives, however, if strictly needs to be disposed it should be disposed of in an area designated by the Government. If such hazardous gas, waste or oil is to be disposed by combustion, it should be done in a way it does not impact human health and environment;
- Article 8 states that any hazardous waste must not be disposed into any part of the Maldives. Before trans-boundary transfer of such waste, approval must be taken from the Ministry of Transport and Communication by writing to the Ministry at least 3 months beforehand.
- Article 9 states that any party who violates this law or any regulation under this law is punishable to no more than MVR 100 million according to the offence. The fine will be applied by the MPHRE.
- Article 10 states that any offence to this law or any regulation under this law or any action resulting in environment damage, the compensation for such damages can be taken through judicial processes.

2.3. 1st addendum to Environmental Protection and Preservation Act (4/93) law no 12/2014

Article 3 and 11 of the Environmental Protection and Preservation Act (4/93) of Maldives is amended as follows:-

Under article 3, all matters relating to environmental protection and preservation must be handled by the Ministry charged with implementation of environmental policy.

2.4. Environmental Impact Assessment Regulation 2012

The EIA Regulation, which came into force in 2007, has been revised and this revised EIA Regulation is currently in force since May 2012. The Regulation sets out the criteria to

determine whether a development proposal is likely to significantly affect the environment and is therefore subject to an EIA. Schedule D of the EIA Regulation defines the type of projects that would be subject to EIA. The main purpose of this Regulation is to provide step-by-step guidance for proponents, consultants, government agencies and general public on how to obtain approval in the form of an Environmental DS.

Since the development of sewerage facilities is in the inclusive list, an EIA report needs to be submitted to the competent authority before the implementation of the project. An EIA application form was submitted to the EPA and a scoping meeting was held on 30th July 2017. During the meeting the ToR for the project was issued. The EIA report is this document and will be submitted to EPA for approval.

2.5. 2nd addendum to the Environmental impact Assessment Regulation 2012

With the 2nd addendum to the environmental impact assessment regulation 2012, there were some procedural changes made to the EIA process. The most important was the shifting of tourism related development projects EIAs to the Ministry of Tourism. Other than that slight changes were made to the process such as the finalization of the ToR during the scoping meeting(article 11(b)) and changes in the fees for the review processes under three different categories (article 7(c)).

Under article 8(a) the decisions for a screening form is as follows:-

1) Environment Management Plan;
2) Initial Environmental Examination;
3) Environmental Impact Assessment;
4) Approval to go forth with the screened project; and
5) Approval to go forth with the project according to the mitigation measures proposed by EPA.

Under article 9(b) the decisions for an IEE is as follows:-

1) Environmental Impact Assessment report if the project is anticipated to have major environmental impacts;
2) Environment Management Plan; and
3) Approval to go forth with the project if the project is not anticipated to have major environmental impacts.

Under article 10 two reviewers are required to review the Environmental Management plan. The reviewers are to be selected according to article 13(b) of the regulation.

2.6. 3rd addendum to the Environmental Impact Regulation 2012

One of the main modifications to the EIA regulation is that the EIA consultants are classified into 2 categories. To be eligible for a category A consultant, the applicant should hold a minimum of level 7 qualification in an environment related field recognized by the Maldives National Qualification Framework. Likewise, to be eligible for a category B consultant, the applicant should hold a minimum of level 7 qualification in specific fields relevant for the

nature of the project recognized by the Maldives National Qualification Framework. As such, this report is prepared by registered category A EIA consultants.

2.7. Waste Management Regulation

The waste management regulation dictates the principles needed to follow when handling waste. The aim is to minimize adverse impacts to the environment and human health from waste. Under this regulation, island councils are required to make a waste management plan and submit it to the competent authority. This plan must be reviewed at least every five years.

2.8. Waste management policy

The waste management policy which came into effect on 2015 is to ensure that the Maldivians are well aware of the waste management techniques and maintains cleanliness as well as the natural aesthetics and clean air quality of the country is well maintained. Under this policy, all the inhabited islands need to implement a waste management plan and manage all the wastes generated from that island in accordance with that policy.

This project will comply with this guideline such that any wastes generated during the construction and operation phases of this project will be dealt with in accordance with the waste management plans of the island under concern.

2.9. National wastewater guideline

The purpose of the guideline is to assist all stakeholders in the water cycle to manage the discharge of wastewater in such a way that it does not limit water's fitness for use by different water users. The guideline suggests specific values of maximum concentrations that can be tolerated by future users of each parameter potentially present in wastewater. These values may not be exceeded when treated wastewater is released back into surface water, groundwater or into the ocean. The values are generic and should be used together with the EIA and clean Production Protocols to finalize the license for the discharge of specific waste water. All relevant sections in the guideline are conformed for the proposed project.

2.10. Regulation on uprooting, cutting and transportation of palms and trees

This regulation was implemented on 1 February 2006 by the Ministry of Environment, Energy and Water. The primary purpose of the regulation is to control and regulate large-scale uprooting, removal, cutting and transportation of palms and trees from one island to another. According to the regulation, certain types of trees and plants that have unique attributes are prohibited to be removed from its natural environment. Also, uprooting and removal of a vast number of trees and palms are subjected to an EIA, which is required to be submitted to the EPA and written approval is required prior to implementation of the project.

The amendment to this regulation (regulation no 2014/R) has specified a set of categories and any tree falling under these categories is not allowed to be removed unless it is a project of the government approved by the parliament.

2.11. Dewatering regulation

The dewatering regulation is enacted with aim of minimizing impacts to groundwater while carrying out dewatering activities.

Article 5 states that for any economic activity water can only extracted and used after getting written approval from the competent authority, however, water can be extracted for domestic wells placement and cleaning, and for agricultural purpose. Nonetheless water extracted from any other project cannot be used even for agricultural purpose.

Article 7 states that dewatering must be done only after getting the necessary approval from the competent authority. The proponent must inform the people living with 100 meters of the dewatering activity via the council using the application form mentioned in annex 1 of this regulation.

Article 8 states that an administrative fee of MVR 500 has to be paid to the competent authority when submitting the form mentioned in article 7.

Article 9 states that water samples must be tested from a certified laboratory and their results attached with the form in this regulations annex 1. The results must not be more than 45 days old from the tested date. The following parameters must be tested;

- Temperature, ^{0}C
- TDS, mg/l
- Dissolved Oxygen, mg/l
- Electrical Conductivity, µS/cm
- Turbidity, NTU
- Salinity, ppm
- Ammonia, mg/l
- Fecal Coliforms 0/100
- Hydrogen Sulphide, mg/l
- Nitrates, mg/l
- Phosphates, mg/l

If any of the parameters cannot be tested then it should mentioned in writing from the laboratory.

Article 10 states that the approval for dewatering will be issued from the competent authority. Dewatering approval will be given for 28 consecutive days including public holidays. For big projects involving dewatering at different places, the places from where dewatering can be started with 28 consecutive days must be submitted as a single approval. The period of approval will be decided based on the following;

- Size of proposed water discharge area
- Water quality

- Work schedule
- Method of water discharge
- Water discharge area

Article 11 states that designated impact radius from water discharge is 30 meters from the discharge point. The proponent must inform the houses within this radius by writing before 24 hours. During the course of dewatering activities if a damage is caused to any of the houses within this radius, the proponent has to take responsibility and also if any of the houses face any difficulties getting groundwater from their wells the proponent has to provide no more than 250 liters of water per household or pay no more than MRV 30.

Article 12 states that an option other than draining water into the ground will be considered if the water quality tests mentioned in article 9 of this regulation shows that the waters quality is bad or if the council decides that there is no space in the island for drainage. Approval to discharge water into sea will be given if a catch pit is created to trap sediments and sand. If water is to be discharge through sanitation system then it is the sanitation service operator's responsibility to create a catch pit and install a valve such that the amount of water going into the sanitation system can be controlled. During ongoing dewatering works a copy of the approval must be at site and a sign board has to be fixed as the model in annex 3 of this regulation.

Article 13 states that for any reason if the site engineer believes that the dewatering works will not be finished within the approval period, then the proponent must fill the form on annex 2 of this regulation and submit to competent authority before 3 days (the 3 days will be counted excluding public holidays) of approval deadline. Upon receival of the form and associated documents the competent authority will issue the approval within 2 working days. However extension will be granted if the original approval granted under article 10 of this regulation is less than 6 months old, if more than 6 months then a new approval must be requested.

Article 14 states that a non-refundable fee has to be paid to the competent authority according to following principle;

- For the first 28 day approval MVR 500 per day
- For the first addition of days to the approval MVR 1000 per day
- For the second addition of days to the approval MVR 1500 per day
- For the third addition and onwards with an increasing rate of MVR 2000 per day

However if the works were delayed due to a natural hazard or bad weather, without any fee days will be added. These type of days will be decided by considering the information from the respective authority.

Article 15 states that the competent authority has to maintain records about the dewatering approvals they give. If a sanitation service provider gives service of water discharging from dewatering activities, then they must provide those dewatering activity details before the 10 of each month for the previous month's activities.

Article 16 states that the competent authority has the full discretion to stop any dewatering activities ongoing without approval.

Article 17 states that the following actions are offenses to this regulation and will be punishable according to article 9(b) of EPPA 4/93;

- For projects requiring dewatering approval, commencing project without dewatering approval
- Sanitation service provider gives water discharge service to a proponent who did not get the dewatering approval according to this regulation
- Re-starting the project when the project without approval, when the project was halted by the competent authority
- Not complying with the project halting order mentioned in article 16 of this regulation from the competent authority

Article 18 states that competent authority must inform the proponent via writing if they go against regulations.

Article 19 states that the proponent has to provide a report about its activities within 3 working days from the day they receive the writing mentioned in article 18 from the competent authority. If the proponent fails to submit the report within the 3 working days, the competent authority has full discretion to reprimand the proponent according to article 20 of this regulation.

Article 20 states that under this regulation the maximum fine is MVR 100 million. The following principles will be used to penalize any offences against this regulation;

- For projects requiring dewatering approval, dewatering for the first day without approval a fine of MVR 50,000 for the owner of land who did the works.
- For projects requiring dewatering approval, dewatering for additional days (excluding first day) without approval a fine of MVR 5000 per day.
- For projects requiring dewatering approval, discharging water using the sanitation system for the first day without approval a fine of MVR 100,000 for the owner of the sanitation system.
- For projects requiring dewatering approval, discharging water using the sanitation system for additional days (excluding first day) without approval a fine of MVR 25,000 per day for the owner of the sanitation system.

If any dewatering activities are required through this project, dewatering permit must be obtained from the EPA.

2.12. Design Criteria and Technical Specifications for Conventional Gravity Systems

The technical specification of the EPA on designing a gravity based sewer system includes all technical details and requirements that need to be followed in the design of a gravity based sewer system.

It guides on the flow rates that need to be maintained in the sewer system and most importantly the limitations on depth of the network pipes along with sizes of the network pipes. In addition, in also reflects on the layout design of the sewerage collection network, pump stations, pumping mains, waste water treatment plant, marine outfall, sludge drying beds, administration buildings and all other facilities of the sewer system.

Construction of all civil engineering works and associated works shall continue in accordance with the approved design and these specifications. The general design parameters shall be followed including the design shall be done for the projected population for 30-year period.

The specification also highlights on the general obligations of the contactor and the operator with regard to environmental protection during both construction and operational phases.

2.13. International Conventions

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

UNFCCC is the first binding international legal instrument that deals directly with the threat of climate change. It was enacted at the 1992 Earth Summit in Rio de Janeiro and came into force on the 21st of March 1994.

Signatory countries have agreed to take action to achieve the goal outlined in Article 2 of the Convention which addresses the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system," Thus all Parties to the Convention are committed under Article 4 to adopt national programs for mitigating climate change, promote sustainable management and conservation of greenhouse gas (GHG) sinks such as coral reefs, to develop adaptation strategies, to address climate change in relevant social, economic and environmental policies, to cooperate in technical, scientific and educational matters and to promote scientific research and exchange of information.

The Kyoto Protocol entered into force on the 16th of February 2005 and is an international and legally binding agreement to reduce GHG emissions globally. It strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to achieve limitations or reductions in their GHG emissions. Maldives has signed and ratified both the Convention and the Protocol.

2.13.2*Paris Agreement*

The Paris Agreement is also an agreement within the framework of the UNFCCC dealing with GHG emission mitigation, adaptation and finance proposed to start in the year 2020. Upon opening for signatories on 22 April 2016, 180 UNFCCC members have signed the treaty

(including Maldives), however, only 22 of which ratified it so far which is not enough for the treaty to enter into force yet. The aim of the convention as described in Article 2 of the treaty is "enhancing the implementation" of the UNFCCC through:-

i. Holding the increase in global average temperature to well below 2° C above pre-industrial level and to pursue efforts to limit the temperature increase to 1.5° C above pre-industrial levels, recognising that this would significantly reduce the risk and impacts of climate change;
ii. Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and lower GHG emissions development in a manner that does not threaten food production; and
iii. Making finance flows consistent with a pathway towards low GHG emissions and climate resilient development.

2.13.3*The Vienna Convention for the Protection of the Ozone Layer*

The Vienna Convention for the Protection of the Ozone Layer is a multilateral environmental agreement which entered into force in 1988. It acts as a framework for the international efforts to protect the ozone layer. In 2009, the Vienna Convention became the first convention of any kind to achieve universal ratification. The objective of the Convention were for the Parties to promote corporation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer. Maldives has signed and ratified this convention and adheres to it.

2.13.4*The Montreal Protocol on Substances that Deplete the Ozone Layer*

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to reduce production and consumption of ozone depleting substances in order to phase out the production and abundance of substances that are responsible for depletion of the ozone layer. This protocol entered into force on 1 January 1989. Since its adoption, it has undergone 8 revisions and the Maldives abide by 4 of those addendums mentioned below:-

- The London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1990);
- The Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1992);
- The Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1997); and
- The Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1999).

2.13.5*Agenda 21*

Agenda 21 is a non-binding voluntary implemented action plan of the United Nations (UN) with regards to sustainable development. It is a comprehensive plan of actions taken globally, nationally and locally by organizations of the United Nations System, Governments and Major Groups in every area in which humans impact on the environment. It is also an outcome of the Earth Summit (UN Conference of Environment and Development) held in Rio De Jeneiro, Brazil in 1992. Maldives is among the 178 countries which adopted this action plan. Out of the 4 sections it is grouped into, the proposed development pertains to:-

i. Section I: *Social and Economic Dimensions* which is directed towards combating poverty, especially in developing countries, changing consumption patterns, promoting health, achieving a more sustainable population and sustainable settlement in decision making; and
ii. Section II: *Conservation and Management of Resources for Development* which includes atmospheric protection, combating deforestation, protecting fragile environments, conservation of biodiversity, control of pollution and the management of biotechnology and radioactive wastes.

2.13.6*Convention on Biological Diversity (CBD)*

The Convention on Biological Diversity (CBD), formally known as the Biodiversity Convention, is a multilateral treaty which entered into force on 29 December 1993. The convention has 3 main goals:-

i. Conservation of biodiversity;
ii. Sustainable use of its components; and
iii. Fair and equitable sharing of benefits arising from genetic resources.

The objectives of the convention is to develop national strategies for the conservation and sustainable use of biodiversity.

2.13.7*Washington Declaration on Protection of the Marine Environment from Land-based Activities*

Maldives is a signatory to the Washington Declaration on Protection of the Marine Environment from Land-based Activities which intends at setting a common goal sustained and effective action to deal with all land-based impacts upon the marine environment, specifically those resulting from sewage, persistent organic pollutants, radioactive substance, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, litter and physical alteration and destruction of habitat.

2.14. Regional plans and programs

In addition to the international treaties and conventions, Maldives is also a key player in the formulating and adopting of various regional plans and programs to protect the environment by actively participating in activities organised by several regional bodies. As such, Maldives is committed to the following which pertains to the proposed project: -

- South Asian Association for Regional Corporation (SAARC) Environment Action Plan adopted in Male' in 1997;
- SAARC Study on Greenhouse Effect and its Impacts on the Region;
- South Asian Regional Seas Action Plan and Resolutions concerning its implementation (1994); SAARC Study on Causes and Consequences of Natural Disasters;
- South Asian Seas Program; and
- Male' Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia (1998).

3. PROJECT DESCIRPTION

3.1. Study area, project boundary and surroundings

In general, the whole island comes under the boundary of study area, however, most environmental studies such as vegetation, water quality and marine environment were restricted to the areas where the proposed locations and alternative for the pump stations and outfall pipe. Socio-economic impacts, on the hand, were undertaken for the whole island population as the whole islands were affected.

Locations for the pump stations have been approved by the respective island council. Land approvals are provided in Appendix C of this report.

3.1.1 Relevant development(s) in the area

In addition to the establishment of sewerage network, there are other development projects proposed in the island. Relevant developments include: -

- Development of a mosque (ongoing)
- STELCO cable upgrading (ongoing)
- Heritage center development (proposed)
- Sports area development (proposed)

3.2. Proposed works

The proposed project involves establishing a gravity based sewer network and sewer facilities at the island of Aa.Ukulhas. Considering the size, population growth and other requirements, the selected is conventional system, where the island is divided into two sections which are provided with three pump stations and a sewerage treatment plant with effluent disposing pipeline to open sea via sea outfall. Outfall pipe is inclined to a depth below 6m from MSL as per EPA regulation. Proposed locations for the pump stations and outfall locations along with alternate locations are shown on (Figure 2).

3.3. Ground Conditions

Maldivian islands typically has soil conditions with 02 to 03m thick sand or coral rubble layer over a porous coral stone base with some limestone or coral stone outcrops. The ground water kens is generally located 0.5 to 1.2 m below ground surface level. Additionally, trial pits for the location of existing services are also proposed to identify electricity, existing private sewer lines (if any), and TV cables, as there are no as built drawings for the mentioned services.

3.4. Design Population of Aa. Ukulhas

Considering the current population provided by island councils as maximum design criteria and with reference to EPA guideline of an average five residents per household, design population was determined.

The Expected consumption of water is estimated in the table below.

Table 1: Projected Consumption of water.

Source Development	**Average Daily Flow (L/unit)**	**Unit**	**Nos**	**Flow (L/day)**
Automobile repair garage	30	Garage	Garages - 3	900
Cafeteria	10	Seat	Cafeteria - 20 seats	2000
Mosque	20	Person	Mosques - 850 persons	17000
Health facility	30	Bed	Health Centre - 4 beds	1200
Office building	50 0	1000 sqft	Council - 2340 sqft	
			School Office - 660 sqft	
			Health Center - 224 sqft	
			Stelco - 224 sqft	
			Ice Plant Office - 110 sqft	
			Court - 2266 sqft	
			Total - 5824 sqft	2912
Domestic use	15	Per	Population - 1202	180300

Restaurant - fixed seat	80 0	1000 sqft	Retro Royal - 2125 sqft	
			Black y garden - 4681 sqft	
			Olhumathi - 1200 sqft	
			Selavi Café - 259 sqft	
			Central diner - 1205 sqft	
			Total - 9470 sqft	7576
School - kindergarten	20	Child	93	1860
School - elementary / junior	20	Student	222	4440
School - high school	25	Student	49	1225
Total Flow (L/day)				**219413**

A total consumption of 219 m^3/day is expected. With 70% of total expected as waste water output the total waste production is estimated to be 154 m^3/day

3.5. Design Criteria

The design criteria has been based on the Design Criteria and Technical Specifications for Conventional Gravity Sewerage Systems provided by the EPA

Sewer Collection Network

1. The sewer collection network shall be a gravity sewer collection network.
2. The maximum distance between the inspection chambers in the network has been limited to 60 meters.
3. The catch pit considered as inside the house 300mm dia and inception chamber considers as in the road as 600 mm dia
4. The main gravity network on the roads is taken as DN 150 (O/D 160 mm UPVC)
5. The Sewer lateral lines from the households upto the sewer main laterals has been taken as DN100 (O/D 110 UPVC)
6. The Minimum depth to the top of the pipe line on the roads is taken as 450 mm earth cover.
7. The maximum depth of excavations has been taken as 3.5 m depth.
8. The slope of the gravity sewer pipe lines has been taken as 0.4% (1/250 slope).
9. The catchment area has been considered based on the maximum length of any main gravity line not to exceed a minimum of 450 mm depth at the beginning of the line to a depth not exceeding 2.25 meters at the discharge point to the pumping station.
10. The sewer effluent from a house hold is taken as 120 l/day , 10% infiltration and other flows as 4% of the ADWF (Total 14%).
11. To calculate the peak wet weather flow, the AWWF has been multiplied by the Babbit formula factor 4.3.

12. The flow velocity for all depths of flow has been taken as 0.6m/s.

13. All the discharge pumps has been considered as submersible pumps (non- clogging submersible pumps).

3.6. Conventional Gravity System

3.6.1 Excavation and Dewatering

The Maldives is a unique environment with respect to construction of wastewater systems due to the extremely high-water tables which on average are between 0.5 and 1.5m below ground level. Because of this, extensive dewatering is required during construction and installation of pipe networks which increases in intensity as depth increases. In addition, the instability of the prevailing sand/soil conditions of Coral Atoll Islands makes excessive dewatering extremely hazardous as increased dewatering with depth removes significant quantities of sand/soil further exacerbating the unstable soil conditions. Previous experience of sewer construction in the Maldives has indicated that excavation depths in excess of 3.5m are not recommended for conventional dewatering methods to avoid the risk of undermining and trench collapses.

For the purpose of the design, a maximum depth of excavation of 3.00 m is proposed as per the guide lines of EPA. Strict adherence to these criteria is considered necessary for island as the streets are very narrow leaving limited space for excavation and installation of pipelines between buildings.

Given the instability of the sand/soil conditions, trench shoring is to be used to maintain the vertical integrity of the sidewalls. All water removed during excavation for trenching and construction will be disposed of inland from the excavation for re-percolation back into the water table as outlined in the EPA guidelines.

3.6.2 Minimum Cover

Considering the limitations with respect to depth of excavation a maximum depth for pipeline excavation should be within the range of 2.0m. This will allow for the installation of pump stations to a depth of not more than 3 to 3.5 m. With a view to minimizing the number of pump stations required, the minimum depth of cover should allow for maximum fall of the pipeline over a specified distance. The standard minimum cover for all the areas is 600mm.

3.6.3 Pipe Size

The minimum pipe size specified for the construction of conventional gravity sewers is 160mm O/D. As the system is designed for a small community, and therefore 160mm O/D is the proposed minimum pipe size for the system, except the property connections within the boundary of the property, which shall be 110 mm O/D UPVC pipes.

3.6.4 Slope

In an effort to minimize the number of pump stations required for the system a maximum slope of 0.4% has been adopted for use uniformly throughout, the EPA guide lines specify a slope of 1/250 (0.4%).

3.6.5 Pipe Material

Given the availability of u-PVC pipes and fittings in the Maldives and wide spread experience of using such materials it is recommended for all gravity sewers for the project. All gravity sewer mains are to be rated SN4 (SDR 41) solid wall and rubber ring jointed.

3.6.6 Maintenance Shafts

Maintenance shafts are to be used in place of manholes and located at pipe junctions or where the lengths of gravity sewer runs exceed 60m. A minimum size of DN600 is to be used for all pipe junctions.

All of the Maintenance Shafts are at a depth which is accessible from the surface and any blockages could be cleared from the surface. 13

Pre-cast PVC fittings have been selected as the preferred material for Maintenance shafts The materials for maintenance shafts will be;

• Maintenance shaft bases will be pre-molded PVC, multiple entries to suit 160/250 uPVC /

HDPE rubber ring jointed sewer mains.

• Maintenance shaft risers will be double walled or corrugated PVC with “O” ring seals at all

Joints.

• Plastic Press- on cover

Maintenance shafts will be installed with a concrete collar surround and trafficable cast iron cover.

Previous experience has indicated that PVC Maintenance shafts installed at depths up to 1m below water tables without concrete ballast do not experience adverse effects due to buoyancy and the collar is provided as added security.

3.6.7 Clean-outs

Clean-outs or, rodding points, will be located at the beginning of all sewer mains and comprised of a O/D 160 mm PVC bend of 45 deg, with threaded end cap and rubber gasket for the purpose of upstream flushing of sewer mains.

3.6.8 Vent Stocks

The Vent stack shall be 9 m in height, 150 mm O/D at the top and 225 mm dia at the base, mounted on a base plate of 20 mm thk x 350 mm x 350 mm size, fixe to the concrete foundation with 18 mm x 4 nos anchor bolts.

The concrete foundation shall be 750 mm x 750 mm x 450 mm ht, of reinforced concrete of grade 25.

3.6.9 Pump Stations

Following design of the Aa.Ukulhas system, total number of catchments designed will be required to adequately service all areas given the design specifications as outlined in the design criteria. Depths have been limited to a maximum of 3.5m which is effectively 2.5m below the water table. The minimum diameter of the pump well shall be 1.5 m. There are a total of four catchments in the proposed sewer design.

3.6.10 General Maintenance

i) Semi-skilled fully trained operator who should be capable to overlook the maintenance of operations, periodic cleaning and backwash, general trouble shooting.

ii) Regular weekly maintenance.

iii) Servicing of hydraulic/pneumatic elements, pumps, blowers every month.

iv) Cleaning of tanks every year

3.6.11 Sea Outfall

The location of the sea outfall has been proposed at the place shown in the annexure as a preliminary site; The location shall be confirmed on the findings and the recommendations of this EIA considering the impacts and alternatives.

As per EPA guidelines, the Ocean outfall pipeline will be constructed of HDPE OD 160mm. The pipeline will be ballasted with concrete ballast blocks, running on the surface of the lagoon bed as per the drawing; the pipe passing through the coral reef shall be placed on the reef exposed, but ballasted suitably with pre-cast concrete blocks of 1800 kg at 4 m intervals as shown in the drawing, to prevent displacement.

The rest of the pipe line shall be laid exposed till it reaches an average depth of 6 m below MSL and ballasted with 1800 kg concrete ballasts at 4m intervals. Following the emergence of the pipeline at 6m depth, it will be secured with a anchor block of 2,500 kg in weight. A “T” head diffuser will be fixed to the discharge end of the OOF pipeline to increase dilution performance and dispersion of effluent.

3.6.12 Safety Precautions

The safety precautions to be applied during the sewer network establishment and operations in accordance to EPA specifications. All necessary precautions will be taken to protect personal

and property from hazards due to falls, injuries, toxic fumes, or other harm. All painting and corrosion protection work, including inside the building and excavation work for pipeline will be performed under strict safety conditions.

3.7. Project inputs and outputs

The materials required for construction which is not available locally, shall be imported and shipped from Male' to the site.

The equipment required for the project are an excavator and general construction tools. Some of these are available at the company and others would be sourced from available shops.

The major inputs required for the construction of the sewer network at AA.Ukulhas are outlined in the table below.

Table 2. Major inputs required for the proposed project (per island)

Input resource(s)	Source/ type	Qty/Volume	Source of resource
Man power	expatriate	Large numbers	Contractor
Construction material	**Temporary site setup**: Galvanized pipes, roofing sheets, cement, sand, timber, spun piles	Small quantities	Local purchase or import
	Concrete works: reinforcement steel bars, river sand, cement, aggregates	Large quantities	Local purchase or import
	Roofing: Timber; Thatch, prefabricated materials.	Large quantities	Local purchase or import
	Electrical: electrical cables and wires, DBs, MMCBs and MCBs, PVC pipes, light weight, telephone cable CAT 5, PVC conduits, 4 core armored cables, PP-R pipe, Multi pump, UPVC (T1000, T600) for sewerage grid	Large quantities	Local purchase or import
	Water and Sewer: HDPE pipes, pumps, control panels, inspection chambers, aerobic tanks	Large quantities	Local purchase or import
	Finishing: floor and wall tiles, gypsum boards, calcium silicate boards, zinc coated corrugated metal roof, paint, varnish, lacquer, thinner, dry walls, carpet etc.	Large quantities	Local purchase or import
Machinery and equipment	Excavator, Truck, Concrete mixer, General construction tools, Small lorry, forklift, Barge, Dewatering pump, total station, level gage	Large quantities	Contractor
Water	Desalinated water	Large quantities	STELCO
Fuel for operation	Petrol	Large quantities	Local purchase
Power	Electricity	Large quantities	STELCO

Main output of the project is a gravity sewer network with pump stations and a sewerage treatment plant along with an admin building.

Table 3. Project outputs anticipated to be generated from the proposed project

Project outputs	Method of generation/Qty	Method of control
Gravity Sewer Network	To be built	EPA specification
Construction wastes	Demolition wastes Waste oils Green waste Wastewater Greenhouse gases, effluents	Construction waste gathered in a designated area and routinely transferred to Thilafushi for disposal. Waste water disposed to sea via temporary outfall
Noise	Localized to the project site	Unavoidable, but could be minimized by limiting working hours to daytime only and completing the project within the earliest possible duration.
Sewerage	Operation of sewer system	Discharged to sea via outfall

3.8. Construction method

3.8.1 Workforce

The workforce required for the construction shall be stationed within the island in existing houses. Utility services such as water, sewer and electricity networks utilized will be of the existing facility on each island. The work profile required for the proposed project is outlined in below.

Table 4. Work profile required for implementation of the proposed project

Designation	responsibility
Project manager	Overall responsibility for the implementation of the project
Project engineer	Ensure that works are in accordance to drawings and specifications
Surveyors	Provide layout and levels
Site manager	In charge of site work implementation and coordination
Implementation Supervisors	Ensures that works are carried out according to project managers instructions
Safety supervisors	Assess risk and ensure that everyone follows the safety rules and regulations.
Laborers	Carries out all the tasks

3.8.2 Mobilization

The excavator required for the project will be carried to the islands via a barge. Other materials and workforce will be transported in a ferry or a hired sea vessel.

3.8.3 Establishment of temporary project facilities

No temporary project housing facilities will be required to build as the required housing for the workforce will be provided from the residential houses on each island. However temporary storage for building materials will be accommodated at a project location which has been approved by the island councils.

3.9. Health and safety measures

Basic first aid facilities and safety gears shall be made readily available by the contractor during the construction phase of the project. In case of an emergency, the workers shall be taken to the health centers on respective islands and if the need be, taken to Male'. Other specific safety measures during construction phases are detailed in the respective components under the project description.

During the operational phase basic first aid facilities and safety gears shall be made readily available to the working staff at the powerhouses. Occupation health and safety guideline (Appendix M) shall be strictly followed by all personnel. In case of an emergency, the workers shall be taken to the health centers on the respective islands and if the need be, taken to Male'.

3.10. Decommissioning

Once the project has been completed, contractor leaves the site after performing the required site clearance and levelling works. Any temporary project facilities will be demolished and the waste will be transported to Thilafushi for disposal.

All heavy machinery brought in by the contractor will be demobilized via barge.

Once the sewer network is handed over to utility company, application for EPA operating license will commence.

3.11. Project duration and schedule of implementation

The construction of the sewer system has already been awarded to Static Company and will commence once the EIA process have been completed. Estimated date is late January 2018. Construction works is expected to be completed by September 2018. Refer to Appendix G for a detailed work plan of the proposed project. The entire project is estimated to be completed within 08 months from project commencement date.

4. METHODOLOGY

4.1. Water quality

5 groundwater sample was collected from existing wells on the island. 3 marine water samples were collected (Refer to Figure 2 and Table 1 for sampling locations and respective GPS coordinates). Samples were collected in 1500 mL plastic bottles by first rinsing the bottle with the sampling water three times. Marine water samples were collected just below the surface. Marine water samples were collected on 22nd December 2017 between 09:35 to 11:45 hours, and ground water sample collected on 22nd December 2017 between at 08:10 to 09:35 hours.

Samples were then sent to Maldives Water and Sewerage Company's (MWSC) water quality assurance laboratory for testing.

4.2. Noise

Noise level around project site was measured using a smart phone via the science journal application. Sound was measured for 1 minute at the desired location and the maximum, minimum and average was recorded (Refer to Figure 2 and Table 5 for sampling locations and respective GPS coordinates).

4.3. Terrestrial Vegetation

As there was no dense vegetation present at the proposed pump station locations and there was no trees to be cleared at these locations, the vegetation on the houses and road was recorded by visual inspection.

4.4. Current measurement

A drogue constructed from plastic plates joined together by bolts to make four fins (Figure 1) to catch the currents, were used to measure currents. The drogue was deployed for five minutes, the start and end location of the drogue was geo-referenced using a hand-held GPS (Figure 1). The distance travelled was later calculated and the speed of currents determined. Drogue runs were done at 3 different locations (the locations of current measurement are shown on Figure 2 and respective GPS coordinates on Table 5.)

Figure 1. Drogue deployed at sea for current measurement (left) and hand-held GPS used to geo-reference sampling locations

4.5. Benthic Substrate Analysis

CPCe software was used to assess the benthic substrate, which is one of the most widely used tools for marine assessments. 20 pictures were taken at each respective site from which 10 photos are chosen for analysis (Refer to Figure 2 and Table 5 for sampling locations and respective GPS coordinates). CPCe used 25 points on each photograph to point out the substrate found at each point. The software calculates the percentage of each substrate for the 10 photographs. The method is repeated to take 3 transects at different locations.

4.6. Fish Census

The frequency of fish (indicator species of fish watch Maldives developed by MRC) encountered while swimming for 5 minutes in a straight line on the reef were tallied to get the total frequency. Fish census were carried out at the 2 locations where benthic substrate analysis were undertaken (Refer to Figure 2 and Table 5 for sampling locations and respective GPS coordinates).

4.7. Geo-Referencing

All the sampling locations were geo-referenced using a hand-held GPS. The coordinates for all sampling locations is shown in Table 5 and Figure 2 below.

