ENVIRONMENTAL IMPACT ASSESSMENT

For Sheet Piling in Hawks Land

Thilafushi, Male Atoll

Proposed by:

The Hawks Pvt. Ltd.

November 2017

Prepared by:

Mahfooz Abdull Wahhab

Mohamed Ibrahim Jaleel

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CONSULTANT DECLARATION

DECLARATION OF CONSULTANT

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

Mahfooz Abdul Wahhab (EIA P22/2016)

COMMITMENT LETTER

بسم الله الرحمن الرحيم

THE HAWKS PRIVATE LIMITED
REG: (C-109/2007)

"Think smart – Supply fast"

Reference no: HF/2017/489

Hon. Mr. Thoriq Ibrahim
Minister
Ministry of Environment and Energy
Male'
Maldives

23rd November 2017

Dear Mr. Thoriq Ibrahim,

Re: Environmental Impact Assessment
Sheet piling in Hawks Land at K. Thilafushi

As per the requirements of the EIA regulation, we hereby confirm our commitment to implement the mitigation and monitoring measures according to what is proposed in the EIA report attached herewith.

Yours sincerely

Hassan Rifau
Chief Executive Officer

H.Soanary, Third Floor, Boduthakurufaanu Magu, PO: 20026
Male', Republic of Maldives.
T: +960 3340949, F: +960 3300949, E: info@thehawks.biz, W: www.thehawks.biz

PROPONENT DECLARATION

Declaration of the proponent

As the representative of the proponent of the proposed development I guarantee that I have read the report thoroughly and that to the best of my knowledge all information provided here is accurate and complete. In addition, I confirm our commitment to making sure that the contractor implements all mitigation measures proposed in the present report and adhere to the monitoring schedule given.

Name: Hassan Rifau

Signature:

Date: 23rd November 2017

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EXECUTIVE SUMMARY

This report discusses the findings of the environmental impact assessment undertaken for the development of a new jetty by Hawks Corporation at Thilafushi. This EIA report is prepared in accordance with Environmental Impact Assessment Regulation 2012 and the subsequent amendments to the regulation.

The Hawks Pvt. Ltd. (Proponent) Site (S4-027) located in the Industrial Island (Thilafushi) is positioned alongside the edge of the island facing the sea with a jetty of approximate width of 3m. Due to major problems the proponent faces due to the current jetty, a new jetty design has been proposed which would overcome these disadvantages, and benefit both Thilafushi Corporation Limited and proponent. Therefore, in order to overcome the aforementioned challenges, the proponent has proposed to carry out the project to the project to construct the new jetty. The major activities of the project include; dresdging and recalamation, sheet piling works and concrete works.

The major impacts of the construction phase is envisaged to be impacts on air quality, noise pollution, vibration and disturbances due to operation of heavy machinery, impact on marine environment from turbidity, waste and chemical spillages. The main impact of operational phase is predicted to arise from the operation of the petrol shed on the newly constructed jetty.

The mitigation measures proposed for the construction phase comprises of commencing the dredging and reclamation works slowly in order to give chance to mobile organism to escape, proper maintenance of machinery, restricting the movement of barges, adhering to proper waste management plans and procedures etc. The mitigations of the operational phase include regular maintenance of machinery, following proper oil/chemical handling procedures and staff training on emergency oil spill cleanup.

An environmental monitoring plan was developed taking into consideration the impacts and mitigation measures to be implemented. The monitoring plan includes assessing the marine water quality, coastline and marine biodiversity.

As every development project, there are envisaged negative environmental impacts due to the proposed project. However these could be reduced by establishing the mitigation measures and proper environmental monitoring. Therefore, considering the greater socioeconomic positive outcome of the project it is justifiable to carry out the works of the proposed project

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1 INTRODUCTION

1.1 Purpose of this EIA

The aim of this EIA is to critically analyze the environmental and socio-economic impacts which may arise due to the coastal modification of K.Thilafushi. After analyzing the impacts, it would be then possible to suggest proper mitigation measures to prevent or reduce any negative impacts and to enhance any positive impacts.

1.1.1 Project Overview and Rationale

The Hawks Pvt. Ltd. (Proponent) Site (S4-027) located in the Industrial Island (Thilafushi) is positioned alongside the edge of the island facing the sea (Image reference) with a jetty of approximate width of 3m. Due to major problems the proponent faces due to the current jetty, a new jetty design has been proposed which would overcome these disadvantages, and benefit both Thilafushi Corporation Limited and proponent.

Figure 1: Location of the proponent site

1.1.2 Disadvantages of the current jetty

- It is not sufficient to dock enough vessels – at present, it can only accommodate two to three vessels at a time.
- The depth of the water at the edge is too shallow and not practical for bigger boats due to their span and the draft of a boats' hull.

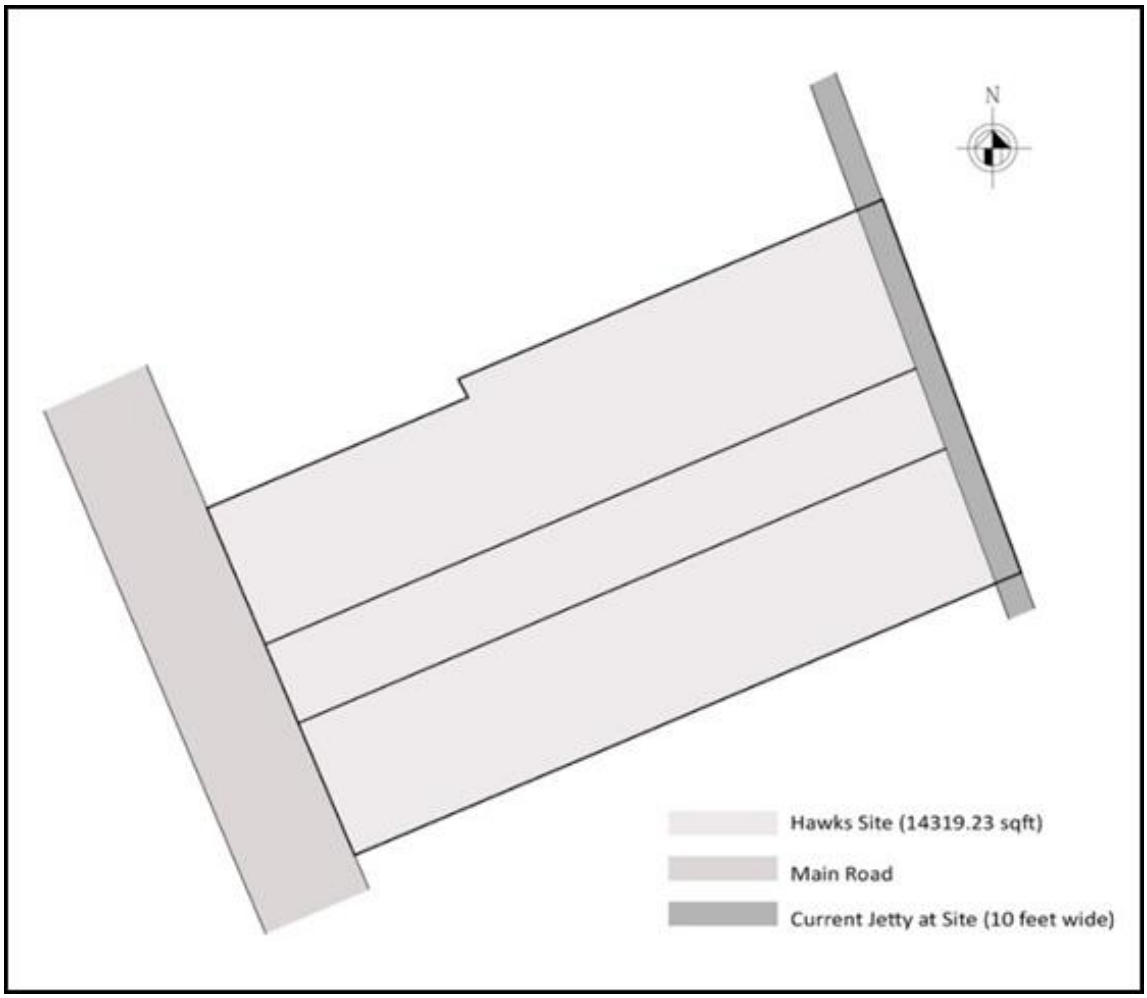


Figure 2: Current Design

1.2 Project Objectives

The objective of the project is to overcome the aforementioned challenges by an improved jetty structure. A detailed description of the project is given in the following chapter.

1.3 EIA Methodology

The methodology adopted for the environmental impact study consists of the following stages:

Identification of significant environmental components and assessment of their baseline (pre-project or existing) status within the study area. This is carried out by site visits to study geophysical and environmental conditions at the site.

Prediction of impacts on various identified environmental parameters due to the proposed project. Data relating to the proposed land clearance activities including excavation as well as other activities causing environmental impacts through an environmental impact matrix.

Evaluation of environmental impacts by use of significance analysis method.

Expert judgment and professional opinion have also been used throughout the impact assessment and evaluation process.

1.4 Review of Relevant Studies

As part of relevant literature review and preparation of the report, the available relevant Environmental Impact Assessment studies have been used as reference in addition to professional experiences of the environmental consultant who have prepared this EIA Report. These are;

- EIA for the proposed renovation of vessel loading jetty at STO godown at K. Thilafushi
- EIA for the proposed sand dredging at Gulhifalhu Jetty Area
- EIA for undertaking Coastal protection at Coastline Thilafushi Site, Thilafushi, Kaafu Atoll

1.5 Proponent

The proponent of the proposed project is Hawks Pvt. Ltd.

1.6 Consultants

This EIA report has been compiled by Mahfooz Abdul Wahhab and Mohamed Ibrahim Jaleel. The lead EIA consultant was Mahfooz Abdul Wahhab.

2 PROJECT DESCRIPTION

2.1 Project background

The Hawks Pvt. Ltd. (Proponent) Site (S4-027) located in the Industrial Island (Thilafushi) is positioned alongside the edge of the island facing the sea (Image reference) with a jetty of approximate width of 3m. Due to major problems the proponent faces due to the current jetty, a new jetty design has been proposed which would overcome these disadvantages, and benefit both Thilafushi Corporation Limited and proponent.

2.2 Disadvantages of the current jetty

- It is not sufficient to dock enough vessels – at present, it can only accommodate two to three vessels at a time.
- The depth of the water at the edge is too shallow and not practical for bigger boats due to their span and the draft of a boats' hull.

2.3 Project objective

The objective of the project is to overcome the aforementioned challenges by an improved jetty structure.

2.3.1 Need for project

The following advantages are deemed to benefit the proponent from the project:

- The Hawks site situated at Thilafushi includes our main Boat Yard and Brick Factory. While the Boat Yard with an area of 10,000 sqft can accommodate two boats at a time, the Brick Factory compromises a land of 12,000 sqft loaded with semi-automatic machinery and provide bricks widely throughout the country. The new jetty will allow us to easily load these bricks to numbers of vessels simultaneously and help us to do these transportations easily. The backfilled area can also be directly used for loading without limited space restrictions for bigger Lorries.
- The numerous vessels that have a bigger draft can now dock near our site with ease due to the bigger depth at the edge of the jetty, making it easier for us to do the loading and unloading of goods and machinery
- The newly designed jetty providing a huge area to handle and park machinery makes it easier for us to handle otherwise difficult and heavy equipment
- The implementation of proposed jetty would allow us to widen our business vastly as it would make the transportation and docking of our vessels very easy.

The following advantages are deemed to be brought to the Thilafushi Corporation Ltd through project:

- Thilafushi is the main industrial zone in Kaafu atoll. A new jetty compromising a wide area to al low loading and unloading equipment and handling machinery would permit others to use this too. This would help to increase the economic growth through industrial development as foreign companies can have access to this jetty.
- The additional jetty is an opportunity to bring in new investors to Thilafushi, which would be a definite advantage to the growth of Thilafshi development
- The petrol hut stationed at the backfilled area would allow boats to easily refill their tanks while being docked at the jetty

2.4 Project location and Study Area

Thilafushi which is located on the Southern rim of North male' atoll is managed by Thilafushi Corporation Limited (TCL) which is mandated to develop Thilafushi as an industrial zone. Hence Thilafushi is now the place where major larger enterprises have their production, storage and servicing works. The proposed project will undertake at the land owned by Hawks Pvt Ltd in Thilafushi. The exact location of the project (Hawks land on Thilafushi) is shown in figure 2.

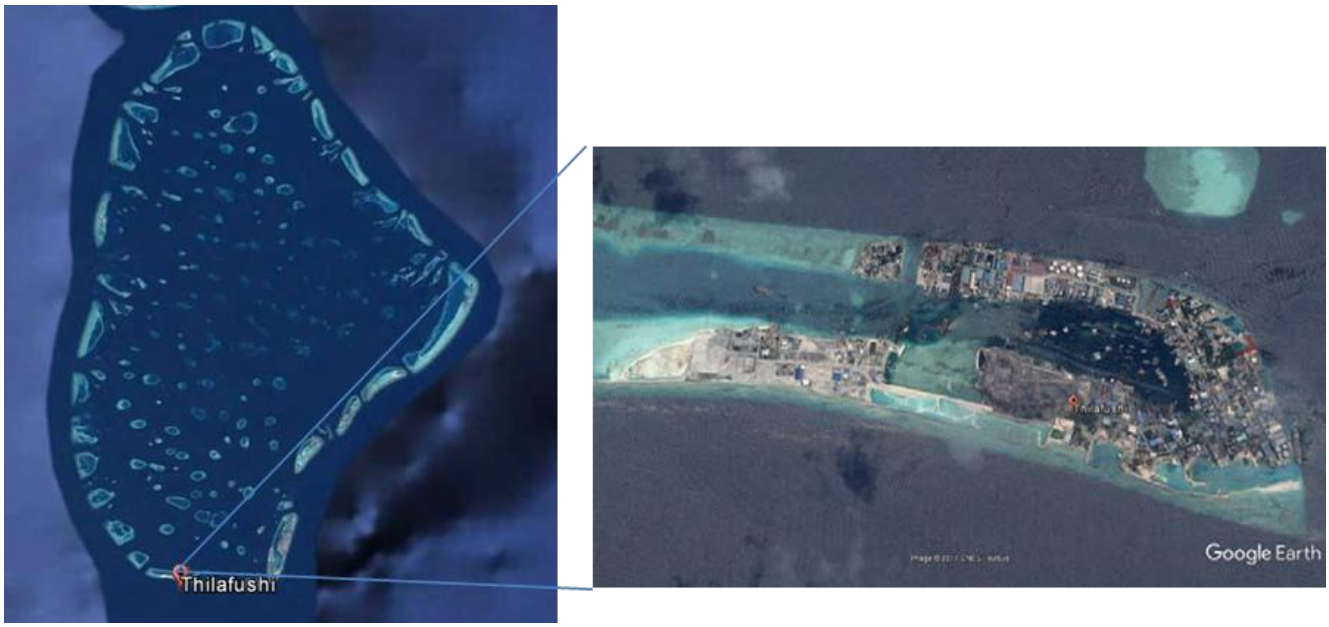


Figure 3:Location of Thilafushi, North male' atoll.

Figure 4:Location of Hawks land (red) on Thilafushi and the proposed location for sheet piling (black)

2.5 Proposed Design

The image (reference) shows the proposed new jetty design. Its dimensions are 31.6m by 30.5m, with the center of the jetty being backfilled for vehicles' access, and do necessary loading and unloading. A petrol shed is also located to pump fuel to vessels docked

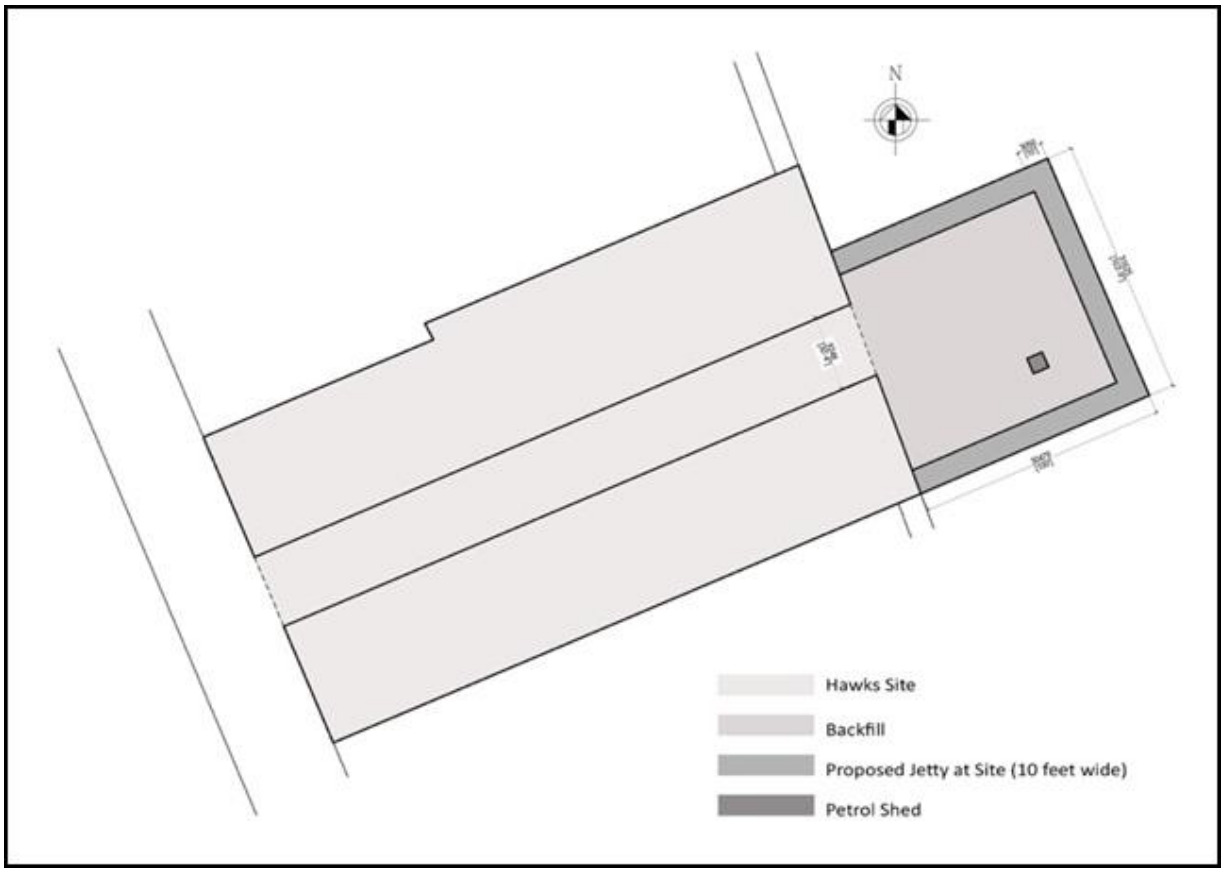


Figure 5: Proposed Design

The Hawks site is designed in such a way that other parties can also access the jetty conveniently as shown (image Road to Proposed Jetty through Hawks Site). This road is wide enough (28m width) to allow big vehicles to transport to the jetty.