Table 5: Geo-coordinates for all sampling locations at Ukulhas

Code	**Type**	**Location**	**GPS Coordinates**	
			Longitude	**Latitude**
PS1	Groundwater sample, noise and vegetation observation	Main road	4°12'47.53154"N	72°51'57.891 04"E
PS2	Groundwater sample, noise	Main road	4°12'52.25917"N	72°51'53.736 34"E

	and vegetation observation			
PS3	Groundwater sample, noise and vegetation observation	Main road	4°12'56.74443"N	72°51'49.86233"E
PS4	Groundwater sample, noise and vegetation observation	Main road	4°13'2.34455"N	72°51'45.02817"E
Outfall	Outfall location	South side of the Harbour	4°12'55.56"N	72°51'57.36"E
Outfall Alternative 1	Outfall location	North side of the Harbour	4°13'4.91"N	72°51'45.61"E
Outfall Alternative 2	Outfall location	Southern Beach	4°12'42.39"N	72°52'2.06"E
Finivairoalhi (OF)	Groundwater samples	Finivairoalhi	4°12'53.03302"N	72°51'55.25139"E
Dive Center (A1)	Groundwater samples	Dive Center	4°13'2.59361"N	72°51'45.80873"E
Marine Survey (M1)	Water samples, Coral transect and Water samples	Northeast reef edge	4°13'13.47712"N	72°51'49.86412"E
Marine Survey (M2)	Water samples, Coral transect and Water samples	Eastern edge of the reef	4°12'55.70455"N	72°52'0.00233"E
Marine Survey (M3)	Water samples, Coral transect and Water samples	Southern edge of the reef	4°12'38.18893"N	72°52'3.15030"E
Old Mosque	Historical Landmark	Near the Center of the island	4°12'53.31383"N	72°51'50.43184"E
Banyan Tree (BT1)	Historical Landmark	Near the Western vegetation boundary	4°12'51.23157"N	72°51'50.11204"E
Banyan Tree (BT2)	Historical Landmark	Near the Western vegetation boundary	4°12'49.55319"N	72°51'51.80731"E
Banyan Tree (BT3)	Historical Landmark	Near the Western vegetation boundary	4°12'48.59926"N	72°51'52.57376"E
Banyan Tree (BT4)	Historical Landmark	Near the Western vegetation boundary	4°12'47.17088"N	72°51'53.86875"E

Figure 2: Sampling locations locations at Ukulhas

5. EXISTING ENVIRONMENT

5.1. The Maldivian setting

Maldives, officially known as the Republic of Maldives and sometimes referred to as the Maldive Islands, is an island nation (Zahid, 2011) consisting of nearly 1192 islands on a double chain of 26 natural atolls (administratively divided into 20 atolls), 80-120 km wide, in the Laccadive Sea in the Indian Ocean (Ministry of Environment & Construction [MEC], 2004). Elevating less than 3 meters above mean sea level, with 80% of land area less than 1 m, Maldives is the flattest country in the world. The total area is about 107,500 km^2 of which roughly 300 km^2 of landmass (Zahid, 2011), with a population of about 338, 434 (as per September 2014 census) (UNFPA, 2016) spread over 194 inhabited islands (Department of National Planning [DNP], 2010). Stretching 860 km from latitude 7°6”35”N, crosses the Equator to 0°42”24”S, and lies between 72°32”19”E and 73°46”13”E longitude (Zahid, 2011). These coral Atolls are located on the 1600 km long Laccadives-Chagos submarine ridge extending into the central Indian Ocean from the SW coast of the Indian sub-continent (MEC, 2004).

The Atolls vary greatly in shape and size as well as the characteristics of the Atolls, reefs and reef islands vary considerably from north to south. The northern atolls are broad banks, discontinuously fringed by reefs with small reef islands and with numerous patch reefs and faros in the Lagoon whereas in the southern atolls, faros and patch reef are rarer in the Lagoon, continuity of the atoll rim is greater and a larger proportion of the perimeter of the Atolls is occupied by islands. The islands also differ depending on location, form and topography. The islands vary in size from 0.5 km^2 to around 5.0 km^2 and in shape from small sandbanks with sparse vegetation to elongated strip islands. Many have storm ridges at the seaward edges and a few are characterized by swampy depressions in the center (MEC, 2004).

Located on the equator, Maldives experiences a warm, humid tropical climate or a monsoonal climate with two distinct seasons known as the northeast monsoon (dry season) from January to March and southwest monsoon (wet season) from May to November (MEC, 2004). The southwest season brings in torrential rain (Zahid, 2011) and rainfall varies from north to south along the atoll chain, with a drier north and wetter south (MEC 2004). Rainfall varied from 1,407 mm to 2,707 mm interannually over the last 30 years. May, August, September and December are the wettest months and January to April the driest (MEC, 2004).

The annual and seasonal temperatures vary very little with a mean annual temperature of 28°C (MEC, 2004); however, the diurnal temperature fluctuates from 31°C during the day to 23°C at night. This is associated with the small size of the islands and the tempering of the hot days by cooling sea breezes surrounding the islands (Zahid, 2011). The highest and lowest temperatures on record are 36.8°C on May 1991 and 17.2°C on April 1978 respectively (MEC, 2004).

Ocean currents are driven by the monsoon winds with the westerly flowing currents dominating the northeast monsoon and easterly currents dominating the southwest monsoon. Changes in current flow patterns occur in April and December corresponding to the transition periods of the southwest and northeast monsoons respectively. Currents near the shoreline slightly differ from oceanic currents depending on the location, orientation and morphology of the reefs and underwater topography (Zahid, 2011).

Sea surface temperature (SST) is reasonably constant throughout the year and ranges between 28 to 29 °C. Mean monthly SST rises from December/January to April/May. However, May 1998 experienced a mean monthly SST of 30.3 °C which is expected to occur every 20 years. Furthermore, temperature drops rapidly to below 20 °C at a depth of 90-100 m (MEC, 2004).

5.2. Climatic conditions

The Bureau of Meteorology of Maldives has compiled a range of climate variables since 1975 from five different meteorological stations located across the Maldives. Climate variables including temperature, rainfall, and wind were analyzed for the nearest meteorological station to Ukulhas at Hulhule'.

5.2.1. Temperature

Analysis of temperature data shows that the variation in temperature throughout the year is very minimal, however, daily temperature ranges from 32°C during the day to 23 °C at night. Looking at monthly variation in temperature, the highest temperature was recorded for the month of April with a temperature of 31.7 °C. With regards to the mean minimum temperature, the lowest temperature at Hulhule, 25.3 °C, was recorded for November (Figure 3).

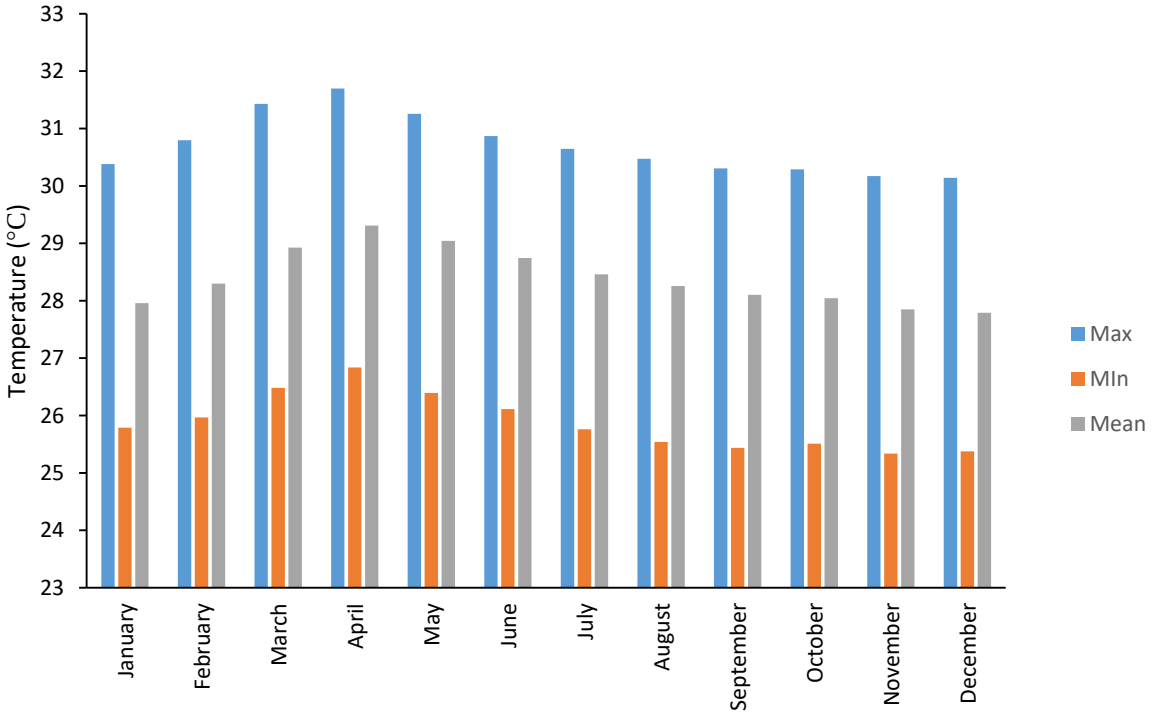

Figure 3. Mean, minimum and maximum monthly temperatures (°C) for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

5.2.2. Rainfall

The rainfall pattern at Hulhule region and for the rest of the Maldives is driven by the monsoonal cycles. Rainfall data for the period between January 2006 and December 2016 from the meteorological station in Hulhule' were used to study the rainfall patterns at Hulhule.

The average annual total rainfall for Hulhule was found to be 1993.1 mm and the heaviest rainfall recorded over the 40 year period was 2711.2 mm in 2006. Monthly mean rainfall shows that the driest months are January to April and the wettest months are May, September to November. (Figure 4).

Generic analysis of vulnerability of Central atolls to flooding is given under hazard vulnerability.

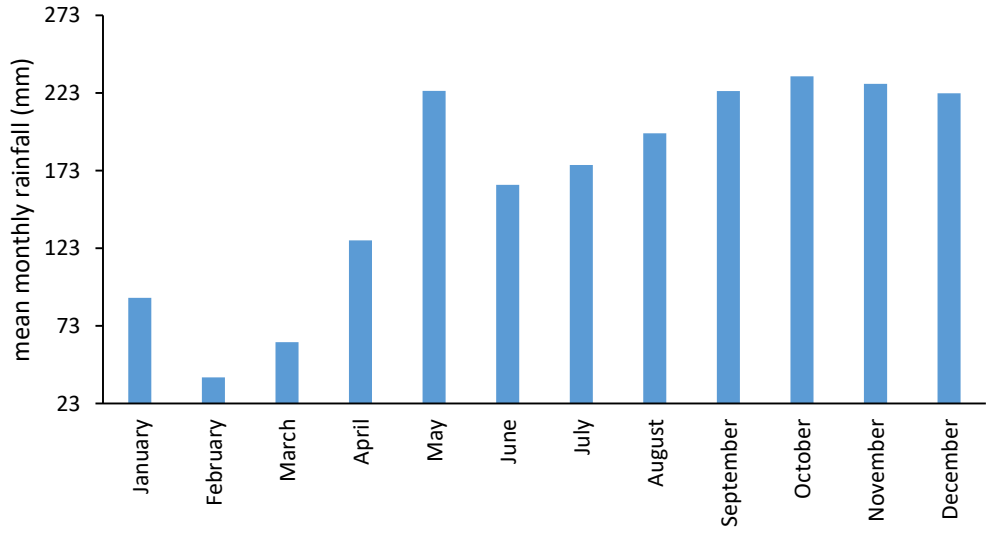

Figure 4. Mean monthly rainfall (mm) for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

5.2.3. Wind

Climate in the Maldives is dominated by the Indian monsoon climate South West (SW) monsoon and North East (NE) monsoon. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia.

The period of the year during which prevailing winds are from south to westerly direction is known as the SW monsoon (Kench, P.S., Parnell, K.E. & Brander, R.W., 2009). The period during which prevailing winds are from north-easterly directions is known as NE monsoon. 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* is from October to November (Table 6). SW monsoon is generally rough and wetter than the NE monsoon. Storms and gales are infrequent in this part of the globe and cyclones do not reach as far south as the Maldivian archipelago.

Table 6: The four seasons in the Maldives. Source DHI (1999).

Season	Month
NE-Monsoon	December
	January
	February
Transition Period 1	March
	April
SW-Monsoon	May
	June

	July
	August
	September
Transition Period 2	October
	November

By analyzing the available wind data from the meteorological station a windrose was drawn (Figure 5-12).

Looking at the mean wind speeds and direction for Hulhule', it was observed that the strongest winds occur from WSW, W, WNW directions (in the SW monsoon) and E, ENE, NE direction (in the NW monsoon). Winds from the South and SE as well as north were less prevalent and with comparatively low speeds. Majority of the times, winds occur at a speed of 4 to 10 kn which is generally known as light to moderate breeze. Wind speeds above 10 kn occurred from the Western quadrant (W, WNW, NW).

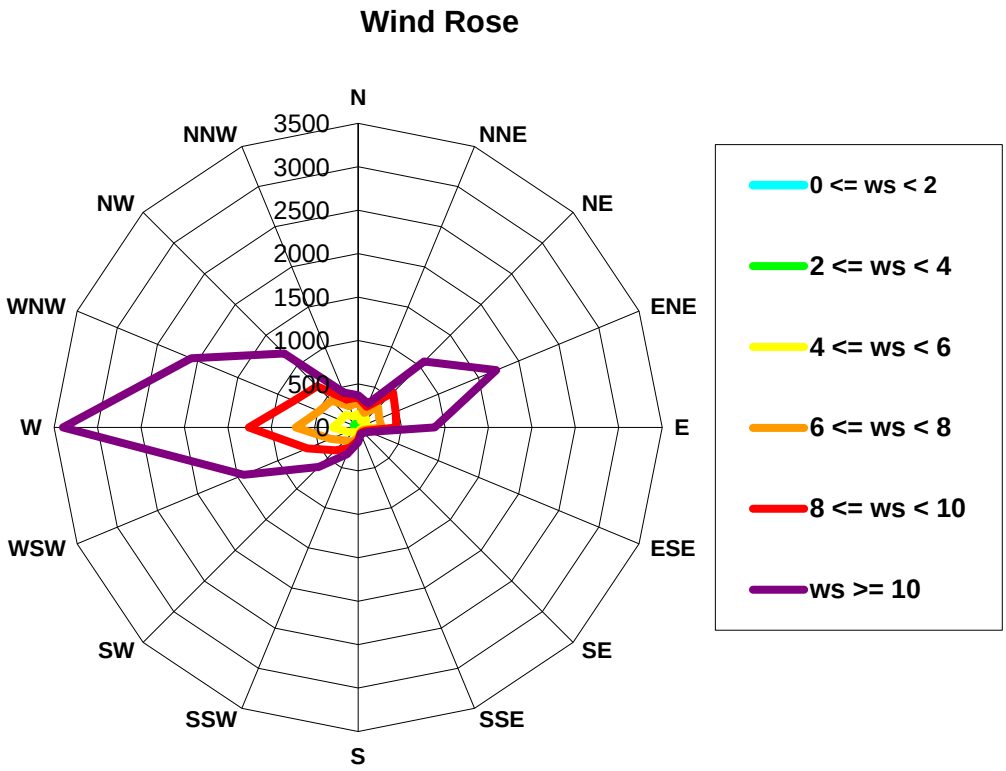

Figure 5. Mean wind speeds for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

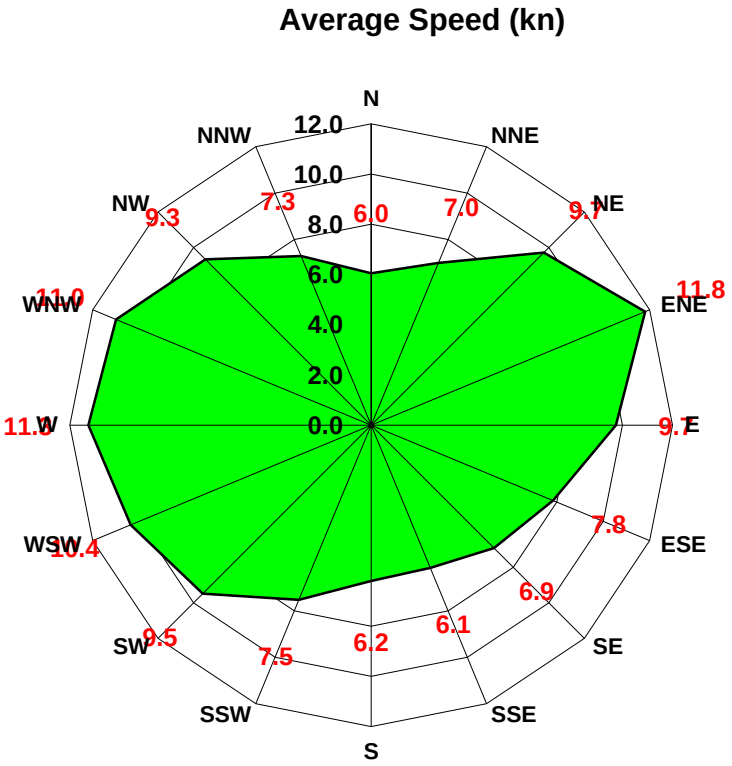

Figure 6: Mean average wind speeds for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

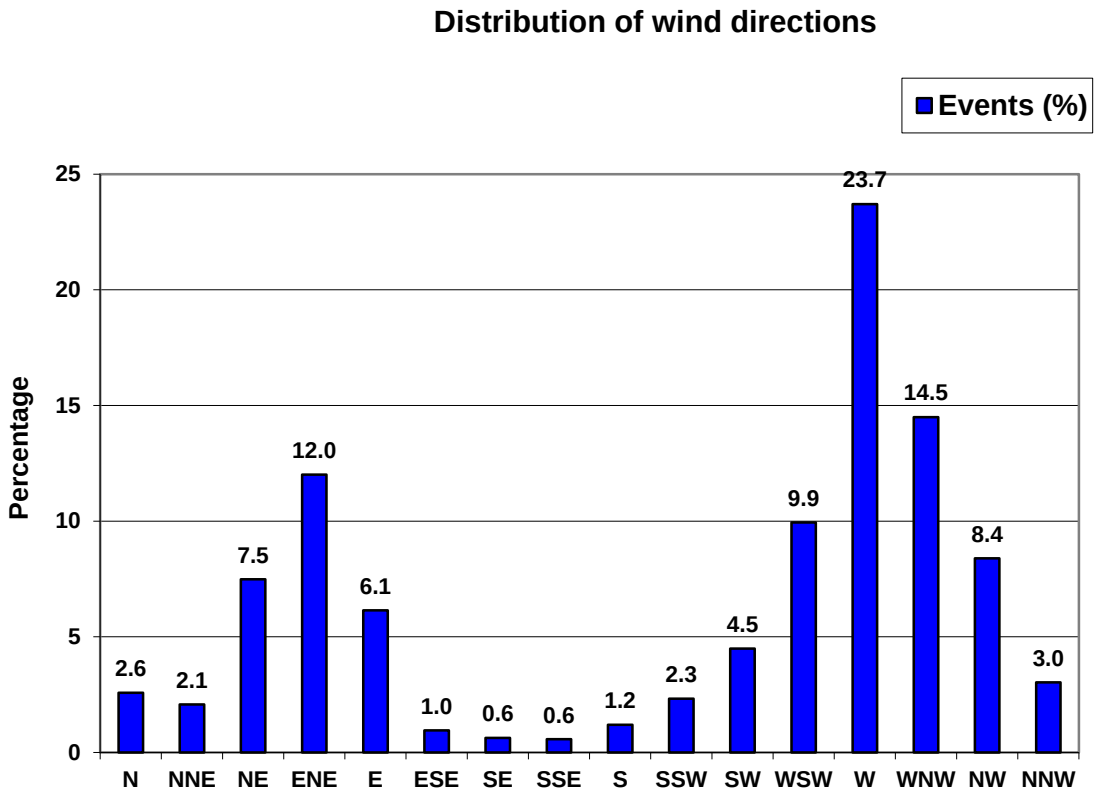

Figure 7: Figure 10: Distribution of mean wind speeds directions for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

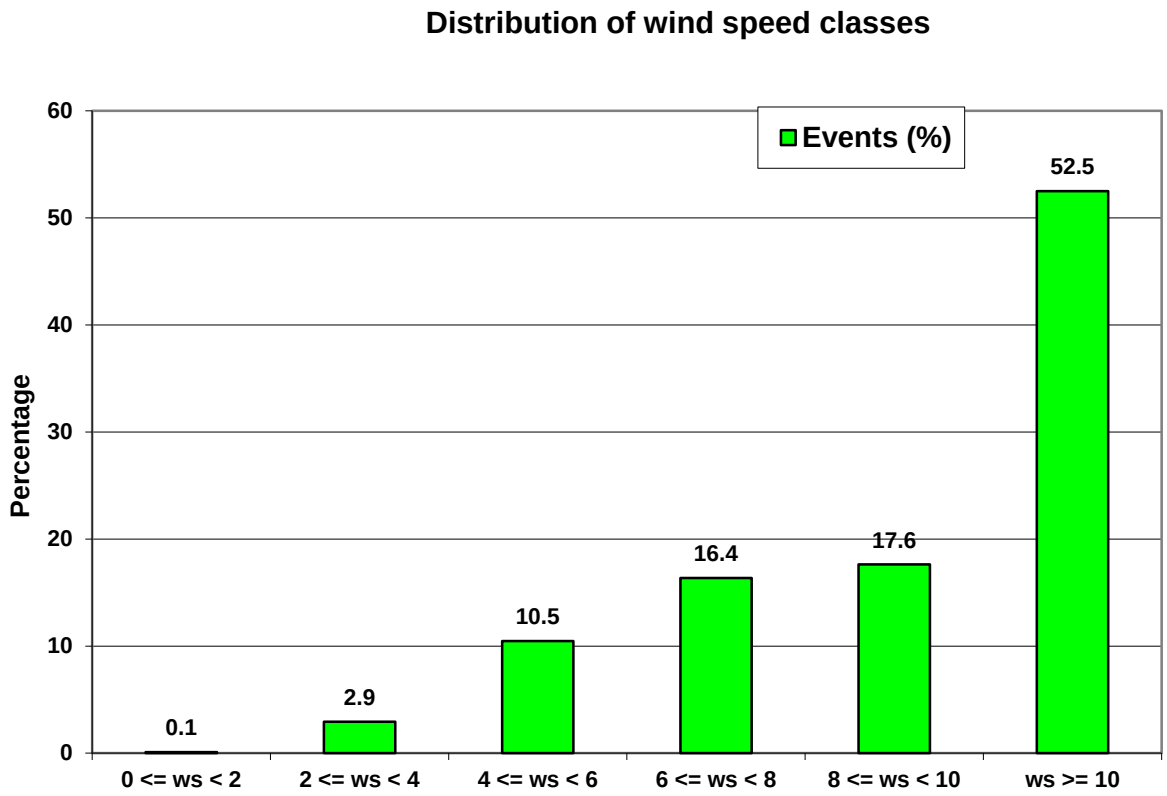

Figure 8: Distribution of mean wind speeds classes for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

With respect to maximum wind speeds, visual inspection of the wind rose plot coincides with that of the mean wind speeds. Approximately 3% of the times, wind speeds had gone as high as > 40 kn at this region. The highest recorded maximum wind speed for the region was 62 kn during the data collection period. The most common maximum wind speed is between 10-20 kn.

Wind rose plots for both maximum and mean wind speeds show that winds from the West are dominant (21.3 % of the times).

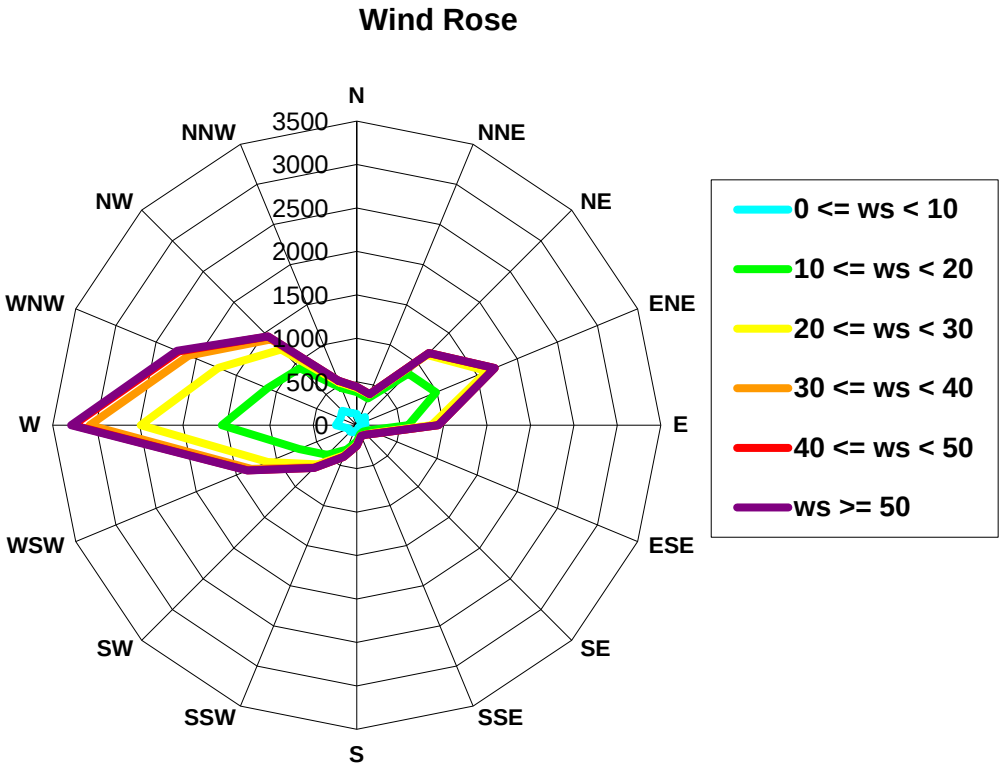

Figure 9: Maximum wind speeds for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

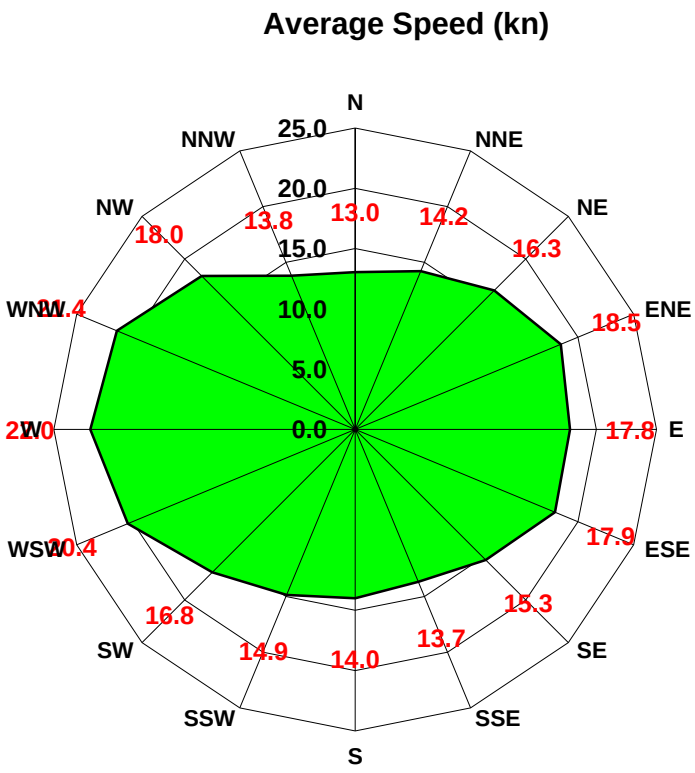

Figure 10: Maximum average wind speeds for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

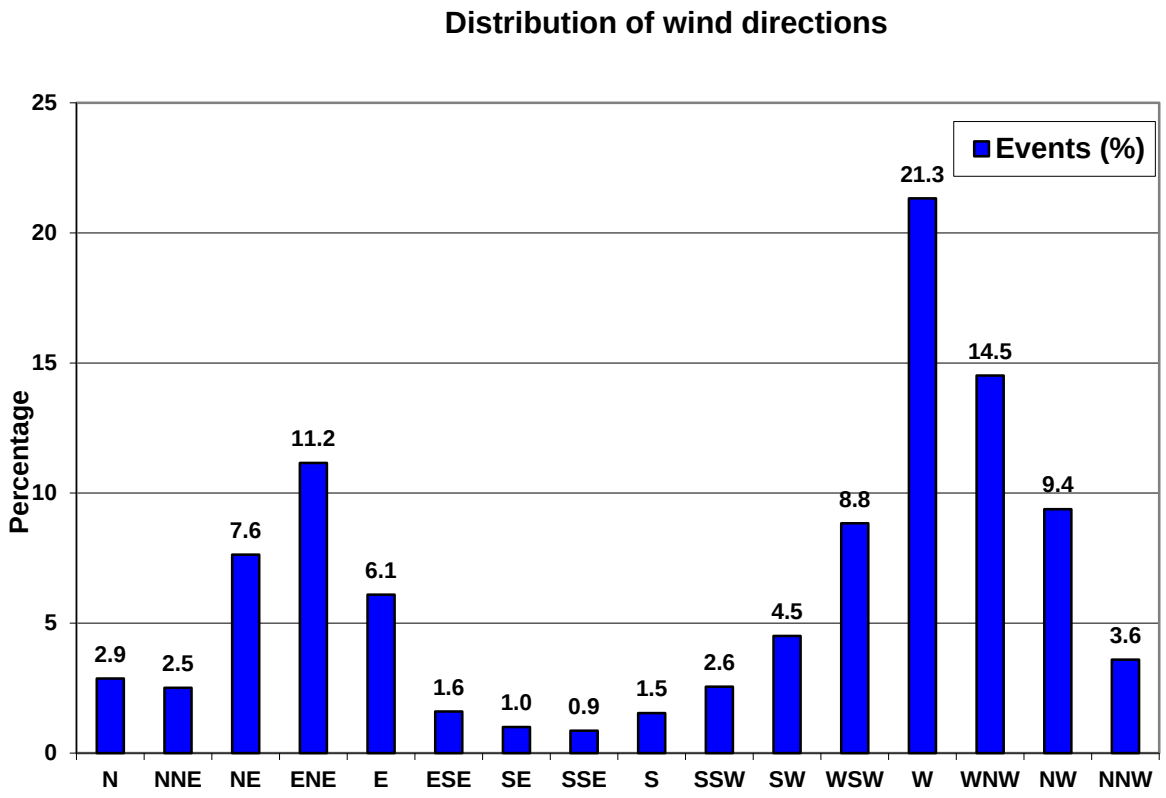

Figure 11: Distribution of maximum wind speeds directions for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

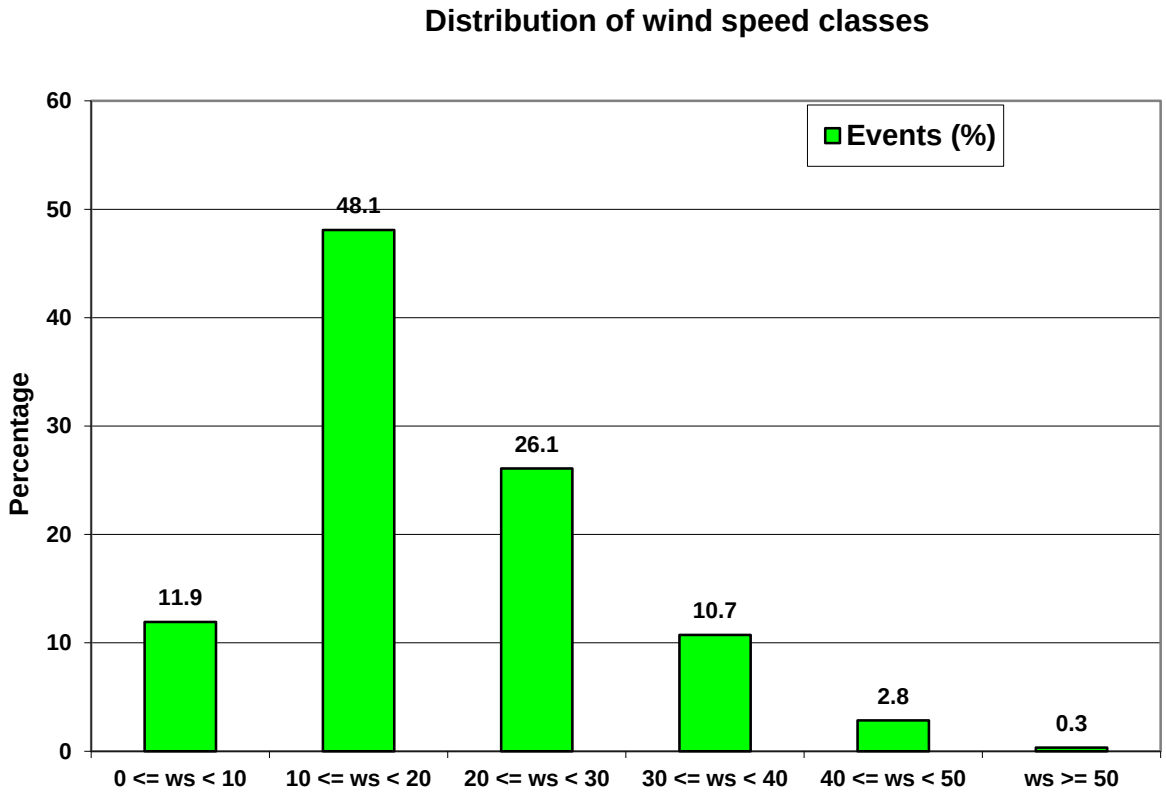

Figure 12: Distribution of maximum wind speeds classes for Hulhule from 1975 to 2016 (Data obtained from the Bureau of Meteorology, Maldives)

5.2.1. Waves

Hydrodynamics features in Maldives have been very poorly studied. Young (1999) shows wave climate data for a ten-year period for each world regional zone. Wave height was measured by satellite (Radar Altimeter), whereas a global wave model was used to precise wave directions. It indicates that the dominant swell approaches from southerly directions (Figure 13). On a seasonal basis, swell is from the south-southwest from April to November (SW monsoon) with a peak significant wave height (Hs) of 1.8m in June, and from the south to southeast directions from November to March (NE monsoon) with minimum Hs of 0.75m in March.

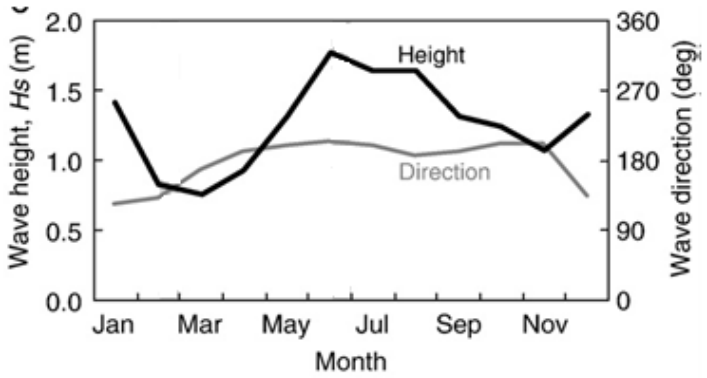

Figure 13: Ten year mean monthly wave height and direction for the central Maldives. Source: Young (1999).

The work of Contestabile, Lauro, Galli, Corselli, & Vicinanza in a report published in 2017 regarding wave energy in the Maldives showed that Young's findings were accurate. They showed that the wave energy in the South (average significant wave height 1.5 m) is higher and diminishing towards the Northern islands (average significant wave height 1.3 m). Furthermore there is a change in wave energy in the Eastern and Western side of the Maldives which are much more evident for extreme events. The maximum significant wave height in the West is 3.59 m and 3.05 in the East. The main reason for these difference in wave energy is because the majority of the swell waves approach the Maldives from the S-SW direction.

In addition to the swell waves Maldivian islands are impacted by local wind generated waves. Wind waves are generated due to monsoonal winds in the Maldives. Therefore the strength and direction of wind waves is dictated by the strength and direction of the winds. Since the monsoonal winds are strongest in the SW monsoon between April-July, it is during this period the strongest wind waves would be generated (CDE Consulting, 2017).

5.2.2. Currents

In the Indian Ocean the Maldivian archipelago has relatively stronger currents (Riyaz, 2016). Current speeds in the channels between the atolls can vary between 0.51-0.77 m/s while the currents in the channels within the atolls are stronger and the E-W oriented channels having the strongest currents between 1.5-2.6 m/s (Rober Gordon Univeristy, 2011).

In the Maldives currents are predominantly caused by the complex interaction of oceanic currents, tidal currents and local wind induced currents. The major current that flows through the Maldives is caused by the monsoonal winds. During the SW monsoon the currents flow from W-E and during the NE monsoon from E-W (Rober Gordon Univeristy, 2011). Other factors which influence the currents are waves, local bathymetry and topography. The resultant currents at a specific location in the Maldives is determined by the complex interaction among the aforementioned factors.

Tidal currents are caused by the horizontal movement of water which is caused by the regular rise and fall of the sea level due to tides (Riyaz, 2016). The strength of the tidal currents are determined by the tidal ranges and follow the same periodicities as the tide meaning the tidal currents would be weaker during low tide and vice versa. In general the tidal currents flow eastward during flood and westward during ebb.

5.2.3. Tides

The tides in the Maldives are semi-diurnal with diurnal inequalities meaning there are two high and two lows everyday with different heights (Rober Gordon Univeristy, 2011). In addition to the daily variation in tides, there are variations in tides due to the lunar cycle which are caused by the varying gravitation pull of the moon due to the position of the moon. When the moon and the sun is aligned in a straight line the gravitational pull is greatest and this causes a spring tide. When the moon and the sun are aligned at 90^0 their combined gravitational pull is at the minimum and this causes a neap tide.

With reference to mean sea level (MSL) the mean higher high water is +0.34 m and mean lower low water is -0.36 m (Riyaz, 2016). However it has been reported that the highest astronomical tide was at +0.64 and lowest astronomical tide at -0.56.

Tide Level	*Referred to MSL*
highest astronomical tide (HAT)	+0.64
mean higher high water (MHHW)	+0.34
mean lower high water (MLHW)	+0.14
mean sea level (MSL)	0.00
mean higher low water (MHLW)	-0.16
mean lower low water (MHLW)	-0.36
lowest astronomical tide (LAT)	-0.56

Figure 14: mean tidal variations in the Maldives (Riyaz, 2016).

5.3. General setting of AA.Ukulhas

Ukulhas is located on the North Eastern tip of Alif Alif atoll. The island is elongated in shape measuring approximately 1.04 Km in lenghth and 301 m in width at the widest. There are no other islands on the same reef flat of Ukulhas (Figure 15), the reef flat extends furthest at the Northwestern side of the island. The nearest inhabited Island is Bodufolhudhoo which is approximately 10.68 Km West of Ukulhas.

Figure 15. Location of Ukulhas in Alif Alif Atoll

5.4. Environmentally sensitive areas

There are no environmentally sensitive or protected area within a 5 Km raduis of Ukulhas except for the location just south of the harbour of Ukulhas where locals claim it to be a good point (not declared senstive by EPA) to spot hammerhead sharks. The point has the same coordinates as M2. The *Muranga gas* enlisted in the protected trees list have been cut down and removed from the backyard of *Athamaa* house.

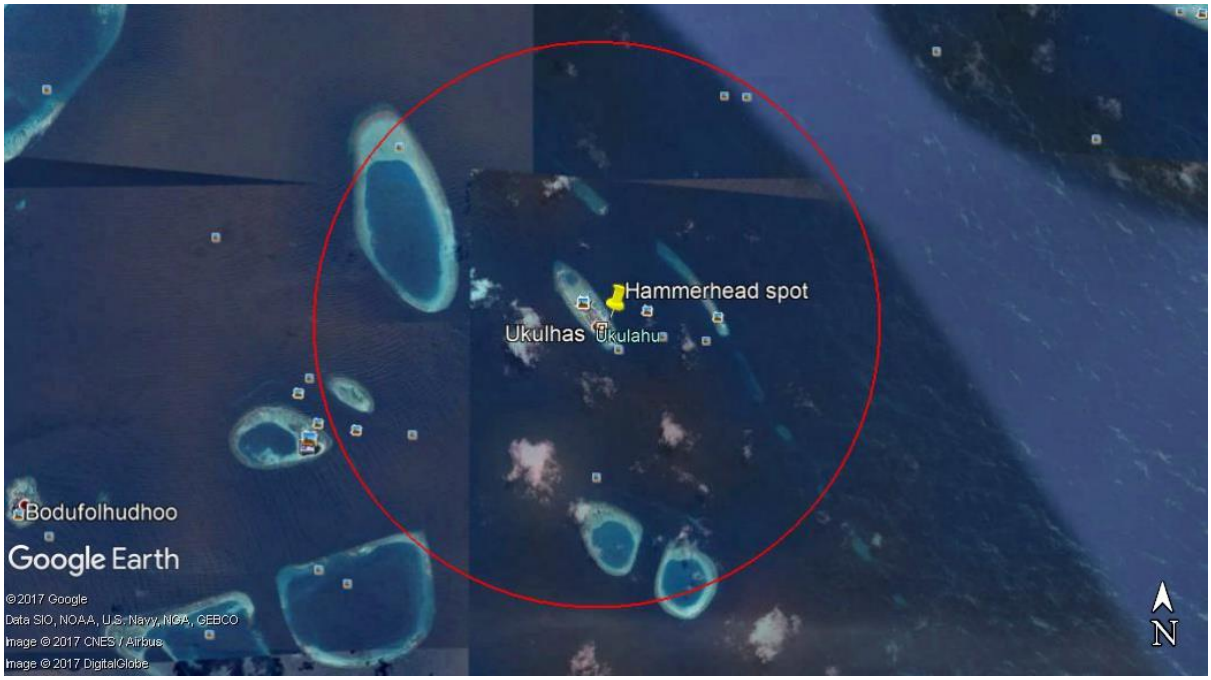

Figure 16: Environmentally sensitive sites around a 5 Km radius of Ukulhas

Figure 17: Shows the location where hammerhead are occasionally sited.

5.5. Groundwater

5.5.1. Groundwater table

The water table at most of the Maldivian islands are just below 90 cm as the islands are very low laying. The water table at *Ukulhas* was just below this mean. The results show that there were locations that were very shallow and comparatively deep. Water table was deepest at Dive Center (85 cm) and lowest at Finihiyaa manzil (53 cm).

Table 7: variations in depth of water table in Ukulhas

Location	**Depth / cm**
PS1 (Ostrov)	89
PS2 (finihiyaa manzil)	47
PS3 (Kanmatheege)	62
PS4 (endherimaage)	76
Finivairoalhi (OF)	99
Dive Center (A1)	110

5.5.2. Groundwater quality

According to the locals, the groundwater of the Ukulhas is poor in all areas of the island with bad smell. The locals believe that the groundwater quality started deteriorating since 10 years ago mostly attributed to the septic tank system in households. With the increase in guest houses in recent years the water demand rose which might had contributed mostly to the deterioration of the groundwater.

Groundwater test results were compared with the EPA standards for the parameters with a specified guideline value as follows (MWSC laboratory test results is attached in Appendix H of this report):-

Table 8: ground water quality optimal ranges

Location	**Optimal Range**	**Reference**
pH	6.5-8.5	EPA
Conductivity (µS/cm)	<1500	EPA
TDS (mg/L)	<1000	EPA
TSS (mg/L)	NA	EPA
Turbidity (NTU)	<5	EPA
BOD (mg/L)	NA	EPA

Salinity (%)	NA	EPA
Temperature(^{0}C)	NA	EPA
Nitrate (mg/L)	<50 mg/l	EPA
Nitrogen Ammonia (mg/L)	<1.5 mg/l	EPA
Sulphate (mg/L)	<250mg/l	EPA
Phosphate (mg/L)	NA	EPA
Total Petroleum Hydrocarbon(mg/L)	NA	EPA

Groundwater test results from MWSC water quality assurance laboratory is attached in Appendix H of this report.

All tested parameters near the proposed pump stations and outfall locations in Ukulhas were within the optimal range. The proposed outfall location showed the highest conductivity (1195). PS3 showed the highest pH (7.53), while it was observed that the alternate location (A1) had highest BOD (6). Although there are no optimal ranges set for BOD by the EPA, groundwater having a BOD greater than 5mg/L is generally attributed to contaminated water, at two locations the BOD was higher than 5 mg/L indicated groundwater contamination.

Table 9: Groundwater quality test results (parameters exceeding EPA standards are highlighted in red)

Parameter	**Locations**					
	PS1	**PS2**	**PS3**	**PS4**	**OF1**	**A1**
Conductivity (µS/cm)	944	247	1157	737	1195	606
pH	7.65	6.51	7.20	7.41	7.20	7.53
Salinity (%)	0.46	0.12	0.57	0.36	0.59	0.29
Temperature(^{0}C)	23.0	21.5	21.2	22.2	21.9	21.6
BOD (mg/L)	3	2	6	4	5	3

5.6. Marine water quality

Marine water quality was compared with a set of internationally agreed optimal ranges as follows;

Table 10: marine water quality optimal ranges

Location	Optimal Range	Reference
pH	8.0-8.3 *Levels below 7.4 pH cause stress	EPA
Conductivity (µS/cm)	NA	-
TDS (mg/L)	NA	-
Nitrate (mg/L)	<5 mg l^{-1} NO_3^-N	UNESCO/WHO/UNEP, 1996
Turbidity (NTU)	3-5 NTU >5 NTU causes stress	Cooper *et al.* 2008
Nitrogen Ammonia (mg/L)	Max. 2-3 mg l^{-1} N	UNESCO/WHO/UNEP, 1996
Sulphate (mg/L)	2 mg l^{-1} and 80 mg l^{-1}	UNESCO/WHO/UNEP, 1996
Phosphate (mg/L)	0.005 - 0.020 mg l^{-1} PO_4^-P	UNESCO/WHO/UNEP, 1996
Biological Oxygen Demand (mg/L)	< 2 mg l^{-1} O_3	UNESCO/WHO/UNEP, 1996

Marine water test results from MWSC water quality assurance laboratory is attached in Appendix H of this report.

Among the tested parameters, most were within the optimal ranges except for Nitrate, Phosphate and Sulphate. The optimal range for Nitrates is between 2-3mg/L however in all the tested samples Nitrates was above 4.7mg/L. Phosphate concentration at site M1 and M2 were at 0.07. Phosphate concentration was highest at M3 with 0.17mg/L. The concentration of Sulphates were very high with all the tested samples with concentration above 2400mg/L.

High phosphate and Sulphate concentration may arise due to disturbance of seabed during reclamation which causes sediments to be suspended in the water column and bacteria in the water reducing the compounds in the sediments to phosphates and sulphates. High Nitrate concentration maybe due to runoff from the island which is high in dissolved organic matter from the septic tanks and fertilizers used in agricultural activities.

Table 11: marine water quality test results (parameters exceeding optimal ranges are highlighted in red)

Location	**M1**	**M2**	**M3**
pH	8.13	8.15	8.16
Salinity(%)	33.61	33.81	33.76
Turbidity (NTU)	0.305	0.306	0.273
Nitrate (mg/L)	**4.7**	**4.9**	**5.2**
Sulphate(mg/L)	**2500**	**2550**	**2450**
Phosphate (mg/L)	**0.07**	**0.07**	**0.17**
Biological Oxygen Demand (BOD)	1	1	1

5.7. Terrestrial vegetation

11 different types of vegetation species were found on Ukulhas near the proposed pump station (PS) areas, the scientific name and Dhivehi names of these are listed in Table 13. The vegetation is not in any area except for PS1 area. The results of the vegetation present near the PS are shown in tables 12-13.

Table 12: types of vegetation found near PS

Species
PS1
Cocos nucifera
Pandanus tectorus
Morinder citrifolia
Ochrosia borbonica
Panicum maximum
PS2
Artocarpus altilis
Eugenia javanica
Musa paradisiaca sapientum
PS3
Mangifera indica
Eugenia javanica
Cocos nucifera
PS4
Piper betle
Moringa oleifera
Musa paradisiaca sapientum
Eugenia javanica

Dhivehi and scientific names for vegetation

Table 13 shows the different species of trees which were encountered during the field surveys near the pump station locations.

Table 13: scientific names and dhivehi name for vegetation species found on Ukulhas

Dhivehi Name	**Scientific Name**
Ruh	*Cocos nucifera*
Kashikeyo	*Pandanus tectorus*
Ahi	*Morinder citrifolia*
Dhunburi	*Ochrosia borbonica*
Onuhui	*Panicum maximum*
Banbukeyo	*Artocarpus altilis*
Janburoalu	*Eugenia javanica*
Faikeyo	*Musa paradisiaca sapientum*
An'bu	*Mangifera indica*
Bilei	*Piper betle*
Muranga	*Moringa oleifera*

Figure 18: Vegetation found near the pump stations, Cocos nucifera (A), Musa paradisiaca sapientum (B) and Panicum maximum(C).

7.5.1.1 Land clearance

No vegetation is required to clear under this project.

5.8. Marine environment

During the snorkeling session, it was observed that the Ukulhas reef had low coral cover (13.60%) at all the examined 3 sites. The diversity of coral substrate categories were also very limited. The only observed categories were *Acropora digitate, Coral submassive* and *Coral massive*. During the snorkeling period the currents at the southern side of the island were very strong compared to the currents observed near the harbour. As we went further away from the harbour the current got stronger significantly. No large fishes or schools of fish were encountered.

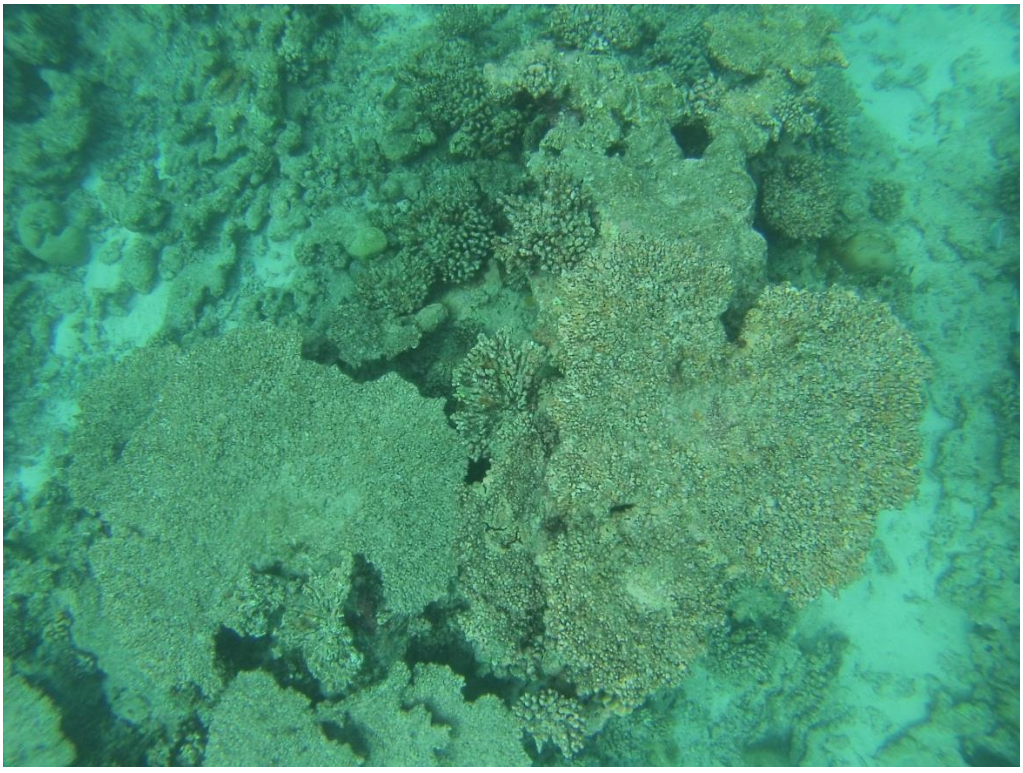

Figure 19: Recently dead Acropora tabular corals

5.8.1. Benthic substrate

Major coral categories

The results show that the total live coral cover of the island reef is very poor (13.60%), the dominant substrate is rock (59.73%) followed by rubble (26.13%). Live coral cover is highest in Transect 2 (34.40%) and transect 1 (4.80%), and lowest coral cover is at Transect 3 (1.60%). The detailed percentages of coral covers in the transects are shown in Table 14 and Figure 20 and Figure 21 below.

Table 14: major coral categories

MAJOR CATEGORY (% of transect)	T1	T2	T3	Mean	CI 95%+	CI 95%-
CORAL (HC)	4.80	34.40	1.60	13.60	24.04	3.16
SOFT CORAL (SC)	0.00	0.00	0.00	0.00	0.00	0.00
OTHERS (OT)	0.00	0.00	0.00	0.00	0.00	0.00
ROCK (RC)	65.20	43.20	70.80	59.73	68.16	51.31
RUBBLE (RB)	28.40	22.40	27.60	26.13	28.01	24.25
SAND (SD)	0.00	0.00	0.00	0.00	0.00	0.00
SILT (SI)	1.60	0.00	0.00	0.53	1.07	0.00

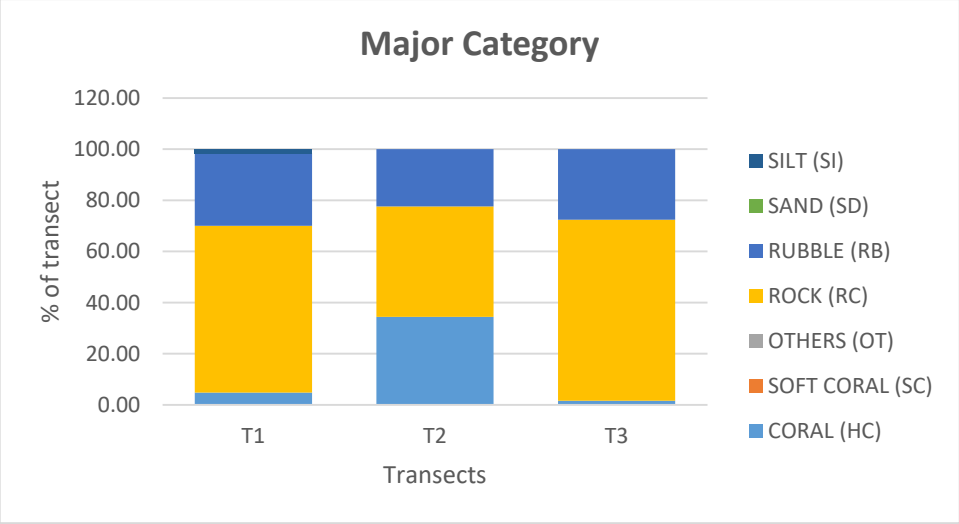

Figure 20: Major coral categories of transects

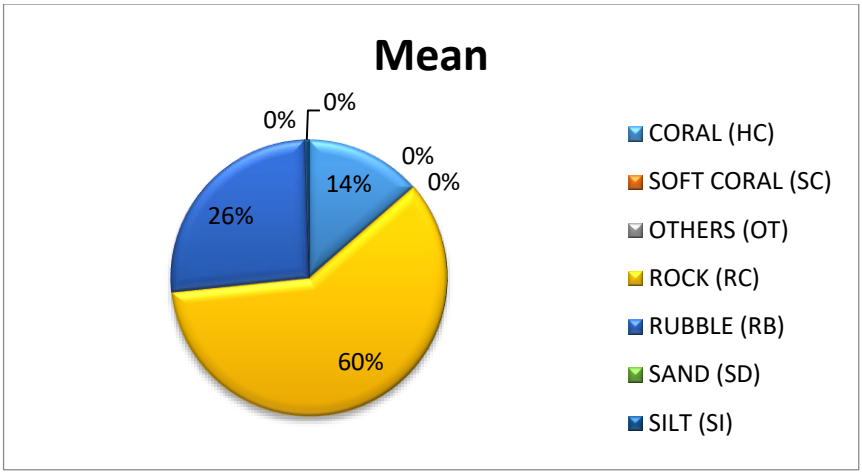

Figure 21: Mean major coral category of all transects

Sub categories

Out of the 14 coral categories, 3 categories were encountered on the reef of *Ukulhas*, which shows that there is poor diversity of corals.

The most abundant category of coral was *Coral Massive* at 12.93%. This was followed by *Coral Submassive* and *Acropora Digitates* with 0.53% and 0.13% respectively. Details are shown in Table 15 and Figure 22 below.

Table 15. Coral subcategories

SUBCATEGORIES (% of transect)	**T1**	**T2**	**T3**	**Mean**	**CI 95%+**	**CI 95%-**
Acropora Branching (ACB)	0.00	0.00	0.00	0.00	0.00	0.00
Acropora Digitate (ACD)	0.40	0.00	0.00	0.13	0.27	0.00
Acropora Submassive (ACS)	0.00	0.00	0.00	0.00	0.00	0.00
Acropora Tabular (ACT)	0.00	0.00	0.00	0.00	0.00	0.00
Acropora encrusting (ACE)	0.00	0.00	0.00	0.00	0.00	0.00
Coral Branching (CB)	0.00	0.00	0.00	0.00	0.00	0.00
Coral Foliose (CF)	0.00	0.00	0.00	0.00	0.00	0.00
Coral Massive (CM)	3.60	33.60	1.60	12.93	23.28	2.58
Coral Mushroom (CMR)	0.00	0.00	0.00	0.00	0.00	0.00
Coral Submassive (CS)	0.80	0.80	0.00	0.53	0.80	0.27
Coral encrusting (CE)	0.00	0.00	0.00	0.00	0.00	0.00
Heliopora (CHL)	0.00	0.00	0.00	0.00	0.00	0.00
Millepora (CME)	0.00	0.00	0.00	0.00	0.00	0.00
Soft Coral (SC)	0.00	0.00	0.00	0.00	0.00	0.00
Zoanthid (ZO)	0.00	0.00	0.00	0.00	0.00	0.00
Other (OT)	0.00	0.00	0.00	0.00	0.00	0.00
Sponges (SP)	0.00	0.00	0.00	0.00	0.00	0.00
Coralline Algae (CA)	0.00	0.00	0.00	0.00	0.00	0.00
Dead coral with Algae (DCA)	0.00	0.00	0.00	0.00	0.00	0.00
Rock (RCK)	42.40	25.20	60.00	42.53	52.58	32.49
Turf Algae (TA)	22.80	18.00	10.80	17.20	20.69	13.71
Rubble (RB)	28.40	22.40	27.60	26.13	28.01	24.25
Sand (S)	0.00	0.00	0.00	0.00	0.00	0.00
Silt (SL)	1.60	0.00	0.00	0.53	1.07	0.00

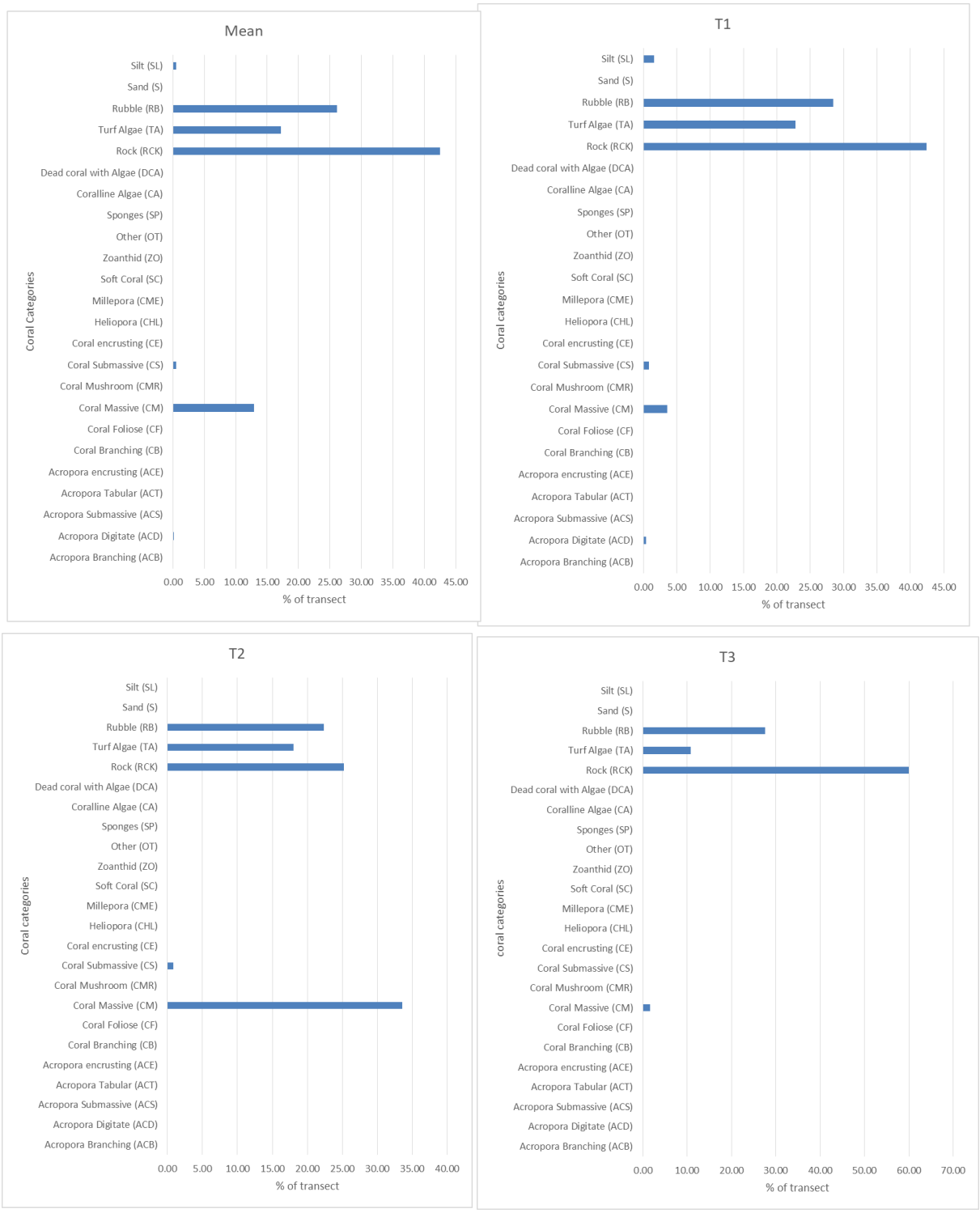

Figure 22: Subcategories of each transect and their mean.

5.8.2. Fish census

Out of the 41 genus of fish from the target fish, only 5 genus was found at the eastern and southern reef of the island. Therefore, the diversity of the fish is very poor. The following figure and table shows the relative abundance of the species found. The highest abundance was displayed by Zanclus with 64.71%.

Table 16: Abundance of fish at different sites

Genus	**Relative abundance**
Chaetodon	8.82%
Zanclus	64.71%
Cephalopholis	20.59%
Caranx	2.94%
Acanthurus	2.94%
Total	100.00%

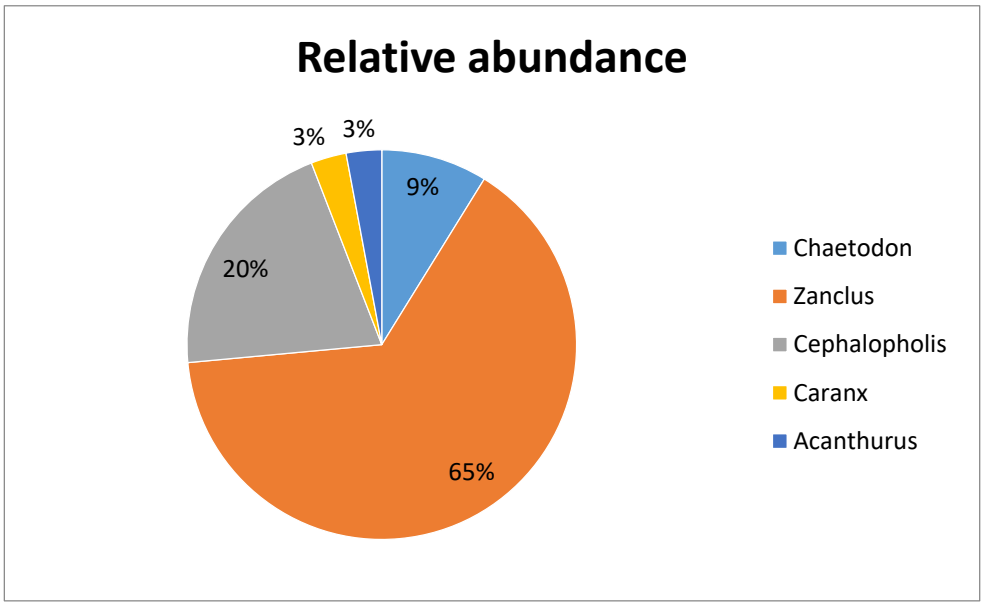

Figure 23: Abundance of fish at different sites

Looking at the frequency of the fish surveyed at the 3 sites, the sites had the same quantity when it comes to species diversity. The highest frequency was found at M2.

Table 17: Shows the frequency of species found at the surveyed sites.

Genus	Frequency		
	M1	**M2**	**M3**
Chaetodon	0	0	3
Zanclus	7	8	7
Cephalopholis	1	4	2
Caranx	0	1	0
Acanthurus	1	0	0

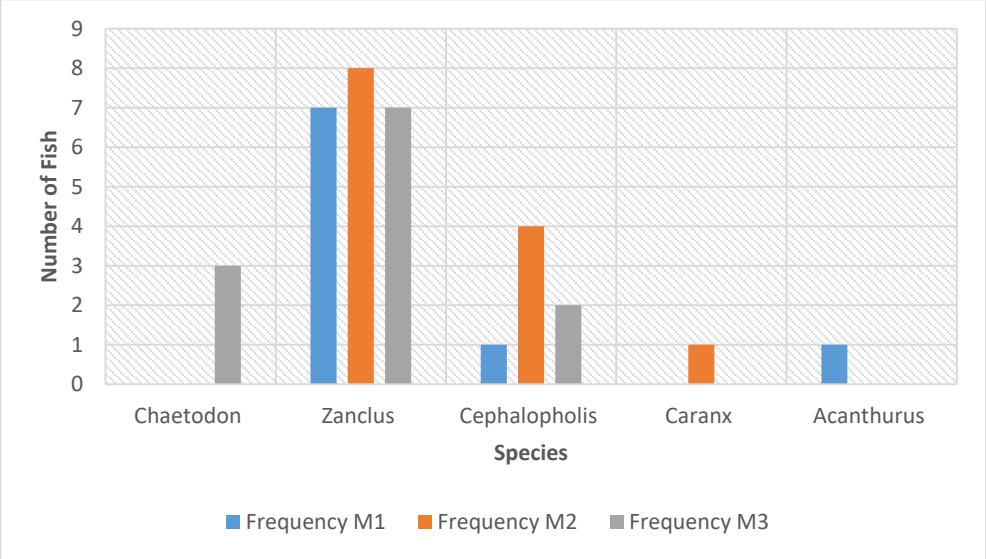

Figure 24: Shows graphical representation of species frequency.

5.9. Island movement

Aerial pictures reveal that there haven't been any island movements and long term erosion. However it shows the seasonal erosion and accretion of sand at the Northern and Southern tip of the island (Figure 25).

Figure 25: Aerials pictures of AA.Ukulhas over the past years (adopted from google earth)

5.10. Current and Coastal dynamics

Ukulhas is located in the NE side of Alif Alif atoll and hence it would be mostly subjected to the NE swell which approaches from the SE direction. However the presence of Kaafu atoll provides lots of cover from the NE swells. Therefore for the most part high energy waves would be generated due to the result of strong winds coming from NE direction. As there is no island or significant reefs to the NE during strong winds the wave energy on the Eastern side of the island would be very high. There were reports (island council) of high wave energy causing flooding near the harbor during strong winds.

Figure 26. Wave patterns around Ukulhas in NE monsoon

To the SW of Ukulhas lies a chain of islands and hence the island will be sheltered from the majority of the SW swells as well. Nevertheless, the island would have weaker protection compared to NE monsoon swells. During the SW monsoon the winds predominantly blow from West but since there are many reefs inside the atoll towards West of Ukulhas, strength of the wind waves reaching the island will be reduced.

Figure 27: Wave patterns around Ukulhas in SW monsoon

The current measurements were taken during the NE monsoon when the general pattern of currents through the Maldives is from East to West. Hence the current was westward flowing, but due to the presence of Ukulhas the flow diverges at the Southern tip of the island, one local current flowing Northward along the island (moving towards the harbor) and the other moves Westward around the southern tip of the island. The current were strongest at both tips of the island, with the NE tip having at strongest at 0.51 m/s.

Schematic diagrams showing the measured current patterns on Ukulhas reef is shown in below.