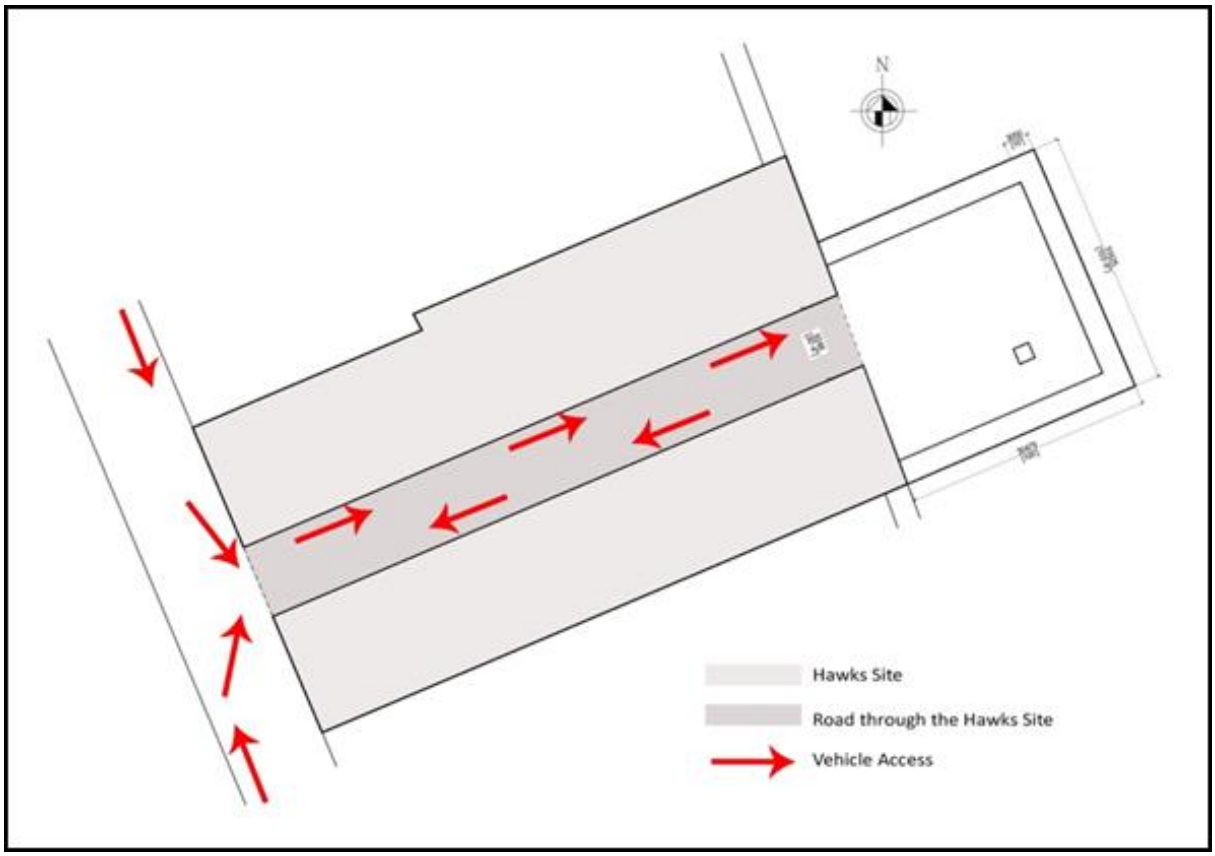


Figure 6: Road to Proposed Jetty through Hawks Site

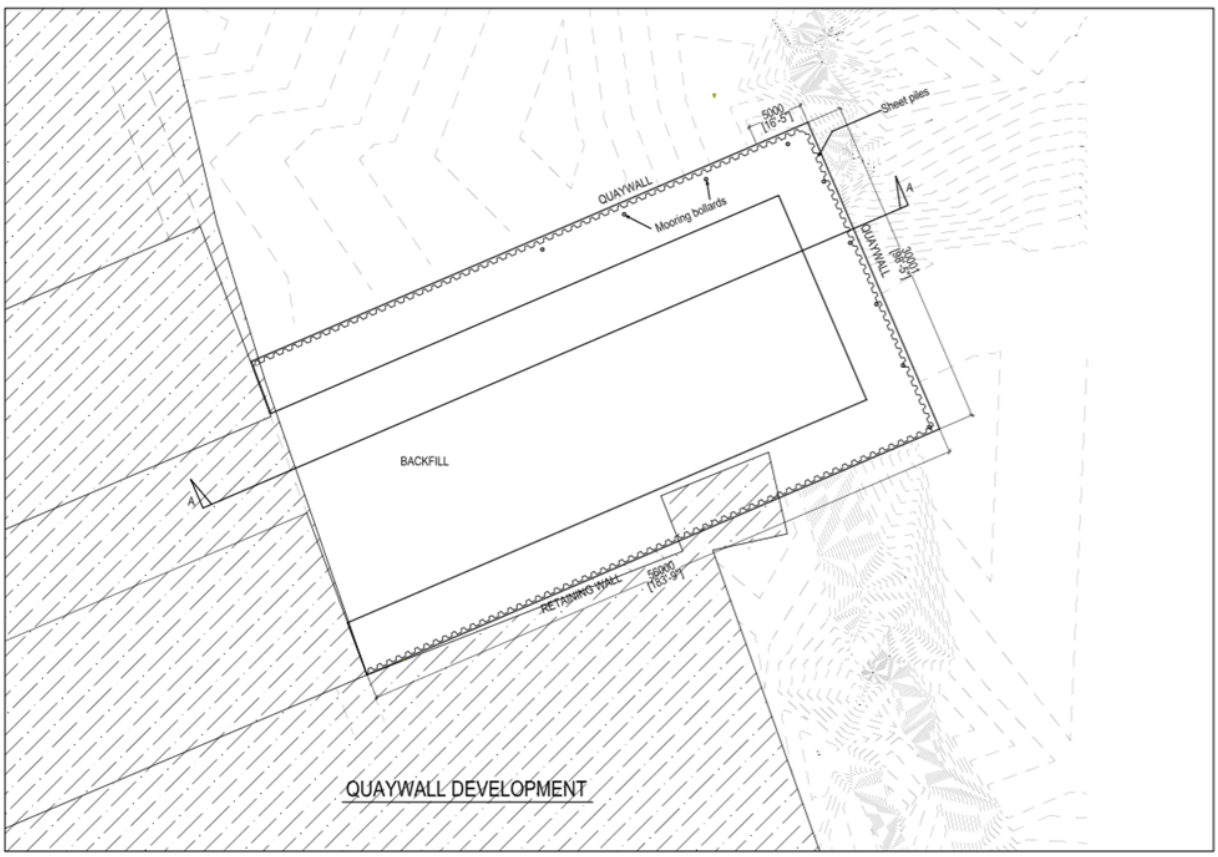


Figure 7: Quay wall development

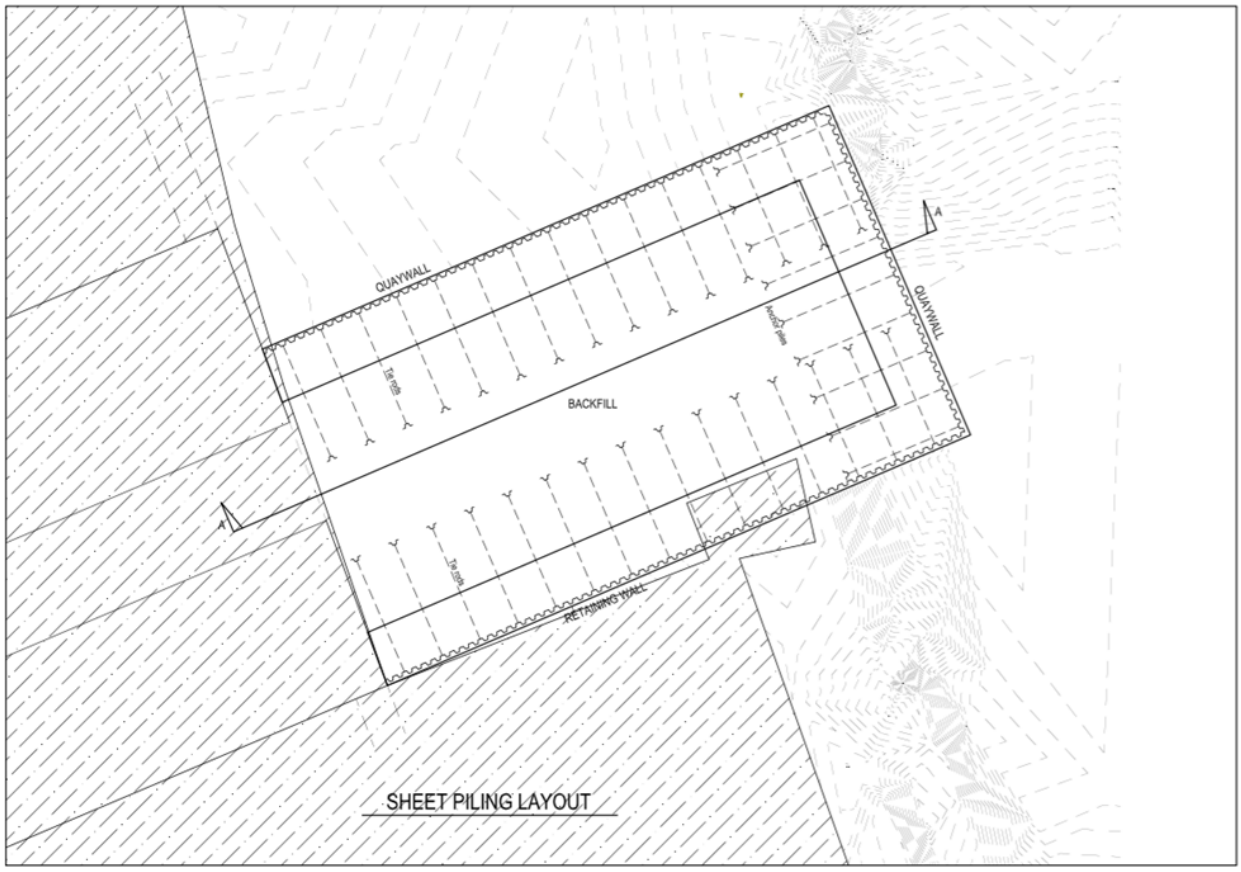


Figure 8: Sheet pile

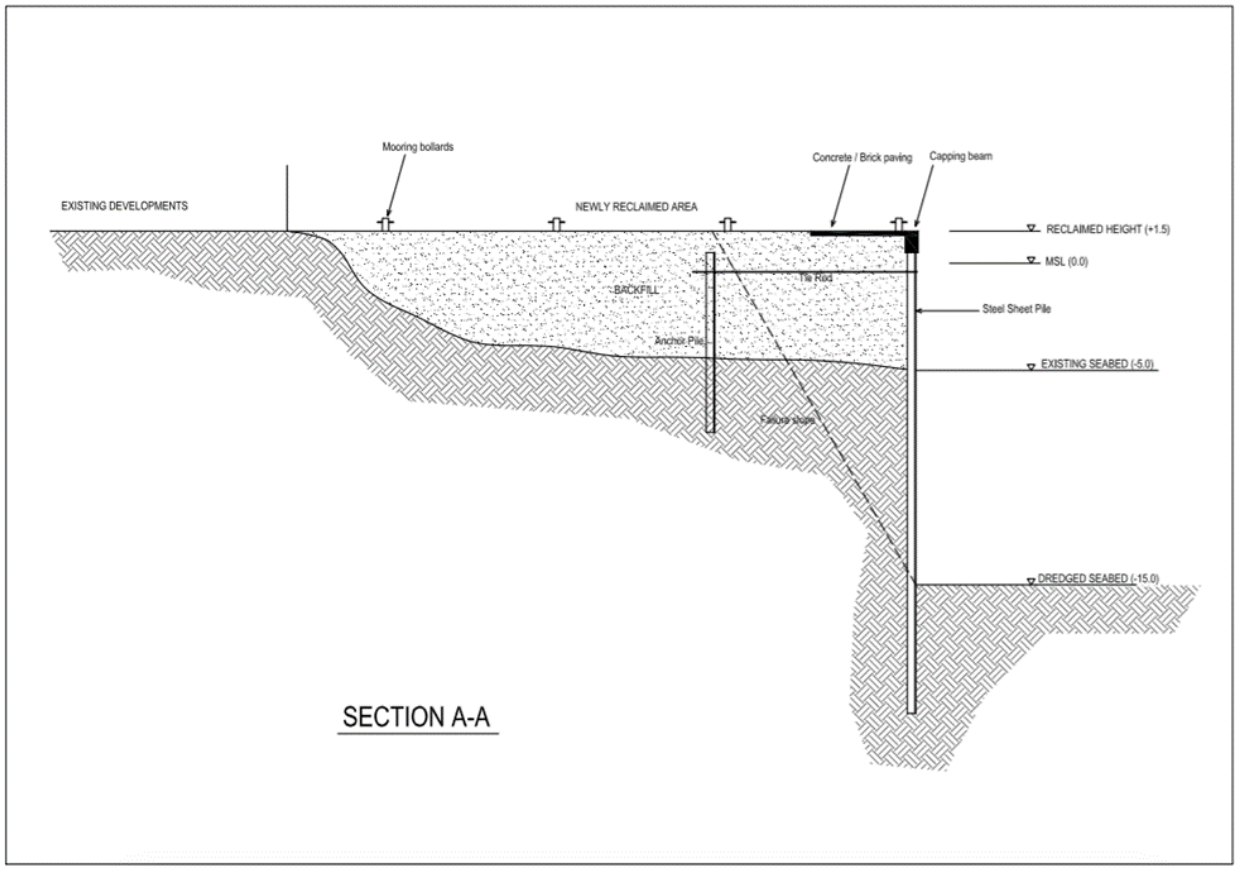


Figure 9:Sheet pile layout 2

2.6 Proposed Work Methodology

Essentially the proposed works under this project include:-

2.6.1 Dredging and reclamation work

Equipment needed for this stage: Cutter Suction Dredger (CSD) and Bulldozer.

2.6.2 Method

Prior to commencing any other civil work on site, dredging work should be completed. Dredging should be done using a Cutter Suction Dredger (CSD) that has a cutter head reaching at least 15m below water level. The dredged soil can be pumped directly to the reclamation area and a bull dozer can be deployed to spread the sand over the proposed reclamation area. The extent of dredging can be increased in terms of dredged area, if more sand is required for reclamation. In any circumstance, dredging depth should not be increased to achieve more sand for reclamation. While carrying reclamation work, it is important to be cautious not to fill more than the slope failure line indicated on drawing, as this will make sheet piling and anchoring works difficult later. The layout of the dredge site is shown in the following image.

The estimated area which needs to be backfilled is 1534 m^2. The estimated volume of sand required to backfill this area is 6687 m^3. It is estimated that 7888m^3 of sand can be excavated from the dredge site shown on following figure, which is enough to backfill the area.

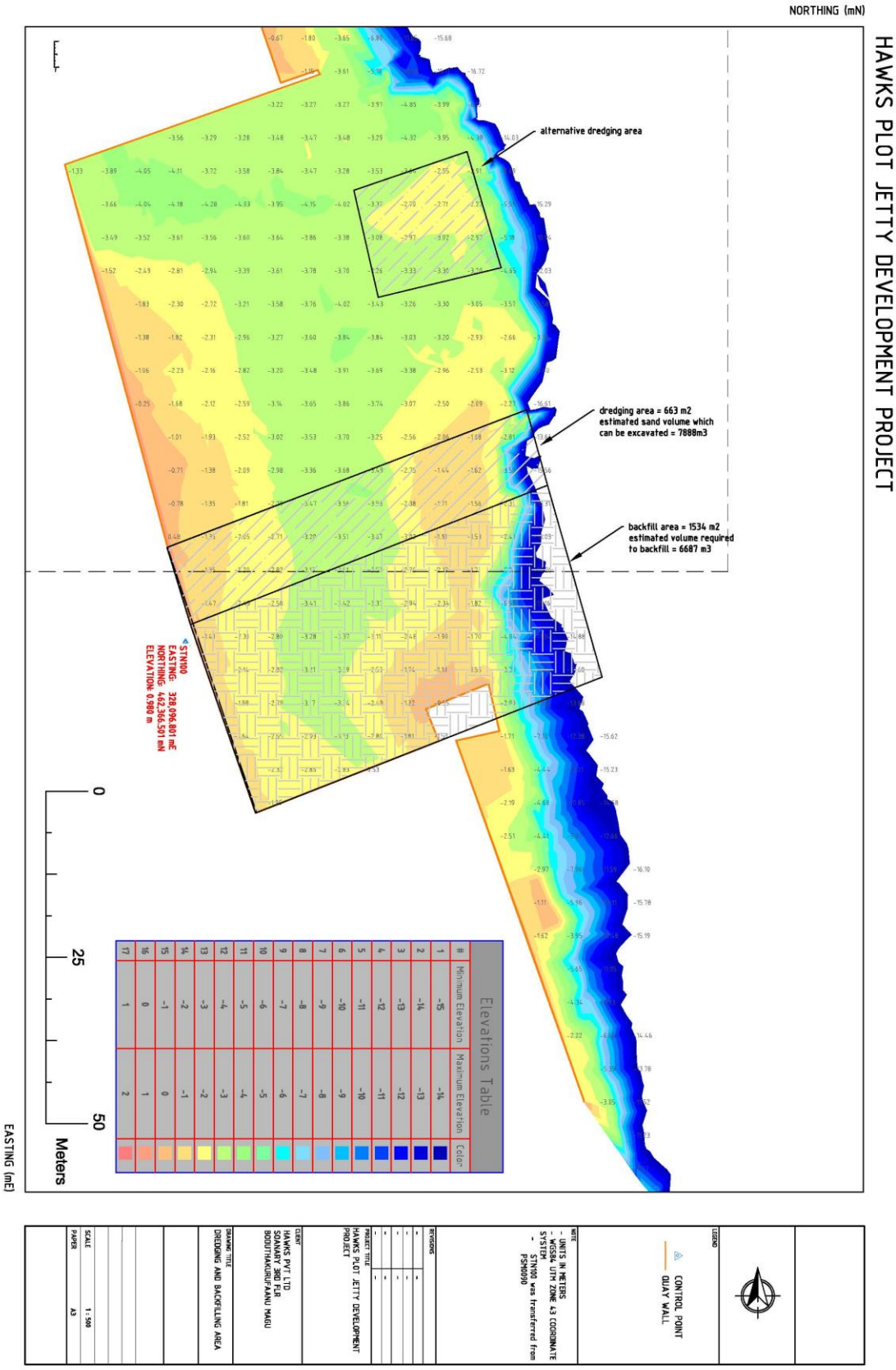


Figure 10: dredging and backfilling plan

2.6.3 Sheet piling works

The equipment needed for this stage are Crawler crane, Excavator Piling hammer (free hanging on crane)

2.6.4 Method

Pile driving is to be done using hydraulic vibro hammer hung from on a crane. The pile is lifted by the vibro hammer and positioned in place with the help of an excavator. Once the pile is placed in position, the vibro hammer is engaged and slowly driven into the sea bed, until the required piling depth is achieved. After each pile is driven to the required depth, the excess pile head is cut using a gas cutter. As the sheet pile driving work proceeds, anchor sheet piles are also driven into the ground until their required depth is achieved. Once the anchor piles are driven in place, they are fitted with tie rods and connected to the main sheet piles, to give the required strength to the main sheet pile wall. After this is done, the remaining backfill work can be completed and the sheet pile capping work can commence.

2.6.5 Concrete and other works

Formwork for sheet pile capping beam can be made from timber and fitted to the top of sheet piles. Once this is done, the required reinforcement can be placed in place and concrete poured into the formwork. Care should be taken to provide expansion joints in the concrete at required intervals. After the capping beam work is done, mooring bollards fixing work can commence. It is anticipated that all mooring bollards will be fixed on separate concrete blocks (flush with ground level) and so these concrete blocks can be cast insitu. At every required mooring point, the ground can be excavated and sufficient formwork and reinforcement placed

to cast the concrete block. Once the preparations are ready, concrete can be poured into these blocks and left for curing. After the curing period is over, the mooring bollards can be fitted on these blocks according to the installation instructions given by the bollard manufacturer.

After bollard fixing work is done, the required paving work can be done using interlocking paving blocks. The ground should be well compacted and levelled prior to commencing the paving work. The Client has the option of casting a ground slab as well, instead of paving. However, if casting a ground slab, sufficient expansion joints must be provided.

2.6.6 Project temporary facilities

The existing facilities at proponent's site will be utilized.

2.6.7 Project temporary facilities

During the construction phase, the following work profile will be utilized.

Table 1. 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

2.6.8 Demobilization

All machinery will be taken on the barge once all works are completed.

2.7 Project Inputs and Outputs

The following two tables details the project inputs and outputs for the sheet piling works at K.Thilafushi.

Table 2: Major project inputs

Input resource(s)	**Source/ type**	**Qty/Volume**	**Source of resource**
Man power	Local, expat	Small numbers	Out sourcing, local hire
Construction material	**Concrete works**: reinforcement steel bars, sand, cement, aggregates	Large quantities	Local purchase or import
	Sheet piles: iron sheet piles,	Large quantities	Local purchase or import
Machinery and equipment	Excavator, Crawler crane, piling hammer, cutter suction dredger, lorry, barge	-	Contractor
Fuel for operation	Petrol / Diesel	Large quantities	Local purchase
Power	Electricity	Large quantities	Proponent site

Table 3: Major project outputs

Project outputs	**Method of generation/Qty**	**Method of control**
Dredged sand, est.7888m3	Dredging works	Mitigation measures is envisaged reduce turbidity, mitigation measures given in 6.4 of the report. Following through best practices of machinery operations is envisaged to reduce overall negative impacts and likelihood of accidents.
Construction wastes	Demolition wastes Waste oils Packaging waste	waste gathered and transferred to Thilafushi waste site for disposal
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.

2.8 Project duration and schedule of implementation

The project will commence once the EIA process have been completed. Estimated date is around November 2017. The mobilization works commence as soon as the EIA decision statement is released and is expected to be completed by end of December 2017. Refer to Appendix D for a detailed work plan of the proposed project.

The entire project is estimated to be completed within 1 months from project commencement date. The major milestones of the project are as follows:-

Table 4: estimated durations required to achieve major milestones of the project

Task Name	***Duration/Days***
Jetty Development	***32***
Dredging and reclamation works	*10*
Sheet piling and backfilling works	*06*
Concrete works	*08*
Finishing off or remaining works	*08*

3 PROJECT SETTING

This section summarizes the relevant environmental legislations, policies and guidelines that the proposed project has to comply with and relevant regulatory bodies regarding environmental protection in the Maldives that are relevant for the proposed project.

3.1 Applicable Laws and Regulations

3.1.1 Environment Protection and Preservation Act of the Maldives (Law no. 4/93)

The Environment Protection and Preservation Act of the Maldives (EPPA; Law no. 4/ 93) provide the legal basis for environmental protection, preservation and conservation in the country. The authority responsible for the Environment Act is the Ministry of Environment and Energy. Being an umbrella law, it gives extensive power to Ministry of Housing and Environment (MHE) in matters concerning the environment.

The following articles of the Environment Act are relevant to the proposed project.

Article 2 states that the guidelines and advice on environmental protection in accordance with the prevailing needs and conditions of the country shall be provided by the concerned government authorities.

Article 3 states that in areas of environmental protection and preservation that do not already have a designated government authority, MHE shall be the responsible authority to formulate policies, rules and regulations.

Article 4 states that MHE shall be responsible for identifying and drawing up legislation for conservation of protected areas and natural reserves.

Article 5 of the act states that an environmental impact assessment has to be submitted to MHE before implementation of any project that may have an impact on the environment. MHE shall formulate the guidelines and determine the projects that require such an assessment.

Article 6 states that MHE has the authority to terminate any project that has an unfavourable impact on the environment without compensation.

Article 7 states that disposal of waste, oil, poisonous gases or other substances harmful to the environment is prohibited within the territory of the Maldives. In the event that disposal of such substances become necessary, they shall be disposed of within the area designated for the purpose by the government.

Article 8 of the Act states that disposal of hazardous, toxic or nuclear waste is prohibited within the territory of Maldives and a permit shall be obtained before any trans-boundary movement through the Maldivian territory.

Under Environment Act the government of Maldives has the right to claim compensation for any damages caused by activities that are detrimental to the environment.

3.1.2 Environment Impact Assessment Regulations 2012

Under the article 5 (a) of the Environment Act, an environmental impact assessment has to be submitted by the developer of a project which may have potential impacts on the environment, to the Ministry of Environment for the approval before commencement of the project.

The first step in environmental assessment process described in the regulation involves screening of the project to be classified as one that requires to conduct an EIA or not. Based on this decision, the Ministry then decides the scope of the EIA with the discussion of the project proponent, EIA consultant and relevant stakeholders. Once the scope is identified, baseline surveys will be carried out by the EIA consultant and the EIA report shall be submitted to the Ministry according the guidelines specified in the EIA regulation. The main components of the EIA report are project description, describing existing natural and socioeconomic environment, public consultation, impact assessment, project alternatives, mitigation and environmental monitoring.

The EIA report is reviewed by the Ministry of Environment following which an EIA decision note is given to the project proponent who will have to implement the decision note accordingly. Under the decision note, the project proponent is committed to implement all impact mitigation measures that are specified in the submitted EIA report. Proponent is also committed to environmental monitoring at the intervals specified in the report.

This report fully complies with EIA regulations.

3.1.3 Waste Management Regulation

Waste Management Regulation came into force in 2014. The main purpose of this regulation is to implement the national waste management policy. Waste Management Regulation gives specific provisions to:

- Implement measures to minimize impacts on human health

- formulate and implement waste management standards

- implement an integrated framework for sustainable waste management

- Encourage waste minimization, reuse and recycling

- Implement polluter pays principle

- Introduce extended producer responsibility

The regulation provides set standard procedures for the following areas:

- Waste collection

- Transportation of waste on land and sea

- Waste treatment

- Waste storage

- Management of waste management centers

- Landfill

- Management of hazardous waste

All the waste produced in the proposed development would be managed according to the standards specified in the waste management regulation.

3.1.4 Regulation on Dredging and Land Reclamation

Regulation on Dredging and Land Reclamation was formulated under the Environment Act and this regulation came into force in 2013. The main purpose of the regulation is to minimize the negative environmental impacts from dredging and reclamation activities in islands and reefs across Maldives.

According to the regulation, all dredging and reclamation activities must be approved by the Environmental Protection Agency in writing. Application process for the permit for the reclamation and dredging includes the submission of the adequate information of the project to Environmental Protection Agency along with a scaled before and after map.

The regulation defines the rationales for reclamation and dredging as those absolutely necessary for social, economic developments. Under this regulation, dredging is restricted in the following areas:

- 500m from the ocean side reef edge
- 50m from island vegetation line
- Environmentally protected areas

Under this regulation, land reclamation is restricted within 200m of an environmentally protected area. And also, land reclamation cannot exceed beyond the 30 percent of the house reef area.