Figure 28. Current patterns around Ukulhas

5.11. Hazard Vulnerability

In addition to monsoonal heavy rains and strong winds, hazardous weather events which regularly affect the Maldives are tropical storms or tropical cyclones and severe local storms (thunder storms/thunder squalls) (UNDP, 2006).

Every so often, tropical cyclones hitting the Maldives are highly destructive due to associated strong winds that exceed a speed of 150 km/hr, heavy rainfall of above 30-40 cm in 24 hrs and storm tides that often exceed 4-5 m. Strong winds often damage vegetation, houses, communication networks and roads. Heavy rainfall is associated with serious flooding. Cyclonic winds can sometimes cause a sudden rise in sea level along the coast, leading to a storm surge. The combined effect of surge and tide, which is known as 'storm tide', can cause catastrophic events in low lying areas, flat coasts and islands such as the Maldives (UNDP, 2006).

Hazards associated with thunder storms include strong winds often exceeding a speed of 100 km/hr, heavy rainfall, lightning and hail. Such thunder storms are very frequent in the equatorial region, which is where the Maldives lie, however, they are less violent at this region. Moreover, land areas are more frequently hit by thunder storms than the open ocean. Strong winds generated by severe local storms generate large wind-driven waves which are hazardous for the Maldives (UNDP, 2006).

5.11.1. Cyclonic wind hazard

Studies of historic data suggests that even though the northern islands of the country were affected by weak cyclones which formed in the southern part of Bay of Bengal and the Arabian Sea, in general the Maldive islands were less prone to tropical cyclones. According to the cyclonic wind hazard zone classification, the north most islands represent the highest risk region and the hazard risk decreases moving down south (UNDP, 2006).

On a scale of 1-5, with 5 being the highest risk zone, Ukulhas falls within the high risk zone (Figure 29) (UNDP, 2006), it should be noted that only 11 cyclones have been recorded across the Maldives since 1877.

5.11.2. Storm surge hazard

According to the bathymetric surveys of the entire Maldives, the ocean slope towards the eastern side is steeper than the west coast which indicates that the eastern islands of the Maldives are more vulnerable to higher surge hazard compared to the western islands. Accordingly, the country has been divided into 5 broad storm surge hazard zones from 1-5, with 5 being the highest risk category. According to this zoning, Ukulhas falls into the low risk zone of storm surge hazard (UNDP, 2006) (Figure 29).

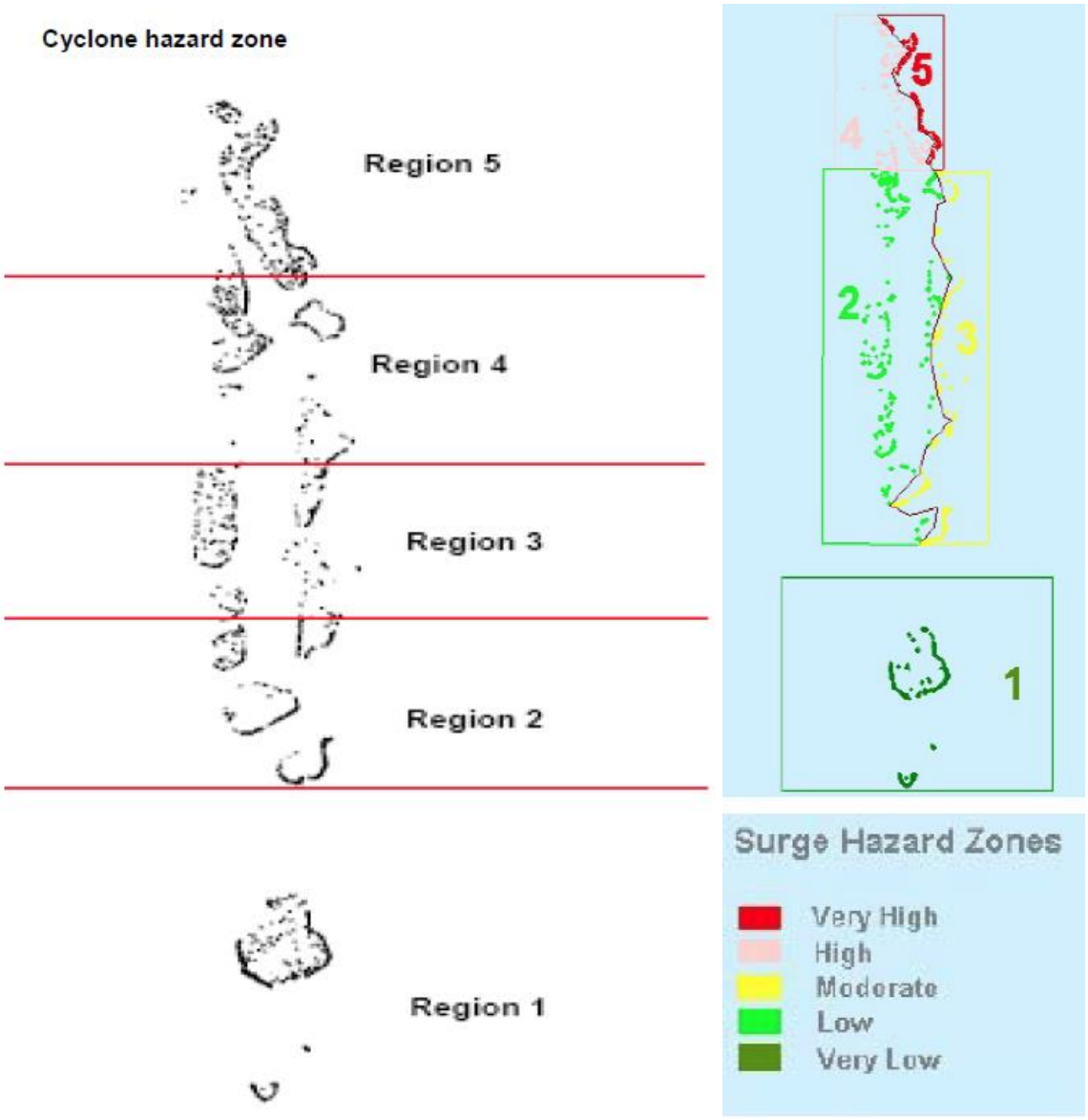

Figure 29. Cyclonic wind hazard map (left) and storm hazard map (right) of the; category 5 is the highest risk zone and category 1 is the lowest (Adapted from UNDP, 2006)

5.11.3. Flooding

Rainfall data from Hulhule' meteorological station have been used to analyze the flood and drought years across Ukulhas. Data has been standardized against the overall mean from each station. Deducing from standard deviation of rainfall from long-term mean, it can be concluded that if the difference between long-term mean and standard deviation is >1, that corresponding year is a flood year whereas if this difference is <-1 it may be considered a drought year.

As such, analysis of rainfall data at Hulhule region showed that 6 years had experienced rainfall >1 standard deviation from long term mean (Figure 30) indicating that flooding is a rare occurrence at this part of the Maldives. However there are other factors that greatly influence risk of flooding for instance alterations to the islands size, width and topography, an

islands risk to flooding may vary despite similar rainfall patterns. Since Ukulhas has a low elevation towards the Eastern side of the island, the risk of flooding on the Eastern side is high.

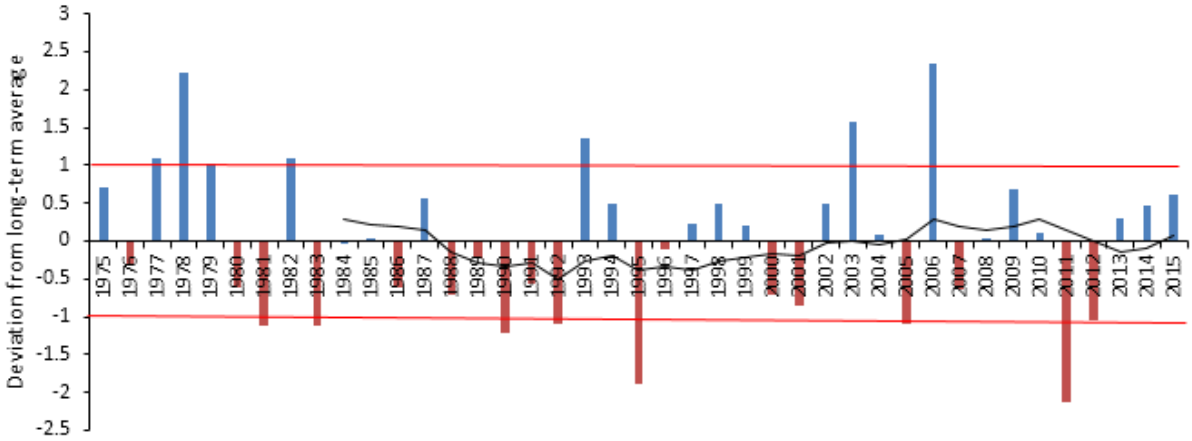

Figure 30. Rainfall anomalies for Hulhule from 1992 to 2015 with the 10 year moving average. Red lines indicate +1 and -1 standard deviations from the mean. (Data obtained from the Bureau of Meteorology, Maldives).

5.12. Noise

Following table shows the noise level near the proposed pump station locations. The noise level at different location were varied. The minimum noise level was at 27 db and maximum recorded at 77 db. On average the highest noise level recorded was 61 db.

Table 18: noise level near project site

Noise (db)	**Location**							
	PS1	**PS2**	**PS3**	**PS4**	**OF1**	**OF2**	**OF3**	**Old Mosque**
Minimum	27	45	28	30	32	29	39	30
Maximum	61	71	49	66	77	66	76	57
Average	42	61	34	44	60	43	58	36

5.13. Socioeconomic status

Demography

The following table shows the demography of the island as of 2017 according to the Ukulhas council statistics. The total registered population is 1053. The sex ratio of male to female is 0.994. The population structure is a young population with little percentage of old. According to the island council the living population on the island would be about 1028.

Table 19: demographics of Ukulhas as of 2017

Age Groups			
0-17	**18-35**	**36-65**	**66 and Above**
424	348	259	19

The following table shows the population growth rate of Ukulhas. The growth rate of the population is consistent as the growth rate drops from around 4% in 2008 to 2% in 2017. The growth rate have been increasing for the last 10 years and it can be predicted it will only increase with the development of the tourism sector in the future.

Table 20: demographics for the last 10 years.

	Population			
YEAR End	**Total**	**Growth Rate**	**Male**	**Female**
2008	806	4.13%	401	504
2009	840	4.22%	420	420
2010	868	3.33%	432	436
2011	888	2.30%	443	445
2012	935	5.29%	470	465
2013	961	2.78%	478	483
2014	983	2.29%	491	492
2015	1005	2.24%	505	500
2016	1020	1.49%	512	508
2017	1050	2.94%	520	530

Community needs

According to the locals consulted and the atoll council, the most important community need right now for Ukulhas is the establishment of a sewerage system. This is because the locals

believe that the groundwater is being polluted due to the operation of many guest houses and increase in population. Therefore to prevent this a sewer system is needed urgently.

Another community need raised by the locals were the development of roads. Currently the Eastern side of the island floods during downpours and it is difficult to walk on the roads during these times. Further the council highlighted that there is a lack of land available for the future generation. This is for the purpose of building private houses and the rapidly developing guest house business on the island.

Main economic activities

The most important economic activity on Ukulhas is tourism. Currently there are 24 guest houses in operation which amounts to roughly 170 beds according to the council. It estimated that by the end of 2019 an additional 348 beds would in operation. In addition fishing is also carried out in the island which includes yellow fin tuna fisheries and reef fishery and is currently the highest contributor for the islands economy.

Looking at the economic ventures of the island there are 20 shops, 17 guest houses, few a pharmacies and café/restaurants.

Proposed projects

- Heritage center development
- Sports area development

Ongoing projects

- Clinical laboratory establishment
- Reconstruction of a mosque (*Nooru*)
- STELCO cable upgrading

Amenities

The island is provided with 24 hours electricity service by state owned utility STELCO. The school teaches up to grade 12 and possibilities for higher degrees from Villa collage.

Additionally there is Island council, medical centre, ice plant, and harbour.

There is an established atoll ferry system operated by MTCC. In addition there is 5 private parties which operate speedboats to Male'.

Locals were satisfied with the quality of electricity services but feel it is expensive. Health facilities provided are poor as there is only a general practitioner and no laboratory services available. Educational services are good, as there is availability to study up to degree level at Villa College campus on the island.

Historically significant sites

There is an old mosque, locally called *Friday Mosque* (Figure 31) in *Ukulhas*. Even though the mosque was previously used, now it has become historic landmark linking to the islands culture and history. In addition to this, there were some Banyan trees a few decades old which was found near the south western side of the island. It is important to protect and preserve such historical sites, as such it would be good to declare these sites as environmentally sensitive.

Figure 31: Historically significant Mosque and Banyan Trees in Ukulhas

Waste management

The island has a waste management center. However the fumes produced from the burning activities sends smoke to the island schools and local households (according to the island council). The lack of machinery available makes waste produced difficult to manage.

6. STAKEHOLDER CONSULTATION

An integral part of this EIA has been consultation with all relevant parties including public consultation, relevant government authorities and community members.

6.1. Public consultation

Public consultation was carried out by visiting few households that were randomly selected. Following identification of the parties, a door knock approach was used for consultation in December 2017 during which an insight of the proposed project was briefed. The consulted parties were given the opportunity to raise any concerns regarding the new development.

Date: 22nd December 2017

Place: Individual households

Table 21: Details of individuals consulted

Name	House	Contact
Shakir	Endherimaage	9101417
Shaheedhaa	Endherimaage	-
Bushree	Cadburys	9759944
Jailam	Cadburys	9646363
Azna	Heenaamaage	-
Shakeeba	Finihiyaa Manzil	-
Shiyaaz	Vaareyvilla	7711122
Shuzain	Fusvilla	7577144
Aalim	Beachrest	9753993
Faaiz	Finihiyaa Villa	-
Ahmed Adhuham	Divers Lodge	9177891

Almost all individuals were happy with the proposed project and concerns regarding the state of urgency was raised. Following are the concerns and discussions raised by the general public;

- Believes that sewerage facilities is the number one development the island currently needs and would like to establish the system as soon as possible
- The second most important development the island needs is road development as currently the islands Eastern side get flooded very easily during downpours
- Finally banking services are very important for the operation of the guest houses on the island
- The best location for outfall is either tips of the island, as the currents would take the sewerage away from the island at both monsoons due to the current patterns. Furthermore it is important to construct the outfall at a location where people do not use as it would not be aesthetically pleasing.

- During the construction phase and operation of the system locals must be provided with job opportunities
- It is very important to implement the project with minimal adverse impacts to the environment as the island is a very tourism-based island

6.2. Meeting with island council, STELCO Ukulhas Branch, Static Company (contractor)

Date: 21st December 2017

Place: AA. Ukulhas Council

Table 22. Attendees of meeting

Name	Designation	Company	Contact
Shaukath Ibrahim	Council president	Ukulhas Council	7989552
Abdulla Waheed Imad	Director	Ukulhas Council	9621214
Mohamed Husny	Council member	Ukulhas Council	7906804
Abdullah Firaq	Council vice president	Ukulhas Council	7943727
Ahmed Shazleen	Assistant Station Manager	STELCO Ukulhas Branch	7848433
Hussain Shivaz	Engine Operator	STELCO Ukulhas Branch	7790605
Abdul Latheef Imad	Project Director	Static	7773473

The meeting was an all-inclusive in order to find out the concerns of all the relevant stakeholders of the project which included representatives from the Ukulhas island council, contractor (Static), EIA consultants, and STELCO Ukulhas branch. Following are the major concerns and discussions of the meeting;

Council were concerned about the outfall location and advised EIA consultants to propose a location which would have minimal impacts to the environment. Highlighted that the Eastern side of the island has stronger wave action. Furthermore the council were concerned as there were no back-up generators or jetting machine in the list of machinery to be provided with the project to the operator.

Council highlighted the islands East side floods always. Also highlighted that they would like the contractor to carry out the construction works with minimal dewatering as much as possible. Static highlighted that they would carry out the works during low tide as much as possible to limit/avoid dewatering.

STELCO Ukulhas Branch was concerned that MEE had still not informed formally regarding the operation of the Sewer network.

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6.3. Consultation with MEE

Date: 28th December 2017
Place: MEE

Name	Designation	Company	Contact
Afsal Hussain	Assistant Director	MEE, water and sanitation department	3018384
Fathmath Rifa	Project Officer	MEE	9191801
Mahfooz Abdul Wahhab	EIA consultant	-	9994467
Ibrahim Rashihu Adam	EIA consultant	-	7785434

- Backup gen-sets are not included in the project as MEE stand is the electricity is 100% guaranteed.
- Jetting machine is not included in the project scope but MEE will procure the jetting machine separately and provide to the operator.

6.4. Consultation with STELCO head office

Date: 2nd January 2018
Place: STELCO

Name	Designation	Company	Contact
Ahmed Saif	Director	STELCO	-
Mahfooz Abdul Wahhab	EIA consultant	-	9994467
Ibrahim Rashihu Adam	EIA consultant	-	7785434
Ali Irfan Mohamed	Asst. Engineer	STELCO	-
Ahmed Sharneez	Director	STELCO	-
Nora Jaleel	Deputy Manager	STELCO	3320982

- STELCO was not yet officially informed from MEE regarding the project, so they were concerned that there inputs would not have been incorporated into the design.

- STELCO is mainly concerned of the economic feasibility of the sewer system operation as they will not be getting revenue as of now and hence would have to operation the system at a loss.
- The sewer system admin building locations should be near the powerhouse, as it would difficult for operations if it is far away.
- Training for staff is extremely important as STELCO is very new to the operation of sewer systems.

7. OPTIONS ASSESSMENT

7.1. Purpose and need for the proposed development

As discussed in the introductory section of this report, residents of the island under concern are at a great risk of health consequences which may arise, if not already, due to use of ground water for daily household purposes which may have been subjected to contamination due to lack of proper sewer facilities.

7.2. Alternatives

The possible causes of actions, in place of another that would meet the same purpose and need, otherwise known as alternatives, have been well considered in this study as alternatives are essential to a sound decision-making process and central to an effective EIA.

With due consideration to the purpose and need for the proposed project, there are two alternatives identified for this project. The "do nothing" or no project scenario and choosing a different location other than the proposed location for the new power house. Details of which are further discussed below: -

Option 1: Maintain status-quo

The first option is a "Do Nothing" scenario, whereby all existing sewer mechanisms will remain operational and condition as they are now without establishment of a sewerage system. Under this scenario, no trees will be removed, there will be no wastes generated during construction and any construction related hazards will be avoided, however, the social consequences which may arise as follows:-

- As existing sewer mechanisms are old and un-serviced, it risks the ground water to be contaminated via sewer leakages and improper discharge. This will further increase the health risks associated with using polluted ground water;
- The deterioration of the environmental status of the island will affect the economic activities which will impact the livelihoods of the locals;
- Groundwater will be further polluted due to sewer discharge and over the years the effects of such pollution may become irreversible;
- Since providing safe sanitation to islands is of upmost importance to the government, in such case the credibility of the government and sustainability of government proposed projects may be questioned.

Option 2: Alternative locations for outfall

The second option considered is to construct the sewer outfall at a different location than the proposed location as shown in Figure 2. The alternate options for the proposed outfall location discussed below: -

Northern side of the harbour

The first alternative location is at the northern side of the harbour so that it moves just north of the dredge reef flat area and ends near the north eastern edge of the reef. The location can be easily accessible and is clear from any vegetation much like the proposed location. As NE of the harbour have currents that move away from the island in both monsoon seasons, the discharge sewerage would be dispersed away from the island. Furthermore, this area is not used for socioeconomic activities which makes it the location ideal.

The only drawback of choosing this location would be that the length of the outfall compared to the other locations would be longer, hence would increase the expenses of the project considerably with the installation of the long outfall pipe.

Southern side of the island

The second alternative location would be to lay the outfall on the southern side of the reef. Here also the current are such that the sewerage would be dispersed away from the island at both monsoons but considering the beach and lagoon area are being used frequently by local's residents and tourists for recreational purposes. Furthermore, there is a dive spot near the southern reef edge where local divers claim to be one of the best dive points near the island and they frequently use the spot for diving. As such laying the outfall at this location would greatly impact the aesthetic value of the island and hence is not a feasible option.

Preferred location and justification: The most preferred location at Ukulhas is the first alternative. As the proposed outfall location (south of the harbor) poses the risk of discharge sewerage being dispersed into the harbor and also being carried over the reef flat due to the current pattern at the location. Furthermore this location is a known hammerhead shark siting spot (according to local divers) and hence the recreational activates would be hindered. Therefore the most preferred and ideal location for the outfall would be the first alternative location even with the additional expense.

8. POTENTIAL IMPACT ANALYSIS

The impacts from any project can be categorized into two broad categories; constructional and operational impacts. Constructional impacts are the potential impacts which might arise during the construction phase of the proposed project. Operational impacts are the potential impacts which might arise once the newly established sewer systems become operational.

8.1 Risk assessment methodology

The proponent and the consultants have conducted a risk-based environmental review as part of the planning process. Data has been drawn from a wide range of sources, including existing similar EIA reports. The risk assessment was conducted based on professional judgment and expertise of the consultants as well as evaluation of the baseline data and consultation with the stakeholders. This provides an outline on how to identify potential hazards associated with the proposal and evaluate the likelihood and consequences. The risk assessment methodology utilized was also consistent with the methodology outlined in AS/NZS ISO31000 Risk Management- Principles and Guidelines.

The first stage of this methodology was to identify hazards. To ensure that all potential hazards were identified, it was important that any specific environment and/or community impact issues were determined based on the locations of the sewer outfall and pump station locations as well as type of service to be provided. As such, the hazards identified were:-

1. Constructional impacts:-
    - Air quality- GHG emissions;
    - Noise pollution- operation of heavy machinery;
    - Water quality- chemical spills and dewatering;
    - Impacts on road and buildings due to operation of heavy machinery and excavation;
    - Marine environment due to sewer outfall construction;
    - Generation of constructional and decommissioning wastes;
    - Vegetation clearance; and
2. Operational impacts:-
    - Air quality- GHG emissions and smell;
    - Noise pollution- operation of pumps;
    - Socio economic- improved sanitation facilities;
    - Health and safety of working staff;
    - Water quality- from leakages; and
    - Marine environment- sewerage discharge.

Hazards were assessed using the following matrix (*Table 23*).

Table 23. Risk assessment matrix

Likelihood		Consequences				
		Minimal (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
	Remote (1)	Negligible	Negligible	Very low	Low	Medium
	Unlikely (2)	Negligible	Very low	Low	Medium	High
	Possible (3)	Very low	Low	Medium	High	Very high
	Likely (4)	Low	Medium	High	Very high	Significant
	Certain (5)	Medium	High	Very high	Significant	Significant

Criteria used for assessing the identified hazards are as follows. Note that the realistic and consequences were judges based on the design consideration for the proposed facility. These criteria were measured against the impact (if the impact occurred), to ecological and/or human health: -

- Likelihood:-
  - Remote- May occur only in exceptional circumstances;
  - Unlikely- Could occur at some time;
  - Possible- Might occur at some time;
  - Likely- More likely to happen than not (i.e. a probability of > 50 %); and
  - Certain- Will probably occur in most circumstances.
- Consequences:-
  - Minimal- Impact has no significant risk to environment either short term or long term;
  - Minor- The impact is short term and causes very limited risk to the environment ;
  - Moderate- Impact gives rise to some concern, may cause long term environmental problems but are likely short term and acceptable;
  - Major- Impact is long term, small scale and environmentally risky. Impact severely damages the environment; and
  - Catastrophic- Impact is long term and irreversible, large scale and detrimental to the environment.

The likelihood measures the probability of occurrence of an event whereas consequences evaluate the significance of impact on the environment in the event of an incident. Based on the likelihood and consequences for each of the identified hazards, the level of risk is determined (*Table 23*). In addition to the level of risk, other impact characteristics such as the type of impact, nature of the impact, impact range, impact duration as well as reversibility of the impacts are also assessed, grading scales for which are given on *Table 24* below.

Table 24. Grading scale of the characteristics of impacts

Characteristic of impact	**Grading**	**Explanation**
Type	Direct	Direct impacts without intervening factors or intermediaries
	Indirect	Triggered by but not immediate effect of the proposed project
Nature	Positive	Impacts resulting in a desirable effect
	Negative	Impacts resulting in an undesirable effect
Range	Local	Impacts limited to project site

	Island	Impacts of importance at island level
	Atoll	Impact of importance at Atoll level
	Nation	Impacts of national character
Duration	Short-term	Occurring over a short period of time
	Intermittent	Impacts occurring at irregular intervals
	Long-term	Occurring over a long period of time
	Continuous	Impacts occurring continuously
Reversibility	Reversible	Previous state (or equivalent) can be restored
	Irreversible	Not able to alter the consequence of impact

8.2 Limitations and uncertainties in impact prediction

Risks and uncertainties are inherent in any environmental and ecological problem solving technique and needs to be acknowledged and incorporated in any decision making process. Risk is the chance that an adverse outcome occurs while uncertainty arises from an imperfect understanding of a system due to uncertainty about facts (McAlpine et al., 2010). Our understanding of the environment are limited mainly due to lack of long term data and complexity of the ecosystem. While every attempt has been made to accurately predict the potential impacts from this project, there are unforeseen and uncertain factors which might cause deviations in the impacts outlined herein. For instance, a natural phenomenon.

Moreover, the lack of monitoring data during the construction and operation of the projects hinders the accuracy of the impact prediction. This leads to the impacts being predicted based on the individual consultants experience.

Anyhow, based on the risk assessment outlined above, the environmental impact assessment is set out below:-

8.3 Constructional impacts

Table 25. Predicted impacts and risk analysis anticipated during construction phase of the project

Potential impacts	**Likelihood**	**Consequence**	**Risk rating**
Air quality- GHG emissions	Certain	Minimal	Medium
Noise pollution due to operation of heavy machinery	Certain	Moderate	Very high
Water quality from chemical spills and dewatering	Certain	Moderate	Very high
Impacts on road and buildings due to operation of heavy machinery and excavation	Possible	Moderate	Medium
Marine environment due to sewer outfall construction	Certain	Moderate	Very high
Generation of constructional and decommissioning wastes	Certain	Minimal	Medium
Vegetation clearance	Remote	Minimal	Negligible

Impacts during construction phase of the project are mainly anticipated to be short-term and reversible (*Table 26*) as most impacts will last only for the duration of the construction phase of the project.

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

Potential impact	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Air quality- GHG emissions	Direct	Negative	Nation	Short-term	Irreversible
Noise pollution due to operation of heavy machinery	Direct	Negative	Local	Intermitte nt	Reversible

Water quality from chemical spills and dewatering	Direct	Negative	Island	Intermitte nt	Irreversible
Impacts on road and buildings due to operation of heavy machinery and excavation	Direct	Negative	Island	Intermitte nt	Reversible
Marine environment due to sewer outfall construction	Direct	Negative	Island	Short-term	Irreversible
Generation of constructional and decommissioning wastes	Direct	Negative	Island	Short-term	Reversible
Vegetation clearance	Direct	Negative	Island	Long-term	Irreversible

8.3.1 Impacts on air quality

Impacts on air quality during the constructional phase is generally credited to operation of machinery and equipment which require electricity and vehicles which burn fuel. The main contributor would be the operation of the excavator and trucks. Release of GHGs and any other gases into the atmosphere during the construction phase is very low, regardless this would contribute to the GHG emission of the nation. However it is expected that any released gases will not remain stagnant to a particular area to cause a public nuance as the island does not have thick vegetation cover. All the roads are moderately wide which would allow the diffuse of any released gases.

Risk analysis shows that impacts on air quality is medium (*Table 25*) and is expected to be limited to project site and would be intermittent hence is not expected to cause any significant adverse impacts on the environment and community.

8.3.2 Noise pollution

Similar to air quality, impacts on noise level during the constructional phase is generally credited to operation of machinery, equipment and vehicles. This impact scored a risk rating of "very high" (*Table 25*) as it is anticipated that the noise levels will be high at localized areas in the island where construction works would be ongoing. Even though the disturbance would be short lived, the resident living in the vicinity would be impacted badly.

8.3.3 Groundwater quality

Impacts on groundwater quality due to this project are anticipated to arise from two aspects of the project. These include:-

- Dewatering- Depending on the depth of foundation for the pump stations and depth of trenching works for laying the sewer pipelines as well as the depth of groundwater table, dewatering maybe required, in which case the groundwater table will be moderately affected by causing thinning of groundwater lens and the impacts are anticipated to be Intermittent and irreversible; and
- Chemical spills- During the operation of machinery and handling of chemicals there is the possibility of chemicals being spilled on to the ground. In which case the chemicals would quickly penetrate through the soil into the groundwater lens as

Maldivian soil is very porous. This would cause moderate impacts on the groundwater lens of the island.

8.3.4 Impacts on road and buildings due to heavy machinery and excavation

Operation of heavy machinery on the road is anticipated to cause soil compaction to some extent, however, since the heavy machinery will be operated for a very short time, the consequence is expected to be moderate. Any accidents during the operation machinery, on the other hand, could lead to serious damage to nearby buildings, especially during the operation of excavator.

8.3.5 Marine environment due to sewer outfall construction

Sewer outfall construction requires excavation and trenching of the sea bed to some extent in order to lay the pipe and armoring. These activities are anticipated to cause both direct and indirect impacts on the marine environment such as loss of habitat, physical removal of substratum and associated biota from the seabed at the excavation/trenching location as well as burial of material due to subsequent deposition.

Indirect effects of excavation of sea bed include stress on photosynthetic organisms due to increased sedimentation (turbidity) as a result of re-suspension of excavated material.

8.3.6 Generation of constructional and decommissioning waste

Plastic waste and packaging waste are expected to be generated in largest quantities. If the waste generated at different locations of the island were not collected, it would be aesthetically not very pleasing. However once the wastes are removed the impact would alleviated therefore this impact is short-term and reversible.

8.3.7 Vegetation clearance

All pump stations are to be constructed on the main road of the island and there are no trees on the path of any pipeline. Therefore no trees need to be removed under this project. Hence this impact is negligible.

8.4 Operational impacts

Table 27. Predicted impacts and risk analysis anticipated during operation phase of the project

Potential impact	**Likelihood**	**Consequence**	**Risk rating**
Air quality- GHG emissions and smell	Certain	Minimal	Medium
Noise pollution from operation of pumps	Certain	Moderate	Medium
Health and safety of working staff	Possible	Major	High

Socio economic:-improved sanitation facilities	Certain	Major	Significant
Water quality from leakages	Possible	Moderate	High
Marine environment:- sewer discharge	Certain	Moderate	High

Unlike constructional impacts, operational impacts are anticipated to be more long-term and irreversible (*Table 28*) since the newly established systems need to run continuously once they become fully established and operational. It should be noted that with the application of proper mitigation measures as outlined in section 9 of this report, almost every negative impact could be minimized.

Table 28. Summary of impacts during the operation phase of the project

Potential impact	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Air quality- GHG emissions and smell	Direct	Negative	Local	Long-term	Irreversible
Noise pollution from operation of pumps	Direct	Negative	Local	Long-term	Reversible
Health and safety of working staff	Indirect	Negative	Local	Long-term	Irreversible
Socio economic:-improved sanitation facilities	Direct	Positive	Island	Long-term	Reversible
Water quality from leakages	Indirect	Negative	Island	Long-term	Irreversible
Marine environment:- sewer discharge	Direct	Negative	Local	Long-term	Irreversible

8.4.1 Air quality

Impacts on air quality is anticipated to be due to operation of gen-sets for providing the electricity to run the pumps in pump stations. The powerhouse of the island is capable of handling the additional load without the installation of new gen-sets. Therefore it is not anticipated to significantly increase the GHG emissions from the powerhouse. However impacts to air quality due to the smell from the pump stations are expected to adversely impact the people, mostly as a nuisance. But with the addition of blower with vent pipe the smell nuisance could be reduced greatly, hence the risk rating is medium.

8.4.2 Noise pollution

Since the pumps are placed underground it is not anticipated that noise pollution will be very high. However as the pump stations on the island are built in very close proximity to residential houses, the people living in the nearest houses would be disturbed, hence the risk rating is medium for this impact.

8.4.3 Health and safety of working staff

During maintenance and cleaning of pump stations, and sewer network, the working staff is at a risk of major health issues in case safety gear is not used. The risks include contact with harmful disease causing agents, inhalation of gases which may lead to even respiratory infections. Therefore due to the major consequences the risk rating is high.

8.4.4 Water quality from leakages

Contamination of groundwater due to leakages in pipelines or from the pump station itself is a common problem in the sewer systems currently established in the Maldives. The main cause is the improper maintenance of the sewer system. And in some cases, individual people damaging the sewer pipelines intentionally or unintentionally. In any circumstance leakage of sewer into the groundwater lens of the island would cause irreversible damages to the groundwater therefore the risk rating is high.

8.4.5 Socioeconomic –improved sanitation facilities

The island currently have a septic tank system to manage the waste water, which is not a very safe method for managing waste water. The proposed development will phase out the public built septic tanks and prevent further contamination of groundwater with the implementation of a sewerage network. This will have direct positive outcomes on the groundwater quality on the island. Consequently, social wellbeing of the population will improve as people are assured of proper sanitation and hygiene for the current and future generations.

8.4.6 Marine environment from wastewater disposal

Once the sewer networks are established, wastewater will be discharged into the sea via sea outfall. Although the sewer discharged will be quickly diffused, it would still cause significant deterioration of the marine water quality at the outlet. The main change in the chemical parameters of marine water would in the BOD due to the fecal matter is the raw sewerage. High BOD concentration would favor the growth of green algae at the outfall location which might inhibit coral growth. Furthermore anions like sulphates and phosphates maybe present in sewerage which come from the washing powders used at households, would alter the pH of the water which might intern alter the composition of the microbial communities.

9. ENVIRONMENTAL MANAGEMENT

This section describes the environmental and operational management systems and plans proposed for the new sewer networks including practical mitigation measures for all identified impacts, a risk management plan, measures for sustainable development as well as environmental monitoring programs.

9.1 Proposed mitigation measures

The mitigation measures outlines in *Table 29* below is proposed with due consideration to their cost effectiveness and feasibility to be implemented. The mitigation measures mainly relate to operation practices of the machinery and appropriate trainings which would ensure that environmental impacts would be minimized as effectively as possible.