3.1.5 Environmental Liability Regulation

This regulation is pursuant to the article 22 of the constitution that states that, protection, preservation and maintenance of the natural environment, the richness of the living species, the natural resources for the present generation as well as for the future generations is a basic obligation of the government. One of the key objectives of the regulation is to practice polluter pays principles in the Maldives. It aimed at maintaining equal standards for enforcing environmental liabilities, fines for those who violates the rules and regulations. The proposed project will be subjected to this regulation for any activity outside of the EIA scope and environmental decision statement. The proponent and the contractor shall take all practical measures to ensure that all relevant laws and regulations are followed.

3.2 Environmental Permits required for the Project

3.2.1 4.2.1 Environmental Impact Assessment Decision Note from Environmental Protection Agency

The proposed project requires the approval of this EIA report and issuance of an Environmental decision note/statement prior to the implementation of the project. The EIA decision note govern the manner in which the project activities must be undertaken. EIA decision note is the final environmental clearance granted by the Environmental Protection Agency for the proposed project.

3.3 International Conventions

3.3.1 Convention on Biological Diversity

Convention on Biological Diversity entered into force in 1993. The Maldives is a party to the Convention on Biological Diversity. The three main goals of this convention are:

- Conservation of biodiversity
- Sustainable use of its components and
- 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. Proposed project involves removal of large number of mature palms, in order to minimize any negative impacts from this activity, proposer mitigation measures will be implemented. This would include replanting 2 palms for each palms removed in this project.

3.3.2 United Nations Framework Convention on Climate Change

United Nations Framework Convention on Climate Change is the first binding international legal instrument that deals directly with the threat of climate change. The objective of the convention is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. 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 16 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 in 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.

4 EXISITING ENVIRONMENT

4.1 Methodology

4.1.1 Water quality

2 marine water samples were collected (Refer to Figure 12 and Table 5 for sampling locations and respective GPS coordinates). Samples were collected in 500 mL plastic bottles by first rinsing the bottle with the sampling water three times. Marine water samples were collected just below the surface. All the water samples were collected on 14th July 2017. The water samples were collected between 1400 to 1530 hours.

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

4.1.2 Current measurement

A drogue constructed from plastic plates joined together by bolts to make four fins (Figure 11) 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 11). 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 12 and respective GPS coordinates on Table 5.)

Figure 11. Drogue deployed at sea for current measurement (left) and hand-held GPS used to geo-reference sampling locations

4.1.3 Benthic substrate analysis

CPCe software was used to assess the benthic substrate, which is one of the most widely used tools for marine assessments. 15 pictures were taken at each respective site from which 10 photos are chosen for analysis (Refer to Figure 12 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 2 transects at different locations.

4.1.4 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 12 and Table 5 for sampling locations and respective GPS coordinates).

4.1.5 Geo-referencing

All the sampling locations were geo-referenced using a hand-held GPS. The geo-coordinates for each sampling locations is shown in Table 5 and Figure 12 below.

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

Code	Type	Location	GPS Coordinates	
			Longitude	Latitude
M1	Marine sampling point 1 for Transect 1, Water Quality sample 1, Fish census 1	Sheet piling area	73.451805248794	4.18101266813408
M2	Marine sampling point 2 for Transect 2, Water Quality sample 1, Fish census 1	South of Sheet piling area	73.4516354072053	4.18177091449643
DR1	Drogue run 1	Sheet piling area	73.4517151421613	4.18168537987625
DR2	Drogue run 2	South of Sheet piling area	73.4519561657624	4.18113842902011
DR3	Drogue run 3	North of Sheet piling area	73.4516241743792	4.181976625629

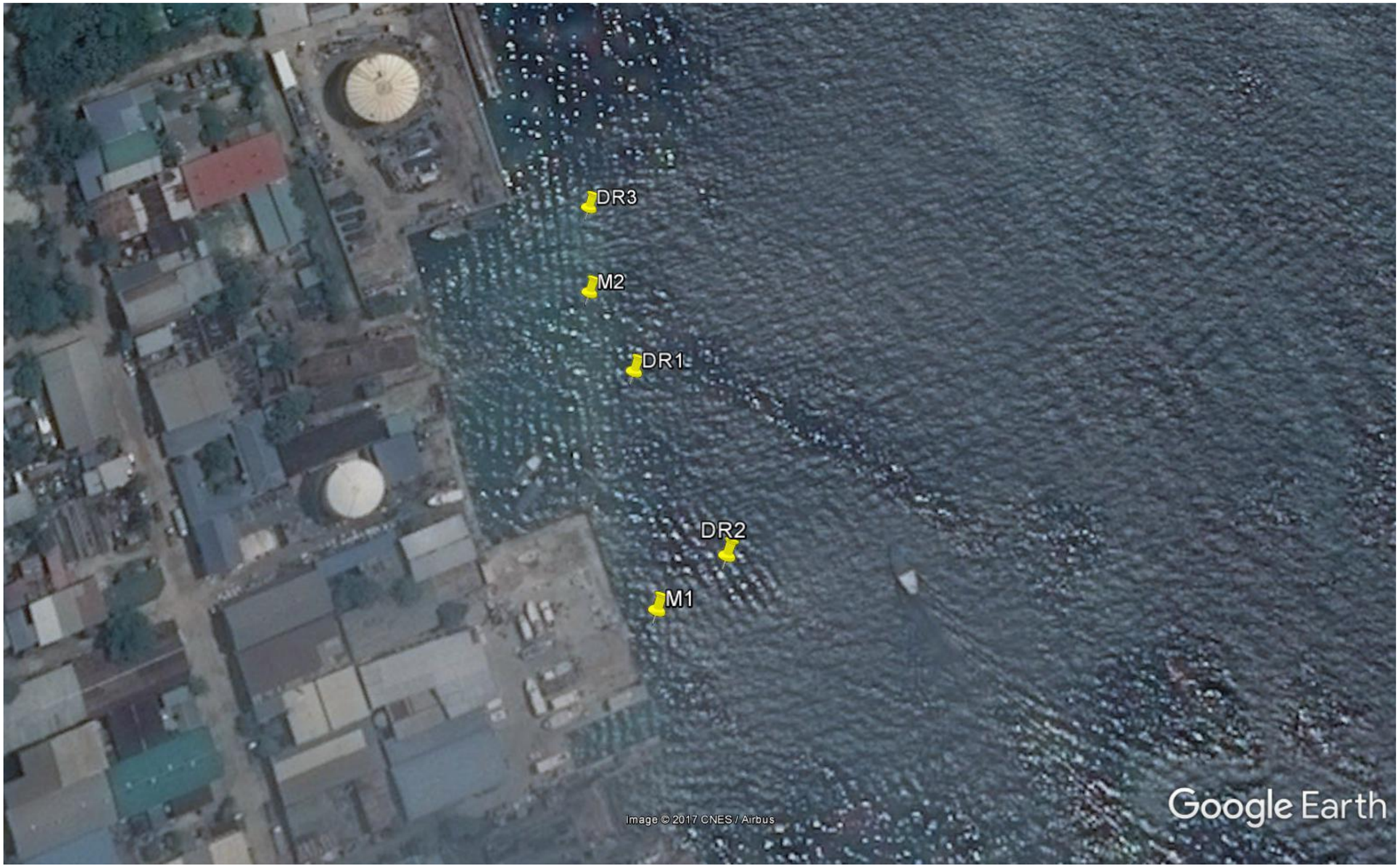


Figure 12: Sampling locations at Thilafushi

4.2 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).

4.2.1 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. Since the nearest station to Male' is Hulhule, the data from this station is used to analyse the climate variables at the study area.

4.2.2 Temperature

Analysis of temperature data shows that the variation in temperature throughout the year is very minimal, however, daily temperature ranges from 31°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 32.3 °C. With regards to the mean minimum temperature, the lowest temperature at Hulhule, 26.3 °C, was recorded for December (Figure 13).

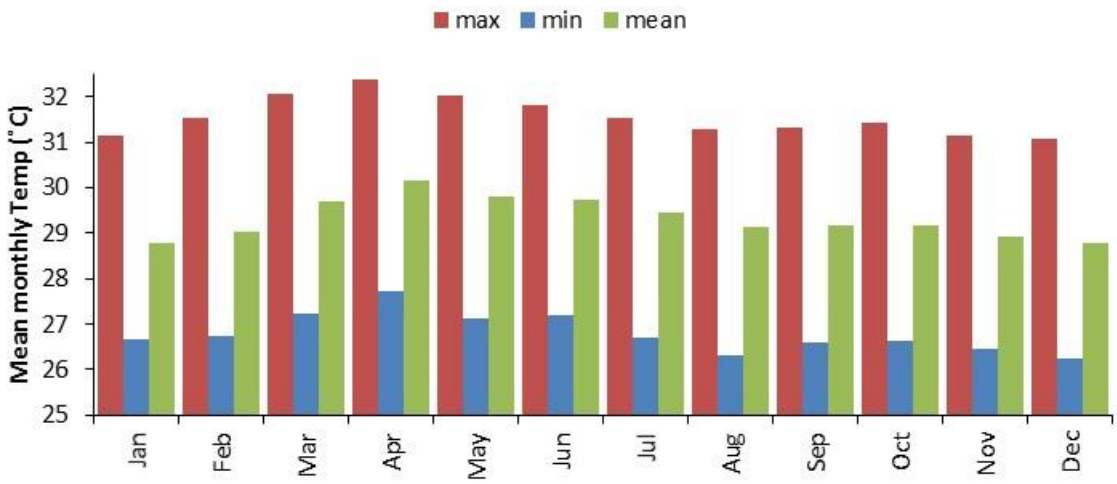


Figure 13. Mean, minimum and maximum monthly temperatures (°C) for Hulhule from 2008 to 2015 (Data obtained from the Bureau of Meteorology, Maldives)

4.2.3 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 Naifaru.

The average annual rainfall for Hulhule was found to be 6.83 mm and the heaviest rainfall recorded over the 10 year period was 142.3 mm. Monthly mean rainfall shows that the driest months are January to April and the wettest months are May, August and September. (Figure 14).

Generally majority of the roads in Male' floods during heavy rainfall as the drainage systems are not maintained. As for Izzudheen road, it also gets flooded badly. But with the introduction of the recent drainage system the flooding is not as severe as it was previously. Nonetheless when there is heavy rain the road still gets flooded. Generic analysis of vulnerability of Male' area to flooding is given under hazard vulnerability.

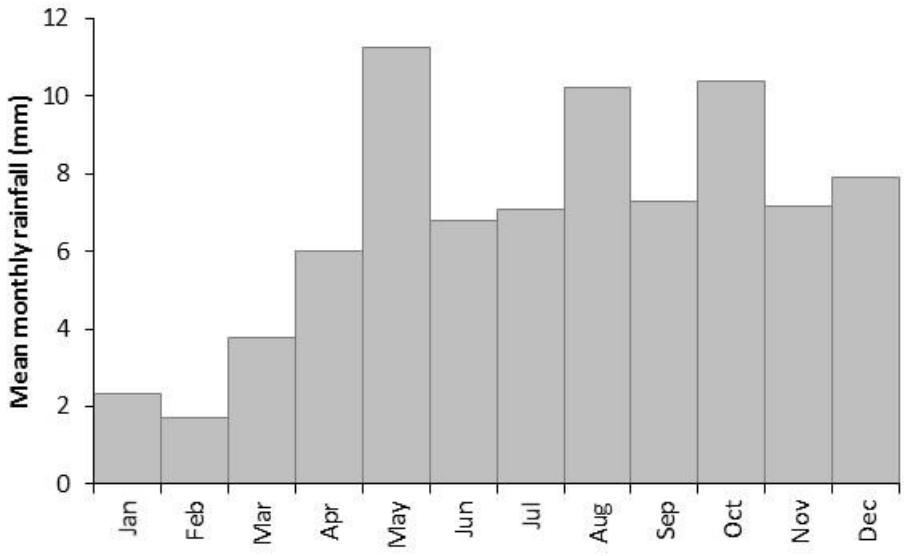


Figure 14. Mean monthly rainfall (mm) for Hulhule from 2006 to 2015 (Data obtained from the Bureau of Meteorology, Maldives)

4.2.4 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 15). Looking at the frequency plot data and wind rose plots, it was observed that the mean wind speed had gone as high as 36 kn towards the WNW direction. But the probability of occurrence was very low (only 0.02 % of the times). In general, the strongest winds occur from WSW, W and WNW directions. Winds from the south and SE as well as north were less prevalent and with comparatively low speeds. Majority of the times (about 12 to 19 % of the times), winds occur at a speed of 4 to 14 kn which is generally known as light to moderate

breeze. Wind speeds above 18 kn were a rare occurrence, occurring about 1.67 to 0.02 % of the times (Figure 15).

With respect to maximum wind speeds, visual inspection of the wind rose plot coincides with that of the mean wind speeds. Approximately 1.57 % 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 54 kn in the month of July during the data collection period. Winds higher that 18 kn were frequent, occurring about 45 % of the times. The most common maximum wind speed is between 12-16 kn.

Wind rose plots for both maximum and mean wind speeds show that winds from the western quadrant are dominant (about 23 % of the times) (Figure 15).

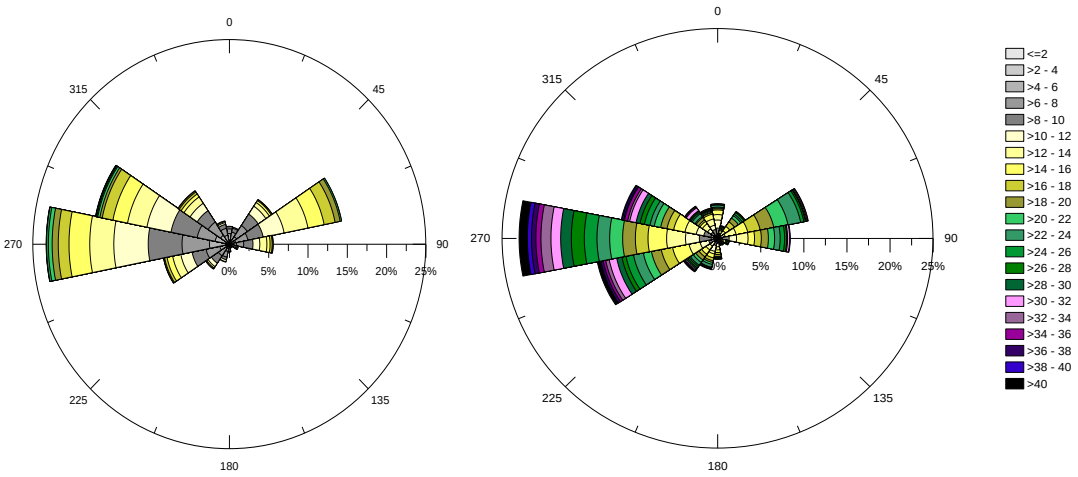


Figure 15. Mean (right) and maximum (left) wind speeds for Hulhule from June 1998 to December 2015 (Sourced from LaMer, 2016)

4.2.5 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 8). 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.

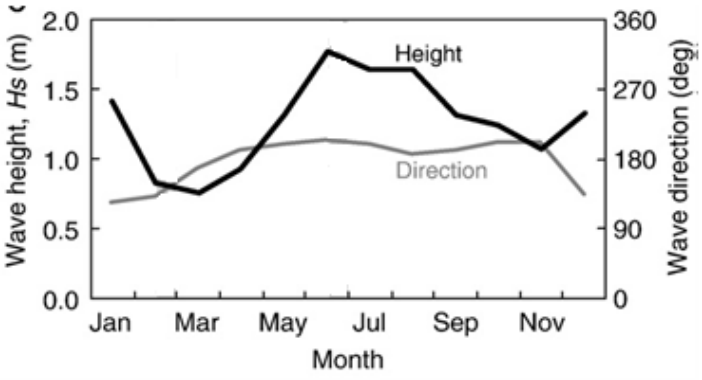


Figure 16: Ten year mean monthly wave height and direction for the central Maldives. Source: Young (1999).

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).

4.2.6 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.

4.2.7 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 17: mean tidal variations in the Maldives (Riyaz, 2016).

4.3 General setting of K. Thilafushi

Thilafushi is located on the Southern rim of North male' atoll. Thilafushi measuring 49 Ha (ISLES, n.d.) was first reclaimed in the 1990's to tackle the waste disposal issues in Male' (Thilafushi Corporation, n.d.). But later due to the demand for land on the island for industrial purposes Thilafalhu was further reclaimed in order to develop an industrial island. Thilafushi is now managed by Thilafushi Corporation Limited (TCL) which is mandated to develop Thilafushi as an industrial zone. Hence Thilafushi is now the place where major larger enterprises have their production, storage and servicing works.

The nearest island, just adjacent to Thilafushi was also reclaimed for industrial purposes and is managed by Gulhifalhu Investment Limited (GIL) in the vision to create an industrial island ("Gulhifalhu Investment Limited," n.d.). The nearest inhabited island is Villingili, which is the sixth district of Male', located approximately 3.6 Km East of Thilafushi.

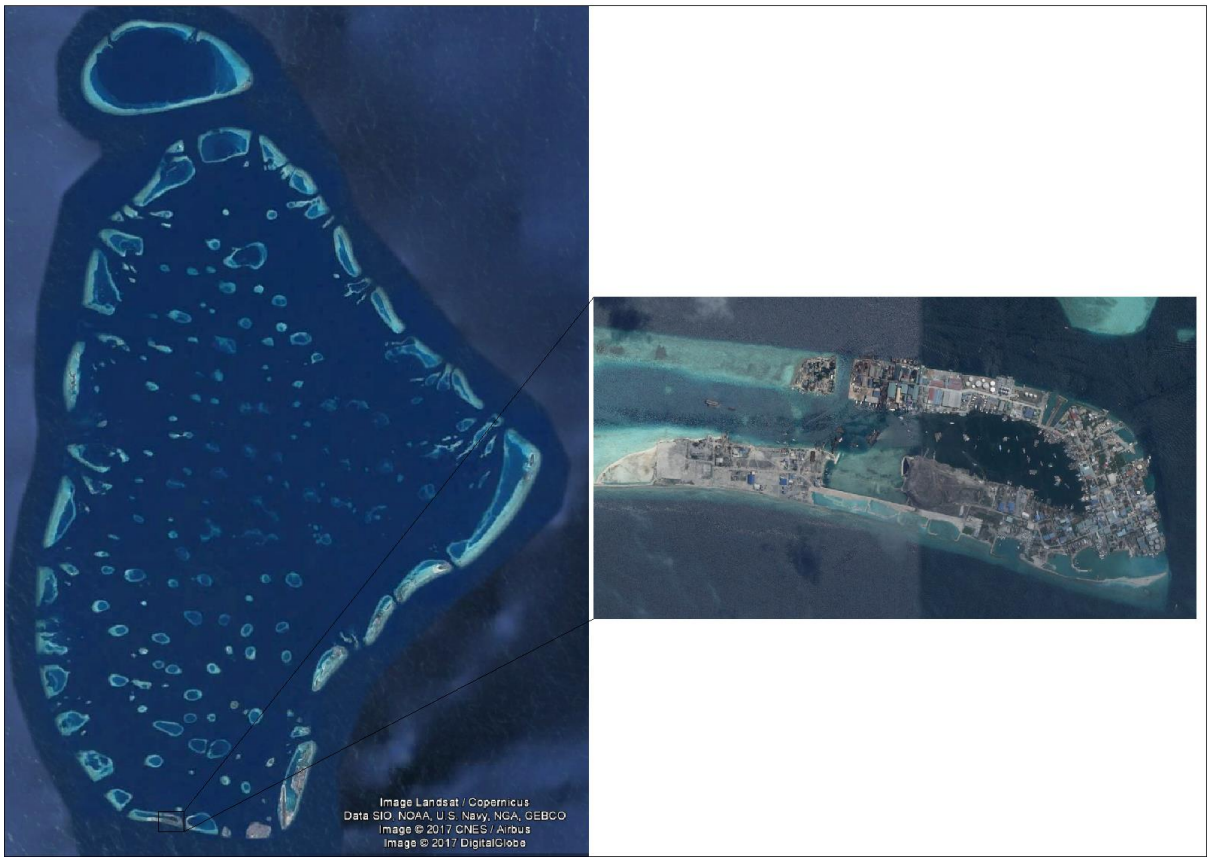


Figure 18. Location of Thilafushi in kaafu Atoll

4.4 Environmentally sensitive areas

There are no declared environmentally sensitive areas on *Thilafushi*. The nearest declared environmentally sensitive site is *Vaadhoo caves and Vellassaru Corner* which is approximately 6.5 Km South of *Thilafushi*. It is not anticipated that the environmentally sensitive areas will be in any way negatively impacted as they are too far away from the project location.

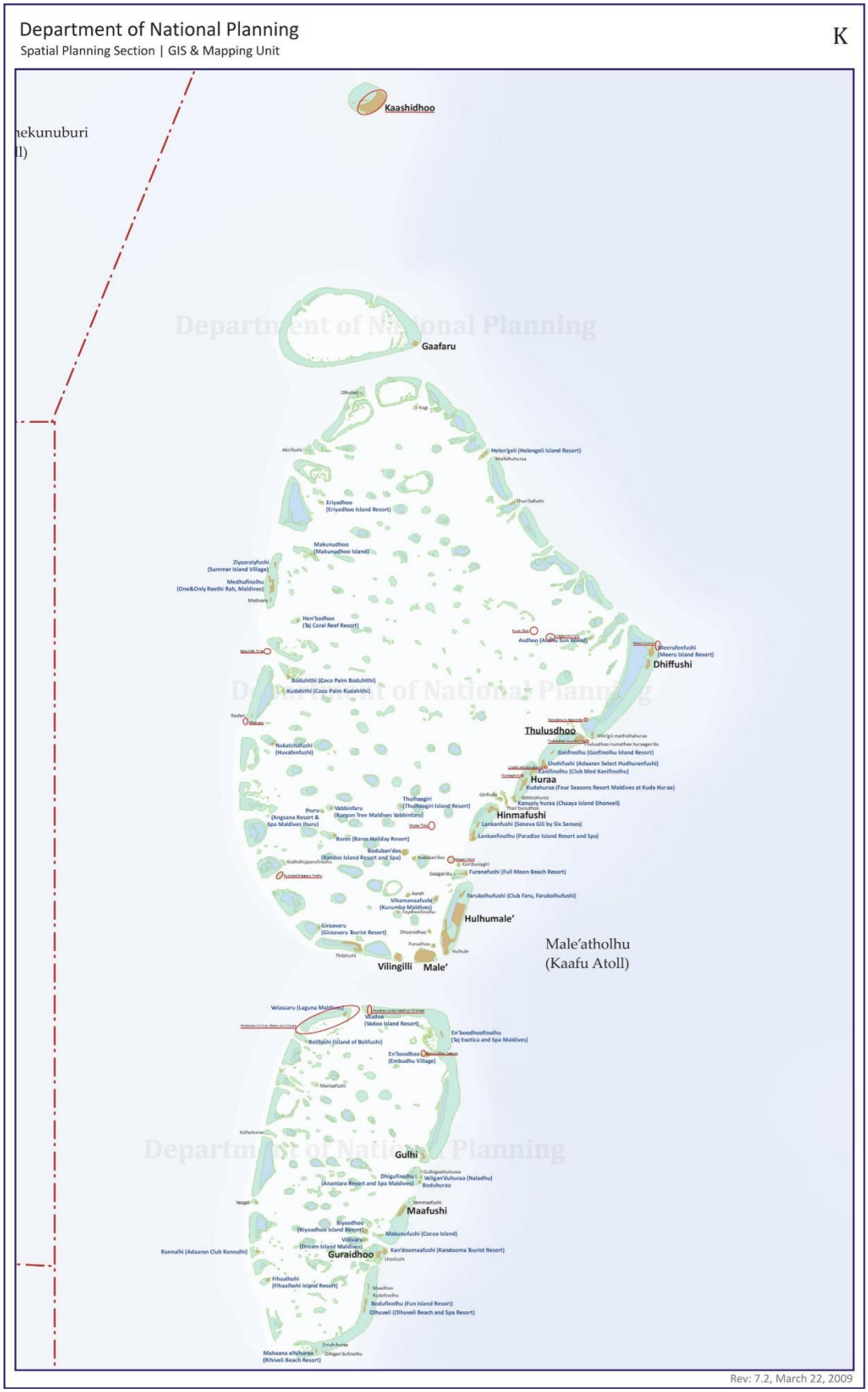


Figure 19: Environmentally sensitive sites of Kaafu Atoll

4.5 Ground water quality

Groundwater test results were compared with the EPA standards for the parameters with a specified guideline value as follows:-

Table 7: ground water quality optimal ranges

Parameter	**Optimal Range**	**Reference**
pH	6.5-8.5	EPA
Total petroleum hydrocarbon (TPH)	NA	NA

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

The pH of both samples were within the optimal range. However both samples contained high concentration of TPH (3.7 and 3.8 mg/L) indicating that the groundwater at Thilafushi near hawks site is already contaminated.