It is the responsibility of the implementing agency to adhere to the proposed mitigation measures and bear any costs related to establishing them.

Table 29. Proposed mitigation measures for the identified risks during construction and operation phases of the proposed project

Aspect	Mitigation measure	Implementing agency	Estimated cost (MRF)
CONSTRUCTION PHASE			
Air quality	• Daily maintenance of vehicles and machinery • Use of light fuel (low sulphur content)	Contractor	N/A
Noise pollution	• Well maintenance of vehicles and machinery • Restrict working hours to day time only • Communicate with the residents on working hours	Contractor	N/A
Water quality	• Oil/chemical handling procedures should be made known to all staff members • Follow corresponding chemical handling procedure when handling chemicals • All machinery and equipment should be well maintained to avoid accidental spillage • Relevant staff members should be well trained about proper use of machinery and equipment • Have emergency oil spill cleanup crew on standby during construction • Wastewater should be disposed of through sea outfall pipes • Proper care should be taken as not to spill any oils or wastewater into the ground • Water extracted from dewatering should be recharged back to the ground to a designated area proposed by the Island Council after checking the water quality	Contractor	N/A
Waste	• Littering, accidental disposal and spillage of any construction wastes should be avoided by pre-planning ways of their transportation and unloading • Careful planning of the work activities can also reduce the amount of waste generated • Waste segregation on site and reuse as much as possible • Segregated waste must be taken to the waste management area on the island and then to Thilafushi for disposal	Contractor	N/A

	• Health and safety materials should be made available to workers specifying instructions on how to handle hazardous wastes and how to act during a chemical spill		
Impacts on road and buildings due to heavy machinery and excavation	• Heavy machinery and equipment operators should be well trained; • Park the heavy machinery within the work site to avoid unnecessary transfer • Usage of heavy machinery and equipment should be restricted to smaller areas (eg take the shortest route possible when accessing to work site); • Shoring for adjacent buildings during excavation if there is any risk of collapse • If necessary, the area should be sprayed with water to minimize human exposure to dust • Trenched material should be stockpiled at a designated area • Safety lights at night to avoid people from falling into open trenches • Backfilling any trenches made during the day before night by careful planning of pipe laying works	Contractor	N/A
Marine environment due to sewer outfall construction	• Excavation works shall be carried out during low tide and calm weather conditions; • Avoid dragging of anchors and pipes over the sea bed and should be carefully placed at the exact location. • Commence trenching works at a slow pace to allow for sessile organism to escape work site; • Restrict movement of barges and excavators to a narrow area only.	Contractor	N/A
Vegetation clearance	• Replantation of any smaller trees either at a suitable area directed by the island councils • Proper care should be taken when uprooting deeply rooted trees • Removed vegetation should be disposed of as green waste • Vegetation occurring outside building/pump station footprint area should not be harmed • All vehicles and machinery must be restricted to the proposed access tracks and sites	Contractor	N/A
OPERATIONAL PHASE			
Air quality	• Regular servicing and maintenance of diesel generators • Blower with vent pipe installed at the pump stations • Aerators installed in pump stations	Operator	15,000
Noise pollution	• Regular servicing and maintenance of pumps	Operator	15,000
Health and safety of working staff	• All personnel must strictly abide by the occupational health and safety procedures • Safety gear such as masks, suites and safety goggles etc shall be provided by the operator • Wear essential personal protection attires at all times • Staff training on health and safety procedures • Follow emergency response plan	Operator	20,000
Water quality from leakages	• water quality monitoring according to operation and maintenance manual • In case of leakages, proper maintenance shall be done to prevent further leaks • Account for the storm water flow during the final detail design of the sewer system	Operator	5,000

	• Account for the increase number of guest houses and the resulting increase in flow in the final design of the sewer system		
Marine environment -sewerage discharge	• Wastewater shall be treated prior to disposal • Ensure outfall location is a potential mixing zone • Ensure the condition of the outfall is good and functional • marine water testing according to operating license	Operator and EPA	N/A

9.2 Risk management and incident response

Risk management procedures in this project are strengthened by adopting a more systematic risk management approach to safety. This is achieved by identifying all foreseeable hazards (as stated in section 8 of this report), assessing the risk of each hazard and providing a means to control the risks (mitigation measures). Moreover, the new facility is to be built in accordance with the MEE and EPA guidelines for a sewerage facility and need to be equipped with modern facilities to ensure that the risks are minimized as much as possible.

9.3 Sustainable development management policy

The design and implementation of the project ensures that the proposed project is sustainable. As such, measures adopted to promote sustainable development include some guiding principles as well as components incorporated into the project design. These include:-

- Incorporating predicted population for the upcoming 35 years was an integral part of project design to ensure that the project is feasible in terms of catering for the future generations;
- Ensure environmental compliance with the Governmental policies and regulations;
- Protect people, property and the local environment;
- Reduce ecological impacts of the services provided; and
- Increase customer satisfaction.

9.4 Managing uncertainties

Uncertainty is an integral part of an EIA as EIA preparation involves prediction. The two types of uncertainties associated with the EIA process include those associated with the process and those associated with predictions. With the former, the question is whether the most important impacts have been identified and whether the recommendations will be acted upon. In order to reduce such uncertainties, a wide range of stakeholders have been consulted (Section 6) in the EIA process in order to minimize the risk of missing important impacts. For the latter, the uncertainty is in the accuracy of the findings. This can be improved by research and quality of the survey.

It should also be noted that even though EIA cannot give a precise picture of the future, it enables uncertainties to be better managed and is an aid to better decision making.

9.5 Environmental monitoring

Monitoring is an essential part of the EIA and project implementation and serves 3 purposes:-

1. Ensures that the proposed mitigation measures are being implemented;
2. Evaluates whether the proposed mitigation measures are working effectively; and
3. Validates the accuracy of models or projections that were used during impact assessment process.

The purpose of monitoring is to compare the predicted impacts with that of the actual impacts, particularly if the impacts are either very important or the scale of the impact cannot be predicted accurately. The results of monitoring can then be used to manage the environment, particularly to highlight problems early on so an action can be taken.

Monitoring should not be seen as an open-ended commitment to data collection and to minimize the expenses associated with collecting unnecessary data, the data collection should cease when the need for monitoring ceases. Therefore, it is important that a proper monitoring schedule is adhered to. Conversely, monitoring may also indicate the need for more intensive study. The information obtained from monitoring can be extremely useful for future EIAs in making them more accurate as well as more effective.

The baseline data collection for the proposed project were conducted in December 2017. Baseline surveys were conducted to determine the reference range, so that comparisons can be made during the monitoring to determine the change.

All monitoring activities must be carried out under supervision of a registered EIA consultant. Details of the monitoring program are given in *Table 30* below.

Table 30. Environmental monitoring plan proposed for the establishment of sewer network at AA.Ukulhas

Parameter	Phase	Method	Indicators	Frequency	Cost / MRF
Groundwater quality	Operation and Construction	Test of groundwater parameters near pump stations	Conductivity pH TDS Nitrate Sulphide Phosphate BOD	Every 6 months during construction and every 3 month during operation	7000
Marine water quality	Operation and Construction	Test of seawater parameters near outfall	Conductivity pH TDS Nitrate Sulphide Phosphate BOD	Every 6 months during construction operation	7000

Monitoring reports must be submitted to the EPA as specified under the monitoring schedule below:-

Table 31. Monitoring schedule recommended for establishment of sewer networks at AA. Ukulhas (assuming that project start date is January 2018 and ends in September 2018)

Description	**Location**	**Date**
EIA Decision statement issued	-	January 2018
Monitoring report during construction- 1	Groundwater Seawater	May 2018
Monitoring report during construction – 2	Groundwater Seawater	August 2018
Monitoring report during operation-1	Groundwater	February 2019
Monitoring report during operation-2	Groundwater Seawater	May 2019
Monitoring report during operation-3	Groundwater	August 2019
Monitoring report during operation-4	Groundwater Seawater	November 2019

10 JUSTIFICATION AND CONCLUSION

Two types of environmental impacts are associated with this project, constructional and operational impacts. While impacts due to construction phase of the project is temporary and short-term, impacts during the operational phase are long-term and permanent. Impacts of highest significance from this project are on coral reef. While impacts on coral reef could be minimized given that the proper mitigation measures are followed.

It should be noted that even though some of the impacts are irreversible and could have detrimental effects on the environment, it should not be seen as a hindrance to the development of any place. As the main purpose of an EIA as well as environmental consultation is to facilitate sustainable development, this report ensures that best possible environmental solutions are provided for the development of sewerage facilities at Aa.Ukulhas. Proposed locations for outfall locations have been chosen with due consideration to the mixing potential and direction of currents. Additionally, outfall pipes will be extended out of reef flat in order to minimize potential impacts to marine environment as a result of wastewater discharge. This is one of the most significant impacts of the proposed project.

Even though risk analysis shows that the only positive outcome of the project is on the socio-economic component of this project, looking at a broader picture, impacts on every category is anticipated to be positive. Impacts on groundwater will be minimized and any further impacts could be avoided or minimized. Risks of health hazards will also be lowered with the establishment of more contemporary sewer system. Overall, the proposed project is for the betterment of the environment and the society. Therefore, the consultants conclude that the proposed project is feasible and given that the proper mitigation measures are applied, any negative environmental impacts could be minimized or even prevented.

11 ACKNOWLEDGEMENTS

Consultants would like to extend sincere gratitude to everyone who have contributed to this report. Thanks are due to representatives of island council members of AA.Ukulhas and STATIC company. Those who contributed to the public consultation meetings are highly appreciated. Special thanks to Yameen Abdullah for assistance in the surveys.

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13 APPENDICES

APPENDIX A- LIST OF ABBREVIATIONS

EIA-Environmental Impact Assessment
MEA-Maldives Energy Authority
EPA-Environmental Protection Agency
ToR-Terms of Reference
DN-Decision Note
RO-Reverse Osmosis
IWRM-Integrated Water Resource Management
MPHRE-Ministry of Planning, Human Resource and Environment
MNDF-Maldives National Defense Force
WIG-Waste incinerator guideline
UNFCCC-United Nations Framework Convention on Climate Change
GHG-Greenhouse gas
UN-United Nations
CBD-Convention on Biological Diversity
SAARC-South Asian Association for Regional Corporation
BS-British Standards
EPDM-Ethylene Propylene Die Memonoma
MWSC-Maldives Water and Sewerage Company
GPS-Global Positioning System
NO_2-Nitrogen dioxide
NO-Nitrogen monoxide
SO_2-Sulphur dioxide
SST-Sea surface temperature
TPH-Total Petroleum Hydrocarbon
H_2S-Hydrogen sulphide
UNDP-The United Nations Development Program

APPENDIX B- TERMS OF REFERENCE

بسم الله الرحمن الرحيم

No: 203-EIARES/438/2017/187

Terms of Reference for the Environmental Impact Assessment for the proposed Sewerage System at Ukulhas. Aa. Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on ***19th December 2017*** for undertaking the EIA of the proposed sewerage facility at ***AA. Ukulhas.*** The proponent of the project is **Ministry of Environment and Energy.**

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with 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 sewerage treatment system 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 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 a minimumA3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location, size and important elements of the proposed sewerage system. The study area should include adjacent or remote areas, such asrelevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3. **Scope of work** – Identify and number tasks of the project including site preparation, construction and decommissioning phases. The following tasks shall be completed:

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):

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

House connection and laterals

- Description of catch pits and expected depth of these catch pits

Collection System

- Type of collection (gravity or forced)
- Lifting stations (if any), type and number of lifting stations
- Road manholes (type and expected number), indicate using site plans
- Sumps and pump stations

STP plant facility design:

- Describe treatment technology and capacity (envisage population growth in the next 30 years);
- Specify catchment area: All flows that contribute to the sewer system including flows from the development area to the point of connection to the main line. I.e. Residential flows + Commercial flows + Institutional flows + Industrial flows (significantly variable depending on industry) + Infiltration/Inflow (rain water collection, if any);
- Describe operations for dewatering excavations for pump stations and sewer trenches;
- mechanisms used to avoid pipe leakages protecting ground water contamination.
- Specify an emergency plan if system fails.

Sea outfall pipeline

- Justify outfall site selection including the distance from the reef and depth of the pipe using oceanographic and ecological information. Currents and waves ought to quickly disperse the discharged water with minimum impacts on marine ecosystems and economic activities. Illustrate the extent of the sediment plume. The public and stakeholders should support the location of the outfall site;
- Describe equipment needed and construction methods for laying the offshore pipeline including handling and transportation.

Sewage collection and disposal network

- Detailed sewage and waste water disposal mechanisms, equipment used and periodicity

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 and from at least two benchmarks. 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:

General climatic conditions

- Rainfall data to measure infiltration and wind including extreme situations, and

Geology and geomorphology

Offshore/coastal geology and geomorphology (use maps);

- Bathymetry(at the proposed outfall location and alternative locations)
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction.

Hydrography/hydrodynamics (localized maps)

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents (north, south, east, west, NE, SW, NW, SE);
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity, phosphate, nitrate, sulphate, BOD.

-Topography of the island

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Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector. Include map;
- Marine habitat status including coral reef health, seagrass beds and benthic and fish community description around the island. Select a control site far from the outfall location and a test site at representative distances from the outfall discharge site;
- Terrestrial monitoring for selecting the sites for STP facility. Include a description of the flora within the STP and lifting stations and quantification of the significant vegetation types;
- Landscape integrity;
- Include ground water monitoring

Socio-economic environment

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

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge to predict infiltration rates.
-

Groundwater Aquifer

- Assess the quality of aquifer (at STP and all pump station locations) for physical, chemical parameters such as pH, Salinity, E. Conductivity, temperature, BOD

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.

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

Terrestrial impacts from construction

- Loss of vegetation and fauna from land clearance activities, lifting stations and pipe works (deployment and dewatering);
- Ground water quality;

Impact from installing the sewage outfall pipe

- Impacts from marine habitat destruction which may affect fish stocks and species diversity and density of invertebrates,
- Increased turbidity and changes in sediment transport due to pipe introduction when pipe is on the sea bed;
- Equipment, technical and spillage impacts during construction;
- Impacts from dewatering (if any)

Operational phase impacts from outfall discharges

- Sediment plume extent should be delimited so that effects from nutrient inputs (water quality changes) on local reefs, fish and invertebrate communities can be identified;

Sewage waste collection and disposal impacts

- Specify methods of collection and transportation to dump site.

Social impacts:

- Odor and noise impacts;
- Aesthetics on-land and underwater from outfall pipeline and turbidity for recreational users;
- Increased demands on natural resources and services (domestic water supply, waste water disposal, treatment systems, solid waste disposal systems, energy supply, etc);
- Land use displacement and economic opportunities.

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. 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. Identify impacts that are cumulative and unavoidable.

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 was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

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. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for:

- Physical parameters such as ground and sea water quality assessments and oceanographic studies.
- Biological parameters such as terrestrial monitoring, coral reef and benthic monitoring, fish community census and terrestrial monitoring.

Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, 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;

- Utility providers
- Aa.ukulhas council
- Aa. Atoll council
- Public of Aa. Ukulhas Island
- Contractor

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Fax: [+960] 333 5953 ފެކްސް:

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މާލެ، ދިވެހިރާއްޖެ، 20392
Email: secretariat@epa.gov.mv އީމެއިލް:
Website: www.epa.gov.mv ވެބްސައިޓް:

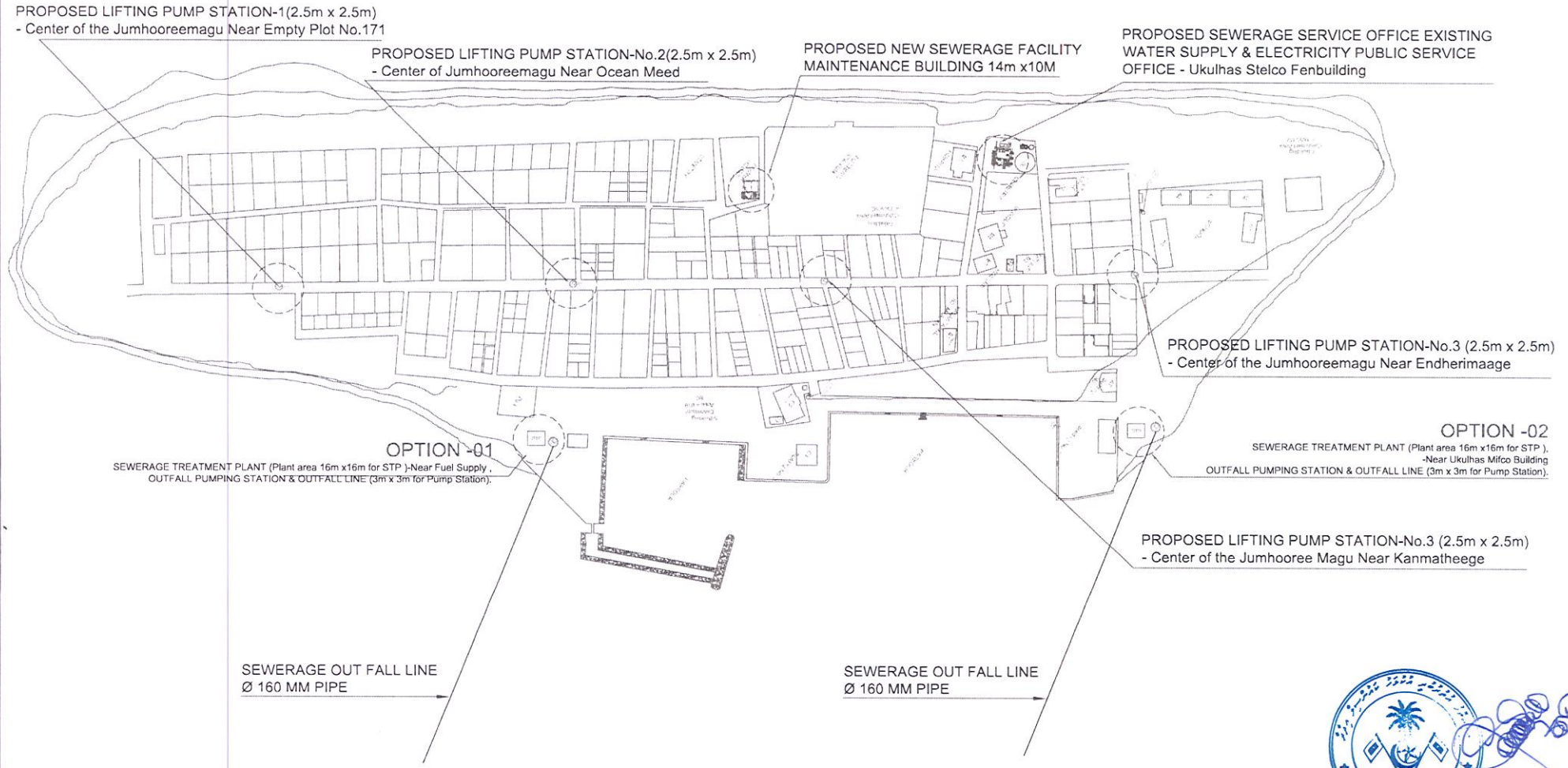
Relevant documentation, references for consultants – Include publicly available studies or references relevant to the current project to be used by the consultant.

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 Environmental Impact Assessment Regulations, 2012 and subsequent ammendements.*

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

Date: 24th Decemeber 2017

APPENDIX C-LAND REGISTRATIONS FOR PROPOSED LOCATIONS OF SEWER FACILITIES



LAND ALLOCATION PLAN
A.A. UKULHUS ISLAND
SCALE- NTS

Client: Ministry of Environment and Energy, Republic of Maldives	Consultant:	M&E Contractor: STATIC COMPANY PRIVATE LIMITED, M. HURAA, FAREEDEE MAGU, MALE 20256, REPUBLIC OF MALDIVES, TEL: +960-3310313, FAX: +960-3326405	Project Title: SEWERAGE PROJECT- A.A. UKULHUS	Design/Drawn: BINU	Date: 27/11/17
			Drawing Title: PRELIMINARY DESIGN SEWERAGE NETWORK LAND ALLOCATION PLAN	Checked: LATHEEF	Scale: N/A
				Approved	Job No.: N/A
				File Path	
				Dwg No.: STC-UKS-SW-LAN-DSGN - 01	Revision: R-0

No. of Submission	1	2	3	4	5	6	
Rev.	Description					Date	Made By
R0	LAND ALLOCATION PLAN					27/11/17	BINU

Secretariat of the Ukulhas Council, North Ariatholhu
AA. Ukulhas, Republic of Maldives

އަރިއަތޮޅު އުތުރުބުރީ އުކުޅަސް ކައުންސިލްގެ އިދާރާ
އއ.އުކުޅަސް، ދިވެހިރާއްޖެ.

ނަންބަރ:(G)U-4/2017/03-04
ތާރީޚް: 07 ޑިސެމްބަރ 2017

ޤަރާރު

ރަށުގައި އުމަސައްކަތް ހިނދު ކަނޑައެޅުން ގައިޑްލައިނުން ނަރުދަމާގެ ނިޒާމުގެ އުކުޅަސްގައި މިއީ، ކުރުމަށް ސަރުކާރުން ހަވާލުކުރެވިފައިވާ ފަރާތް ކަމުގައިވާ ސޮލިޑް ކޮމްޕެނީ ޕްރައިވެޓް ލިމިޓެޑް ގެ ފަރާތުން ތަޢާރުފުކުރި ކައުންސިލުން އެޕްރޫވްކުރެވިފައިވާ ޕްލަމްބިންގ ޑިޒައިންގައި ޕަމްޕް ސްޓޭޝަނެއް ބަހައްޓާނެކަމަށް، އައިސްފައިވާ ގޮތުން ކައުންސިލުން ސްކެޗް ޑްރެއިނޭޖް ލޭއައުޓް ގައިޑްލައިނުގެ ކަނޑައެޅުމުގެ ސަރަހައްދުތަކުގައި އުކުޅަސް ކުރުމަށް އެޕްރޫވް ބޭނުންކުރުމަށް ކައުންސިލުން ކަނޑައެޅިނީ 07 ޑިސެމްބަރ 2017 ވީ ބުރާސްފަތި ދުވަހުގެ 09:30 ގައި އޮތް ކައުންސިލްގެ (Y) U-4/2017/03-27 ނަންބަރު ޖަލްސާއިން އިއްތިފާޤުން ނަރުދަމާގެ މަސައްކަތްތަކުގެ ކަނޑައަޅާ ބިންތަކުގެ އުމަސައްކަތްތަކުގެ ބޭނުންކުރުމަށްވެސް ކަނޑައަޅާ މިފަދަ ކައުންސިލްގެ 03 މެމްބަރުންގެ އިއްތިފާޤުން ފާސްކޮށްފިއެވެ.

ޝައުކަތު އިބްރާހީމް
އއ. އުކުޅަސް ކައުންސިލްގެ ރައީސް

މޯބައިލް ނަންބަރު	އައިޑީ ކާޑު ނަންބަރު	ސޮއި	މަޤާމް	އެޑްރެސް	ނަން	އަދަދު
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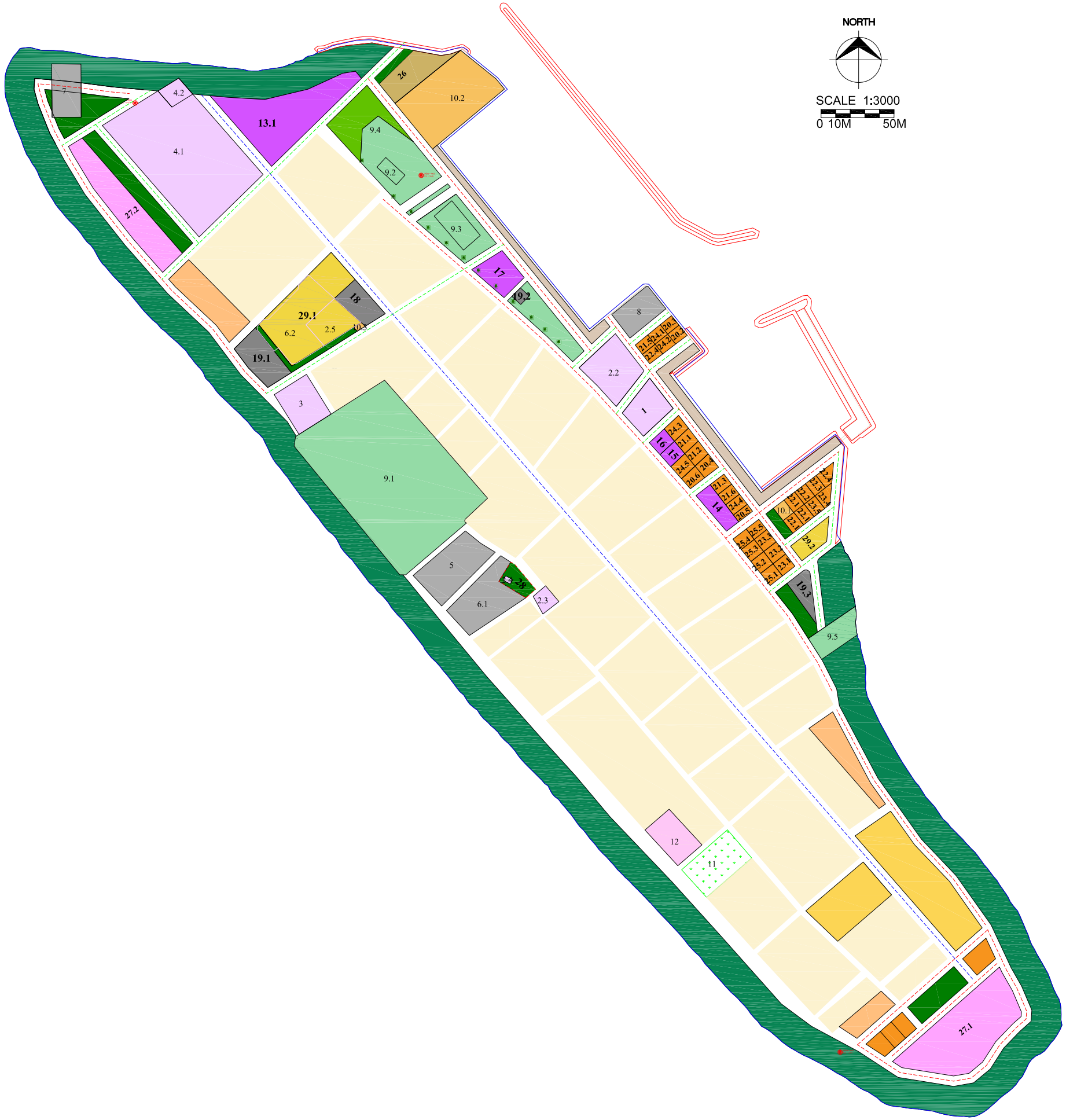
7943727	A007900		ކައުންސިލްގެ ނައިބު ރައީސް	ނާރެސް/ އއ. އުކުޅަސް	އަލްފާޟިލް އަބްދުﷲ ވިޔާޒް	02
7906804	A009371		ކައުންސިލްގެ މެންބަރު	ގުލްޝަނުގެ/ އއ. އުކުޅަސް	އަލްފާޟިލް މުޙައްމަދު ހުސައިން	03

APPENDIX D- LAND USE PLAN



AA.UKULHAS: PROPOSED LAND USE PLAN

LEGEND

EXISTING LAND USE

- **RESIDENTIAL ZONE**
- **INSTITUTIONAL & COMMUNITY ZONE**
  - *1 - Island Council Office*
  - *2.1 - Mosque*
  - *2.2 - Mosque*
  - *2.3 - Mosque*
  - *2.4 - Abandoned Mosque*
  - *2.5 - Abandoned Mosque*
  - *3 - Health Center*
  - *4.1 - AA Ukulhas School*
  - *4.2 - Pre-School*
- **UTILITIES AND MUNICIPAL ZONE**
  - *5 - Power House*
  - *6.1 - Cemetery*
  - *6.2 - Abandonded Cemetery*
  - *7 - Waste Management (to be relocated once island is reclaimed)*
  - *8 - Ferry Terminal*
- **SPORTS AND RECREATIONAL ZONE**
  - *9.1 - Football Pitch*
  - *9.2 - Volley Court*
  - *9.3 - Netball Court*
  - *9.4 - Stage*
  - *9.5 - Park*
- COMMERCIAL ZONE
  - *10.1 - Fuel Station*
  - *10.2 - Ice Plant*
  - *10.3 - Shop*
- **AGRICULTURAL ZONE**
  - *11 - Agricultural Plot*
- **TOURISM ZONE**
  - *12 - Tourist Guest House*
- *Existing Shoreline*
- *Existing Vegetation Line*
- *Existing Harbor Loading Area*
- *Existing Revetment/Coastal Protection*
- *Existing Permanent Station Markers*
  PSM 0001: 262837.5217E, 466474.8069N
  PSM 0002: 263008.6064E, 466340.4919N

PROPOSED LAND USE

- **RESIDENTIAL ZONE**
- **PUBLIC HOUSING FLAT DEVELOPMENT ZONE**
- **INSTITUTIONAL & COMMUNITY ZONE**
  - *13.1 - College/Junior College*
  - *13.2 - Pre-school*
  - *14 - Police Station*
  - *15 - Bank*
  - *16 - Post Office*
  - *17 - Community/Youth Centre*
  - *18 - Community Guest House (Rahvehige)*
- **UTILITIES AND MUNICIPAL ZONE**
  - *19.1 - Water Supply*
  - *19.2 - Dhirragu Telecommunications Tower*
  - *19.3 - Land for Sewerage Treatment Plant*
- **SPORTS AND RECREATIONAL ZONE**
- COMMERCIAL ZONE
  - *20.1 - 20.5 - Cafe/Restaurant*
  - *21.1 - 21.6 - Souvenir Shops*
  - *22.1 - 22.3 - Fuel Supply*
  - *23.1 - 23.3 - Hardware Shops*
  - *24.1 - 24.4 - Retail Shops*
- INDUSTRIAL ZONE
  - *25.1 - 25.6 - Warehouses*
  - *26 - Fish Processing Facility*
- **TOURISM DEVELOPMENT ZONE**
  - *27.1 - City Hotel Development Zone*
  - *27.2 - Guest House Development Area*
- **GREEN/OPEN SPACES**
- **CONSERVATION AREA**
  - *28 - Kuda Miskii*
- **ENVIRONMENTAL PROTECTION ZONE**
- **HARBOR AREA - LOADING/UNLOADING AREA**
- **RESERVED FOR FUTURE USE**
  - *29.1 - 29.2 - Reserved for non-residential uses*

ROADS

- 8m ROADS
- 7m ROADS
- 6m ROADS

PROJECT: **PREPARATION OF LAND USE PLAN FOR AA.UKULHAS**

TITLE : **PROPOSED LAND USE PLAN - AA . UKULHAS**

CLIENT : AA . UKULHAS ISLAND COUNCIL

SURVEYED BY : USMAN MOHAMED	DRAWN BY : MOHAMED AZIM	DATE : DECEMBER 2013	DWG No. 03
SCALE : AS GIVEN	CHECKED :		
IF IN DOUBT - ASK - DO NOT SCALE			

riyan pte. ltd.
Riyan pte.ltd. | 3rd Floor | H.Coleezium Ameenee Magu | Male' 20054 | Rep. of Maldives
T +9603315049 | F +9603310776
E info@riyan.com.mv | W www.riyan.com.mv

APPENDIX E-SITE PLAN FOR THE PROPOSED PROJECT

بسم الله الرحمن الرحيم

Ministry of Environment and Energy
Male', Republic of Maldives.

ފަރީދާ ދާއިރާ ތަރައްގީ ކުރުމުގެ ތަނ
ދަފާ، ދިވެހިރާއްޖެ.

ތިމާވެއްޓެއް ހުއްދަކުރުމާ ގުޅޭ ކަންކަން - ތިމާވެއްޓެ ހަދަން

ނަންބަރު: 438-WS/PRIV/2017/1197

ސުންގާ ކޮންސްޓްރަކްޝަން ކޯޕަރޭޝަން ލިމިޓެޑް،

ވަޒީރު ސަލާހުކުރައްވާ ފަދައިން.

ތއ. ދަންބަދޫ ކަނޑުގައި ހިއްދެވުމަށް ފާހަގަ ކުރެވިފައިވާ ތިމާ ގާތް

ތިމާ ގާތް ހިއްދެވުމަށް ހުއްދަ ދިނުމުގެ ފޯމް STC-PD/L-016/2017 (04 ޖެނުއަރީ 2017) ސާފު
ކުރުމަށް ފާހަގަ ކުރަމެވެ.

ކުރިން ދަންނަވާ ފަދައިން ތއ. ދަންބަދޫ ކަނޑުގައި ހިއްދެވުމަށް ފާހަގަ ކުރެވިފައިވާ ތިމާ ގާތް
ހިއްދެވުމަށް ހުއްދަ ދިނުމަށް ކުރިއަށް ގެންދާ ކަންތައް ހަމަ ވަންދެން ތިމާ ގާތް ހިއްދެވުމަށް ހުއްދަ
ދިނުން ހުއްޓާ ލުމަށް ދަންނަވަމެވެ. ވީމާ ތ.ވ.ދ.ގަ ގައުމީ ތަރައްގީ ކައުންސިލްގެ ތ.ތ.ގ.ގަ
ފާހަގަ ކުރެވިފައިވާ ތ.ތ.ގ.ގަ ތިމާ ގާތް ހިއްދެވުމަށް ހުއްދަ ދިނުން ހުއްޓާ ލުމަށް ފާހަގަ
ކުރަމެވެ.

ތިމާ ގާތް ހިއްދެވުމަށް ހުއްދަ ދިނުން ހުއްޓާ ލުމަށް ފާހަގަ ކުރެވުނު ކަމަށް ދަންނަވަމެވެ.

26 ރަބީޢުލްއައްވަލް 1439ھ.
14 ޖެނުއަރީ 2017ء.

ފާތިމަތު ނާދިރާ
ވުޒާރާ ވުޒާ
ޖެނެރަލް

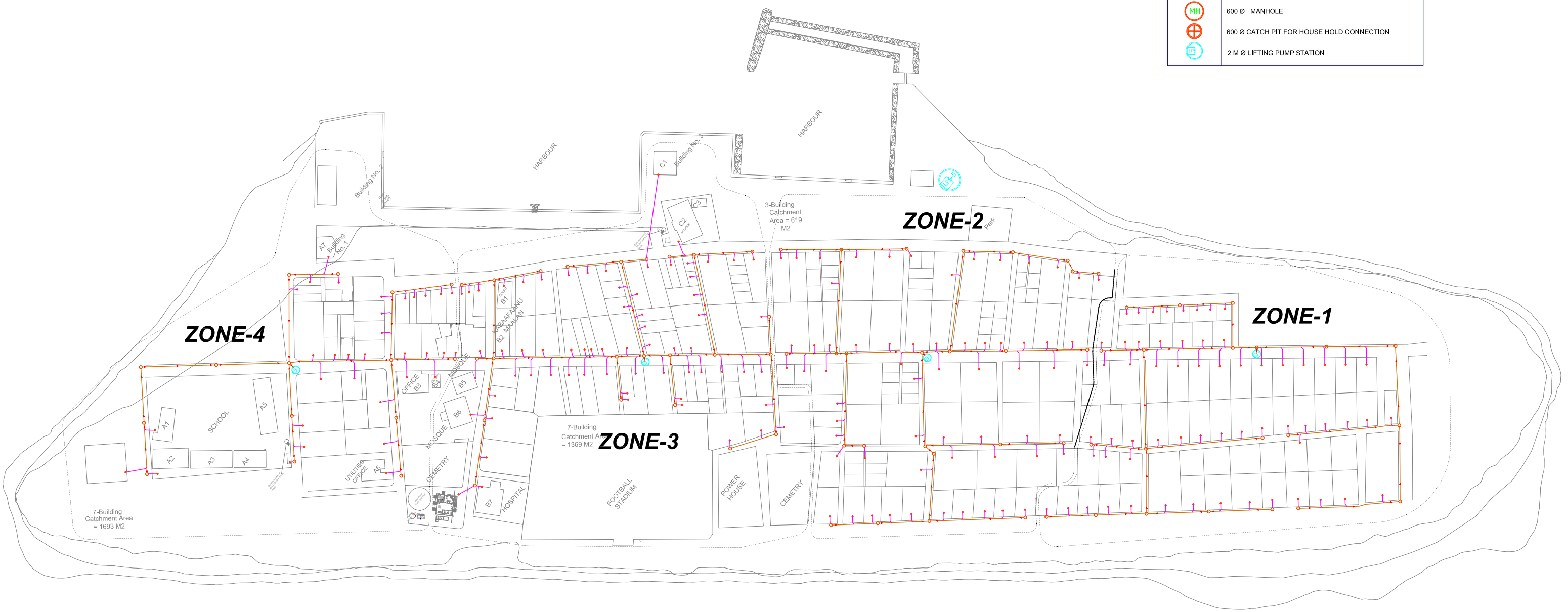
ސުންގާ ކޮންސްޓްރަކްޝަން ކޯޕަރޭޝަން ލިމިޓެޑް،
ދަފާ، ދިވެހިރާއްޖެ.

Green Building, Handhuvaree Hingun,
Maafannu, Male', 20392, Republic of Maldives.
+(960) 301 8300
+(960) 301 8301
www.environment.gov.mv

ފަރީދާ ދާއިރާ ތަރައްގީ ކުރުމުގެ ތަނ،
ދަފާ، 20392، ދިވެހިރާއްޖެ.
secretariat@environment.gov.mv
www.twitter.com/ENVgovMV
www.facebook.com/environment.gov.mv

LEGEND ;

SYMBOL	NAME
	160 Ø UPVC PIPE- SEWERAGE GRAVITY COLLECTION MAIN.
	110 Ø UPVC PIPE- SEWERAGE GRAVITY COLLECTION.
MH	600 Ø MANHOLE
	600 Ø CATCH PIT FOR HOUSE HOLD CONNECTION
LPS	2 M Ø LIFTING PUMP STATION



PRELIMINARY DESIGN-SEWERAGE NETWORK

A.A. UKULHUS ISLAND

SCALE- 1:100

Client;

Ministry of Environment and Energy, Republic of Maldives

Consultant;

M&E Contractor;

STATIC COMPANY
PRIVATE LIMITED

M. HURAA, FAREEDEE MAGU,
MALE 20256,
REPUBLIC OF MALDIVES

TEL : +960-3310313
FAX: +960-3326405

Project Title;

A.A. UKULHUS ISLAND.

Drawing Title; PRELIMINARY DESIGN

SEWERAGE NETWORK
A.A. UKULHUS ISLAND

NO. OF SUBMISSION:	1	2	3	4	5	6		
R1	AS PER THE LATEST CHANGE						03/12/17	BINU
R0	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SW-PMRY-DSGN - 01/05			R-1

PROPOSED LIFTING PUMP STATION-1(2.5m x 2.5m)
- Center of the Jumhooreemagu Near Empty Plot No.171

PROPOSED LIFTING PUMP STATION-No.2(2.5m x 2.5m)
- Center of Jumhooreemagu Near Ocean Meed

PROPOSED NEW SEWERAGE FACILITY
MAINTENANCE BUILDING 14m x10M

PROPOSED SEWERAGE SERVICE OFFICE EXISTING
WATER SUPPLY & ELECTRICITY PUBLIC SERVICE
OFFICE - Ukulhas Stelco Fenbuilding

PROPOSED LIFTING PUMP STATION-No.3 (2.5m x 2.5m)
- Center of the Jumhooreemagu Near Endherimaage

OPTION -01

SEWERAGE TREATMENT PLANT (Plant area 16m x16m for STP)-Near Fuel Supply ,
OUTFALL PUMPING STATION & OUTFALL LINE (3m x 3m for Pump Station).

OPTION -02

SEWERAGE TREATMENT PLANT (Plant area 16m x16m for STP),
-Near Ukulhas Mifco Building
OUTFALL PUMPING STATION & OUTFALL LINE (3m x 3m for Pump Station).

PROPOSED LIFTING PUMP STATION-No.3 (2.5m x 2.5m)
- Center of the Jumhooree Magu Near Kanmatheege

SEWERAGE OUT FALL LINE
Ø 160 MM PIPE

SEWERAGE OUT FALL LINE
Ø 160 MM PIPE

LAND ALLOCATION PLAN
A.A. UKULHUS ISLAND

SCALE- NTS

Client;
Ministry of Environment and Energy, Republic of Maldives

Consultant;

M&E Contractor;
STATIC COMPANY
PRIVATE LIMITED
M. HURAA, FAREEDEE MAGU,
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FAX: +960-3326405

Project Title;
SEWERAGE PROJECT-
A.A. UKULHUS

Drawing Title; PRELIMINARY DESIGN
SEWERAGE NETWORK
LAND ALLOCATION PLAN

NO. OF SUBMISSION:	1	2	3	4	5	6		
R0	LAND ALLOCATION PLAN						27/11/17	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	27/11/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SW-LAN-DSGN - 01			R-0

Client;

Ministry of Environment and Energy, Republic of Maldives

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M&E Contractor;

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PRIVATE LIMITED

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REPUBLIC OF MALDIVES

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FAX: +960-3326405

Project Title;

A.A. UKULHUS ISLAND.

Drawing Title; PRELIMINARY DESIGN

SEWERAGE NETWORK
A.A. UKULHUS ISLAND

NO. OF SUBMISSION:	1	2	3	4	5	6		
R1	AS PER THE LATEST CHANGE						03/12/17	BINU
R0	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
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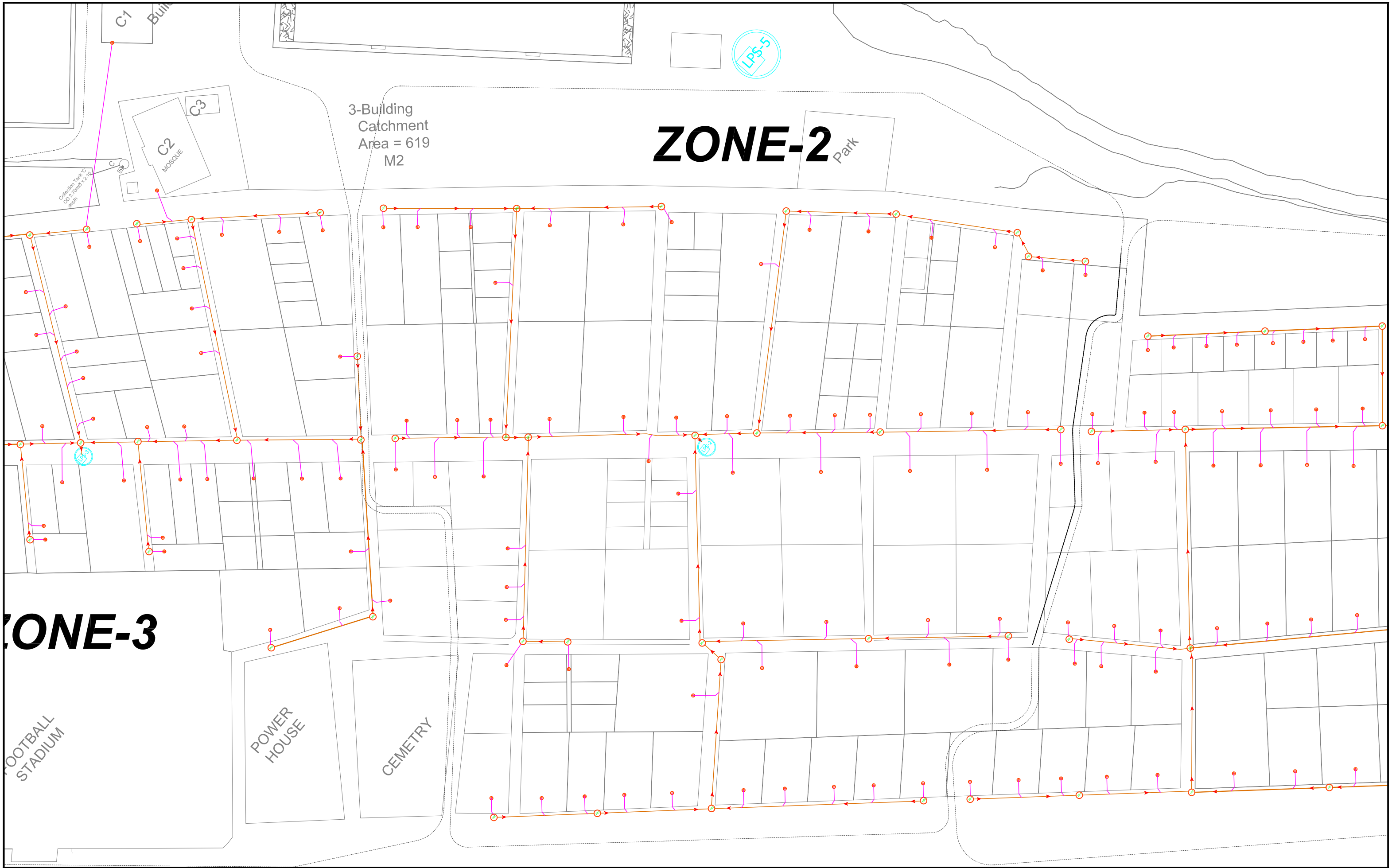
Dwg No.			Revision
STC-UKS-SW-PMRY-DSGN - 02/05			R-1



Client;

Ministry of Environment and Energy, Republic of Maldives

Consultant;

M&E Contractor;

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PRIVATE LIMITED

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MALE 20256,
REPUBLIC OF MALDIVES

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FAX: +960-3326405

Project Title;

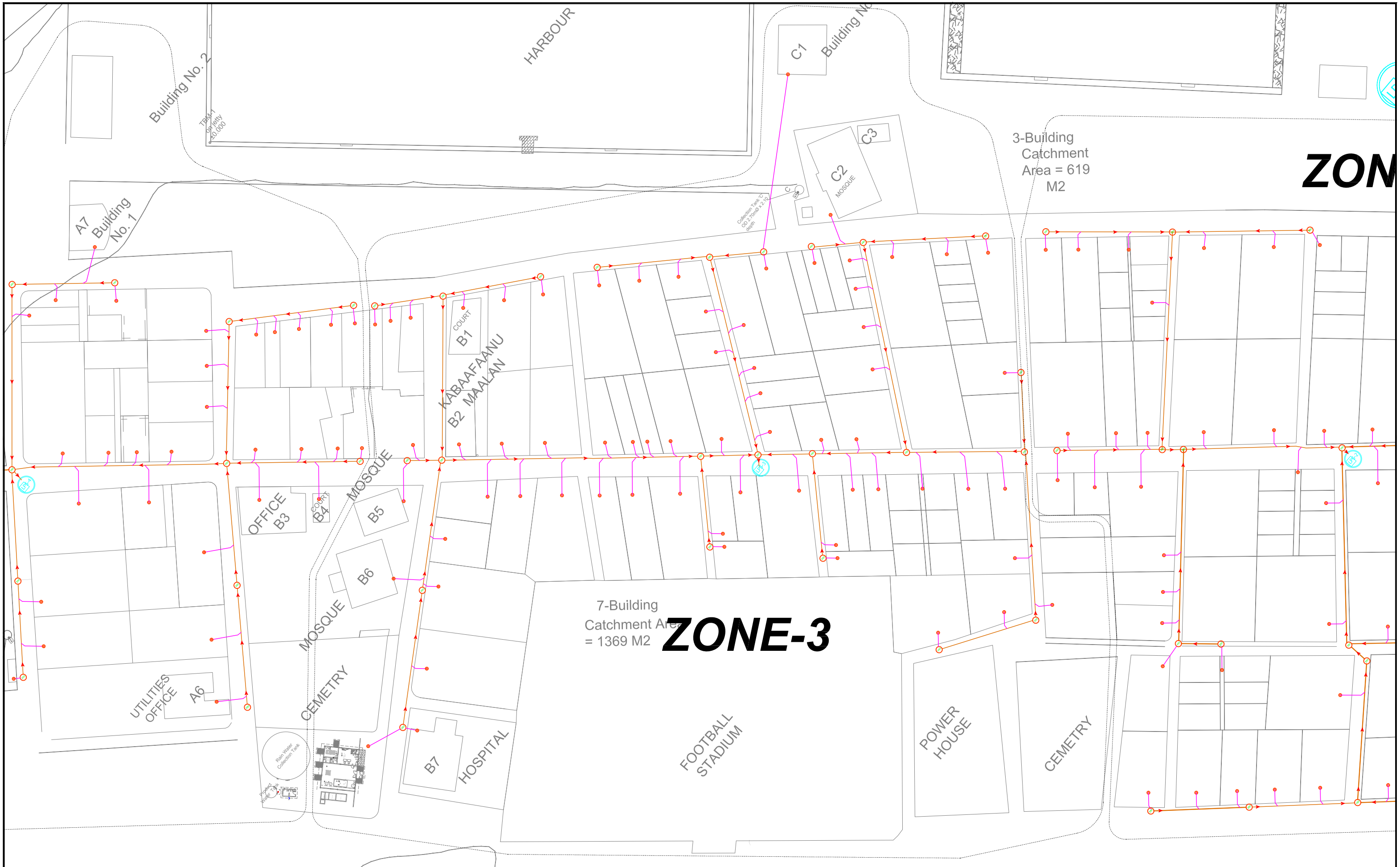
A.A. UKULHUS ISLAND.

Drawing Title; PRELIMINARY DESIGN

SEWERAGE NETWORK
A.A. UKULHUS ISLAND

NO. OF SUBMISSION:	1	2	3	4	5	6		
RO	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SW-PMRY-DSGN - 03/05			R-1



Client;

Ministry of Environment and Energy, Republic of Maldives

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M&E Contractor;

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PRIVATE LIMITED

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MALE 20256,
REPUBLIC OF MALDIVES

TEL : +960-3310313
FAX: +960-3326405

Project Title;

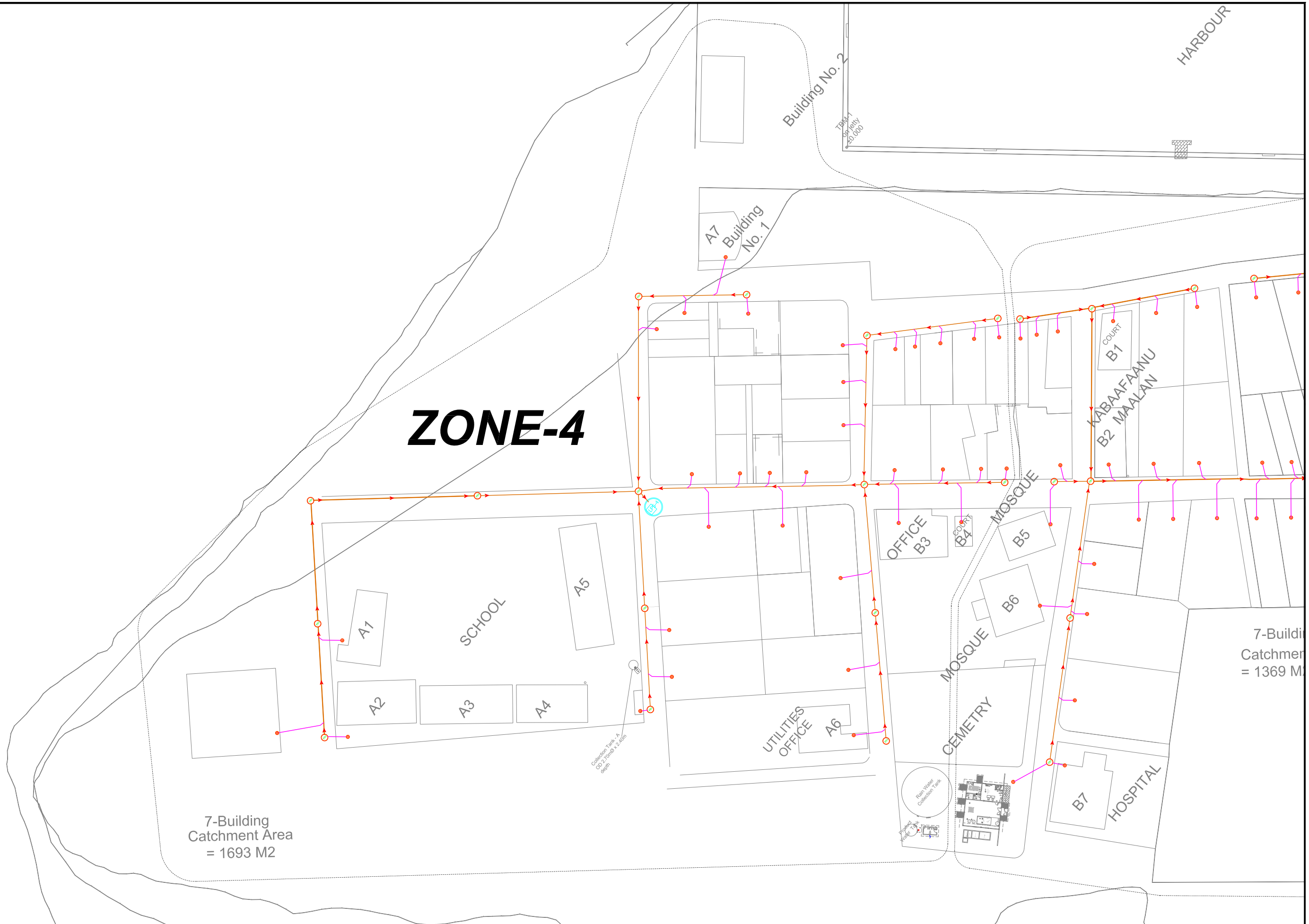
A.A. UKULHUS ISLAND.

Drawing Title; PRELIMINARY DESIGN

SEWERAGE NETWORK
A.A. UKULHUS ISLAND

NO. OF SUBMISSION:	1	2	3	4	5	6		
R1	AS PER THE LATEST CHANGE						03/12/17	BINU
R0	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SW-PMRY-DSGN - 04/05			R-1



Client;

Ministry of Environment and Energy, Republic of Maldives

Consultant;

M&E Contractor;

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MALE 20256,
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Project Title;

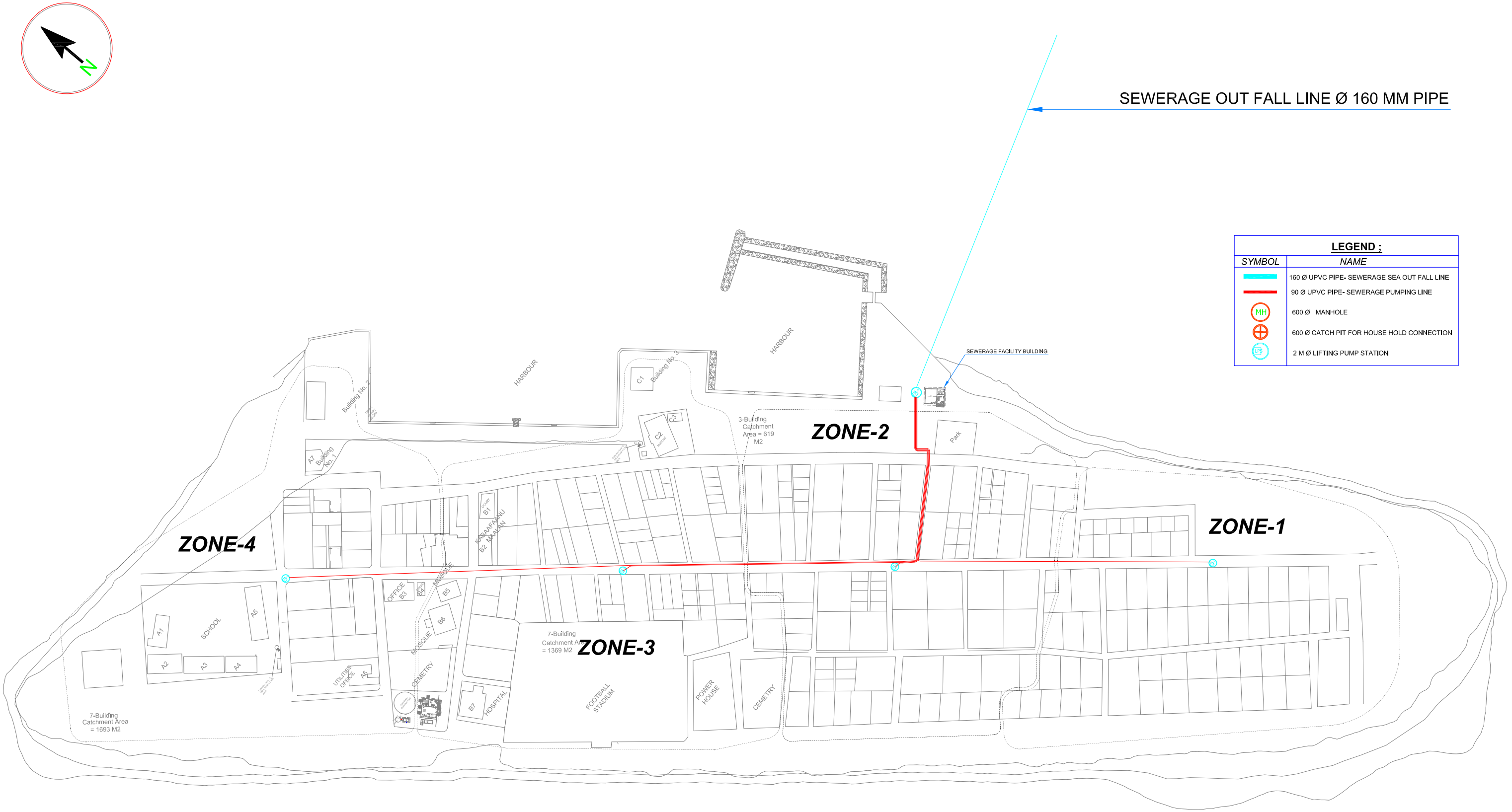
A.A. UKULHUS ISLAND.

Drawing Title; PRELIMINARY DESIGN

SEWERAGE NETWORK
A.A. UKULHUS ISLAND

NO. OF SUBMISSION:	1	2	3	4	5	6		
R1	AS PER THE LATEST CHANGE						03/12/17	BINU
R0	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SW-PMRY-DSGN - 05/05			R-1



PRELIMINARY DESIGN-SEWERAGE PUMPING LINE

A.A. UKULHUS ISLAND

SCALE- 1:100

Client;

Ministry of Environment and Energy, Republic of Maldives

Consultant;

M&E Contractor;

STATIC COMPANY PRIVATE LIMITED

M. HURAA, FAREEDEE MAGU,
MALE 20256,
REPUBLIC OF MALDIVES

TEL : +960-3310313
FAX: +960-3326405

Project Title;

A.A. UKULHUS ISLAND.

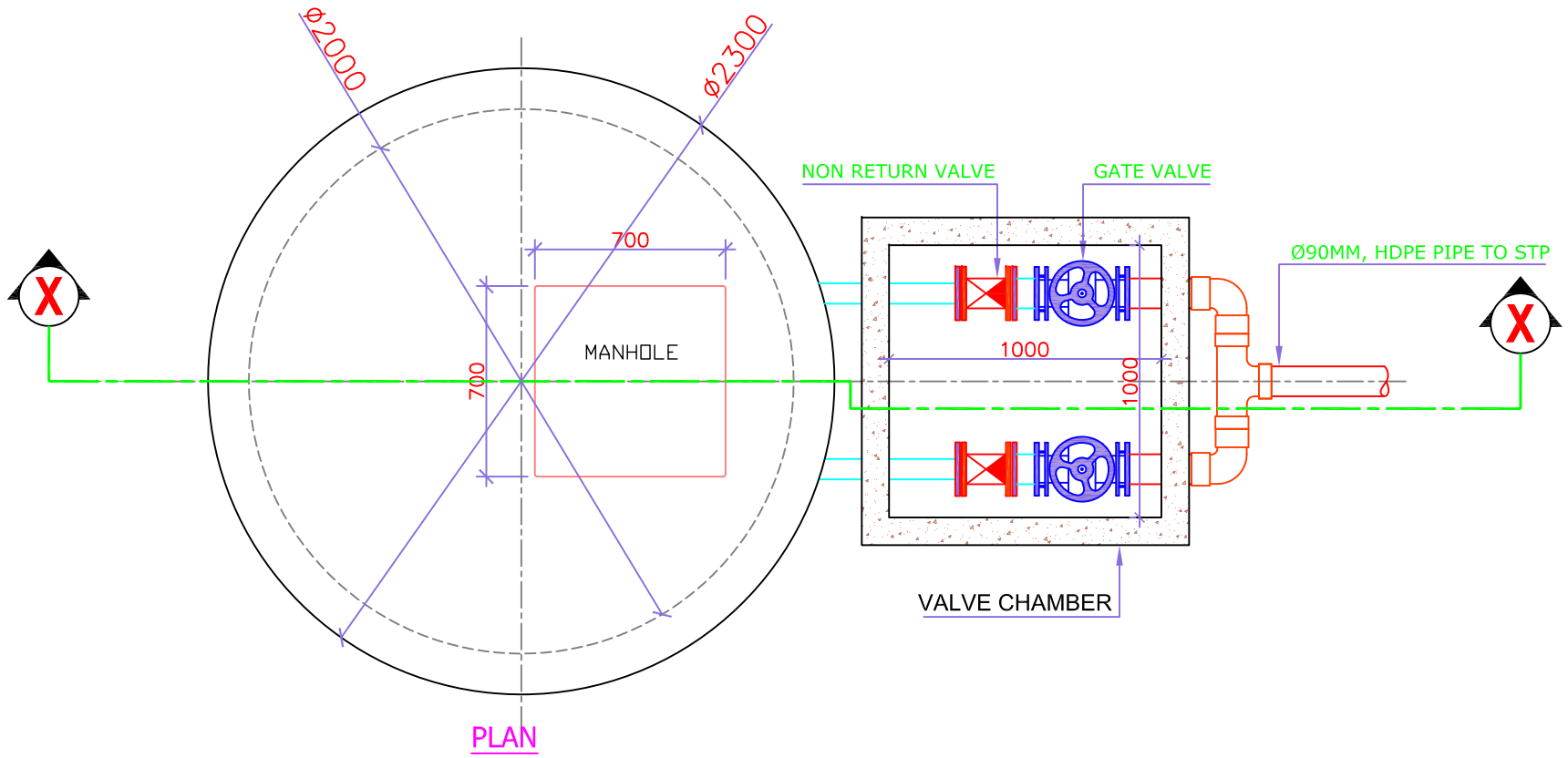
Drawing Title; PRELIMINARY DESIGN

SEWERAGE PUMPING LINE A.A. UKULHUS ISLAND

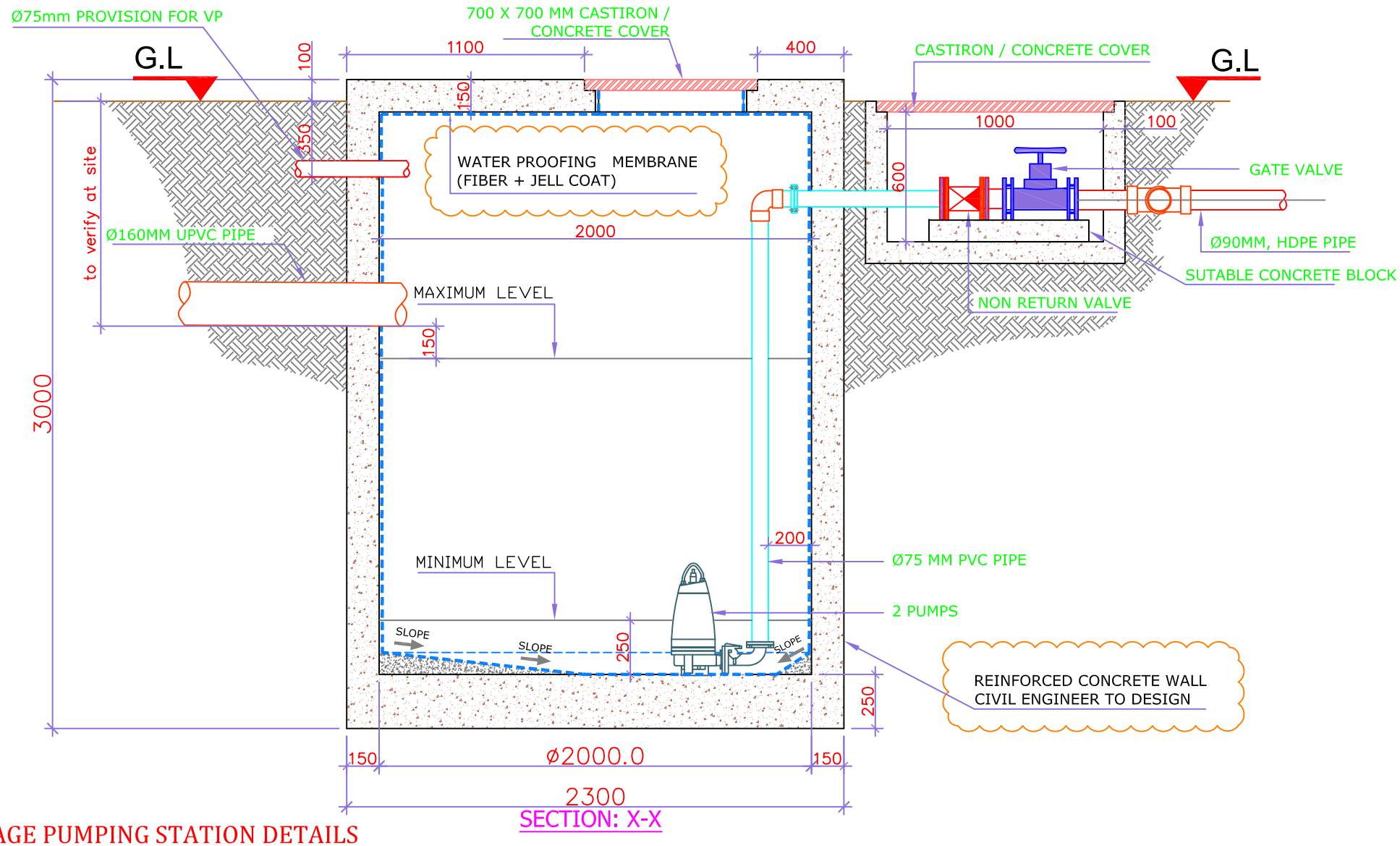
NO. OF SUBMISSION:	1	2	3	4	5	6		
R1	AS PER THE LATEST CHANGE						03/12/17	BINU
R0	PRELIMINARY DESIGN						15/02/16	BINU
Rev.	Description						Date	Made By

Design/Drawn	BINU	Date	03/12/17
Checked	LATHEEF	Scale	N/A
Approved		Job No.	N/A
File Path			
Dwg No.			Revision
STC-UKS-SPL-PMRY-DSGN - 01/00			R-1

APPENDIX F-PUMPSTATION DRAWING



PLAN



SECTION: X-X

TYPICAL SEWERAGE PUMPING STATION DETAILS
UKULHUS ISLAND DEVELOPMENT PROJECT
SCALE: NTS

NOTE:
– UNITS FOR ALL THE PIPE LINES ARE IN MILLIMETERS
– ALL UNKNOWN UNITS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED

NO. OF SUBMISSION:	1	2	3	4	5	6
R-01	AS PER THE LATEST REQUIRMENT			BINU	14/07/17	
REV.NO.	REVISION			MADE BY	DATE:	

CLIENT:

CONSULTANTS

MEP - CONTRACTOR;

STATIC COMPANY
PRIVATE LIMITED
M. HURAA, FAREEDEE MAGU,
MALE 20256,
REPUBLIC OF MALDIVES.
TEL : +960-3310313
FAX: +960-3326405

PROJECT TITLE:
UKULHUS ISLAND-DEVELOPMENT PROJECT

DRAWING:
TYPICAL PUMPING STATION DETAILS FOR LAND AREA.

DESIGNED BY:	CHECKED BY:
BINU	LATHEEF

SCALE:	DATE:
NOT TO SCALE ASK IF IN DOUBT	23-10-2017

SERVICE:
M E P SERVICES

DWG NO:	Revision:
STC-UKS-PS-SD-001	R:0

APPENDIX G-DETAILED WORKPLANS OF PROPOSED PROJECT

Static Company Pvt Ltd

Project Name:- AA.Ukulhas Sewerage Project
Subject:- Work Schedule 20th September 2017 to 20th September 2018.