Table 8: Groundwater quality test results (parameters exceeding EPA standards are highlighted in red)

Parameter	**Locations**	
	Hawks site	Nalahiyaa site
pH	7.15	7.43
Total petroleum hydrocarbon (TPH)	3.8	3.7

4.6 Marine water quality

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

Table 9: marine water quality optimal ranges

Location	**Optimal Range**	**Reference**
pH	8.0-8.3 *Levels below 7.4 pH cause stress	EPA
Salinity(‰)	3.2% - 4.2%	GBRMPA, 2009
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

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

Almost all the parameters in all the samples were within the optimal range except for Sulphates which was at 2850 mg/L in both samples. The high sulphate concentration maybe attributable to the high intensity of coastal modification works on Thilafushi reef which had stirred up sediments and bacteria reducing sulphates in the sediment to sulphate ions in solution.

Table 10: marine water quality test results (parameters exceeding optimal ranges are highlighted in red)

Location	**M1**	**M2**
pH	8.10	8.09
Salinity(‰)	3.38	3.41
Turbidity (NTU)	0.264	0.349
Nitrogen Ammonia (mg/L)	<0.02 (LoQ 0.02 mg/L)	<0.02 (LoQ 0.02 mg/L)
Sulphate (mg/L)	**2850**	**2850**

4.7 Terrestrial environment

There is not much vegetation present at the proposed project site as the coastline have been highly modified and no terrestrial fauna was encountered during the survey. Each of the plot owners had their own jetties build which had formed maze of coastal structure which does not follow the reef line as mentioned by TCL (chapter 5) which was not aesthetically very pleasing.

Figure 20: existing jetty at Hawks Thilafushi site

4.8 Marine environment

During the snorkeling session, it was observed that the Eastern reef (near the hawks land) of Thilafushi was in bad condition. Majority of the reef was compose of rock with very few coral colonies. The small stretch of reef flat present in front of the hawks land had mostly rubble and rock. There were extensive damages caused to the reef most probably due to the construction of coastal structures. The reef had a high amount of construction debris on the edge, and plastic and food waste dumped into it inside the harbor basin of Hawks land. As for the fishes on the reef, herbivorous fish was observed in high numbers probably due to the presence of food waste.

4.8.1 Characteristics of seabed sediments

The sediment characteristics were visually observed. Two distinctive patterns of seabed sediment were observed at the project site. The reef flat and slope was dominated by rock and rubble, while the inner harbour basing composed of sand.

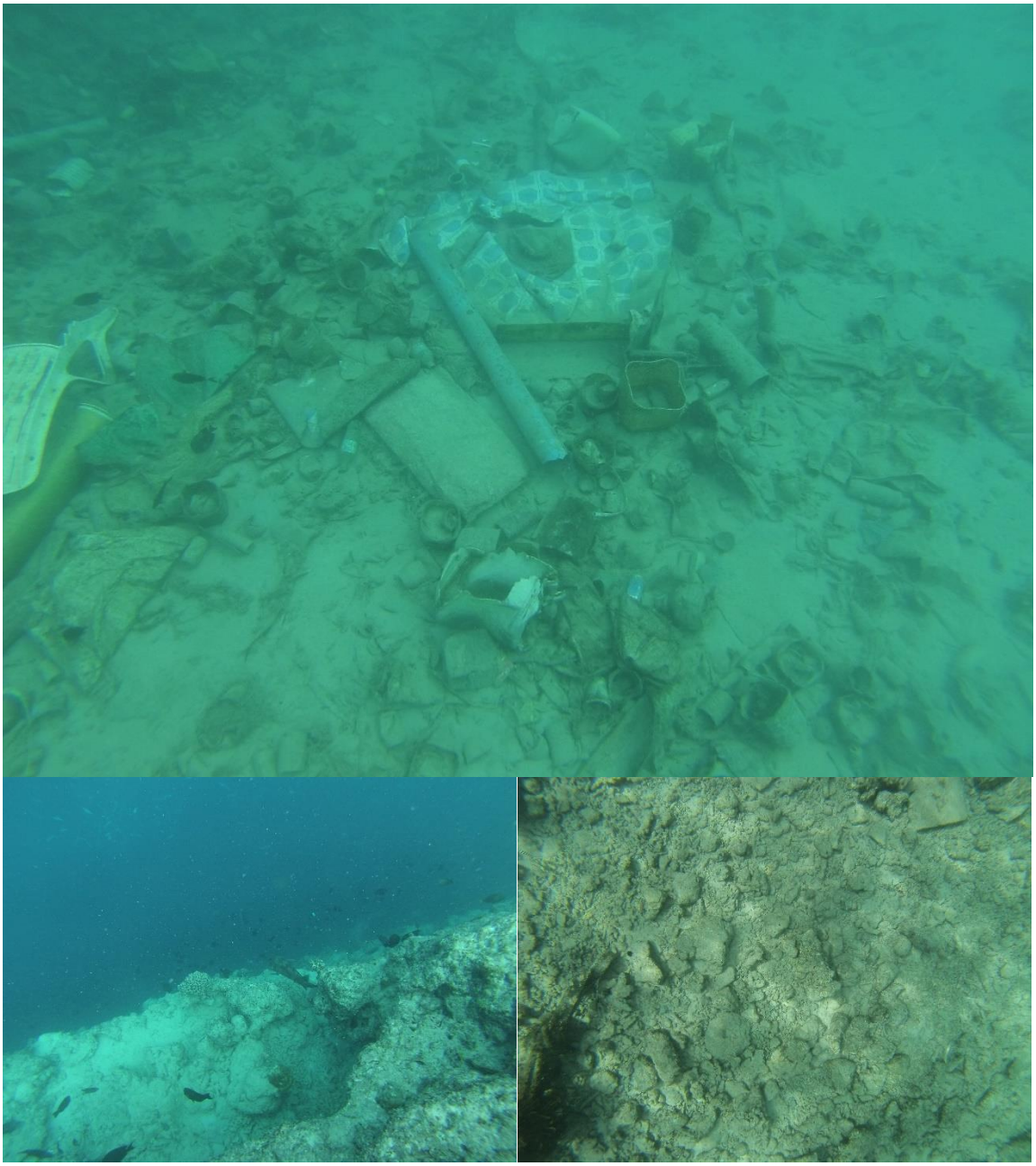


Figure 21: top; sandy bottom inside harbour basin littered with debrs, bottom left; reef flat composed mainly of rubble and rock, bottom right; reef slope composed mainly of rock

4.8.2 Benthic substrate

The results show that more than 53% of the reef (near the hawks land) is composed of rock with no live corals. The second major coral category occurring in the transect was rubble with 41.2%. Below are the tables and figures highlighting major and subcategories results used to analyse the benthic composition of reef.

Major coral categories

Table 11: Shows results for Major Category.

MAJOR CATEGORY (% of transect)	T1	T2	Mean	CI 95%+	CI 95%-
CORAL (HC)	0	0	0	0	0
SOFT CORAL (SC)	0	0	0	0	0
OTHERS (OT)	0	0	0	0	0
ROCK (RC)	86.4	20.8	53.6	86.4	20.8
RUBBLE (RB)	13.6	68.8	41.2	68.8	13.6
SAND (SD)	0	10.4	5.2	10.4	0

Looking at individual transects, Rubble is more dominant in Transect 2 (68%). This is because Transect 2 is on the small reef flat which exists near the hawks land. On this reef flat there is a small percentage (5.2%) of sand as well. While on the reef slope (Transect 1) there is mostly rock (86.4%).

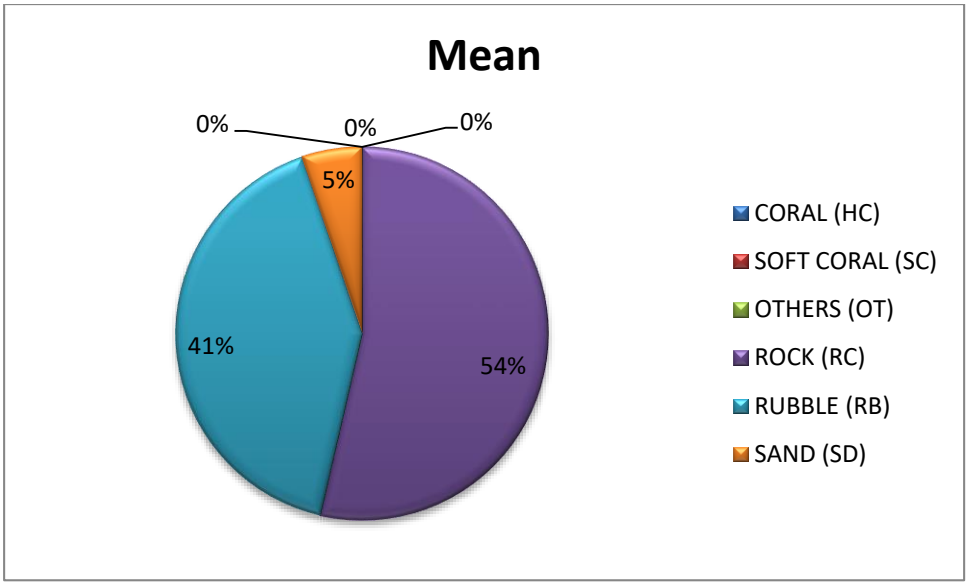


Figure 22: mean major coral categories.

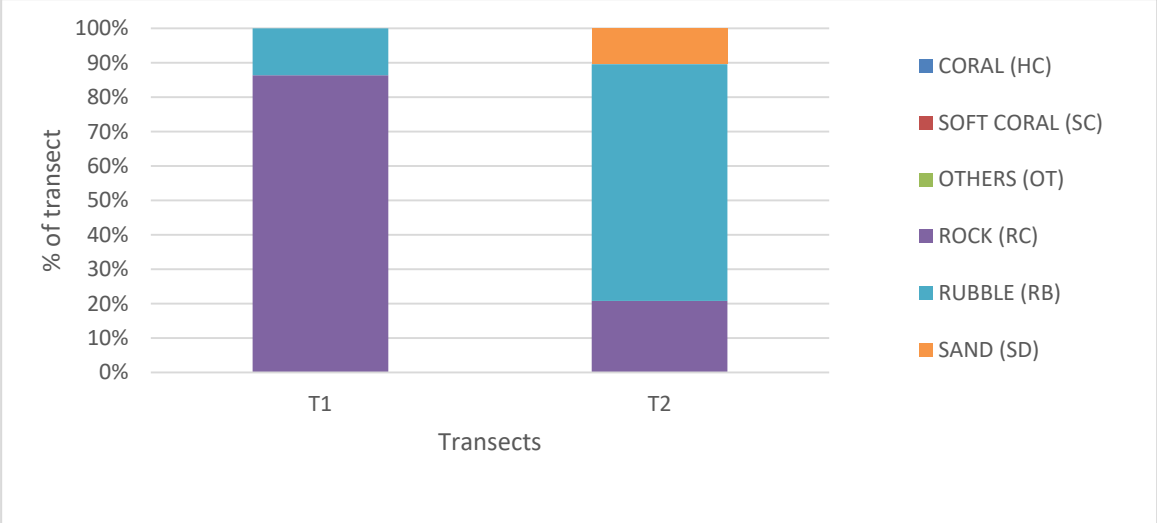


Figure 23: mean major categories of transects

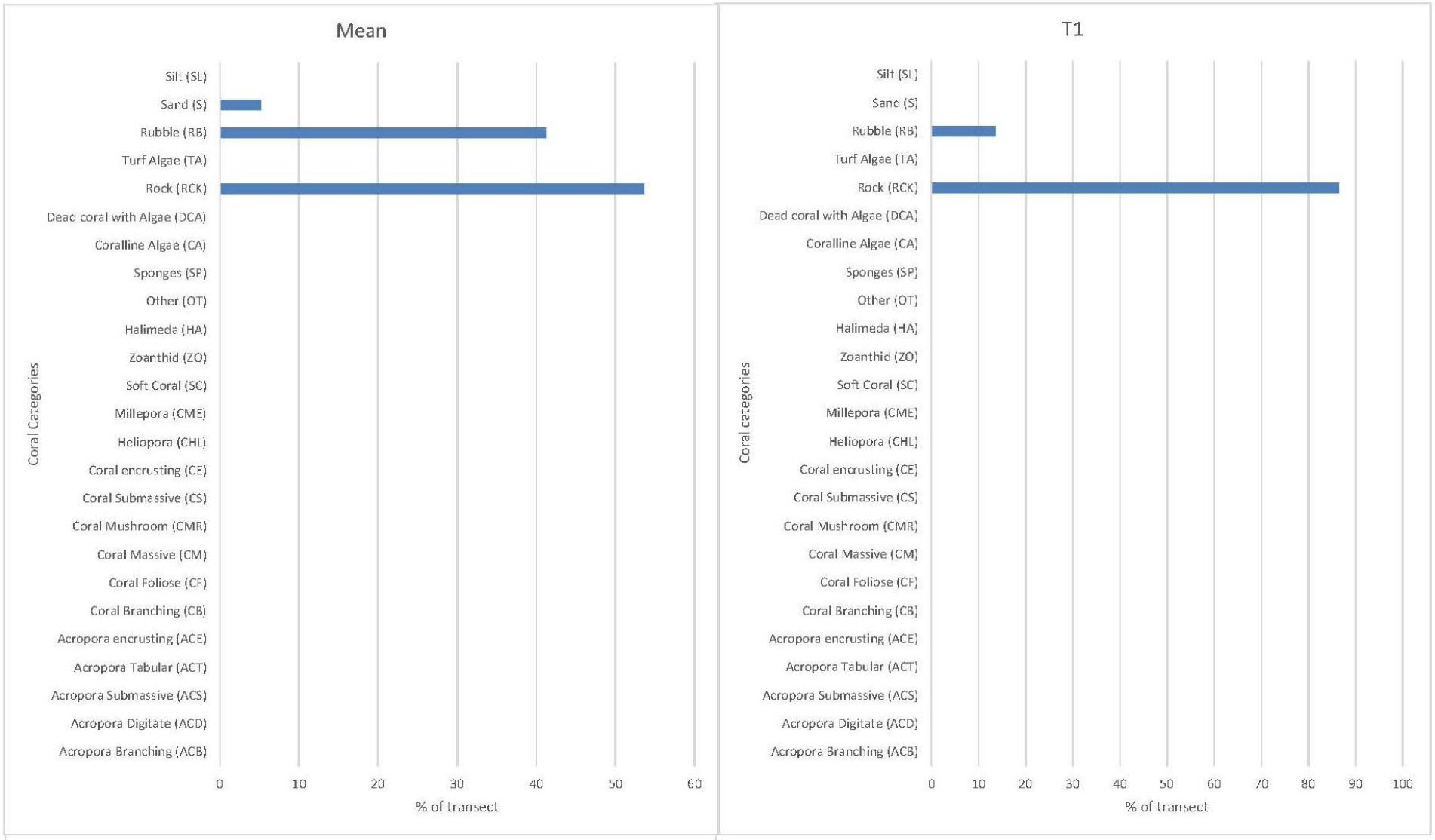
Sub categories

There are no live sub-category of corals.

Table 12: Shows results for Subcategory

SUBCATEGORIES (% of transect)	T1	T2	Mean	CI 95%+	CI 95%-
Acropora Branching (ACB)	0	0	0	0	0
Acropora Digitate (ACD)	0	0	0	0	0
Acropora Submassive (ACS)	0	0	0	0	0
Acropora Tabular (ACT)	0	0	0	0	0
Acropora encrusting (ACE)	0	0	0	0	0
Coral Branching (CB)	0	0	0	0	0
Coral Foliose (CF)	0	0	0	0	0
Coral Massive (CM)	0	0	0	0	0
Coral Mushroom (CMR)	0	0	0	0	0
Coral Submassive (CS)	0	0	0	0	0
Coral encrusting (CE)	0	0	0	0	0
Heliopora (CHL)	0	0	0	0	0
Millepora (CME)	0	0	0	0	0
Soft Coral (SC)	0	0	0	0	0

Zoanthid (ZO)	0	0	0	0	0
Halimeda (HA)	0	0	0	0	0
Other (OT)	0	0	0	0	0
Sponges (SP)	0	0	0	0	0
Coralline Algae (CA)	0	0	0	0	0
Dead coral with Algae (DCA)	0	0	0	0	0
Rock (RCK)	86.4	20.8	53.6	86.4	20.8
Turf Algae (TA)	0	0	0	0	0
Rubble (RB)	13.6	68.8	41.2	68.8	13.6
Sand (S)	0	10.4	5.2	10.4	0
Silt (SL)	0	0	0	0	0



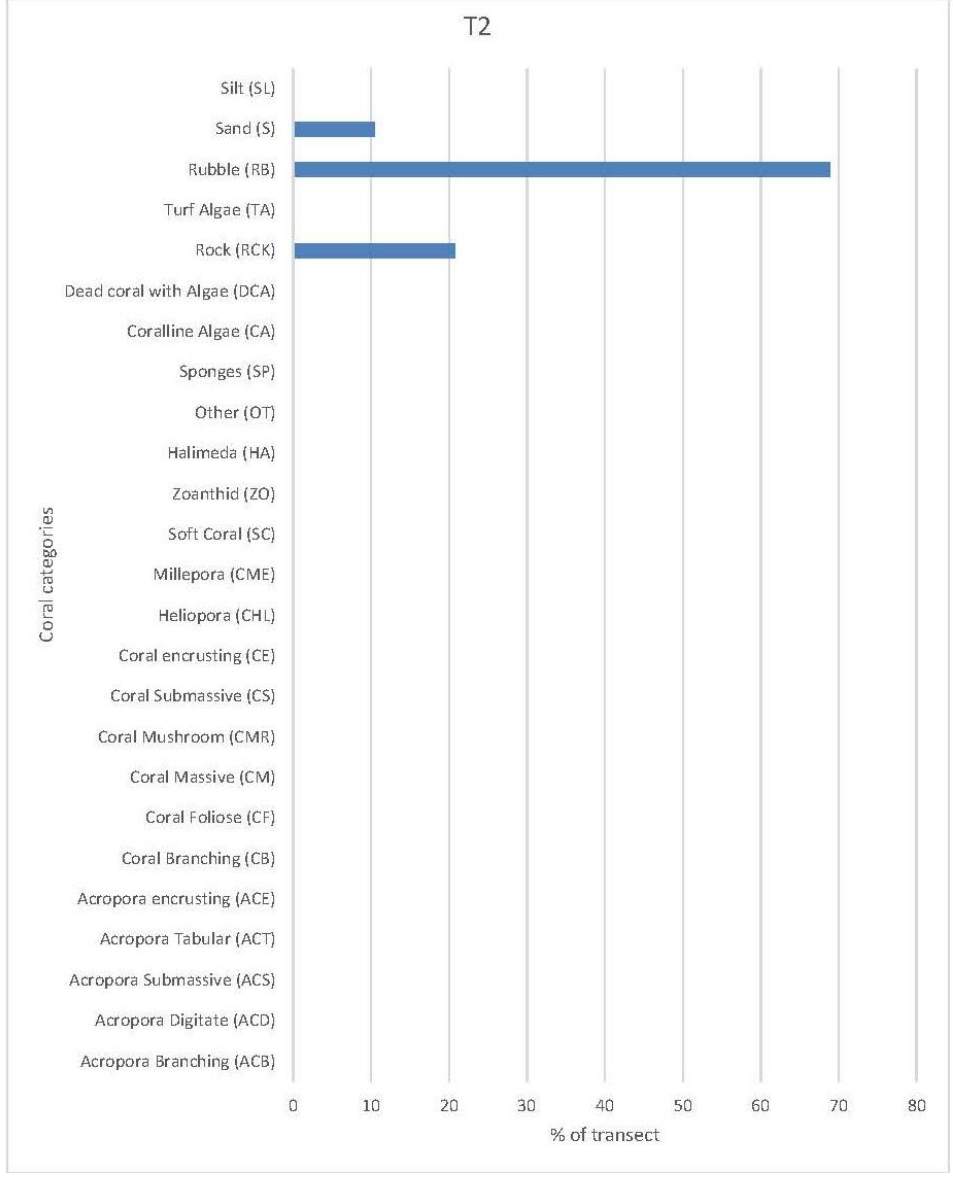


Figure 24: mean and subcategories of transects

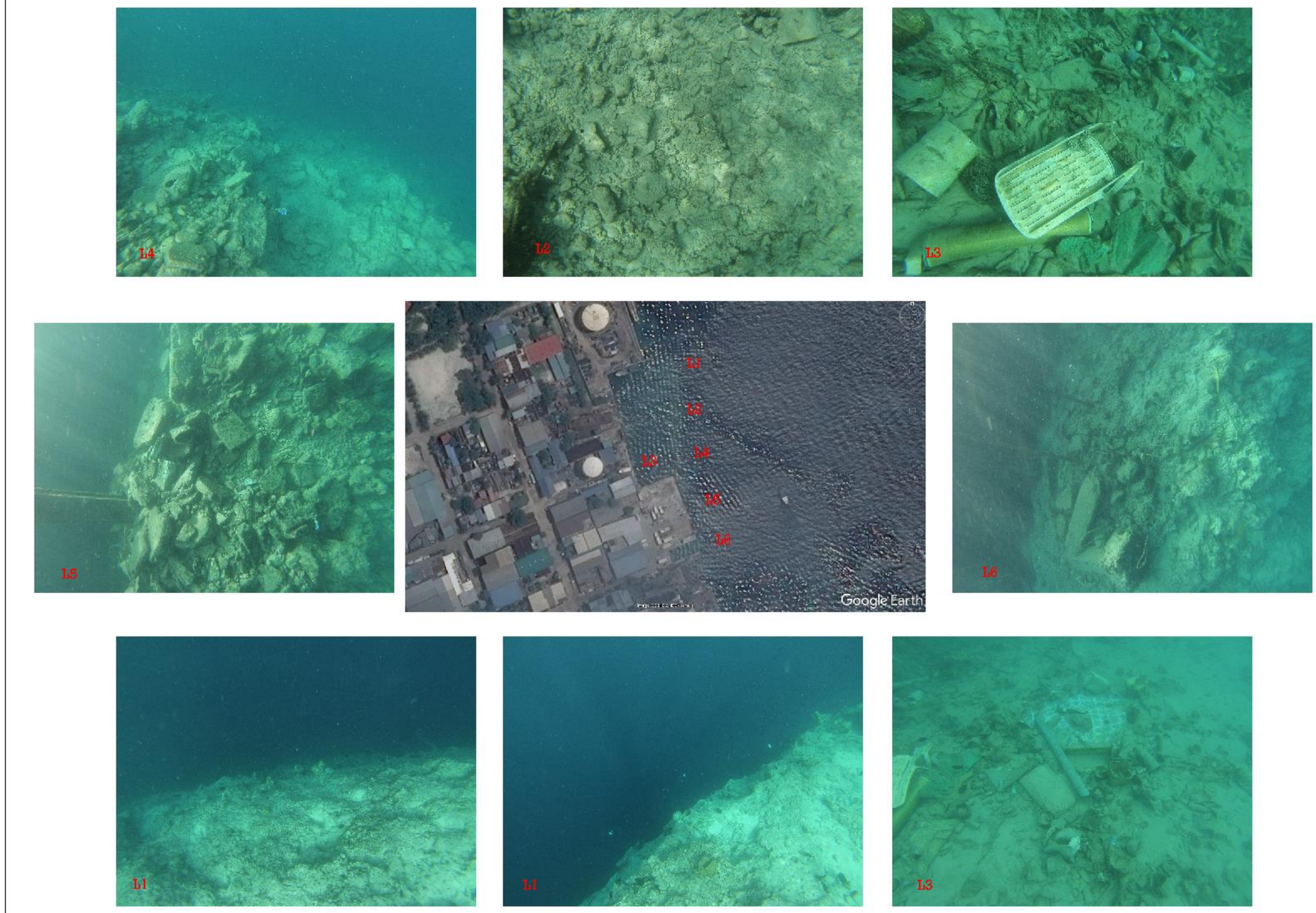


Figure 25: Shows the condition of the reef at different surveyed locations on Thilafushi

4.8.3 Fish census

Out of the 41 genus of fish from the target fish, only 4 genus was found on the Eastern reef of Thilafushi. Therefore, the diversity of the fish is low. The following table (Table 13) shows the relative abundance of the species found. The genus with the highest abundance was Acantharus at 50.0% followed by Zanclus (33.33%). The genus with the lowest abundance was Cephalopholis and Variola at 8.33%.