Item Duration
Schedule
Progress

Date: 27th November 2017.

#	Details	No.Weeks		Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
Project Period			Progress													
1	Mobilization															
1.1	Submission of Bank Guaranties & Insurance	4	100%													
1.2	Request and Receipt of Advance	4	100%													
1.3	Submission of Inception Report & Approval	2	50%													
1.4	Submission of Prilim. Design Report & Approval	2	50%													
1.5	Land Survey	4	75%													
1.6	EIA Survey	4	10%													
1.7	Detail Design	4	0													
1.8	EPA , MEA & MEE Approval of the Detail Design	3	0													
1.9	Preperation of Temporarry Facilities	8	20%													
1.10	Mobilization to Site	9	20%													
2	Procurement															
2.1	Placing Orders & Supply of Pipes and Fittings	16	20%													
2.2	Placing Orders & Supply of Electrical & Machanical Items	16	0%													
2.3	Placing Orders & Supply of Construction Items	3	20%													
3	Installation Works															
3.1	Construction of Pump Stations	23	0													
3.2	Installation of Pipes & Fittings	28	0													
3.3	Installation of Electro Mechanical Items	5	0													
4	Final Connection, T&C and Hand over		0													
4.1	Connection to Consumers	8	0													
4.2	Testing Commissioning and Hand Over	4	0													

APPENDIX H- WATER TEST RESULTS FROM MWSC

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: 500178096

Customer Information:
Mahfooz Abdull Wahhab
A293039

K.villingili -

Report date: **02/01/2018**
Test Requisition Form No: **900182727**
Sample(s) Recieved Date: **24/12/2017**
Date of Analysis: **24/12/2017 - 30/12/2017**

Sample Description	AA.Ukulhas PS-1	PS-2	PS-3	**TEST METHOD**	**UNIT**
Sample Type	Ground Water	Ground Water	Ground Water		
Sample No	83195629	83195630	83195631		
Sampled Date	22/12/2017	22/12/2017	22/12/2017		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Pale yellow with particles	Clear with particles	Clear with particles		
Conductivity	944	247	1157	Method 2510 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	µS/cm
pH	7.65	6.51	7.20	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	0.46	0.12	0.57	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	23.0	21.5	21.2	Electrometry	°C
Biological Oxygen Demand (BOD)	3	2	6	HACH Method 8043	mg/L

Keys: µS/cm : Micro Seimen per Centimeter, **‰** : Parts Per Thousand, **°C** : Degree Celcius, **mg/L** : Milligram Per Liter

Checked by

Aminath Sofa
Assistant Laboratory Executive

Approved by

Mohamed Eyman
Assistant 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

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

MWSC

WATER QUALITY TEST REPORT

Report No: 500178096

Customer Information:
Mahfooz Abdull Wahhab
A293039

K.villingili -

Report date: **02/01/2018**
Test Requisition Form No: **900182727**
Sample(s) Recieved Date: **24/12/2017**
Date of Analysis: **24/12/2017 - 30/12/2017**

Sample Description	PS-4	OF-1	A-1	**TEST METHOD**	**UNIT**
Sample Type	Ground Water	Ground Water	Ground Water		
Sample No	83195632	83195633	83195634		
Sampled Date	22/12/2017	22/12/2017	22/12/2017		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Clear with particles	Pale yellow with particles	Clear with particles		
Conductivity	737	1195	606	Method 2510 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	µS/cm
pH	7.41	7.20	7.53	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	0.36	0.59	0.29	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	22.2	21.9	21.6	Electrometry	°C
Biological Oxygen Demand (BOD)	4	5	3	HACH Method 8043	mg/L

Keys: µS/cm : Micro Seimen per Centimeter, **‰** : Parts Per Thousand, **°C** : Degree Celcius, **mg/L** : Milligram Per Liter

Checked by

Aminath Sofa
Assistant Laboratory Executive

Approved by

Mohamed Eyman
Assistant 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 **********

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

MWSC

WATER QUALITY TEST REPORT

Report No: 500178097

Customer Information:
Mahfooz Abdull Wahhab
A293039

K.villingili -

Report date: **02/01/2018**
Test Requisition Form No: **900182727**
Sample(s) Recieved Date: **24/12/2017**
Date of Analysis: **24/12/2017 - 30/12/2017**

Sample Description	AA.Ukulhas M-1	M-2	M-3	**TEST METHOD**	**UNIT**
Sample Type	Sea Water	Sea Water	Sea Water		
Sample No	83195635	83195636	83195637		
Sampled Date	22/12/2017	22/12/2017	22/12/2017		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
pH	8.13	8.15	8.16	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	33.61	33.81	33.76	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Turbidity	0.305	0.306	0.273	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Nitrate	4.7	4.9	5.2	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	2500	2550	2450	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Phosphate	0.07	0.07	0.17	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Biological Oxygen Demand (BOD)	1	1	1	HACH Method 8043	mg/L

Keys: ‰ : Parts Per Thousand, **NTU** : Nephelometric Turbidity Unit, **mg/L** : Milligram Per Liter

Checked by

Aminath Sofa
Assistant Laboratory Executive

Approved by

Mohamed Eyman
Assistant Manager, Quality

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

This test report is ONLY FOR THE SAMPLES TESTED.
~ Information provided by the customer

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

APPENDIX I-LAND AND HYDROGRAPHIC SURVEY REPORT

2017

Control Survey Report of AA.Ukulhas

TECHNICAL SURVEY REPORT

AHMED NASHID [BP02006] |NOVEMBER 2017

CLIENT: STATIC COMPANY PVT LTD

PROJECT MANAGER: HUSSAIN NEESHAM

Table of Contents

Abbreviations

GNSS	Global Navigation Satellite System
MLSA	Maldives Land Survey Authority
MoT	Ministry of Tourism
MSL	Mean Sea Level
PSM	Permanent Station Mark
STN	Station
T-GST	Tourism Goods and Service Tax
WGS	World Geodetic System
UTM	Universal Transverse Mercator

NOTE: All the distances, coordinates and elevation in this report, unless otherwise stated, are given in meters and all the angles are in Degrees, Minutes and Second unless otherwise stated.

Introduction

Purpose:

The purpose of this survey is to establish Geodetic points (hereafter referred as PSM) in AA.Ukulhas for AA.Ukulhas sewerage project by Static Company PVT LTD.

There was already established monuments in the island for LUP project by Riyan Pvt Ltd. Although, monuments meet the requirements of control survey guideline, it was not registered at MLSA. Hence, one of the objectives was to determine the difference between coordinates provided by Riyan Pvt Ltd and GNSS static observations in this project.

This document contains all the technical information of the control survey.

Site/Location Description

Declaration

Surveyor's Declaration

I, Ahmed NASHiD (Reg. No: BP 02006) hereby certify that this survey was conducted by me and was done in accordance with best Surveying practice to follow as closely to the current standards and guidelines published by the relevant authorities and to the terms agreed with Static Company PVT LTD.

May our Lord! Accept from us: He is the All-Hearing, the All-Knowing.

Ahmed NASHiD
Registered Land and Hydrographic Surveyor
Surveyor. Reg. No: BP02006
NIC No: A079666

Survey Team

Project manager

Name: Hussain Neesham

Contact No: +(960) 7784350

Email: neesham@gmail.com

Registered Land and Hydrographic Surveyor: (Chief Surveyor)

Name: Ahmed NASHiD

Surveying License No: BP02006

NID: A07966

Address: Beachroadge, Maafannu, Male'

Cell: 7790999

Email: mr.nashid@gmail.com

Assistant Surveyor:

Name: Moosa Latheef

NID: A314597

Address: G. Rivarin. Male'

Cell: 9909949

Email: latheif49@gmail.com

Equipment's

GR-5 Advanced GNSS RTK System.

FC-250 Field Controller

Compact, ruggedized, hand-held, Windows Mobile 6.5, field controllerfor big-time results Design, running MAGNET™ Field.

GNSS

G3 GNSS Receiver	GPS + GLONASS + Galileo*
Number of Channels	216 Universal Channels
WAAS/EGNOS	Yes
Antenna Type	Integrated Micro-Center Fence Antenna™ with Ground Plane

Accuracy

RTK	H:10mm + 1.0ppm
	V: 15mm + 1.0ppm
Static	H: 3mm + 0.5ppm
	V: 5mm + 0.5ppm

Communication

Optional Radio Type	Integrated UHF2 TX/RX, or 915MHz Spread Spectrum
Base Radio Output	0.01 - 1.0W, user selectable
Cellular Communications	Integrated GSM/GPRS or CDMA
Wireless Communications	Bluetooth®

MAGNET™ Field.

Collect field data with smart coding, stakeout in live roading, or simply measure the volume of a stock pile. All this and the ability to share data to cloud storage is all built into MAGNET Field.

Leica Sprinter 150M.

Technical Data	Sprinter 50	Sprinter 150	Sprinter 150M	Sprinter 250M
Art. No.	762628	762629	762630	762631
Height accuracies	standard deviation height measurement per 1 km double run (ISO 17123-2)			
-Electronic measurement*	2.0 mm	1.5 mm	1.5 mm	1.0/0.7* mm
-Optical measurement	With standard aluminium E-scale/numeral staff: 2.5 mm			
-Single staff reading	standard deviation: 0.6 mm (electronic) and 1.2 mm (optical) at 30 m			
Distance accuracies	standard deviation distance measurement 10 mm for D ≤ 10 m and (distance in m x 0.001) for D > 10 m			
Range	2 –100 m (electronic)			
Measuring modes		single and tracking		
Time for single measurement	<3 sec			
Compensator	magnet damped pendulum compensator (range +/- 10 min)			
Telescope	magnification (optical) 24x			
Data storage			up to 2'000 points	
Protection class	IP 55			
Power supply	AA dry cells (4 x LR6/AA/AM3 1.5 V)			
Weight	<2.5 kg			

* With Sprinter aluminium barcode staff, 0.7 mm can be achieved with Sprinter fibre glass barcode staff (3 m, 1 section)

Software's.

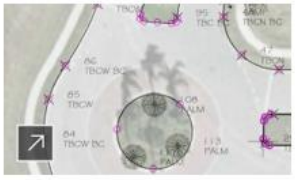
TOPCON Magnet Office

Magnet Office Tool Solution

Magnet Office Tools

Post Processing

AUTOCAD CIVIL 3D



GPS survey & data collection

Traverse Editor (enhanced)

Traverse Adjustment

Surface modeling

Base map creation

Point clouds

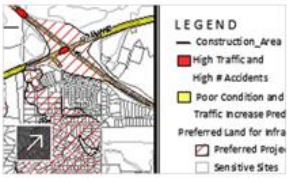
Visualization & analysis

Geospatial analysis

Model analysis

Visual analysis

River and flood analysis



Civil drafting & documentation

Add property set data to labels

Drafting standards

Map production

Reports and tables

Cross section view control

Control Survey

PSM established during this assignment would serve as high accuracy geodetic control points for all Land and Hydrographic Surveys carried out at AA.Ukulhas and its vicinity. Procedures adapted during this survey are as per Control Survey Guidelines published by MLSA (as of October 2015).

http://www.surveyofmaldives.gov.mv/v1/uploads/Control%20Survey%20Guideline%2023102015_.pdf

Survey Methodology

Horizontal Control

COORDINATE SYSTEM used is WGS84 and Projection is UTM Zone 43 North.

Permanent Survey Marks (PSM):

Permanent Station Marks (PSM) are the main stations marks that is needed to be registered at MLSA and constructed under MLSA's standards. AA.Ukulhas council was informed about the importance of these PSM's, not to disturb them, maintaining the sky views and by any chance, if they were to relocate it they should get permission from MLSA and follow MLSA's instructions.

Monumentation

All Monuments was established by Riyan Pvt Ltd for AA.Ukulhas LUP project and meet the requirements specified in control survey guideline.

PSM number platesPSM0172, PSM0173, PSM0174 were purchased from MLSA.

Specification of PSM

1. PSM0172

   Constructed to monument type A specification.

   - Concrete Casted in situ to 1m long and diameter 0.2m pvc pipe.
   - Casted and Finished to the 100mm above ground level.
   - 12mm rod driven to the center with cross mark.
   - Monument Labeled with PSM plate stating point number

   PSM0173 is visible from PSM0172.

2. PSM0173

   Constructed to monument type A specification.

   - Concrete Casted in situ to 1m long and diameter 0.2m pvc pipe.
   - Casted and Finished to the 100mm above ground level.
   - 12mm rod driven to the center with cross mark.
   - Monument Labeled with PSM plate stating point number

   PSM0172 is visible from PSM0173.

3. PSM017

   Constructed to monument type A specification.

   - Concrete Casted in situ to 1m long and diameter 0.2m pvc pipe.
   - Casted and Finished to the 100mm above ground level.
   - 12mm rod driven to the center with cross mark.
   - Monument Labeled with PSM plate stating point number

Observations and Data processing.

Initial coordinates

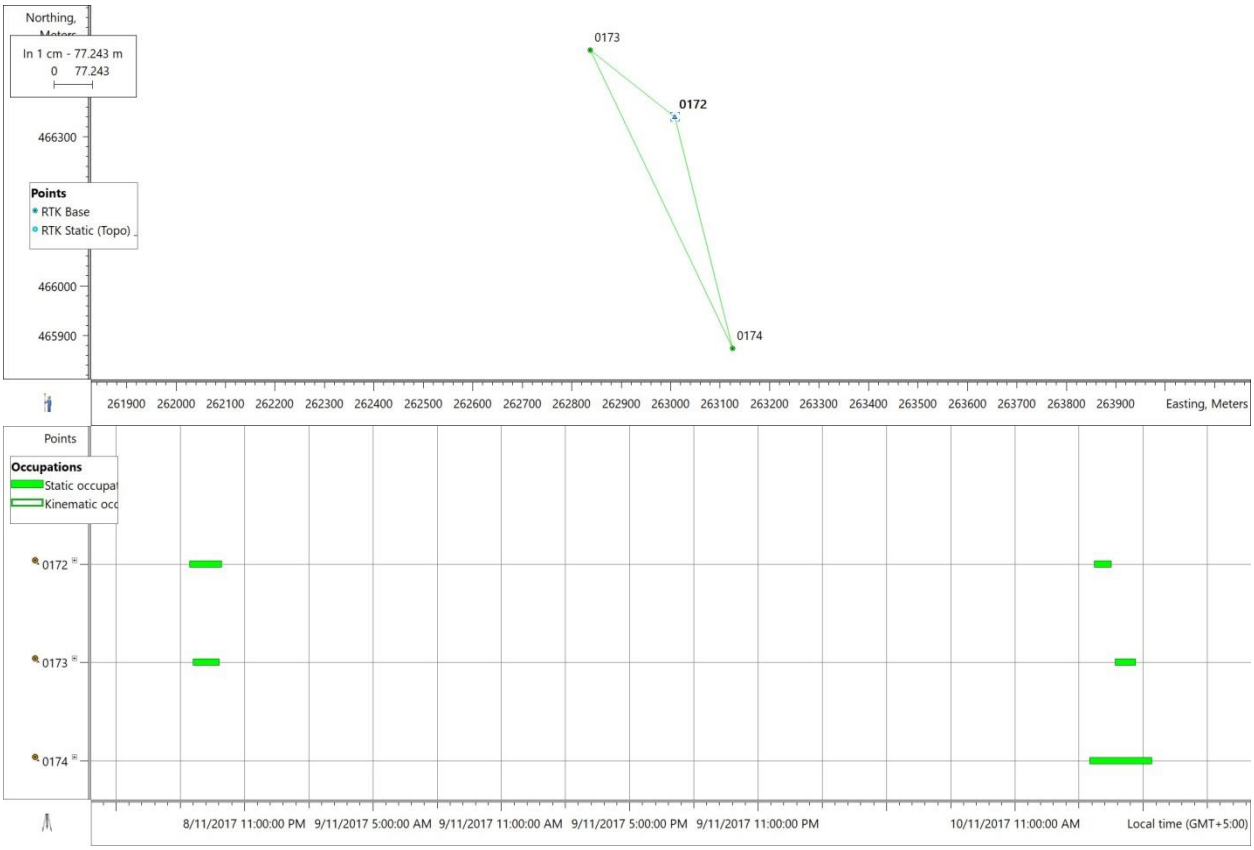
Initial Cordinatges					
Name	Ground Northing (m)	Ground Easting (m)	Elevation (m)	Code	Control
0174	465874.169	263125.989	3.472	PSM	None
0172	466340.194	263006.604	4.016	PSM,PSM	None
0173	466475.562	262835.219	6.947	PSM,PSM	None

GPS Occupations

GPS Ocupation									
Point Name	Original Name	Antenna Type	Antenna Height (m)	Ant Height Method	Start Time	Stop Time	Duration	GPS week,day	NEpoch
0172	0172A	GR-5/Atlas	1.706	Slant	14:43	15:31	0:47	1974314	2850
0173	0173A	GR-5/Atlas	1.658	Slant	15:41	16:40	0:58	1974314	3537
0173	173	GR-5/Atlas	1.546	Slant	20:36	21:50	1:14	1974312	4461
0172	172	GR-5/Atlas	1.577	Slant	20:25	21:57	1:31	1974312	5495
0174	174	GR-5/Atlas	1.622	Slant	14:30	17:25	2:55	1974314	10551

Minimum 30 minutes of baseline observation was maintained during GNSS static observations. The height of antenna's phase center above the station marker was measured and recorded to nearest millimeter to Topcon magnet field software using Topcon Hi-rod.

GPS Occupation View



Adjustment Results.

Baselines were adjusted and adjusted 3 dimensional coordinates were produced.

Loop Closures									
Loop	**dHz (m)**	**dU (m)**	**Horz Tolerance (m)**	**Vert Tolerance (m)**	**dHz (ppm)**	**dU (ppm)**	**Length (m)**	**dN (m)**	**dE (m)**
0172-0173(8/11/2017 8:36:16 PM)	0.0044	0.0086	0.0568	0.0668	3.25	6.34	1363.9932	0.0040	0.0019
0172-0174(10/11/2017 2:43:43 PM)									
0173-0174(10/11/2017 3:41:39 PM)									

Name	Ground Northing (m)	Ground Easting (m)	Elevation (m)	Code	Control	Std Dev n (m)	Std Dev e (m)	Std Dev u (m)	Std Dev Hz (m)
172	466340.492	263008.606	1.183	PSM,PSM	Both	0	0	0	0
173	466474.795	262837.519	1.463	PSM,PSM	None	0	0	0.001	0.001
174	465873.894	263124.827	1.905	PSM	None	0.001	0.001	0.003	0.002

Difference Between Adjustment Result and Coordinates Provided By Riyan Pvt Ltd.

	Ajusted Final			Coordinates Provided by RIYAN PVT LMT			Difference		
Point name	Northing (m)	Easting (m)	Elevation (m)	Northing (m)	Easting (m)	Elevation (m)	dN (m)	dE (m)	dHt (m)
0172	466340.492	263008.606	1.183	466340.492	263008.606	1.183	0	0	0
0173	466474.795	262837.519	1.463	466474.807	262837.522	1.460	-0.012	-0.003	0.003
0174	465873.894	263124.827	1.905	465873.903	263124.831	1.892	-0.009	-0.004	0.013

The difference between the coordinates obtained from the GNSS static survey was compared with the coordinates provided by Riyan Pvt Ltd. Since the difference was within the acceptable range and LUP of the Island was done using Riyan Pvt Ltd coordinates, it was used as a final PSM coordinates.

Control Network diagram is provided in Appendix 1 (CONTROL NETWORK MAP).

Vertical Control

Vertical Datum

Vertical Datum is Mean Sea Level.

MSL reduction

Tide correction procedure is from the publication New Zealand Nautical Almanac 2011-12 -Tidal Information.

http://www.linz.govt.nz/sites/default/files/docs/hydro/tidal-info/tide-tables/ mfth-between-hlw.pdf

TO FIND THE HEIGHT OF THE TIDE AT A GIVEN TIME

Using the form

1. Plot the time of high water on the time axis marked HW, and the time of low water on the time axis marked LW. Connect these two points by a straight line called the "time-line".

   Note: Hours from 0000 to 0800 are repeated on the right hand side of the scale for use when midnight (0000) falls between HW and LW.

2. Plot the height of high water on the height axis marked HW, and the height of low water on the axis marked LW. Connect these two points by a straight line called the "height-line".

3. To find the height of the tide for a given intermediate time, plot the time on the LW time axis, project it up to the time-line, go across to the curve, go down to the height-line then across to the LW height axis, from which the height can be read off.

Using the formula

If t_1 and h_1 denote the time and height of the tide (high or low) immediately preceeding time t, and t_2 and h_2 denote the height of the tide (high or low) immediately following time t, then the height h at time t is given by the following formula:

$$h = h_1 + (h_2 - h_1)[(\cos A + 1)/2]$$

where $A = \pi\{[(t - t_1)/(t_2 - t_1)] + 1\}$ radians

Note 1: On falling tides $(h_2 - h_1)$ will be negative.

Note 2: t, t_1 and t_2 are in decimal hours.

Vertical coordinate value (Z) was obtained by the taking sea level at 9:19 AM on 11 November 2017 and correcting it to Mean Sea Level by using Tide Table released by the University of Hawaii Sea Level Centre for Hulhule obtained from Maldives Meteorological Centre. The mean sea level of Hulhule tide station is 1.878m.

MALDIVES METEOROLOGICAL SERVICE

Hulhule', 22000, Republic of Maldives

☎ (+960) 332 3084, 💻 www.meteorology.gov.mv, ✉ admin@meteorology.gov.mv

HIGH AND LOW WATER PREDICTIONS FOR Hanimaadhoo
LAT:06 46N LONG:073 10E, local time, heights in centimeter

NOTE: These tide predictions are based on data collected between Oct. 1992 and October 1993. The mean sea level during this period was 209.6 cm. The datum for these tide predictions is the zero point of the tide staff at Hanimaadhoo, Rep. of Maldives established in July 1991. Please note that the quoted values are not related to chart datum and should be used with caution.

Sea Level Correction to MSL	
Mean of Male Tide Guage	1.878
t (water surface was measured)	9:19:00 AM
t1	4:04:00 AM
t2	10:06:00 AM
h1	2.211
h2	1.686
t-t1	5:15:00 AM
t1-t2	6:02:00 AM
h2-h1	-0.525
A	5.875
h	1.708
SEA LEVEL from MSL (m)	-0.170

Sea Level with reference to Mean sea level by Metrology department was determined as -0.170m. Level of PSM0172 with reference to water surface using SPRINTER was measured as 1.041m.

Name	BS	FS	R/F	RL_(MSL)	Date	Time
WL	2.5483	-	-	-0.170	11/11/2017	9:19:00 AM
PSM 0172	-	1.3364	1.2119	1.041	11/11/2017	9:20:00 AM

The required vertical accuracy is [10mm+4ppm]. With the Topcon GR5 geodetic receivers, vertical accuracy for post processing is 5mm +0.5ppm. Since the GR5 accuracy was within tolerance and conventional leveling for such a length on soft sand can lead to more uncertainties. Hence height of PSM0173 and PSM0174 were determined by GNSS Static Survey.

Difference Between Reduced level and Level Provided By Riyan Pvt Ltd.

	Reduced Level	Reduced Level By RIYAN PVT LMT	Difference
Point name	Elevation (m)	Elevation (m)	dHt (m)
PSM0172	1.041	1.183	-0.142

Level of PSM0172 was previously determined by Riyan Pvt Ltd and the difference was 0.142m. Since the difference is reasonable and previous surveys was done based on Riyan Pvt Ltd level, it was used as a final reduced level of PSM0172.

Topography and Bathymetry

Data acquisition

Ground levels was collected using GR5 GPS receiver on 2m pole attached to vehicle receiving RTK corrections from base station, ground levels recorded to field controller with Point number, Northing, Easting, Elevation (MSL) and Description. To present change in elevation at its best, sufficient data was collected in changing elevation of the ground and existing features.

For the depths of outfall areas, speed boat with an out-board engine was used. Hydrographic equipment was setup on right side of the boat. One and half meter pole was attached to the hull of survey vessel where 0.15m was submerged with echo sounder transducer attached to the bottom of submerged pole. The transducer offset is 0.15m. On top of the pole RTK GNSS rover receiver was attached.

Echo sounder was connected to the field computer via USB connection, and RTK GNSS data was fed to the bathymetric survey program via Bluetooth in NMEA format. Topcon Field Controller FC-250 was connected to RTK GNSS receiver via serial cable and Topcon Magnet Field program was used for navigation. Data processing

Data processing and presentation

All feature lines and points were exported from the controller and loaded to AutoCAD Civil 3D software for data processing and drafting. Anomalies in the echo sounding data were identified when TIN surface was created on AutoCAD Civil 3D. Once the data has been cleaned and confirmed TIN surface was labelled and represented with color bands. All cross-section views, spot heights, elevation bands are dynamic and scaled to present it clearly.

Final Data

Adjusted Final PSM Coordinates

Name	Ground Northing (m)	Ground Easting (m)	Elevation (m)	Code
0172	466340.492	263008.606	1.183	PSM
0173	466474.807	262837.522	1.460	PSM
0174	465873.903	263124.831	1.892	PSM

Appendix

1. CONTROL SURVEY MAP
2. PSM Sheets
3. Topographic survey Map
4. Topo-Bathy maps of outfall locations

AA.UKULHAS SEWERAGE

AHMED NASHID
SURVEY LICENSE NO: BP02006
BEACHROADGE, HANDHUVAREE
HIGUN, MALE'20306, MALDIVES.
CELL: +960779099
EMAIL: MR.NASHID@GMAIL.COM

LEGEND

PROFILE LINE

PSM

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING. ROVER ATTACHED WITH ECO SOUNDER FOR BATHYMETRY AND GNSS RTK POSITIONING FOR TOPOGRAPHY, RTK CORRECTION RECEIVED FROM BASE STATION SET ON PSM0173
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE

AA.UKULHAS SEWERAGE

CLIENT

STATIC COMPANY PVT LTD
+960 3310313
INFO@STATIC-COMPANY.COM
WWW.STATIC-COMPANY.COM

DRAWING TITLE

BATHYMETRY OF LOCATIONS FOR SEWERAGE OUTFALL

SHEET TITLE

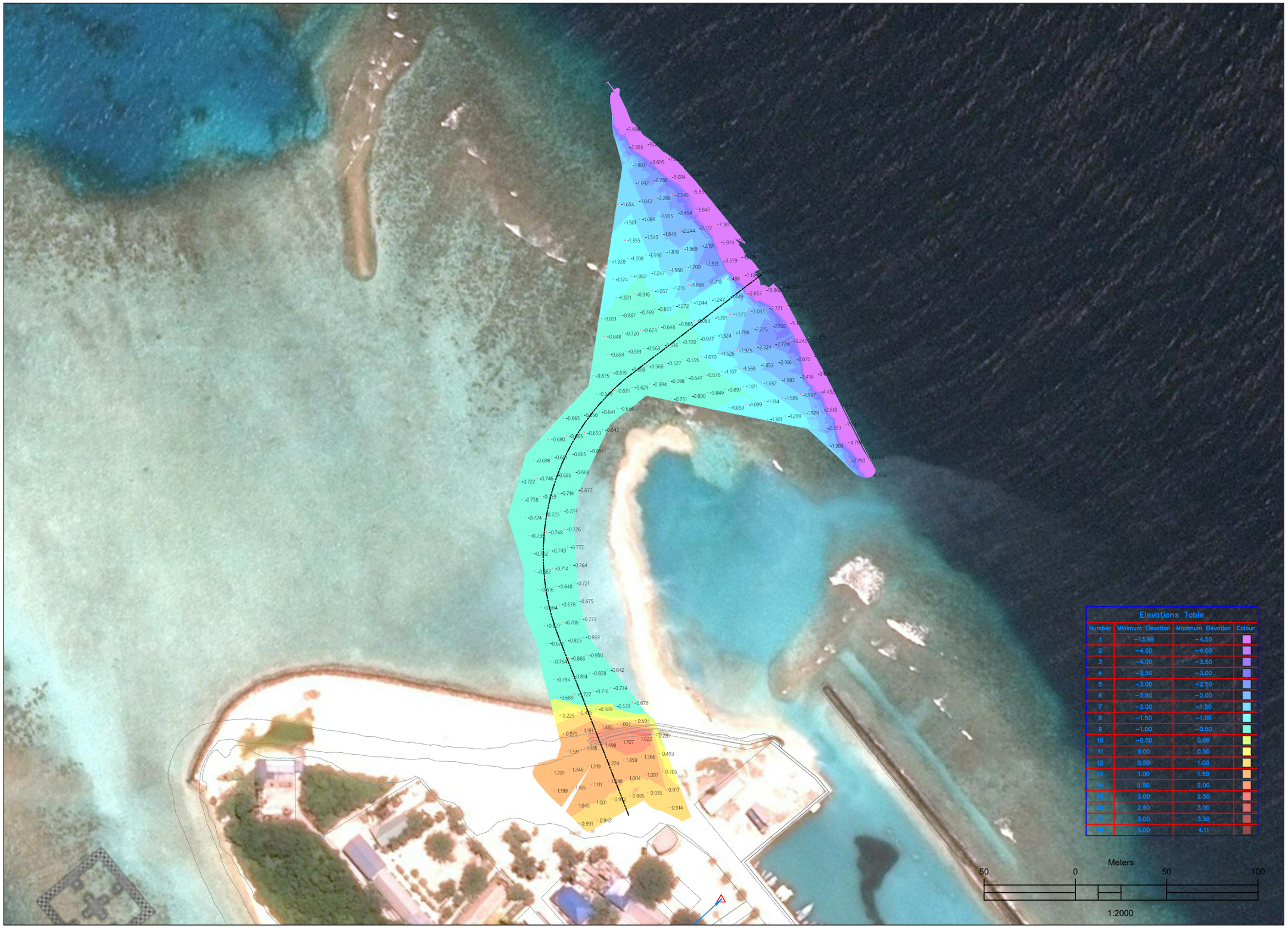
INDEX MAP

SURVEYOR AHMED NASHID MOHAMED SAEED	S/L # BP02006 BP07116
SURVEYED DATE	24/12/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	27-Dec-17
SCALE	1:5000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

AN/2017/128/02.1

AA.UKULHAS SEWERAGE



AHMED NASHID
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BEACHROADGE, HANDHUVAREE
HIGUN, MALE'20306, MALDIVES.
CELL: +960779099
EMAIL: MR.NASHID@GMAIL.COM

LEGEND

PROFILE LINE

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING. ROVER ATTACHED WITH ECO SOUNDER FOR BATHYMETRY AND GNSS RTK POSITIONING FOR TOPOGRAPHY, RTK CORRECTION RECEIVED FROM BASE STATION SET ON PSM0173
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE

AA.UKULHAS SEWERAGE

CLIENT

STATIC COMPANY PVT LTD
+960 3310313
INFO@STATIC-COMPANY.COM
WWW.STATIC-COMPANY.COM

DRAWING TITLE

BATHYMETRY OF LOCATIONS FOR SEWERAGE OUTFALL

SHEET TITLE

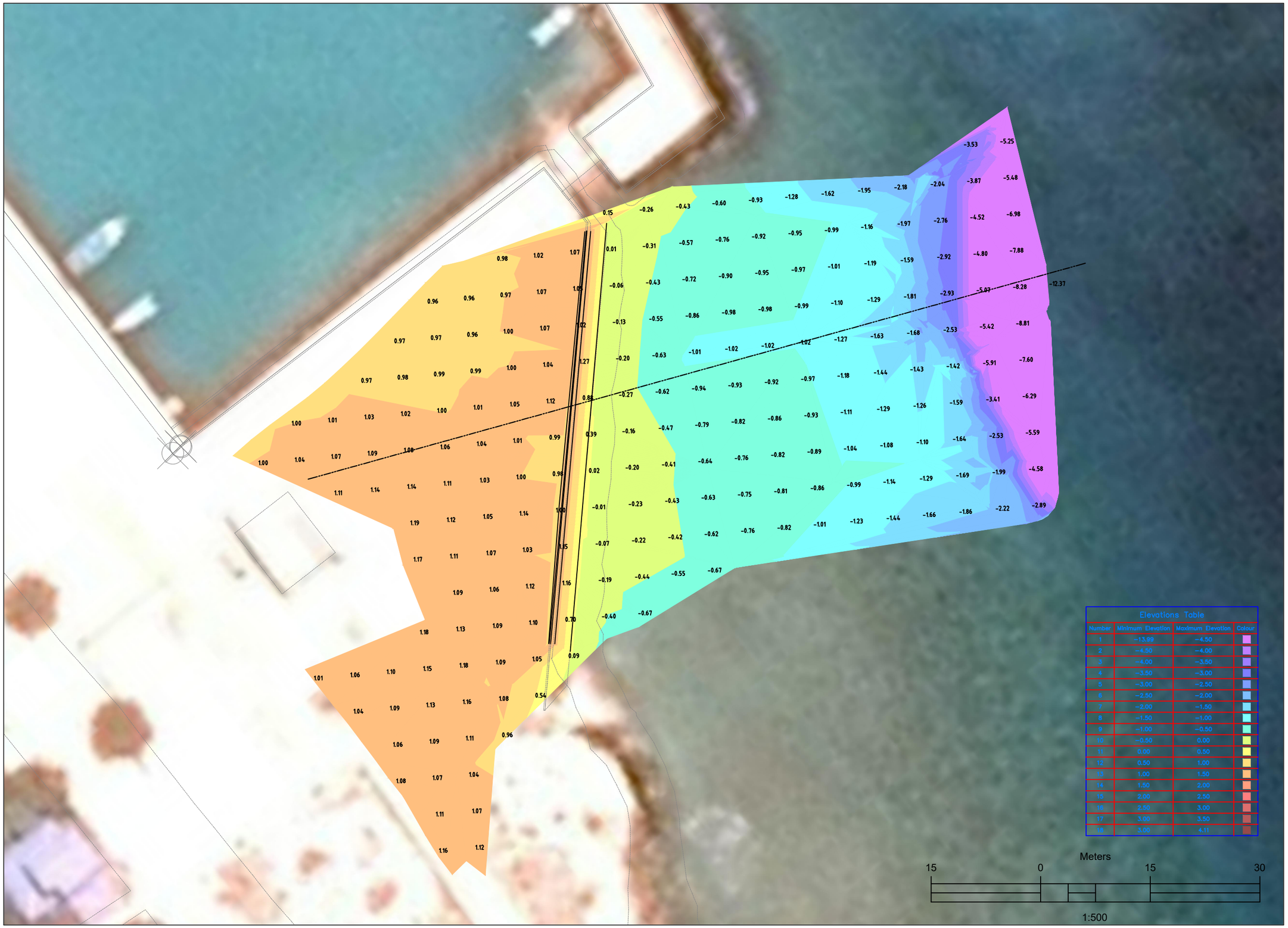
LOCATION 1

SURVEYOR AHMED NASHID MOHAMED SAEED	S/L # BP02006 BP07116
SURVEYED DATE	24/12/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	27-Dec-17
SCALE	1:2000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