Table 13. Abundance of fish at different sites

Genus	**Relative abundance**
Cephalopholis	8.33%
Zanclus	33.33%
Variola	8.33%
Acanthurus	50.00%

Adding the 2 genus Acanthurus and Zanclus the total abundance of herbivorous fish add up to 83%. While the abundance of predatory fish comes to 14%. This coincides with the observation that a lot of herbivorous fish was present in the reef.

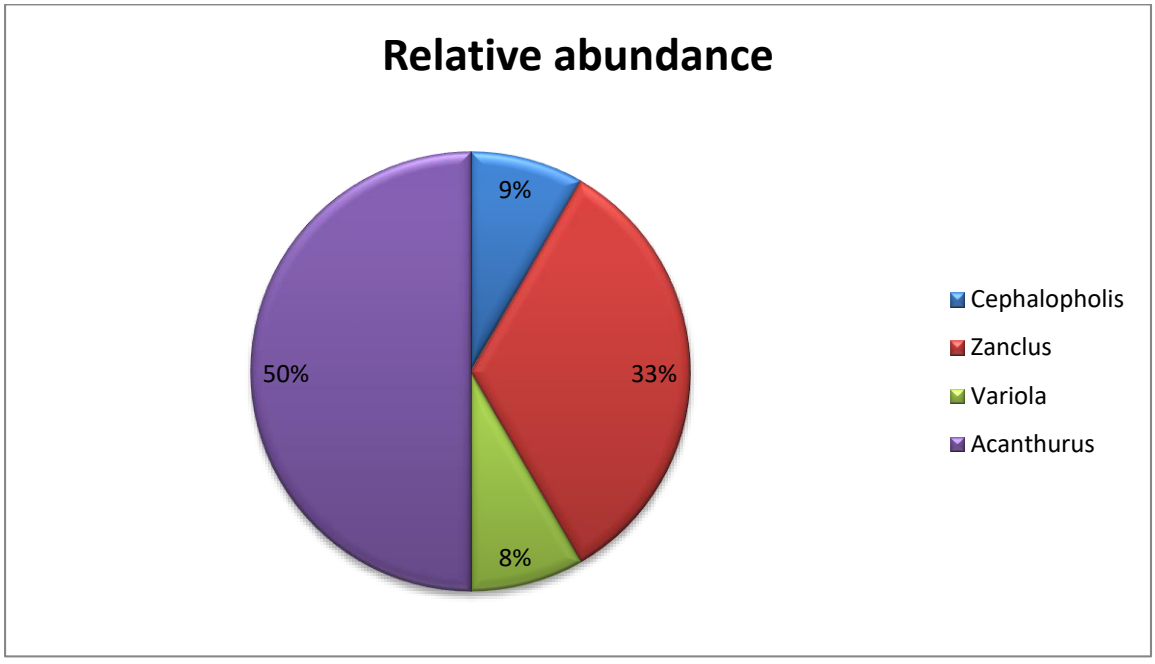


Figure 26: relative abundance of fish in Eastern reef of Thilafushi

Looking at the frequency of fish at both sites, the fish diversity seems higher at M1 since 4 genus of fish were found on contrary 2 genus was found at M2. This coincides with the observation that there were food waste discarded inside the harbor basin, it can be concluded that the food waste had contributed to the accumulation of herbivorous fish.

Table 14: frequency of fish in Eastern reef of Thialfushi

Genus	**Frequency**	
	M1	**M2**
Cephalopholis	1	0
Zanclus	2	2
Variola	1	0
Acanthurus	1	5
Total	5	7

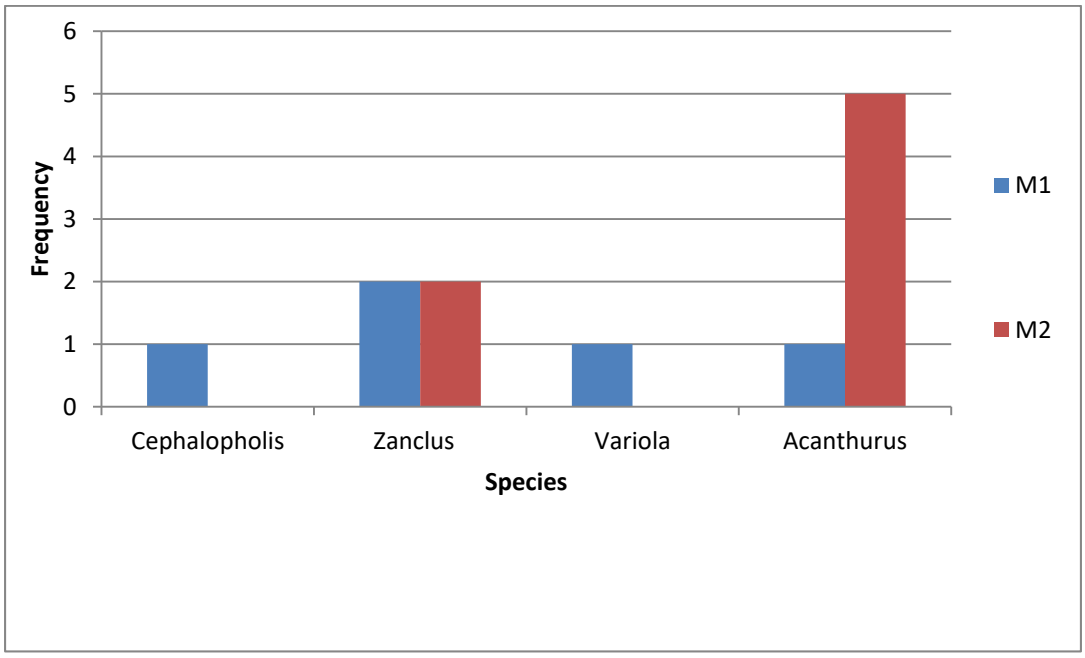


Figure 27: frequency of fish in Eastern reef of Thilafushi

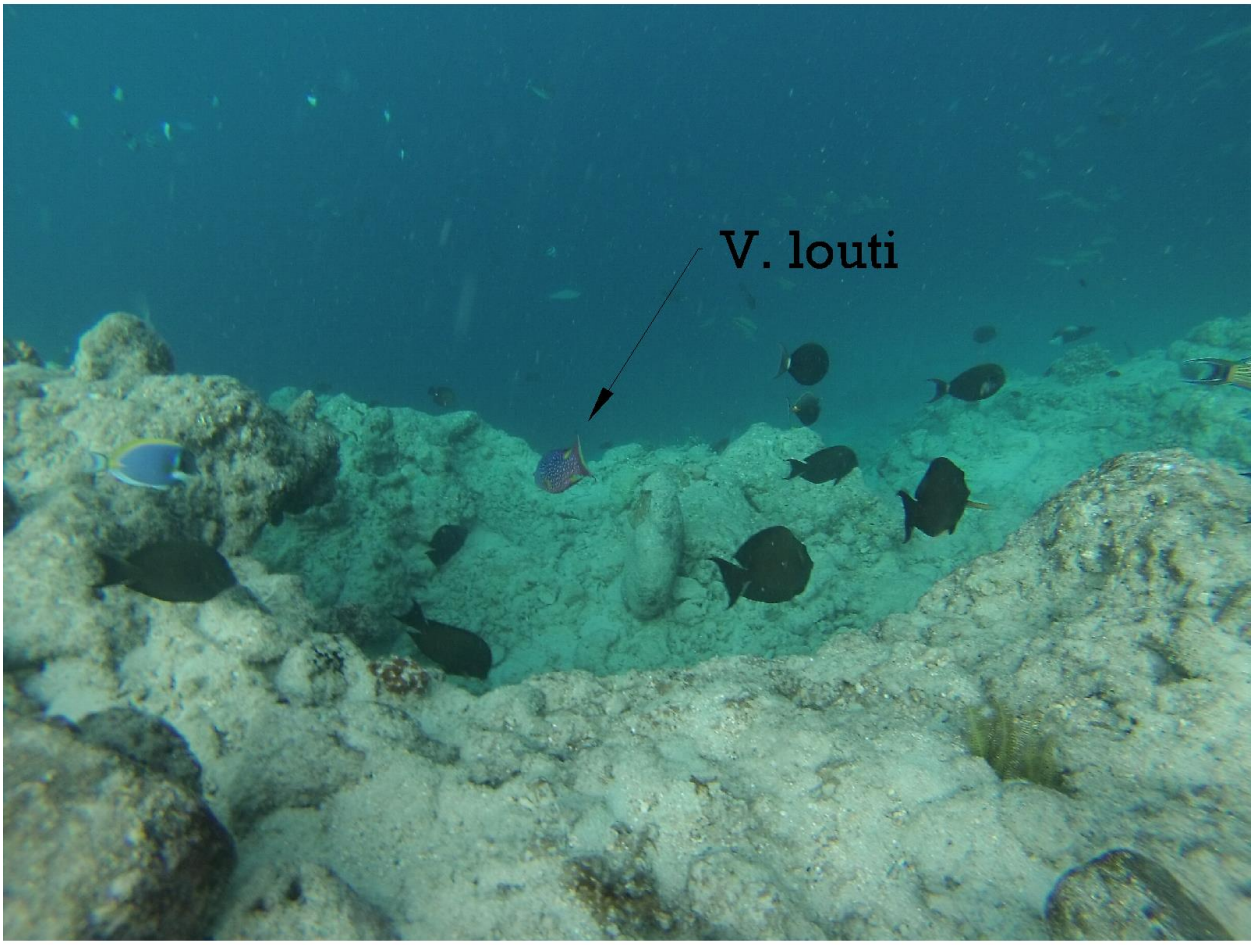


Figure 28: V. louti in Thilafushi reef

4.9 Island movement

Aerial pictures reveal the severe changes that were made to Thilafushi from 2005 to 2017. Several industrial buildings have been erected during this period. The most

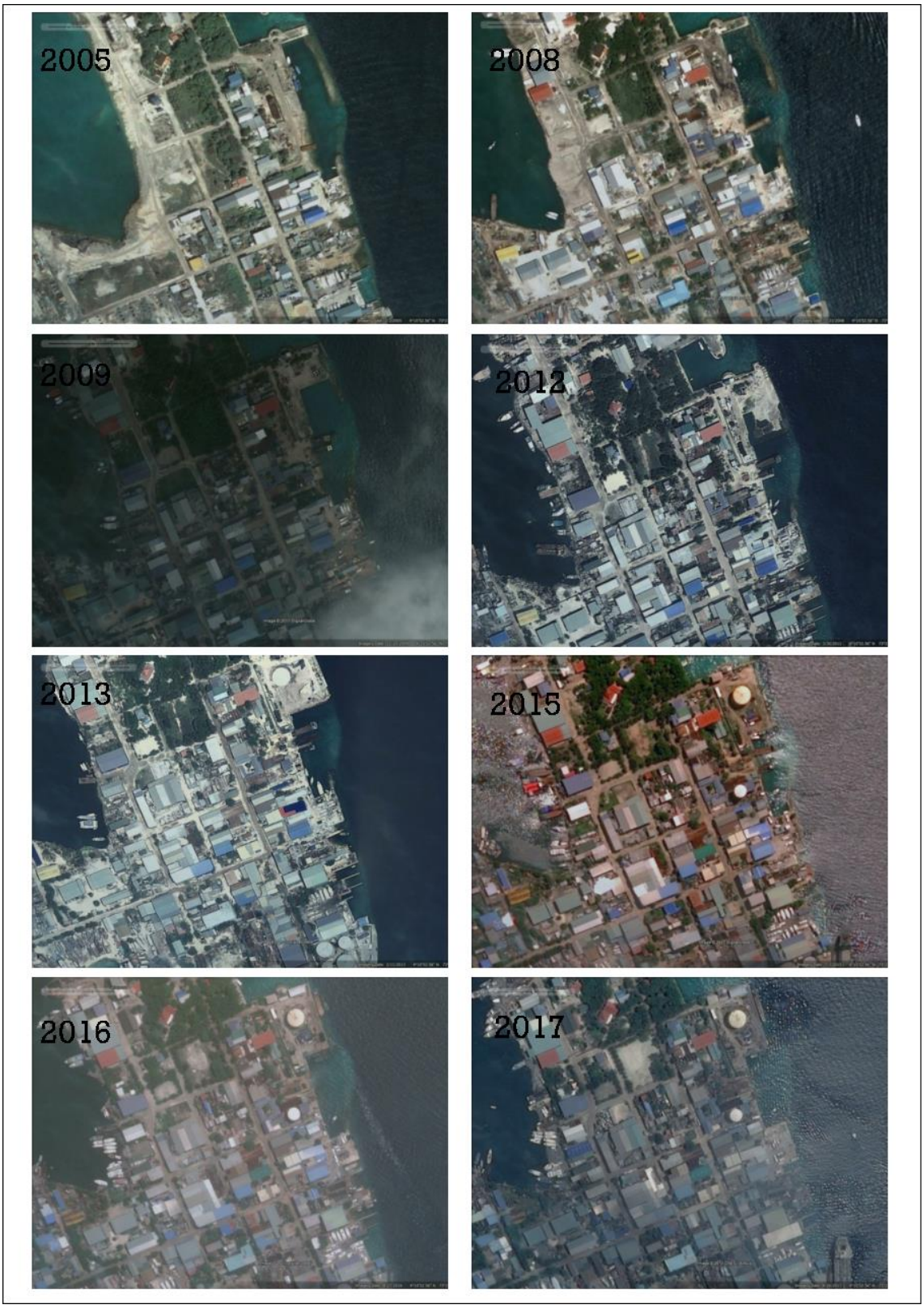


Figure 29. Aerials pictures of Thilafushi over the past years (adopted from google earth)

4.10 Current and Coastal dynamics

Thilafushi is located on the Southern rim of K. Atoll and hence is well sheltered from the North East swells due to the many islands and reefs on the North Eastern side of the Atoll. Due to these reasons from the North East side the wind waves would be dominating especially in the North East monsoon. The following figure shows how the resultant waves during the North East monsoon will approach the island. Even though the swell wave energy reaching the Eastern side of Thilafushi will be weak due to diffraction from the reefs on the Eastern side, the wind waves generated within the atoll from the NNE will reach Thilafushi therefore when heavy winds are blowing from NNE the wave energy on the Eastern side of Thilafushi would be high. Furthermore it is possible that some of the diffracted swell waves from the SE may reach Thilafushi.

Figure 30: wave patterns around Thilafushi in NE monsoon

Since there are no islands or reefs to the South West of the island, full force of the South West swells will reach Thilafushi. It is due to this reason that it is believed a hard-rock reef flat

developed on the South Western side of the island. With regards to the project site on the Eastern side of Thilafushi, it is well sheltered from the Swells and wind waves on SW monsoon.

Figure 31: wave patterns around Thilafushi in SW monsoon

The currents on the Eastern side of Thilafushi flows from North to South through the channel in between Thilafushi and Gulhifalhu. The currents measured during the survey time showed that the currents flows in this pattern. Schematic diagrams showing the current patterns on the Eastern side *Thilafushi* is shown in Figure 32 below.

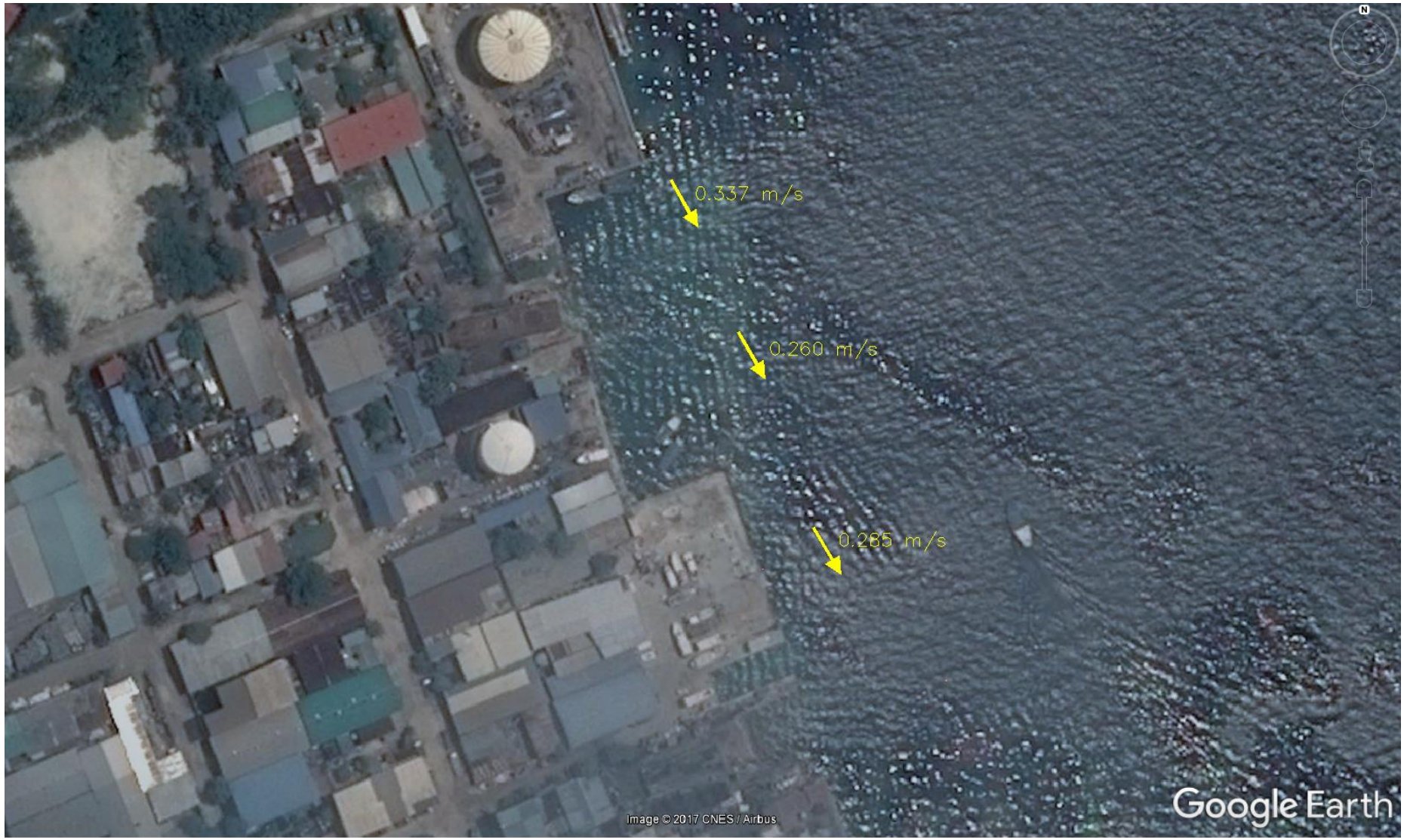


Figure 32. Current patterns on the Eastern side of Thilafushi

4.11 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).

4.11.1 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, Thilafushi falls within high to moderate risk zone (Figure 33) (UNDP, 2006), however, it should be noted that only 11 cyclones have been recorded across the Maldives since 1877.

4.11.2 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, Thilafushi falls into the moderate risk zone of storm surge hazard (UNDP, 2006) (Figure 33).

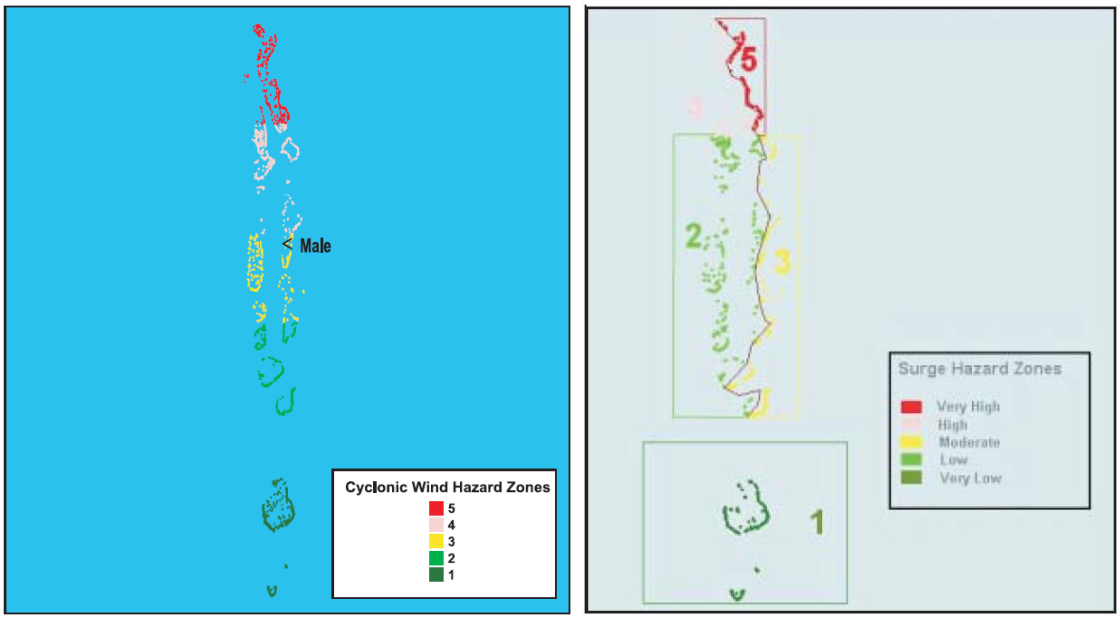


Figure 33. Cyclonic wind hazard map (left) and storm hazard map (right) of the; category 5 is the highest risk zone and category 1 is the lowest (Adapted from UNDP, 2006)

4.11.3 Flooding

Rainfall data from Hulhule' meteorological station have been used to analyze the flood and drought years across Thilafushi. 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 34) 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 Thilafushi is a reclaimed island with not much vegetation and drainage systems established on the roads the roads of the island get flooded easily. This is partly because of the compaction of the soil due to the operation of heavy machinery on the island.

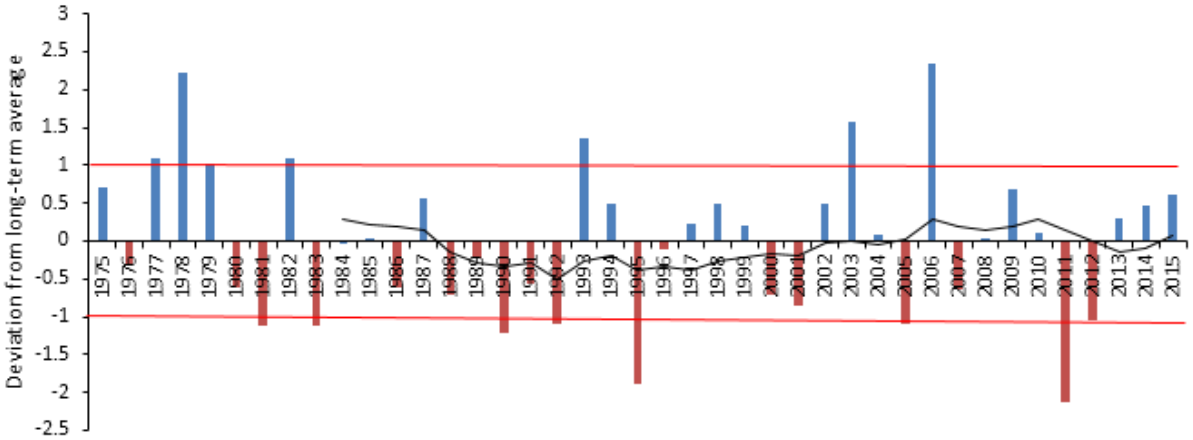


Figure 34. Rainfall anomalies for Hulhule from 1992 to 2015 with the 10 year moving average. Red lines indicate +1 and -1 standard deviations from the mean. (Data obtained from the Bureau of Meteorology, Maldives).

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5 STAKEHOLDER CONSULTATIONS

This section outlines the major findings of the consultations undertaken with regards to the proposed project in K.Thilafushi.

5.1 Key Stakeholders

The approved Terms of Reference for the EIA requires to consult the key stakeholders that could affect from the proposed project.

- Thilafushi Corporation Ltd.
- Ministry of Housing and Infrastructure.

5.2 Methods of Consultation with the Stakeholders

Both formal and informal methods have been used to inform the stakeholders about the proposed project and also gather the important information from the key stakeholders as per the EIA regulation.

5.3 Meeting with Thilafushi Corporation Ltd.

Date: 20th July 2017, 10:00 am, Fen building

Name	Designation	Company	Contact
Waseem	Project manager	TCL	
Hassan Rifau	CEO	Hawks Pvt Ltd	
Mahfooz Abdul Wahhab	EIA consultant	-	9994467

- Since the buildings alignment on the hawks land area does not follow the reef contour line, TCL intends to shape the buildings along the reef contour line hence wants Proponent reclaimed area also to be in line with this.
- Requested Hawks to do a detailed engineering design for the project and submit to TLC for approval prior to project implementation.

5.4 Consultation with Ministry of Housing and Infrastructure

Date: 26th October 2017, 12:30 pm, MHI

Name	Designation	Company	Contact
Amir Musthafaa	Engineer	MHI	7981711
Anoosha Hashim	Environment Analyst	MHI	

Mahfooz Abdul Wahhab	EIA consultant	-	9994467
Nafha Aujaz	Environment Analyst	MHI	7721554

- Advised the proponent to carry out proper studies in the design phase being mindful to the wave impacts in order to ensure the sustainability of the investment.
- Currently there is no guideline established for sheet piling in the Maldives.

5.5 Consultation with RKL

Date: 2nd November 2017, 08:27 am, via phone call

Name	Designation	Company	Contact
Mohamed Moosa	Operation GM	RKL	7668020

- As long as Hawks maintain activities in a way that does not interfere with our works we do not have any issues. However if during the project Hawks does any damage to their plot, then they should be liable for that damages.

6 SIGNIFICANT ENVIRONMENTAL IMPACTS AND MITIGATIONS MEASURES

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 stage of the proposed project. Operational impacts are the potential impacts which might arise once the newly constructed structures become operational.

6.1 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 location of the structures and type of service to be provided. As such, the hazards identified were:-

1. **Constructional impacts:-**
   - Air quality;
   - Noise, vibration and disturbance;
   - Generation of constructional and decommissioning wastes;
   - Oil and chemical leakage;
   - Impacts on marine environment due to coastal structure construction; and
   - Risk of accidents and pollution on workers
2. **Operational impacts:-**
   - Soil and marine pollution; and
   - Economic;

Hazards were assessed using the following matrix (Table 15).

Table 15: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 15). 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 16 below.

Table 16: 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

6.2 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, assessment of existing conditions require a benchmark against which these conditions can be compared, however, lack of such benchmarks are a great hindrance to analyzing the environmental impacts at some instances. In addition to this, limited time availability and lack of available factual information are among major limitations to impact predictions. In the Maldives, more often than not, limited availability of published information on environmental and social environment of the islands have led to the dependency on verbal communication with locals and island councils which are not always very accurate.

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

6.3 Constructional impacts

Table 17: 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, vibration and disturbance due to operation of heavy machinery	Certain	Minimal	Medium
Impacts on marine environment from turbidity, chemical spillages and direct damage to benthos	Certain	Moderate	Medium
Generation of constructional and decommissioning wastes	Certain	Minimal	Medium
Risk of accidents and pollution on workers	Possible	Major	High

Impacts during construction phase of the project are mainly anticipated to be short-term and reversible (Table 18) as most impacts will last only for the duration of the construction phase of the project.

Table 18: Summary of impacts during the construction phase of the project

Potential impact	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Air quality- GHG emissions	Direct	Negative	Local	Short-term	Reversible
Noise pollution, vibration and disturbance due to operation of heavy machinery	Direct	Negative	Local	Short-term	Reversible
Impacts on marine environment from turbidity, chemical spillages and direct damage to benthos	Direct	Negative	Local	Short-term	Irreversible
Generation of constructional and decommissioning wastes	Direct	Negative	Local	Short-term	Reversible
Risk of accidents and pollution on workers and local population	Direct	Negative	Local	Short-term	Irreversible

6.3.1 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. Release of GHGs and any other gases into the atmosphere during the construction phase is very low and since

construction site is close to the coast, it is expected that any released gases will not remain stagnant to a particular area to cause a nuisance.

Risk analysis shows that impacts on air quality is medium (Table 18) and is expected to be limited to project site and last only for the duration of the construction phase of the project hence is not expected to cause any significant adverse impacts on the environment and people working on Thilafushi within the vicinity of the project site.

6.3.2 Noise pollution, vibration and disturbance

Similar to air quality, impacts on noise level during the constructional phase is generally credited to operation of machinery, equipment and vehicles. This impact has no significant risk to the environment as there are no avian fauna living at the project site which would otherwise be scared off due to the noise disturbance. Furthermore as no humans live in the vicinity, no community would get disturbed due to the noise. The workers who work in this environment would be already used to the higher than normal noise level in an industrial area. Finally, the impact is short term and limited to only the construction phase of the project. Therefore the impact rating is medium.

6.3.3 Impacts on marine environment from turbidity and direct damage to benthos

Impacts to marine environment arises from three different ways. Firstly direct damage caused to the benthos due to the operation of the excavator and complete displacement of any benthic substratum which is directly on the footprint of the coastal structure and from the dredging. Secondly indirect damages to corals and photosynthetic marine organisms due to increase turbidity (sedimentation) as a result of re-suspension of excavated material, fish and other marine organisms that can move will probably move away from the high turbid areas temporarily to return once the turbidity level drop to normal after completion of the project. Thirdly indirect damages to marine organisms due to chemical (and oil) spillages which may occur during the operation of heavy machinery and construction works. The estimated impact area due to the project is given on following figure.

Since there are no live corals at the project site, there are no major direct damages that could incur due to the construction of this coastal structure to the benthic substratum and considering the low fish diversity at the project site, the consequences are moderate. Therefore the overall significance rating of this impact was medium.

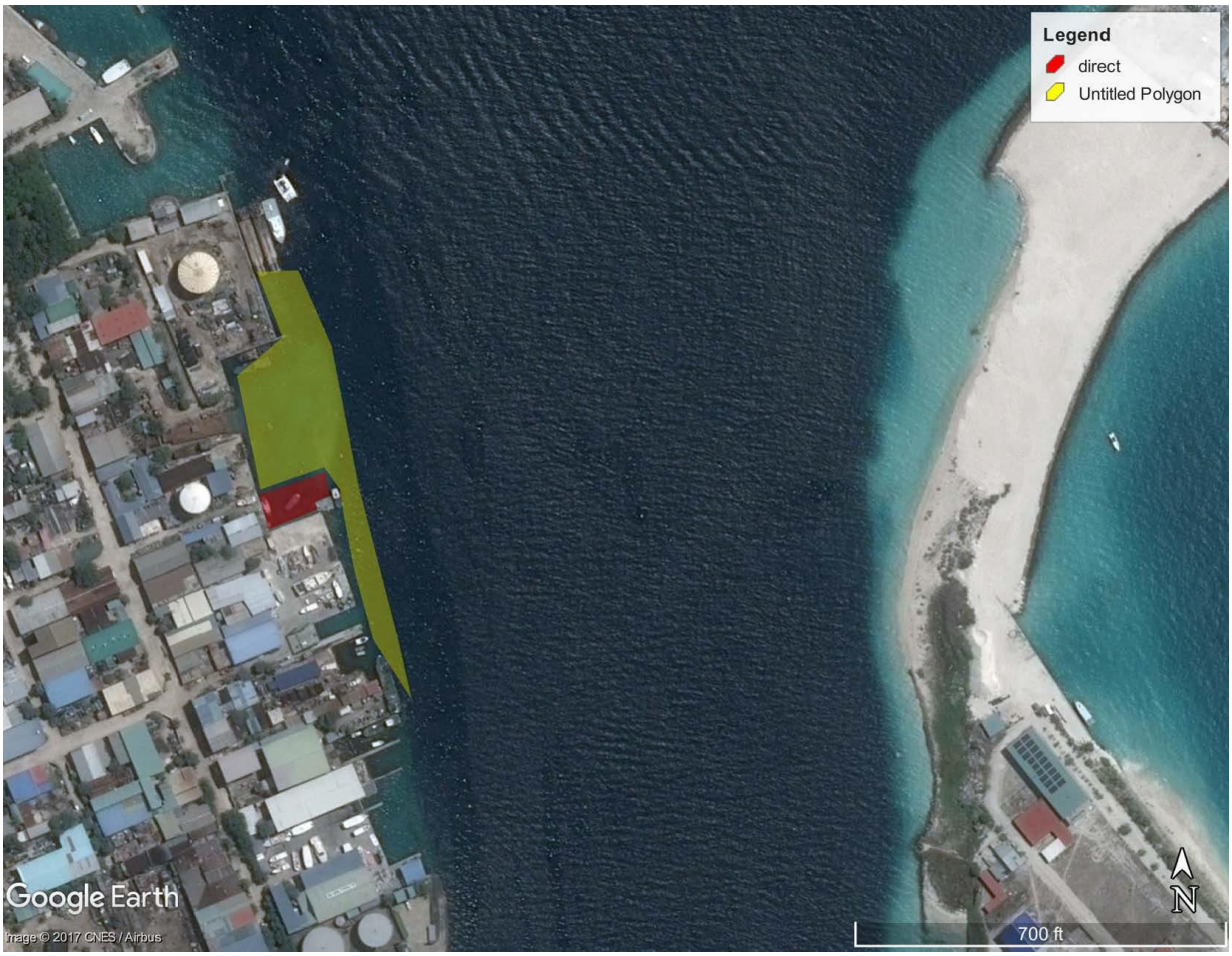

Figure 35: Estimated direct and indirect damage area due to construction of coastal structure at Hawks land in Thilafushi

6.3.4 Generation of constructional and decommissioning waste

It is expected that a small quantity of waste would be generated as this project does not involve any demolition of existing structures. The waste stream would comprise mostly of plastic, wood and metal that would generated from packaging waste and from the construction works. Once the waste materials are transported to Thilafushi waste management site the impact would be levitated and hence this impact is short-term. However if the waste materials were not stored properly, there is the risk of it being carried into the sea by wind and causing indirect impacts to the marine organisms especially plastic waste. Therefore the final risk rating for this impact is medium.

6.3.5 Risk of accidents and pollution on workers

As typical of any construction project, there lies the risk of accidents and pollution on workers. Occupational health and safety measures should be strictly followed in addition to placement of danger signs around the project area. The risk analysis has yielded a risk rating of "high" because the risks to human health are very serious and any injuries may result in irreversible consequences.

6.4 Mitigations of Construction phase

The proposed mitigation measures for the construction phase are detailed in the table below

Impact	Mitigation
• Air quality and Noise pollution, vibration and disturbance due to operation of heavy machinery	• Daily maintenance of vehicles and machine • Regular maintenance of the machinery and vehicles • Conduct the work during the daytime to reduce the noise impact on the surrounding • Workers who are working with dusty activities such as excavation, cement mixing and concrete works shall be provided with appropriate clothing.
• Impacts on marine environment from turbidity, chemical spillages and direct damage to benthos	• Commence trenching works at a slow pace to allow for mobile organism to escape work site; • Restrict movement of barges and excavators to a narrow area only; • Release of dredge waters to the bottom waters only • Silt screens to be used during dredging and reclamation to reduce sediment movement
• Generation of constructional and decommissioning wastes	• Adhere to the waste management plans and procedures during the construction and operation of the facility • Stock pile and store of waste in one area during construction • Segregation of waste would be done at the waste management area

	• Solid waste, oil and hazardous materials needs to be carefully handled and transported in sealed containers
• Risk of accidents and pollution on workers and local population	• Adhering to best workmanship. • Raising awareness on workers on the safeguards of accidents and workmanship. • Have adequate measures for spill cleanup in case of accidents

6.5 Operational impacts

Table 19: Predicted impacts and risk analysis anticipated during operation phase of the project

Potential impact	**Likelihood**	**Consequence**	**Risk rating**
Economic impacts	Certain	Major	Significant
Soil and marine pollution due to oil operations	Certain	Moderate	Significant

Unlike constructional impacts, operational impacts are anticipated to be more long-term and irreversible (Table 20). It should be noted that with the application of proper mitigation measures as outlined in section 6.4 of this report, almost every negative impact could be minimized.

Table 20: Summary of impacts during the operation phase of the project

Potential impact	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Economic impacts	Direct	Positive	Atoll	Long-term	Reversible
Soil and marine pollution due to oil operations	Direct	Negative	Island	Short – terms	Reversible

6.5.1 Soil and marine pollution

One of the plans of the proponent is to establish an oil refill point for the vessels. During the operations of the refill point, if proper care is not taken it is envisaged marine and soil oil spills may occur and this are deemed to have negative impacts. Although the new jetty would be a reclaimed area and the existing marine conditions adjacent to the jetty are not in pristine conditions, appropriate steps shall be undertaken to reduce these impacts.

6.5.2 Economic impacts

The new coastal structure at the hawks land will allow larger vessels to dock outside and will improve the efficiency of their operations. The improved efficiency of the company would reflect as huge economic benefits

6.6 Mitigations of the Operational phase

There are no noticeable negative impacts on the environment during operational phase of the project except for the operation of the oil refill point. The mitigation measures for the operation of the refill points are:

- Regular maintenance of machinery.
- Following proper oil/chemical handling procedures.
- Staff training on emergency oil spill cleanup.
- Oil spill cleanup materials readily available at the site.
- Providing guidance to the staff and vessel crew members for best procedural practices during oil transfer.

7 EVALUATION OF ALTERNATIVES

7.1 No-project option

The no project scenario means that the new jetty shall not be constructed and the proponent shall use the existing jetty. The negative environmental impacts that may occur due to the project will be avoided, however the following issues shall remain unaddressed:

- It is not sufficient to dock enough vessels – at present, it can only accommodate two to three vessels at a time.
- The depth of the water at the edge is too shallow and not practical for bigger boats due to their span and the draft of a boats' hull

Furth more, the advantages for the proponent and TLC mentioned in the **"need for project"** section of the report will not be achieved if the no project option is selected. Therefore, after considering the pros and cons of the option, the preferred alternative is to continue the project as planned.

7.2 Considerations for dredge methods

7.2.1 Mechanical Bucket Dredges

Mechanical bucket or clamshell dredge uses a crane or an excavator similar to excavators used in the construction and mining industries to mechanically scoop the sediment from the channel bottom and place it on a barge for transport to the placement site. Different types of buckets, such as clamshell or excavator can be used depending on the dredging requirements. However this type of dredge is inefficient for the removal of soft fine-grained sediment. Furthermore, the production rates relative to cutter head pipeline dredges are lower in mechanical dredges. Moreover, due to the slower production rate and the dredge process, it is anticipated that more sediments would be released to the dredge area for a prolonged time period increasing the negative environmental impact. Given these factors, it is taken that to proceed with the proposed method of dredging (cutter suction) is more advantageous than the alternative.

7.3 Considerations for dredge areas

An alternative location is shown in the dredging and backfilling plan in the project description section of this report (figure 10). This location is roughly 30 m north of the proposed dredge area. The area also have a mean elevation of -3m and the substratum is composed of rock, sand and rubble without any live corals.

However, given the nature of the project, the proposed dredge area not only gives the required sand for the reclamation of the jetty, but also provides the needed depth for the jetty's operation. Therefore, with the proposed dredge area, the total environmental footprint of the project could be kept at a minimum, hence it is preferred to carry out the project as planned.

8 MONITORING PROGRAM

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

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

The before-impact data collection at Thilafushi was carried out during baseline surveys in September 2017. Baseline survey is carried out to quantify ranges of natural variation and/ or directions and rates of change that are relevant to impact prediction and mitigation. A set of reference data was obtained from these surveys, which can be used during the relocation and after relocation phases to evaluate whether the predicted impacts occurred and to test the efficiency of the mitigation measures that will be implemented.

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

In summary, environmental monitoring can:

- Illustrate the extent of environmental effects and resource losses;

- Provide scientific information on the response of the environment to human activities and mitigation measures;
- Provide data that can be used in the environmental auditing for management purposes.

All monitoring activities will be carried out under the supervision of the environmental consultants. The details of the monitoring program are given in Table 10.

Table 21: Environmental Monitoring Plan.

Monitoring Parameter	**Phase**	**Methodology**	**Indicators**	**Sampling Frequency**	**Estimated Cost**
Marine water quality	Construction and operation phase	Water testing	Water quality	Bi weekly during the construction phase. -Once after project completion - Bi annually in operational phase for 1 year	USD 200/ survey
Coastline	Operational phase	Topographic surveying	Net loss in sand budget of the island	Seasonally during operational phase for 3 years	USD 2000/ survey
Marine Bio diversity	Construction and operation phase	Baseline Surveys	Decrease in marine diversity	Every three months during the construction phase. - Bi annually in operational phase for 2 year	USD 200/ survey

Monitoring will be carried out every week for one month from the date replantation. A monitoring report will be submitted to the Ministry of Environment and Energy 2 months following data collection, as outlined in Table 11.

Table 22: Time frame for monitoring and reporting.

Description	**Month/ Year**
EIA Approval	November 2017
Report submission to EPA - 1	January 2018
Report submission to EPA - 2	April 2018
Report submission to EPA - 3	December 2018
Report submission to EPA - 4	April 2019

9 CONCLUSION

The Hawks Pvt. Ltd. (Proponent) Site (S4-027) located in the Industrial Island (Thilafushi) is positioned alongside the edge of the island facing the sea with a jetty of approximate width of 3m. Due to major problems the proponent faces due to the current jetty, a new jetty design has been proposed which would overcome these disadvantages, and benefit both Thilafushi Corporation Limited and proponent. Therefore, in order to overcome the aforementioned challenges, the proponent has proposed to carry out the project to the project to construct the new jetty. The major activities of the project include; dredging and reclamation, sheet piling works and concrete works.

The major impacts of the construction phase is envisaged to be impacts on air quality, noise pollution, vibration and disturbances due to operation of heavy machinery, impact on marine environment from turbidity, waste and chemical spillages. The main impact of operational phase is predicted to arise from the operation of the petrol shed on the newly constructed jetty.

The mitigation measures proposed for the construction phase comprises of commencing the dredging and reclamation works slowly in order to give chance to mobile organism to escape, proper maintenance of machinery, restricting the movement of barges, adhering to proper waste management plans and procedures etc. The mitigations of the operational phase include regular maintenance of machinery, following proper oil/chemical handling procedures and staff training on emergency oil spill cleanup.

An environmental monitoring plan was developed taking into consideration the impacts and mitigation measures to be implemented. The monitoring plan includes assessing the marine water quality, coastline and marine biodiversity.

As every development project, there are envisaged negative environmental impacts due to the proposed project. However these could be reduced by establishing the mitigation measures and proper environmental monitoring and management during the project implementation and operational phase. Therefore, considering the greater socioeconomic positive outcome of the project, it is justifiable to carry out the works of the proposed project.