AN/2017/128/02.2

AA.UKULHAS SEWERAGE



AHMED NASHID
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BEACHROADGE, HANDHUVAREE
HIGUN, MALE'20306, MALDIVES.
CELL: +960779099
EMAIL: MR.NASHID@GMAIL.COM

LEGEND

PROFILE LINE

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING. ROVER ATTACHED WITH ECO SOUNDER FOR BATHYMETRY AND GNSS RTK POSITIONING FOR TOPOGRAPHY, RTK CORRECTION RECEIVED FROM BASE STATION SET ON PSM0173
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE

AA.UKULHAS SEWERAGE

CLIENT

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FLEXINC PVT LTD

DRAWING TITLE

BATHYMETRY OF LOCATIONS FOR SEWERAGE OUTFALL

SHEET TITLE

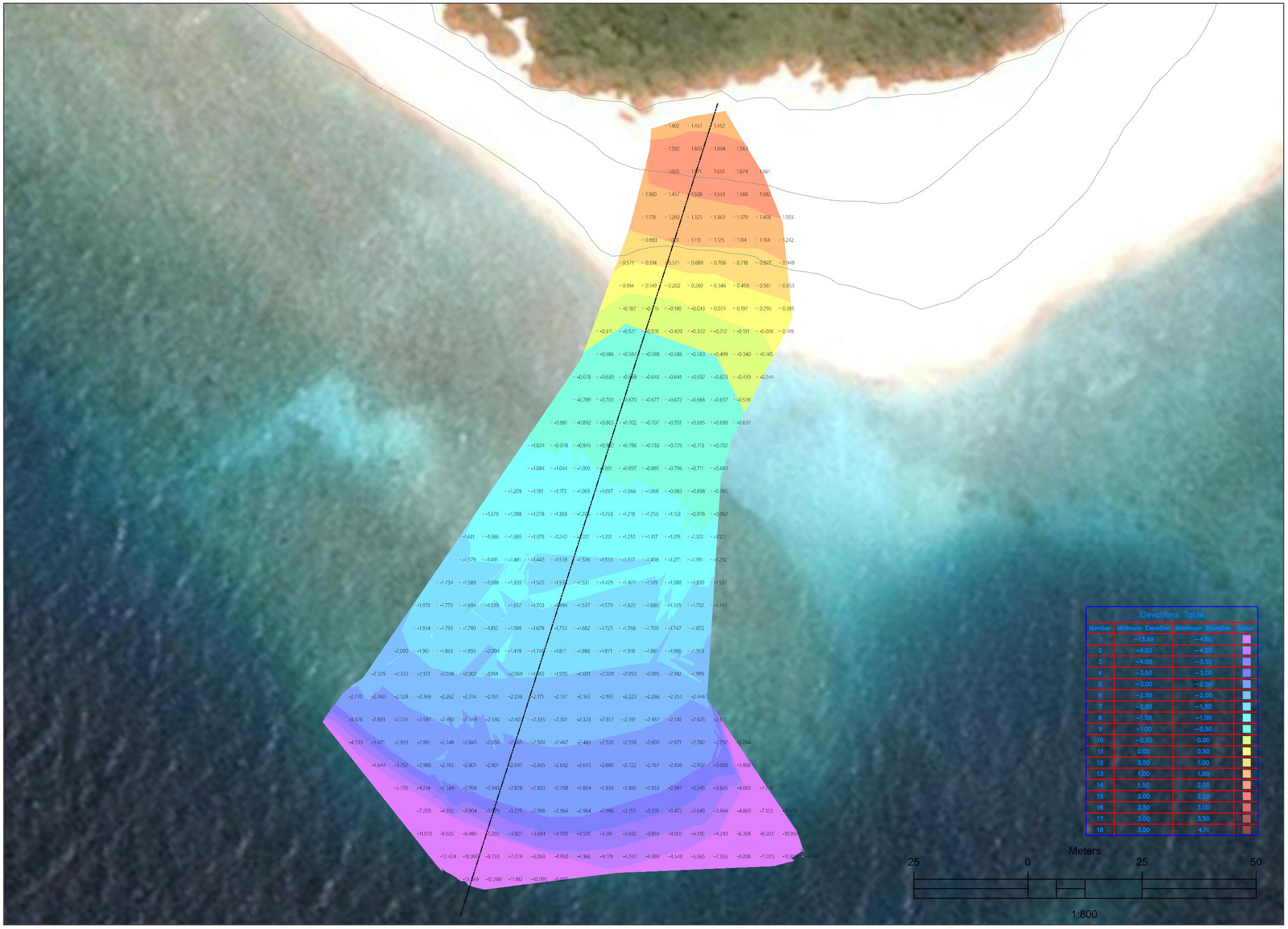
LOCATION 2

SURVEYOR AHMED NASHID MOHAMED SAEED	S/L # BP02006 BP07116
SURVEYED DATE	24/12/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	27-Dec-17
SCALE	1:500
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

AN/2017/128/02.3

AA.UKULHAS SEWERAGE



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LEGEND

PROFILE LINE

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING. ROVER ATTACHED WITH ECO SOUNDER FOR BATHYMETRY AND GNSS RTK POSITIONING FOR TOPOGRAPHY, RTK CORRECTION RECEIVED FROM BASE STATION SET ON PSM0173
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

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PROJECT TITLE

AA.UKULHAS SEWERAGE

CLIENT

STATIC COMPANY PVT LTD
+960 3310313
INFO@STATIC-COMPANY.COM
WWW.STATIC-COMPANY.COM

DRAWING TITLE

BATHYMETRY OF LOCATIONS FOR SEWERAGE OUTFALL

SHEET TITLE

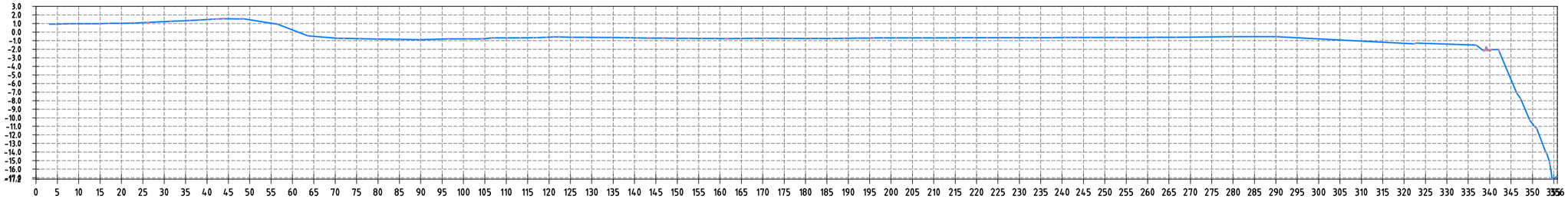
LOCATION 3

SURVEYOR	S/L #
AHMED NASHID	BP02006
MOHAMED SAEED	BP07116
SURVEYED DATE	24/12/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	27-Dec-17
SCALE	1:800
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

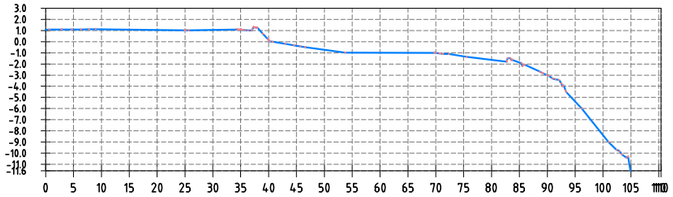
DRAWING NUMBER

AN/2017/128/02.4

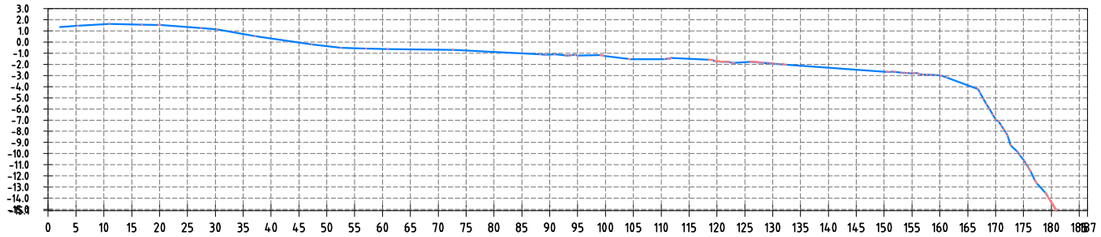
AA.UKULHAS SEWERAGE



LOCATION 1 PROFILE



LOCATION 2 PROFILE



LOCATION 3 PROFILE

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CELL: +960779099
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LEGEND

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- PROFILE VIEW ARE EXAGGERATED VERTICALLY TO 2 FOR CLEAR REPRESENTATION OF ELEVATIONS

REVISIONS

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PROJECT TITLE

AA.UKULHAS SEWERAGE

CLIENT

STATIC COMPANY PVT LTD
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WWW.STATIC-COMPANY.COM

DRAWING TITLE

BATHYMETRY OF LOCATIONS FOR SEWERAGE OUTFALL

SHEET TITLE

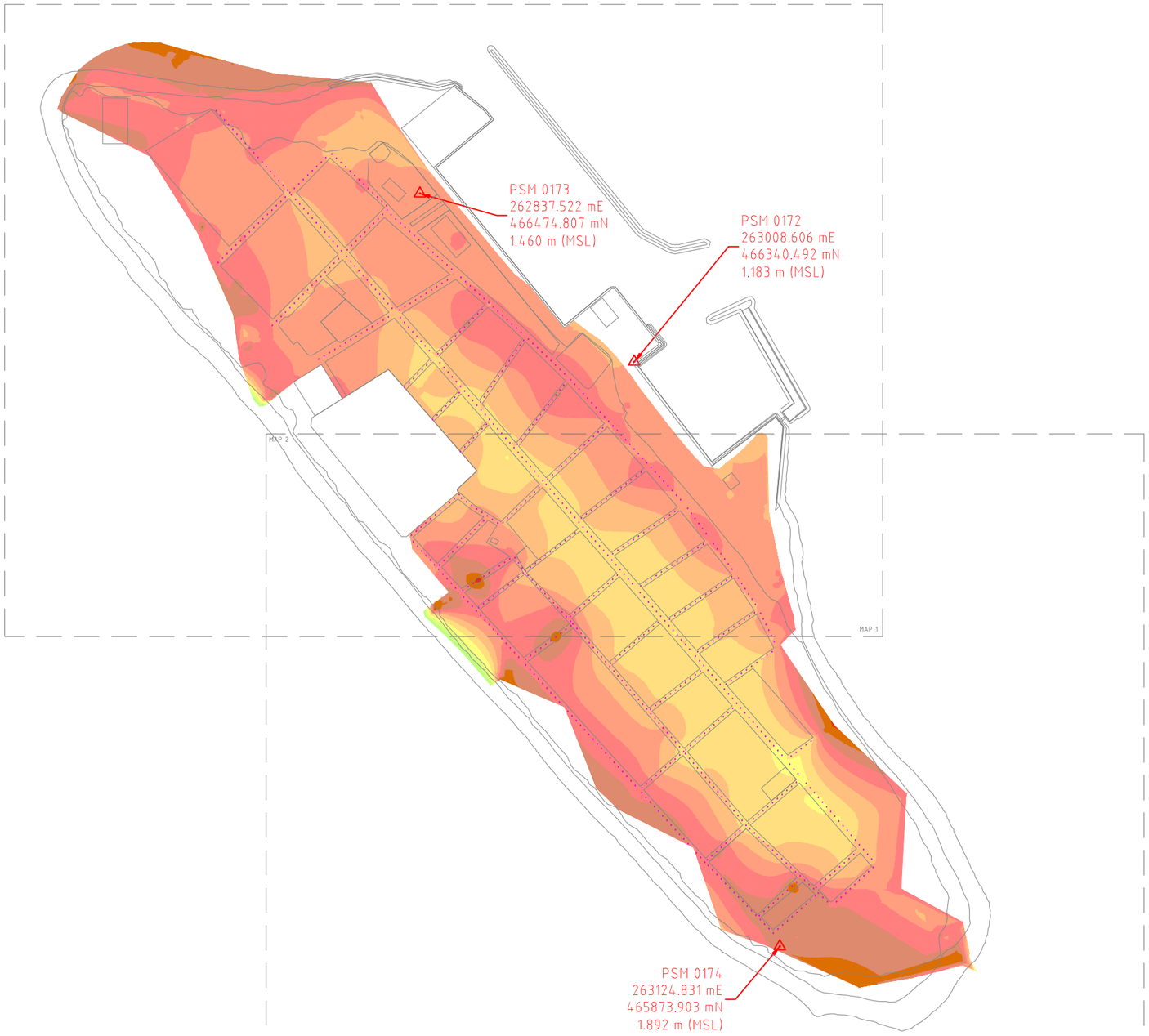
PROFILES

SURVEYOR	S/L #
AHMED NASHID	BP02006
MOHAMED SAEED	BP07116
SURVEYED DATE	24/12/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	27-Dec-17
SCALE	1:1100
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

AN/2017/128/02.5

AA. UKULHAS TOPOGRAPHIC SURVEY



Meters
200 0 200 400
1:4000

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LEGEND

- PSM
- MARKED ELEVATION
- SPOT HEIGHT
- PAGE BREAKS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- VERTICAL DATUM MSL

REVISIONS

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PROJECT TITLE
AA. UKULHAS SEWERAGE

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STATIC COMPANY PVT LTD
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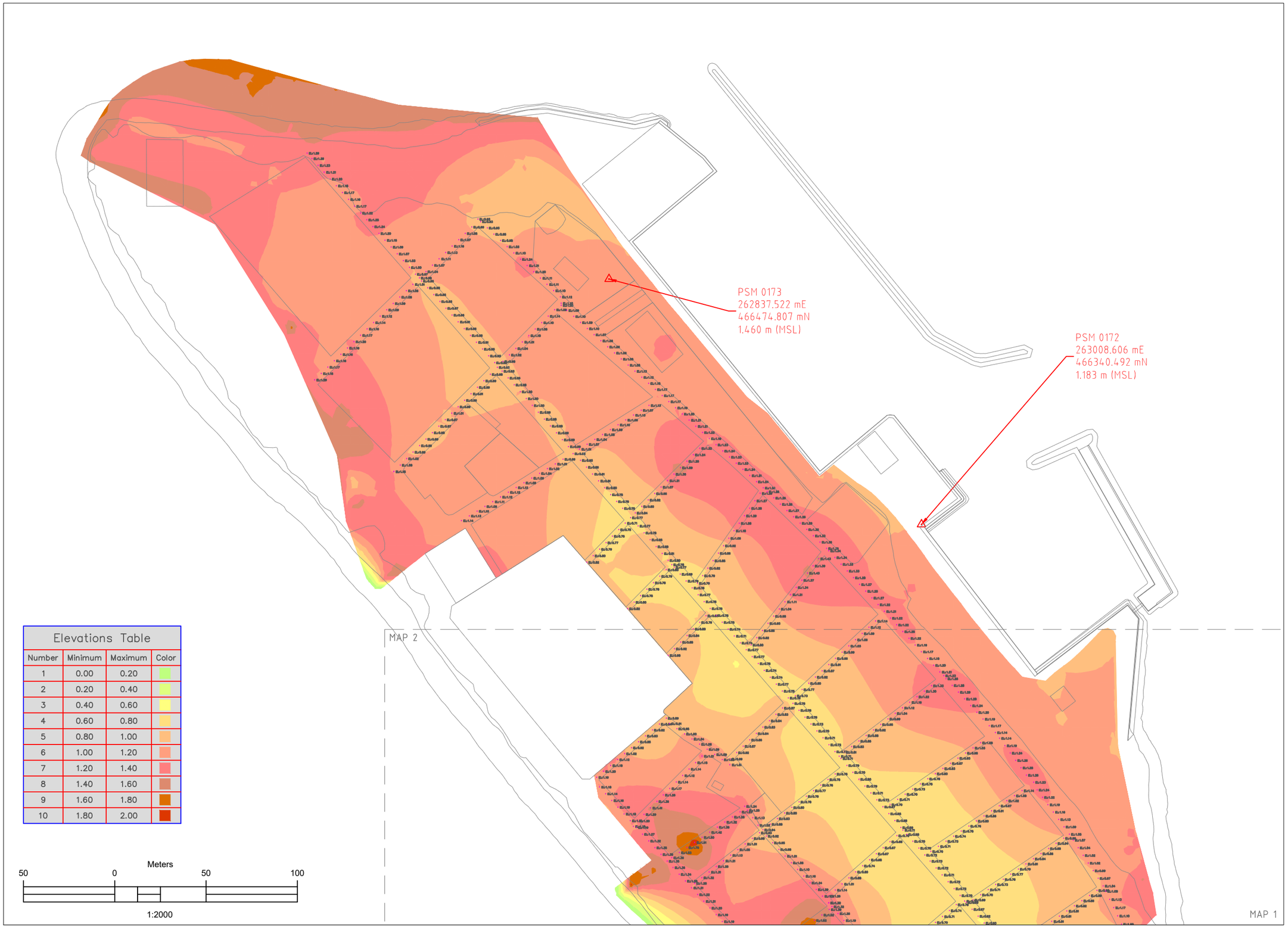
DRAWING TITLE
AA. UKULHAS TOPOGRAPHIC MAP

SHEET TITLE
INDEX MAP

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	08-11/11/2017
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	13/11/2017
SCALE	1 : 4000
PAPER	A3

DRAWING NUMBER
AN/2017/128/01.01

AA. UKULHAS TOPOGRAPHIC SURVEY



Elevations Table			
Number	Minimum	Maximum	Color
1	0.00	0.20	
2	0.20	0.40	
3	0.40	0.60	
4	0.60	0.80	
5	0.80	1.00	
6	1.00	1.20	
7	1.20	1.40	
8	1.40	1.60	
9	1.60	1.80	
10	1.80	2.00	

Meters
50 0 50 100
1:2000

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LEGEND

- PSM
- LEVEL MARK
- SPOT HEIGHT
- PAGE BREAKS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- VERTICAL DATUM MSL

REVISIONS

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-	-

PROJECT TITLE
AA. UKULHAS SEWERAGE

CLIENT
STATIC COMPANY PVT LTD
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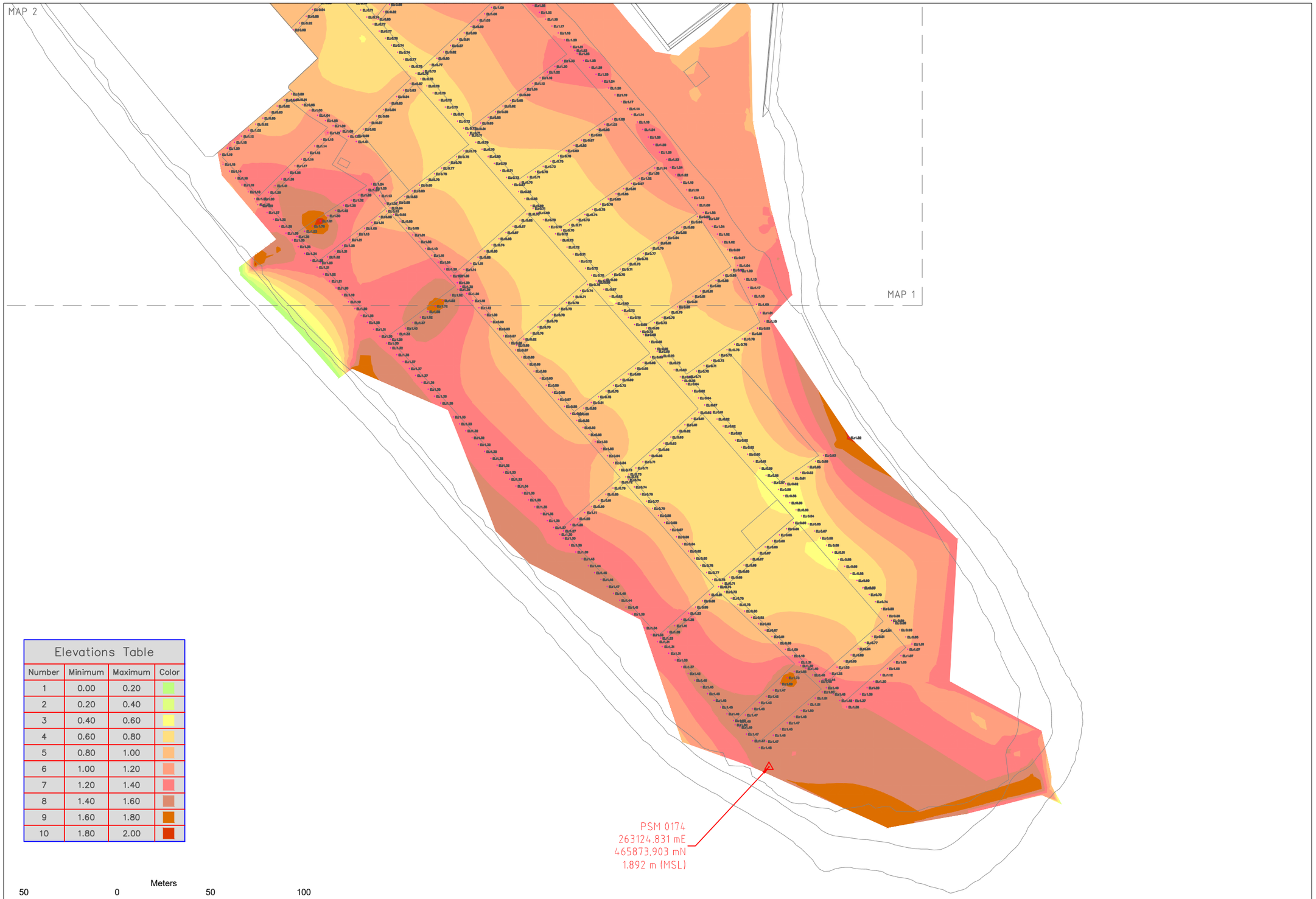
DRAWING TITLE
AA. UKULHAS TOPOGRAPHIC MAP

SHEET TITLE
ELEVATION MAP 1

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	08-11/11/2017
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	13/11/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER
AN/2017/128/01.02

AA. UKULHAS TOPOGRAPHIC SURVEY



Elevations Table			
Number	Minimum	Maximum	Color
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3	0.40	0.60	
4	0.60	0.80	
5	0.80	1.00	
6	1.00	1.20	
7	1.20	1.40	
8	1.40	1.60	
9	1.60	1.80	
10	1.80	2.00	

Meters
50 0 50 100
1:2000

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LEGEND

- PSM
- LEVEL MARK
- SPOT HEIGHT
- PAGE BREAKS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- VERTICAL DATUM MSL

REVISIONS

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-	-

PROJECT TITLE
AA. UKULHAS SEWERAGE

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www.static-company.com

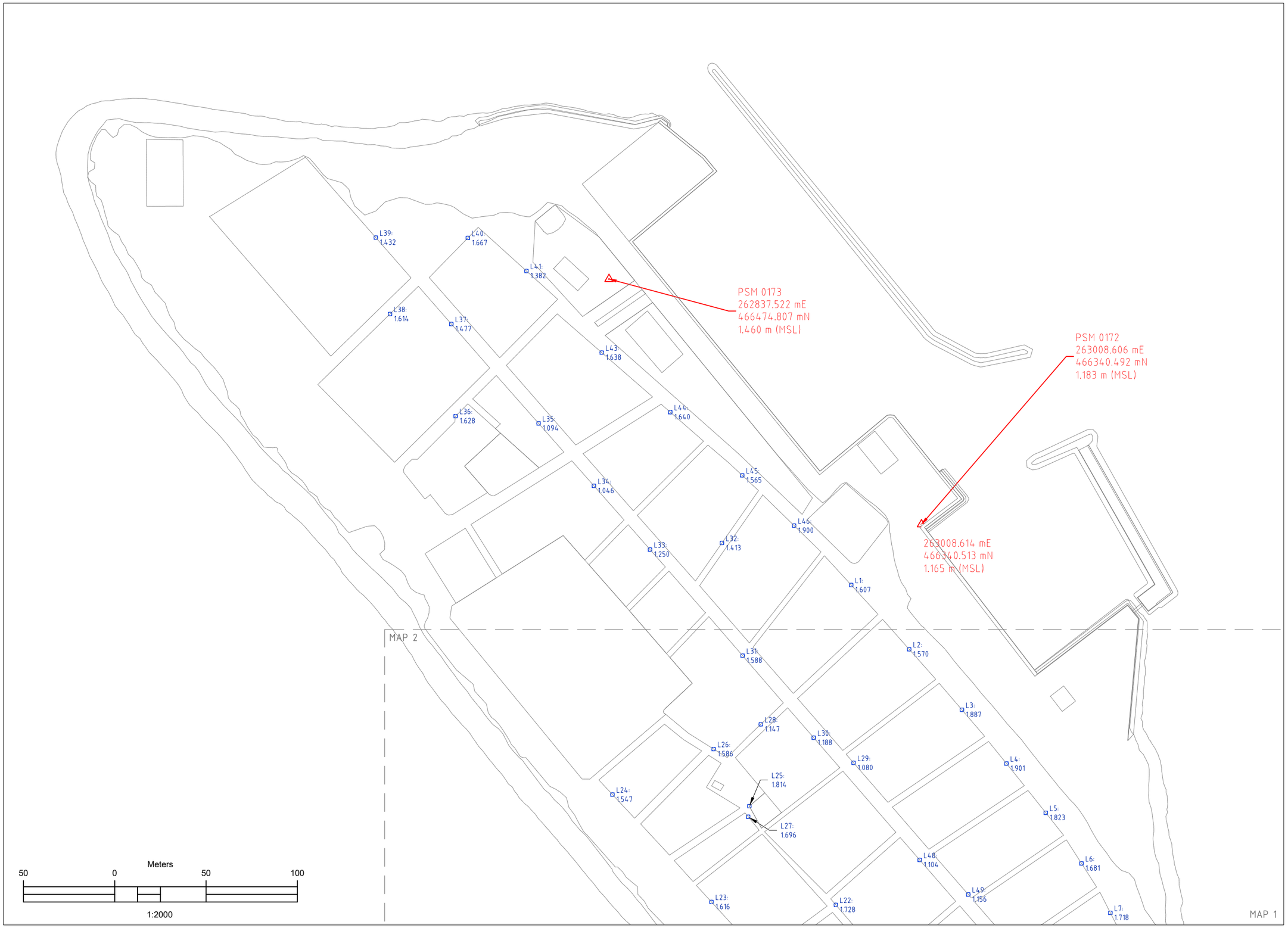
DRAWING TITLE
AA. UKULHAS TOPOGRAPHIC MAP

SHEET TITLE
ELEVATION MAP 2

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	08-11/11/2017
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	13/11/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER
AN/2017/128/01.03

AA. UKULHAS TOPOGRAPHIC SURVEY



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LEGEND

- PSM
- LEVEL MARK
- SPOT HEIGHT
- PAGE BREAKS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- VERTICAL DATUM MSL

REVISIONS

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PROJECT TITLE

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DRAWING TITLE

AA. UKULHAS TOPOGRAPHIC MAP

SHEET TITLE

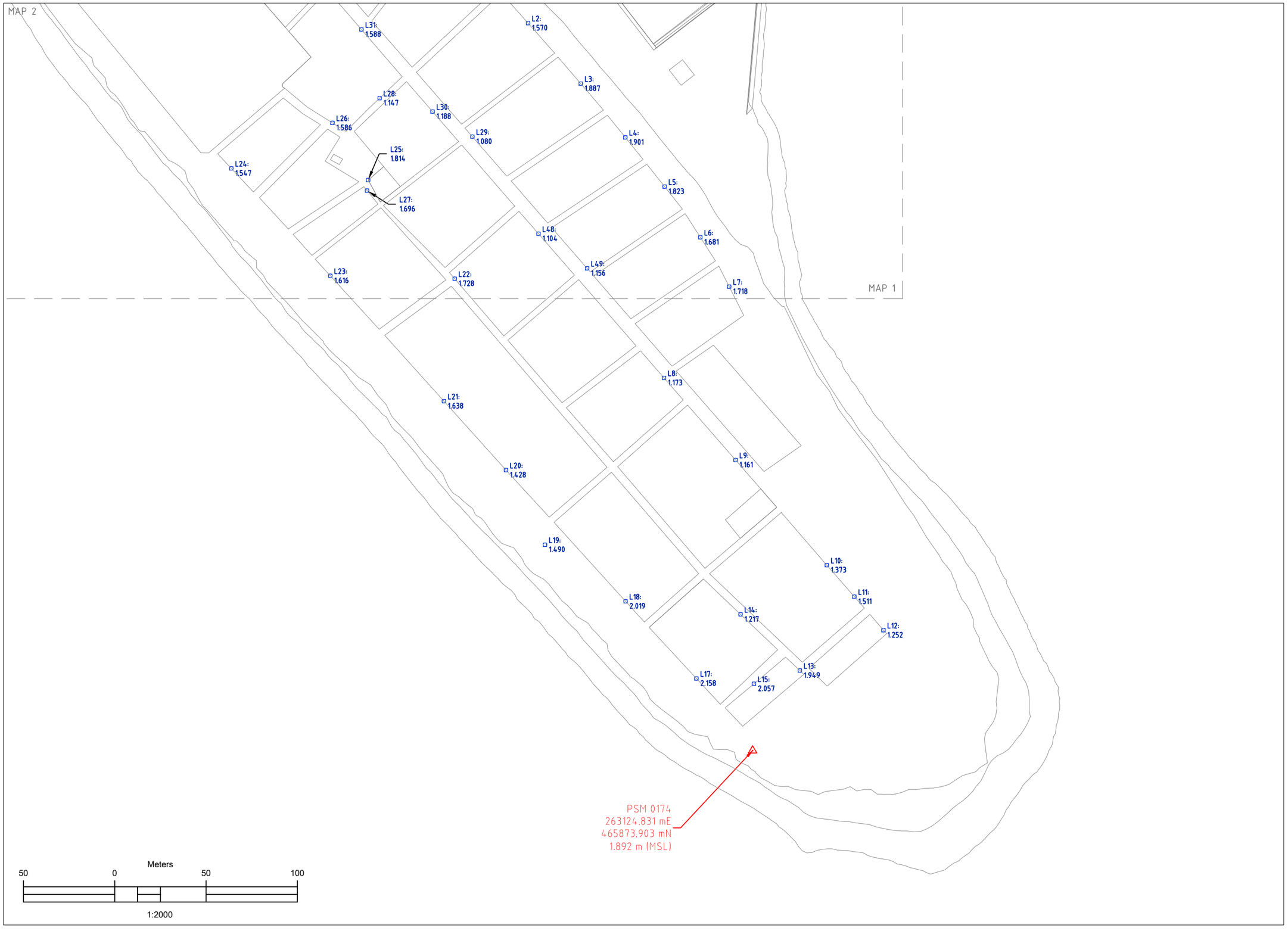
ELEVATION CONTROL MAP 1

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	08-11/11/2017
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	13/11/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER

AN/2017/128/01.04

AA. UKULHAS TOPOGRAPHIC SURVEY



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LEGEND

- PSM
- LEVEL MARK
- SPOT HEIGHT
- PAGE BREAKS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- VERTICAL DATUM MSL

REVISIONS

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DRAWING TITLE

AA. UKULHAS TOPOGRAPHIC MAP

SHEET TITLE

ELEVATION CONTROL MAP 2

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	08-11/11/2017
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	13/11/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER

AN/2017/128/01.05

APPENDIX J-EVIDENCE OF EIA REPORT SUBMISSION TO ATOLL COUNCIL

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EIA report for the establishment of sewerage network at Aa. Ukulhas

Mahfooz AbdullWahhab <mahfoozabdullwahhab@gmail.com>
to secretatiat, Ibrahim

Dear Sir,

Attached please find the EIA report for the establishment of sewerage network at Aa. U

Best,

Mahfooz Abdull Wahhab
Environmental Consultant
(+960) 9994467

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بسم الله الرحمن الرحيم

Secretariat of North Ariatholhu Atoll Council
Aa. Rasdhoo, Republic of Maldives

ތަރިއާދޫ ތެރޭގެ ކައުންސިލްގެ ލިޔުންތަކުގެ ދަފްތަރު
ހއ.ތަރާދޫ، ދިވެހިރާއްޖެ

28 ފެބްރުވަރީ 2018

ފ.ވަދ.ން ކިޔާ ލިޔުމާ ބެހޭ ވަނަ ދުވަސް

ކިޔުމުގެ ނަންބަރ: ތއ. ކައުންސިލްގެ ކަންތައްތަކުގެ ސިއްދު ހުށަހެޅުމާ ފ.ވަދ.ން ކިޔުން

ކަންފުޅުގެ ތަފާތު ނަންބަރ: ތަރިއާދޫ ތެރޭގެ ކައުންސިލްގެ ތަރުތީބު ތަފާތު ކުރުން

ކަންފުޅުގެ ގަޑުގަނޑު ނަންބަރ: ތާވަލްﷲ ތަރުތީބު

ކަންފުޅުގެ ތާރީޚް: 29 ފެބްރުވަރީ 2018

ސޮއި:

ސ.ސ.ސ.ސ.

ފޯން: 6660707 (960+) ފެކްސް: 6660606/ 6660808 (960+)
ވެބްސައިޓް: www.alifalif.gov.mv ،ގ secretariat@alifalif.gov.mv / admin@alifalif.gov.mv :ގ