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11 APPENDICES

Appendix A- list of abbreviations

EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPPA	Environmental Protection and Preservation Act
MEA	Maldives Energy Authority
MHE	Ministry of Housing and Environment
TPH	Total Petroleum Hydrocarbon
TOR	Terms of Reference
UNDP	United Nations Development Program

Appendix B- Terms of reference

بسم الله الرحمن الرحيم

Environmental Protection Agency EPA

No: 203-EIARES/PRIV/2017/888

Terms of Reference for Environmental Impact Assessment for Sheet Piling in Hawks Land at K. Thilafushi

The following is the Terms of Reference (ToR) following the scoping meeting held on *24th October 2017* for undertaking the EIA for Sheet Piling in Hawks Land at K. Thilafushi. The proponent of the project is The Hawks Private Limited.

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 and rationale** – Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific.

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 and size. The study area should include adjacent or remote areas, such as relevant 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** – The report should be categorised into the following components:

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

- Details of sheet piling location
- Method and equipment used for sheet piling

Dredging/Excavation (if any)

- Location and size of harbor basin, reef entrance and other dredge area(s) on a scaled map,
- Justification for the selection of the location, depth and size of dredge area(s),
- Equipment used for dredging and justification, including equipment capacity and description of positioning system (where appropriate), depth control system and operational control procedures,
- Exact method and process(es) of dredging/excavation (e.g. details of the use of sand beds or use of barge mounted excavation)

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Website: www.epa.gov.mv

- Dredged material disposal/usage details, e.g. for land reclamation, beach replenishment or coastal protection works,

The EIA report should investigate possibilities for alternatives

- Alternative methods/equipment for dredging
- Alternative borrow area locations: have these been considered and if so, give arguments why these alternatives have not been selected.

Harbour Quaywall and Pavement construction

a) Submit an A3 size plan of proposed harbor quaywall site plan with labeled drawings
b) Methodology of quaywall construction
c) Design of quaywall
d) Specify materials, equipment, heavy machinery, staff estimate (quantity and period of time)
e) Measures to minimize environmental impacts during construction of harbour

Project management (include scheduling and duration of the project (component wise scheduling) and life span of facilities; communication of construction details, progress, target dates, labour requirement, local labour availability, housing of temporary labour, construction/operation/closure of labour camps, emergency plan in case of spills (diesel, grease, oil) access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills).

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

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

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

Information should be divided into the categories shown below:

Climate

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

Marine

- Benthic substrate analysis
- Fish census
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during sand borrowing and construction;

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Hydrography/hydrodynamics (use maps)

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Ground water quality measuring pH, Temperature, TPH

Marine water quality

- Marine water quality measurement measuring pH, Salinity, Turbidity, Sulphates, TPH.

Bathymetry

- Bathymetry of sheet piling location

Currents

- Current measurement near the sheet piling location

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 relevant to the project impact area

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. Include permits and approvals in the EIA document. Legal requirements:

- Approval from Thilafushi Corporation Limited (TLC)
- Dredging and reclamation permit from EPA (if any)

Task 4. Potential impacts of proposed project, incl. all stages – The EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

Impacts on the natural environment

- Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Sediment dispersal in water column (turbidity at the dredging site (overflow) and related to shore protection activities), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;

Construction related impacts and risks

- Pollution of natural environment (Eg. Oil spills, discharge of untreated waste water and solid waste including construction waste resulting from project activities)
- Risk of accidents and pollution on workers and local population
- Impacts on social values, norms and belief due to presence of construction workers if they are non-resident.

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. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts.

Task 5. Alternatives to proposed project – Describe alternatives including the *"no action option"* should be presented. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". 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.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures with particular attention paid to sedimentation control and future changes in coastal processes. Measures for both construction and operation phase shall be identified. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included.

Task 7. Development of monitoring plan - Identify the critical issues requiring monitoring to ensure compliance to mitigation measures. 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 7. Stakeholder consultation, Inter-Agency coordination and public/NGO participation – The EIA report should include a list of people/groups consulted and summary of the major outcomes and concerns raised. The following parties should be consulted;

1. Thilafushi Corporation Limited
2. Neighbouring businesses
3. Ministry of Housing and Infrastructure

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 relevant amendments.

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

26th October 2017

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Appendix C- Detail drawings

Figure 1:Location of Hawks land (red) on Thilafushi and the proposed location for sheet piling (black)

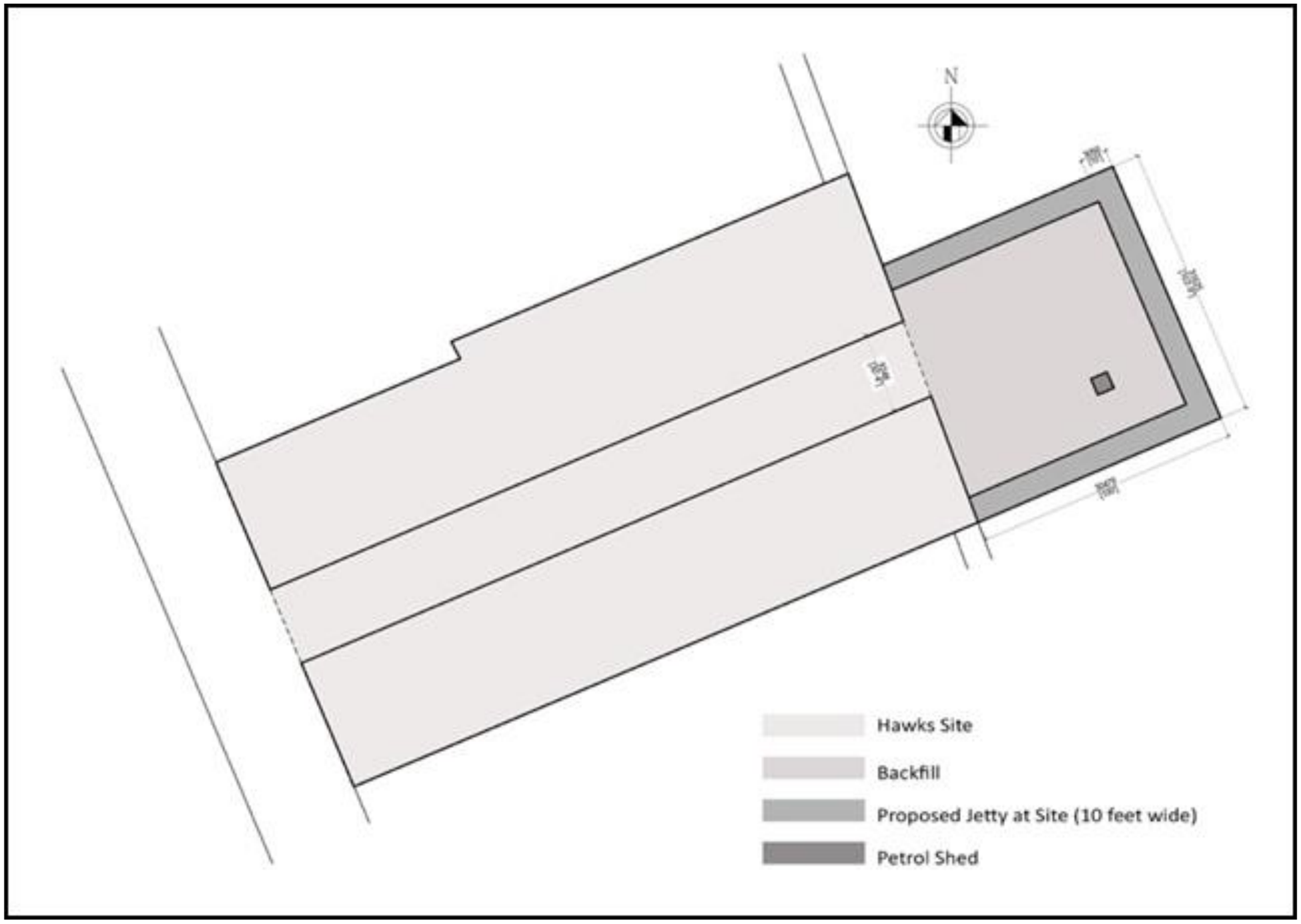

Figure 2: Proposed Design

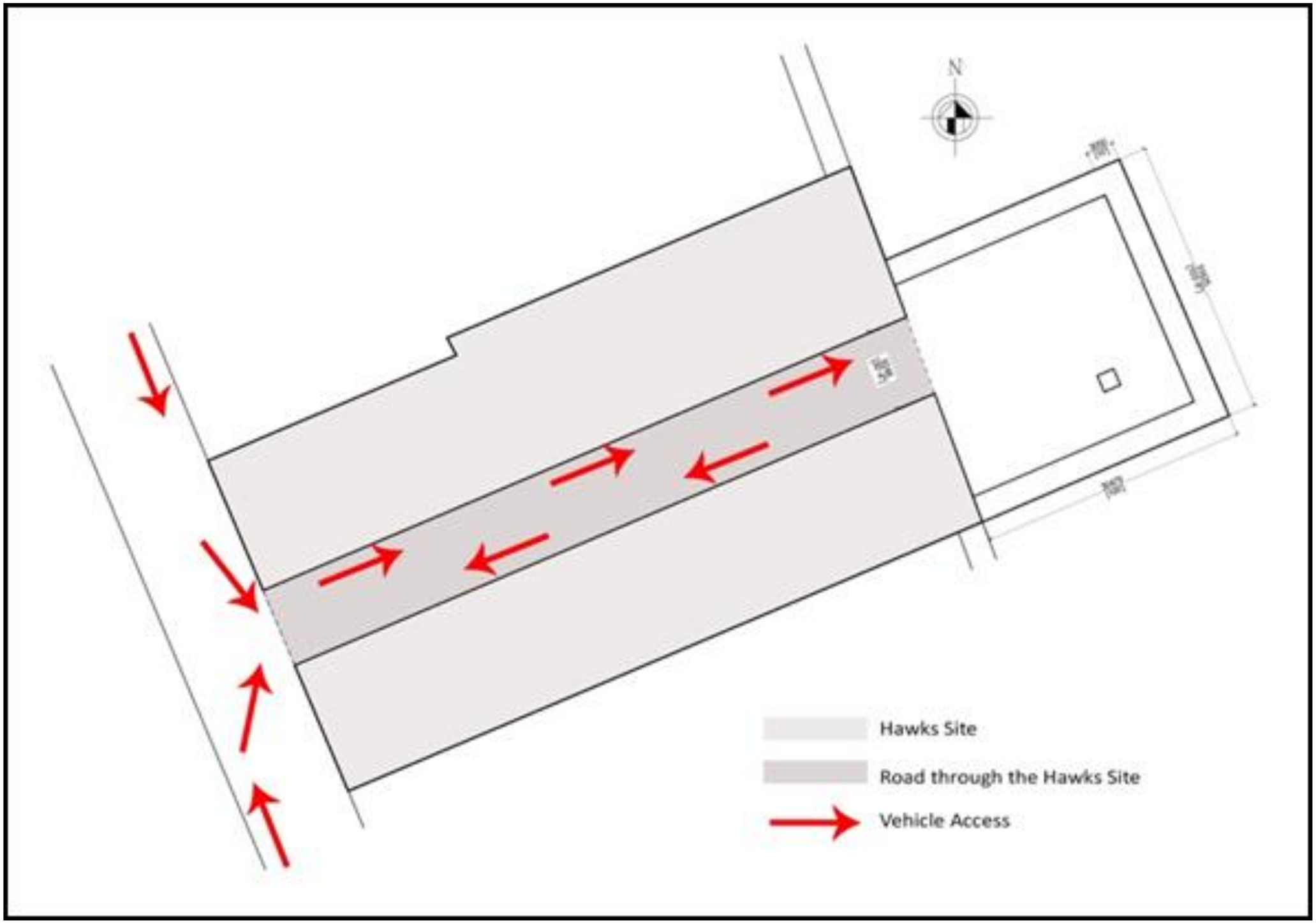

Figure 3: Road to Proposed Jetty through Hawks Site

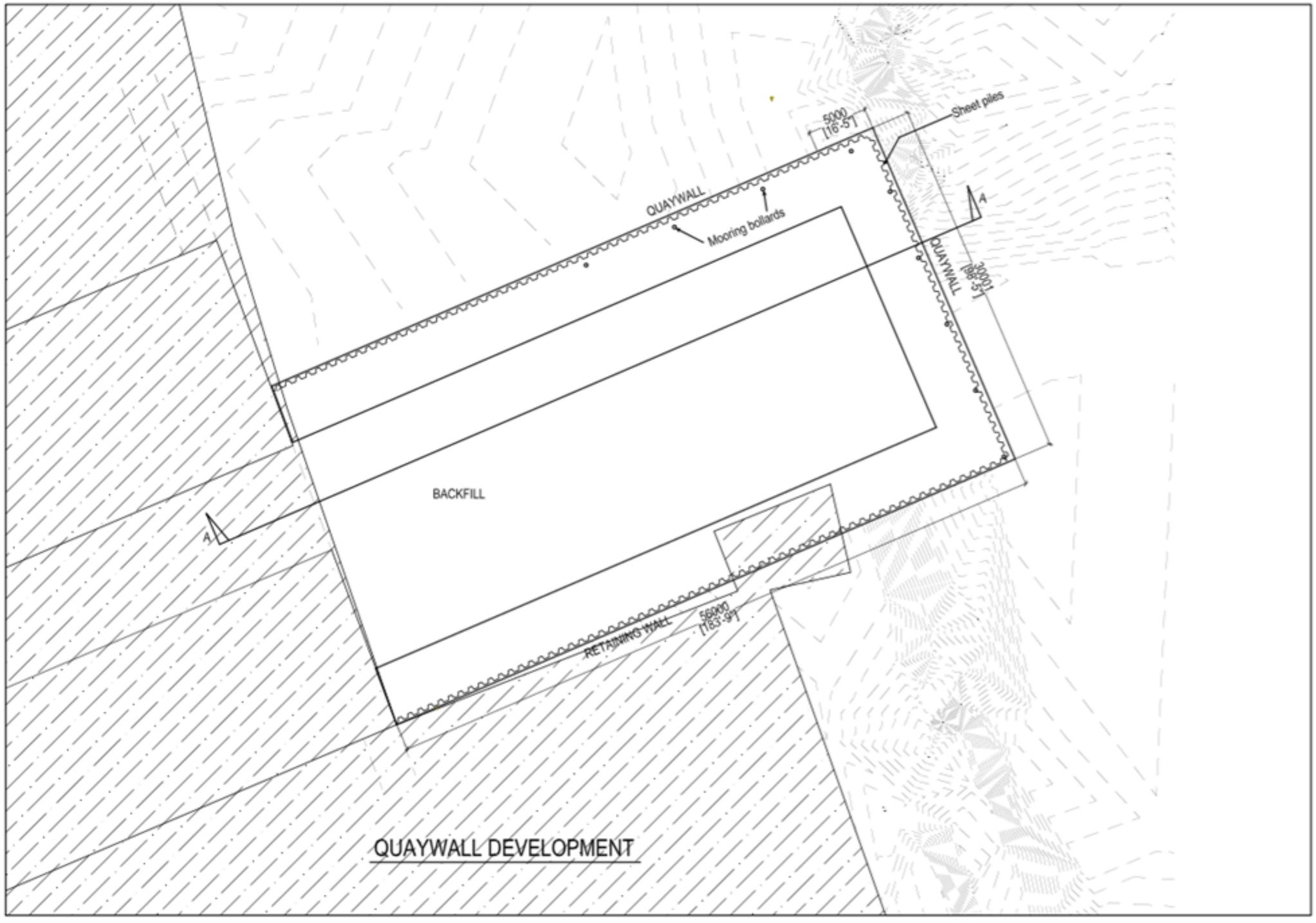

Figure 4: Quay wall development

Figure 5: Sheet pile

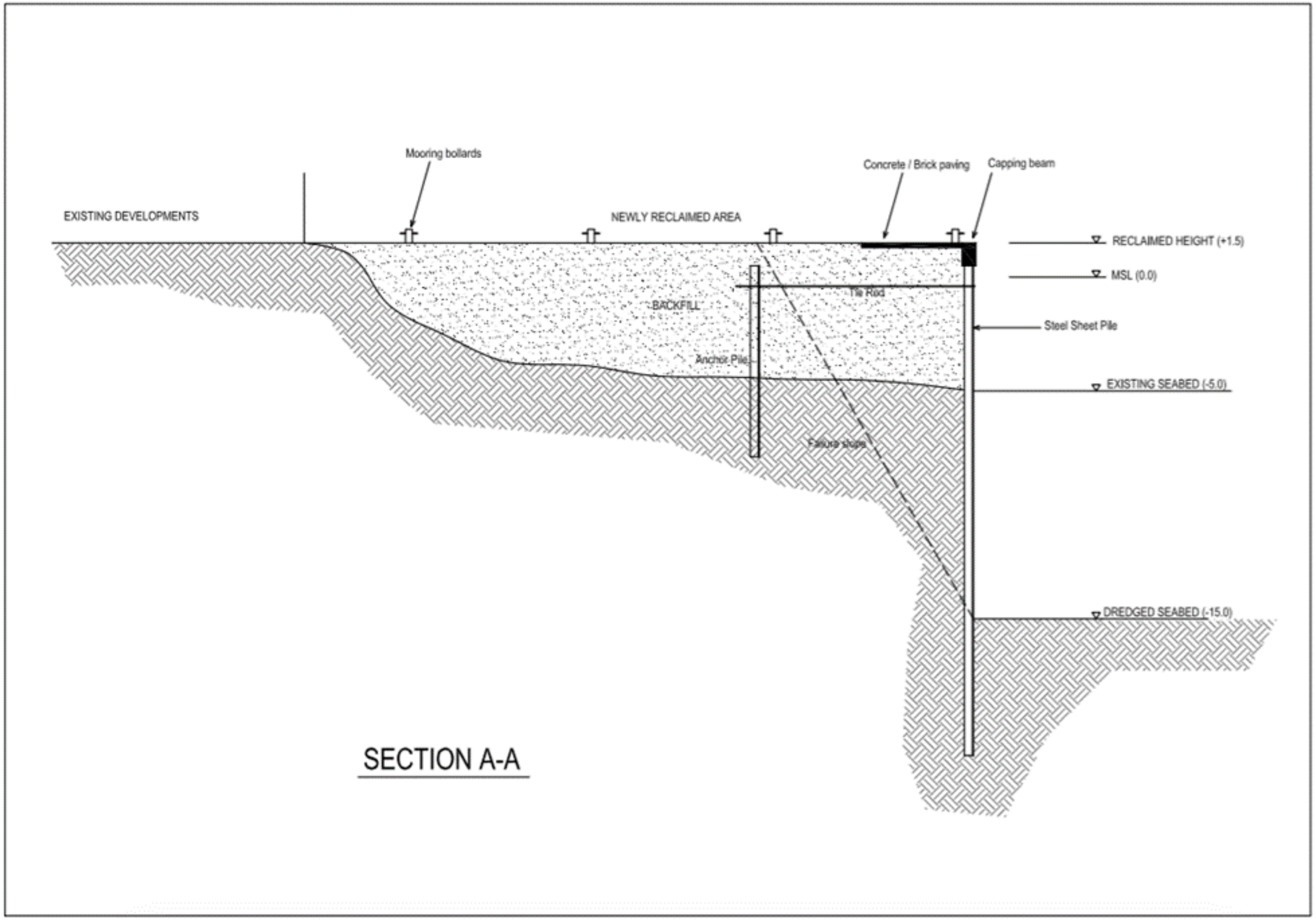

Figure 6:Sheet pile layout 2

Appendix D- Detail work schedule

The Hawks pvt. ltd. 2017

Jetty Development – Thilafushi Island

Appendix E- EIA team

The EIA for the present project was carried out by an experienced professional team led by Mr. Mahfooz Abdul Wahhab (EIA consultant No. P22/2016). The team members are Mohamed Ibrahim Jaleel and Yameen Abdullah.

Appendix F- Water sampling results

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
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WATER QUALITY TEST REPORT

Report No: 500176703

Customer Information:
Mahfooz Abdull Wahhab
A293039

K.villingili -

Report date: **30/10/2017**
Test Requisition Form No: **900181414**
Sample(s) Recieved Date: **26/10/2017**
Date of Analysis: **26/10/2017 - 28/10/2017**

Sample Description	Thilafushi Hawks Site	Nalahiyaa Site	**TEST METHOD**	**UNIT**
Sample Type	Ground Water	Ground Water		
Sample No	83193810	83193811		
Sampled Date	25/10/2017	25/10/2017		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear with particles	Clear with particles		
pH	7.15	7.43	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Temperature	23.3	23.1	Electrometry	°C
Total Petroleum Hydrocarbon (TPH)	3.8	3.7	UV Fluorescence	mg/L

Keys: °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
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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

WATER QUALITY TEST REPORT

Report No: 500175109

Customer Information:
Mahfooz Abdull Wahhab
A293039

K.villingili -

Report date: **23/07/2017**
Test Requisition Form No: **900177881**
Sample(s) Recieved Date: **16/07/2017**
Date of Analysis: **16/07/2017 - 20/07/2017**

Sample Description	Thilafushi M1	M2	**TEST METHOD**	**UNIT**
Sample Type	Sea Water	Sea Water		
Sample No	83189470	83189471		
Sampled Date	14/07/2017	14/07/2017		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear with particles	Clear with particles		
pH	8.10	8.09	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	33.81	34.09	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	23.1	23.1	Electrometry	°C
Turbidity	0.264	0.349	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Nitrogen Ammonia	<0.02 (LoQ 0.02 mg/L)	<0.02 (LoQ 0.02 mg/L)	Method 8038 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	2850	2850	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L

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

Checked by

Nashath Ali
Senior Laboratory Technician

Approved by

Afnan Farooq
Laboratory Executive Gr.1

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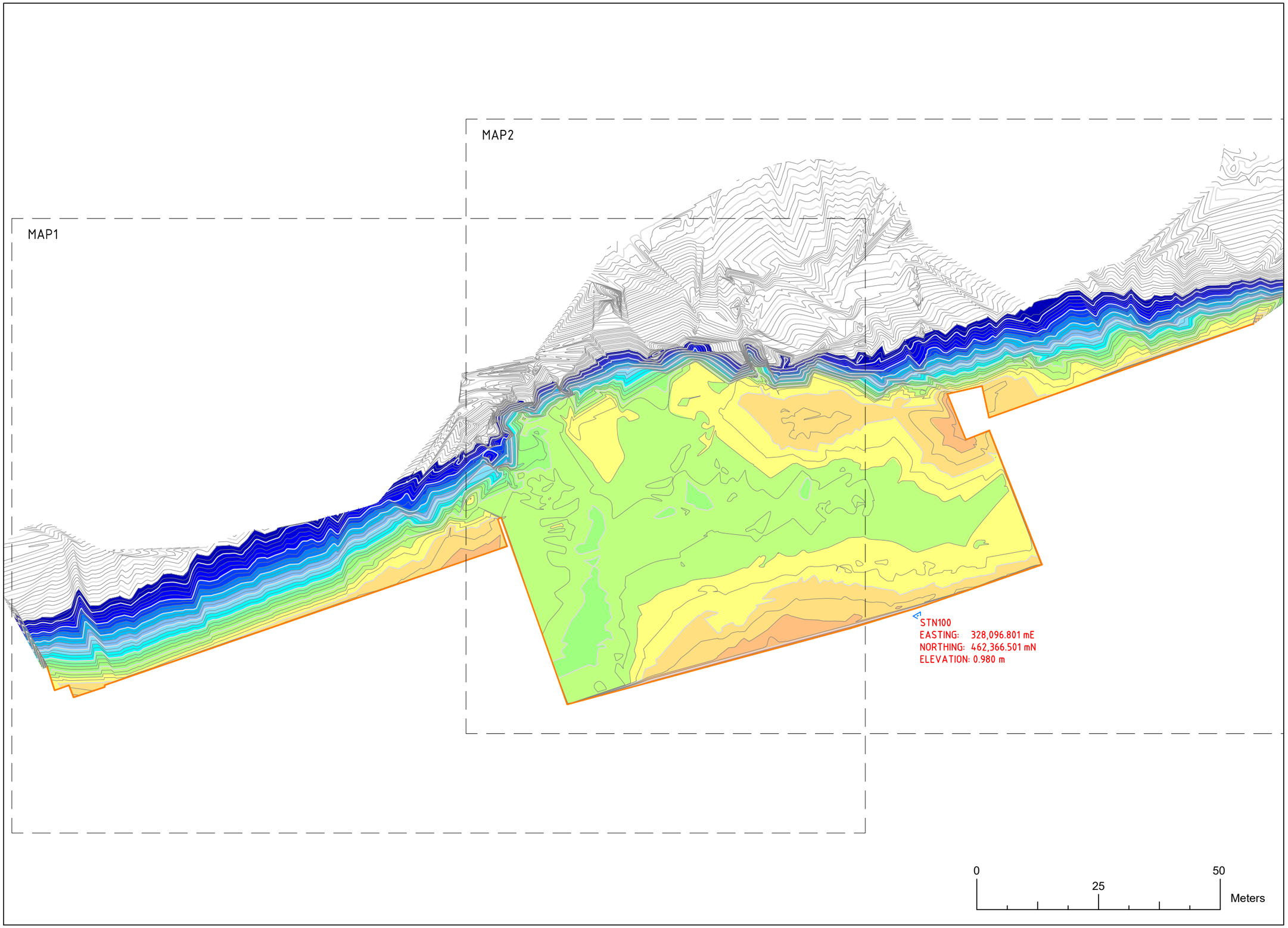
********** END OF REPORT **********

Appendix G- Bathymetry and dredging plan maps

HAWKS PLOT JETTY DEVELOPMENT PROJECT



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

LEGEND

CONTROL POINT
QUAY WALL

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
  - STN100 was transferred from PSM0090

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE

HAWKS PLOT JETTY DEVELOPMENT PROJECT

CLIENT

HAWKS PVT LTD
SOANARY 3RD FLR
BODUTHAKURUFAANU MAGU

DRAWING TITLE

BATHYMETRIC SURVEY DRAWINGS

SHEET TITLE

BATHY MAP OF JETTY AREA

SURVEYOR	S/L #
AHMED NASHID	BP02006
SURVEYED DATE	5/8/2017
DRAWN BY	NASHID
DRAWN DATE	10/8/2017
SCALE	1 : 1750
PAPER	A3

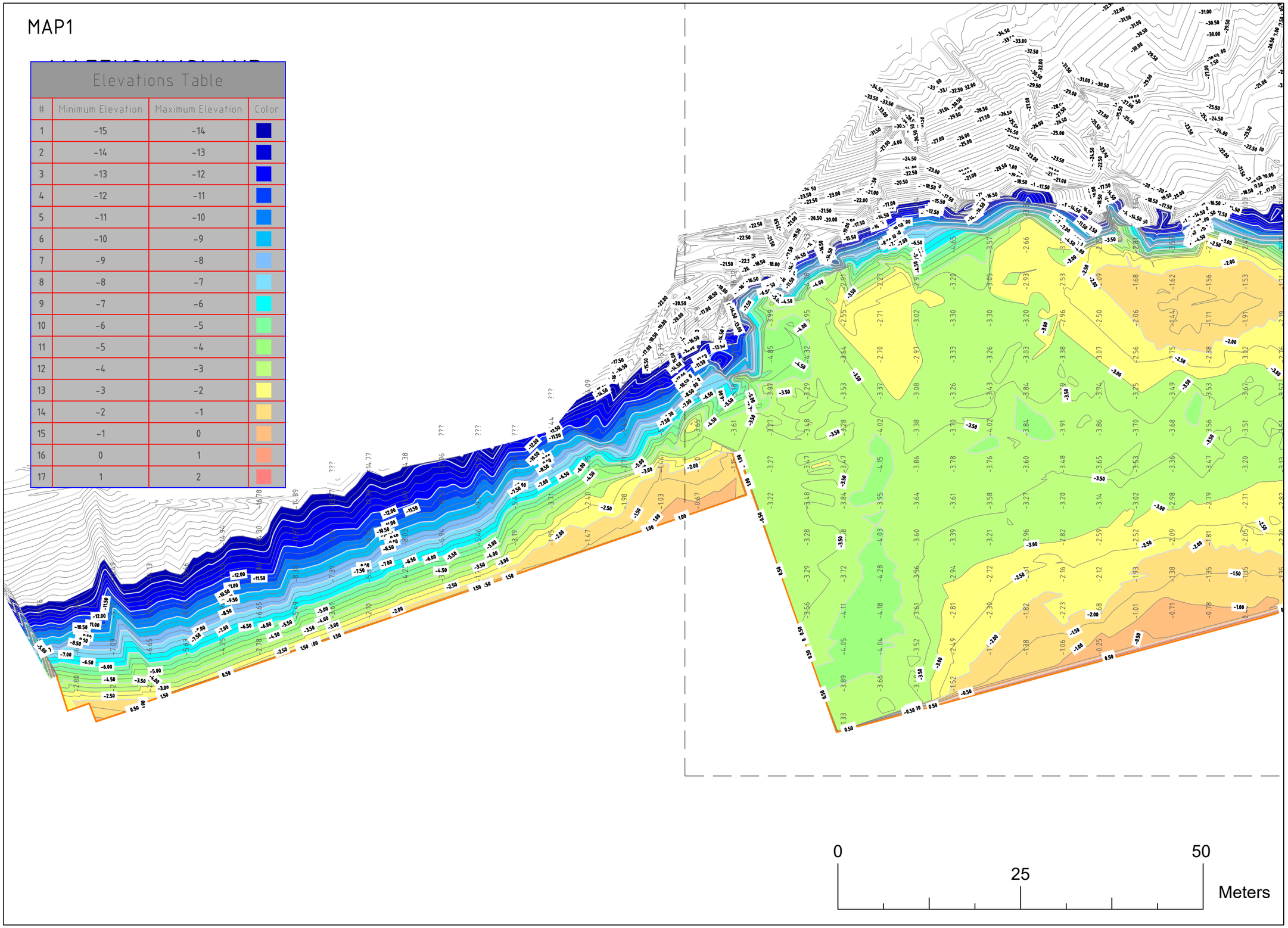
DRAWING NUMBER

AN/2017/121/01.1

HAWKS PLOT JETTY DEVELOPMENT PROJECT

MAP1

Elevations Table			
#	Minimum Elevation	Maximum Elevation	Color
1	-15	-14	
2	-14	-13	
3	-13	-12	
4	-12	-11	
5	-11	-10	
6	-10	-9	
7	-9	-8	
8	-8	-7	
9	-7	-6	
10	-6	-5	
11	-5	-4	
12	-4	-3	
13	-3	-2	
14	-2	-1	
15	-1	0	
16	0	1	
17	1	2	



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

LEGEND

CONTROL POINT
QUAY WALL

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
  - STN100 was transferred from PSM0090

REVISIONS	
-	-
-	-
-	-
-	-
-	-

PROJECT TITLE
HAWKS PLOT JETTY DEVELOPMENT PROJECT

CLIENT
HAWKS PVT LTD
SOANARY 3RD FLR
BODUTHAKURUFAANU MAGU

DRAWING TITLE
BATHYMETRIC SURVEY DRAWINGS

SHEET TITLE
BATHY MAP OF JETTY AREA

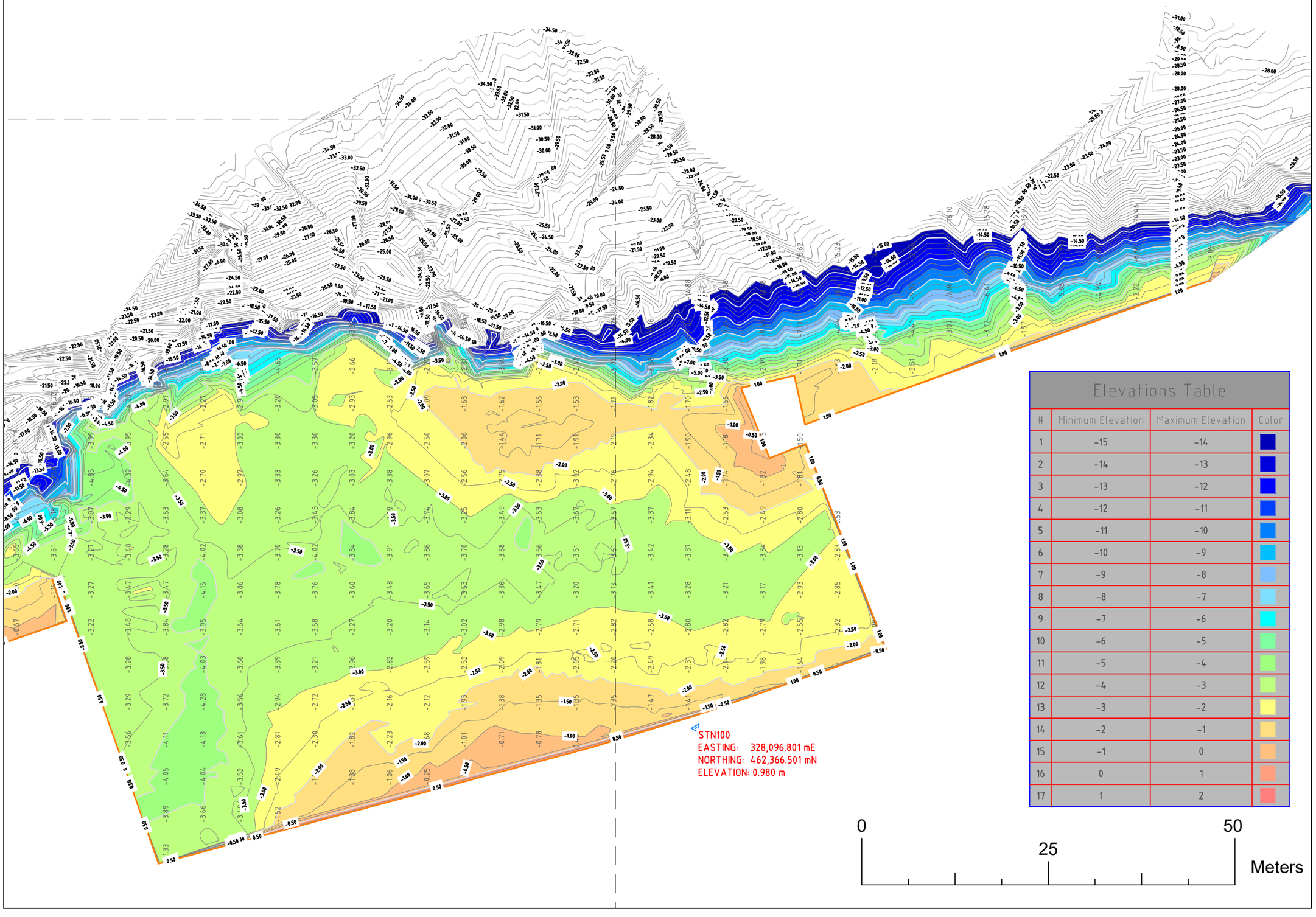
SURVEYOR	S/L #
AHMED NASHID	BP02006

SURVEYED DATE	5/8/2017
DRAWN BY	NASHID
DRAWN DATE	10/8/2017
SCALE	1 : 500
PAPER	A3

DRAWING NUMBER
AN/2017/121/01.2

HAWKS PLOT JETTY DEVELOPMENT PROJECT

MAP2



Elevations Table

#	Minimum Elevation	Maximum Elevation	Color
1	-15	-14	
2	-14	-13	
3	-13	-12	
4	-12	-11	
5	-11	-10	
6	-10	-9	
7	-9	-8	
8	-8	-7	
9	-7	-6	
10	-6	-5	
11	-5	-4	
12	-4	-3	
13	-3	-2	
14	-2	-1	
15	-1	0	
16	0	1	
17	1	2	

AHMED NASHID
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LEGEND

CONTROL POINT
QUAY WALL

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
  - STN100 was transferred from PSM0090

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE
HAWKS PLOT JETTY DEVELOPMENT PROJECT

CLIENT
HAWKS PVT LTD
SOANARY 3RD FLR
BODUTHAKURUFAANU MAGU

DRAWING TITLE
BATHYMETRIC SURVEY DRAWINGS

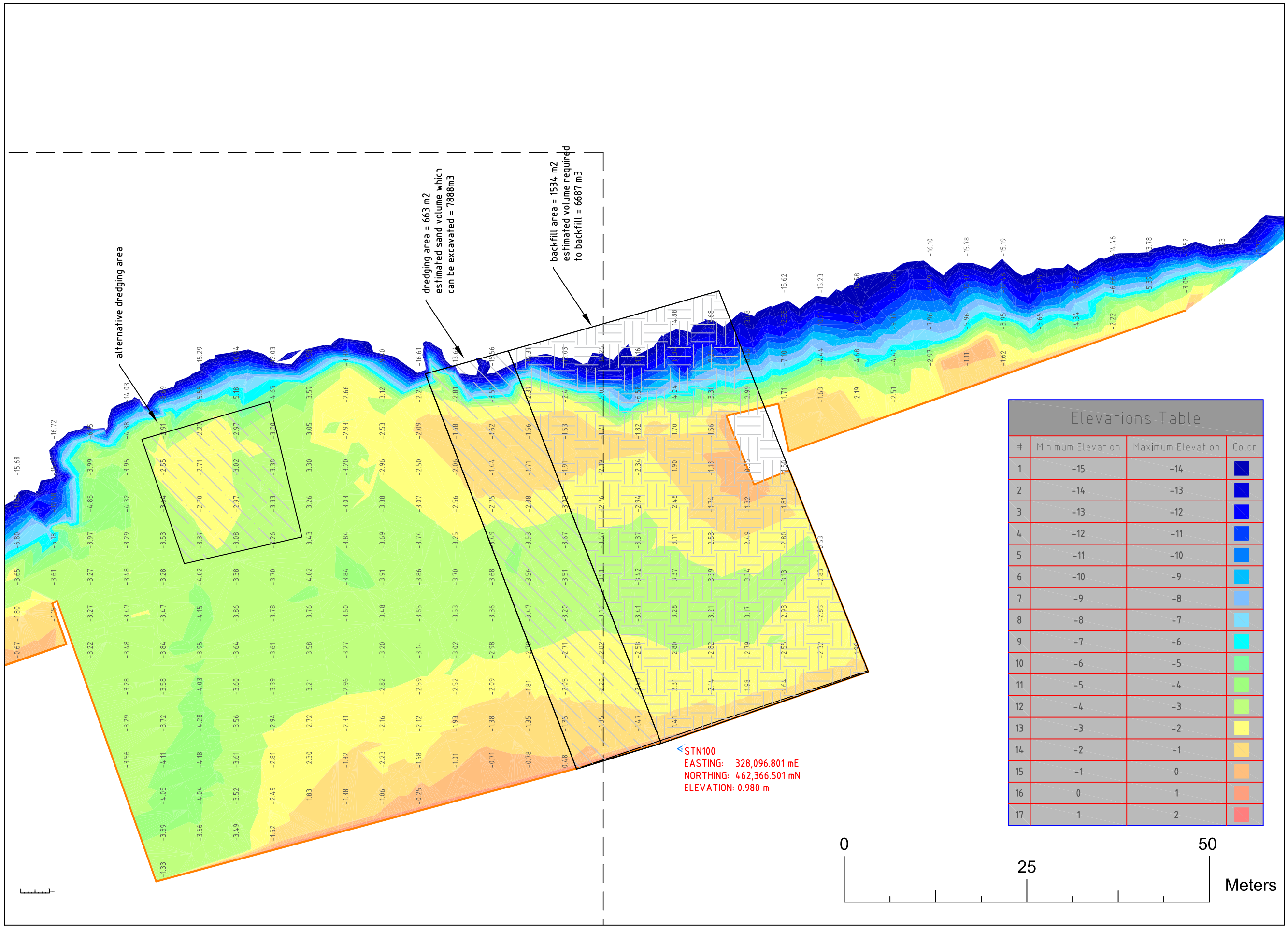
SHEET TITLE
BATHY MAP OF JETTY AREA

SURVEYOR AHMED NASHID	S/L # BP02006
SURVEYED DATE	5/8/2017
DRAWN BY	NASHID
DRAWN DATE	10/8/2017
SCALE	1 : 500
PAPER	A3

DRAWING NUMBER
AN/2017/121/01.3

HAWKS PLOT JETTY DEVELOPMENT PROJECT

NORTHING (mN)



Elevations Table

#	Minimum Elevation	Maximum Elevation	Color
1	-15	-14	
2	-14	-13	
3	-13	-12	
4	-12	-11	
5	-11	-10	
6	-10	-9	
7	-9	-8	
8	-8	-7	
9	-7	-6	
10	-6	-5	
11	-5	-4	
12	-4	-3	
13	-3	-2	
14	-2	-1	
15	-1	0	
16	0	1	
17	1	2	

EASTING (mE)

LEGEND

CONTROL POINT

QUAY WALL

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
  - STN100 was transferred from PSM0090

REVISIONS

-	-
-	-
-	-
-	-
-	-

PROJECT TITLE

HAWKS PLOT JETTY DEVELOPMENT PROJECT

CLIENT

HAWKS PVT LTD
SOANARY 3RD FLR
BODUTHAKURUFAANU MAGU

DRAWING TITLE

DREDGING AND BACKFILLING AREA

SCALE	1 : 500
PAPER	A3

EIA for sheet piling in Hawks land at K. Thilafushi

Existing situation

Legend

hawks plot

Google Earth

Image © 2017 CNES / Airbus

N

100 m

EIA for sheet piling in Hawks land at K. Thilafushi

Future situation

Legend

- backfill area
- hawks plot
- quay wall

Google Earth

Image © 2017 CNES / Airbus

N

100 m

Appendix H- Approval for concept design from TCL

THILAFUSHI
CORPORATION

TCL-PRJ/~~GOV~~ PRIV/2017/025 : ނަންބަރު

ދިރާކްސް ޕްރައިވެޓް ލިމިޓެޑްގެ ޗީފް އެގްޒެކެޓިވް އޮފިސަރ އަލްފާޟިލް ހުސައިން ރިފާއު އަށް،

ވުދިން ސަލާމަތުން ދަންނަވަމެވެ.

ތިޔަކުންފުނީގެ ސިޓީ ނަންބަރު HF/2017/385 އާއި އެކު ހުށަހެޅުއްވާފައިވާ އެއްބަސްވުމުގެ ތަރައްޤީގެ މަސްއޫލުގެ މަސައްކަތްތަކާ ހުއްދަދިނުމާއި ގުޅޭގޮތުން ތިކުންފުނީގެ ބޭނުން ނިންމާފައިވާ ނިންމުންތަކާއި ތަފްސީލުކުރަމެވެ.

ދިރާކްސް ޕްރައިވެޓް ލިމިޓެޑްގެ ބޯޑާއި އިންވެސްޓަރުން ދުވާލިރިޔާތަން ދެކެ ސަރަހައްދު ހިއްކައިގެން ޓޫރިޒަމްގެ ބޭނުންކުރުމަށް ތިޔަފަރާތުން ހުށަހެޅުއްވާފައިވާ ޕްރޮޕޯޒަލްގައިވާ ގޮތަށް އެ ސަރަހައްދުގެ މަސައްކަތް ކުރުމަށް ގެންދިޔުމަށް އެ ސަރަހައްދާއި ގުޅޭ އިންތިޒާމުތައް ޕްރޮޖެކްޓް ސަރަހައްދުގެ ސަރަހައްދު ދިވެހިރާއްޖޭގެ ރަސްމީ ތަރައްޤީކުރުމުގެ ކުރިއަށްގެންދިޔުމުގެ ހުއްދަ ދިނުމަށް ތިޔަފަރާތް ކޯޕަރޭޝަނުގެ ބޯޑުން ފާސް ނިންމާފައެވެ.

ވީމާ މިނިންމުމާއި އެއްގޮތަށް، ގުޅޭ މަސައްކަތް އާއި ގުޅޭ އެގްރީމެންޓް ދިވެހިރާއްޖޭ ރިޕޯޓާއި އަދި ޖީއޯސަރވޭ ސަރވޭޖަހައިދެ އަދި މަސައްކަތް ކުރިއަށްގެން ދިޔުމަށް ތިޔަފަރާތުން ނިންމާފައިވާ ތަފްސީލުކުރުމުގެ ޓެކްނިކަލްވައިވާ ފީސް ޝެއަރ ހުރިހާ މަސައްކަތް ގުޅޭ އަދި މަސައްކަތް ކުރިއަށް ގެންދިޔުމަށް ދަންނަވަމެވެ. އަދި އަމަލީމަސައްކަތް ފެށުމަށް ތިޔަ މަސައްކަތްތަކުގެ ޕްރޮގްރާމް ރިޕޯޓް ތިކުންފުނީގެ ޕްރޮޖެކްޓް ޓީމުން ކުރިން ދުއްވަން އެކުލަވާ މަސައްކަތް ނިމުމުން ހުށަހަޅުއްވަން ގެންދިޔުމަށްވެސް ދަންނަވަމެވެ.

އިޙްތިރާމް ގަބޫލުކުރައްވަން އެދެމެވެ.

25 މުޙައްރަމް 1439

15 އޮކްޓޫބަރު 2017

ހާދިމުކަމު

މުޙައްމަދު ފަސީލް

މެނޭޖަރ، ޕްރޮޖެކްޓްސް

ދިރާކްސް ޕްރައިވެޓް ލިމިޓެޑް

މާލެ، ދިވެހިރާއްޖެ

Appendix I- Evidence of report submission to atoll council

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COMPOSE

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Sent Mail

Drafts (1)

More

Mahfooz

mohamed furqan

EIA report for sheet piling in Hawks land at K. Thilafushi

Mahfooz AbdullWahhab <mahfoozabdullwahhab@gmail.com>
to secretariat, Hassan, Mohamed

Dear Sir,

Attached please find the EIA report for sheet piling in Hawks land at K. Thilafushi. Plea

Best regards,

Mahfooz Abdull Wahhab
Environmental Consultant
(+960) 9994467


ENVIRONMENTAL IMPACT ASSESSMENT
For Sheet Piling in Hawks Land
Thilafushi, Male Atoll
Proposed by:
The Hawks Pvt. Ltd.

PDF 171122 EIA for sh.

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