

Environmental Impact Assessment for Rehabilitation and Repair of Harbour at Inguraidhoo Island, Raa Atoll



August 2015

Prepared for
Ministry of Housing and Infrastructure

Prepared by
MEECO 

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Declaration of the Consultant

I certify that the statements made in this Environmental Impact Assessment are true, complete and correct to the best of my knowledge and available information at the time of writing this report.

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August 2015

Acknowledgement

We express our gratitude to the island Council of R. Inguraidhoo for their cooperation and assistance provided to us in the compilation of this EIA Report, and to Mr. Abdulla Abdul Rahman, Council Vice President for his extensive effort and invaluable information provided for all our requests.

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1 NON TECHNICAL SUMMARY

1. The Ministry of Housing and Infrastructure requested the services of Maldives Energy and Environmental Company (MEECO) to provide an Environmental Impact Study (EIA) for the rehabilitation and repair of the harbour, Inguraidhoo Island, Raa Atoll, Maldives.
2. The assessment addresses specific key issues stated in the Terms of Reference (ToR) as agreed between EPA and the Proponent following the Scoping Meeting held on the matter.
3. Inguraidhoo harbour was developed in 1998 by dredging into the island from the original coastline of the Island to create the required space for the harbour basin. Since then there was a major repair done in the year 2005, however, the repair and maintenance activity for the harbour had been performed was not adequate. Moreover, the island envision of expanding the basin to cater to the growing demand of increasing vessels in the island.
4. Inguraidhoo has a registered population of 1,842 people. Due to the poor design and workmanship during the construction of its existing harbour, it has failed to provide much anticipated protection and safety for the travellers and vessels. Consequently, the people of the island have suffered enormously. The present entrance channel creates dangerous situations particularly during the rough weather conditions. There had been several incidents of damages to the vessels, people and to property while trying to pass through the channel. In addition to the problems caused due to the deterioration of the breakwater, the original height of the seawall is not adequate to prevent overtopping of waves into the harbour basin creating very rough conditions during bad weather. Similarly the low height of the quay wall allows overtopping of waves into the coast causing flooding.
5. In order to alleviate the above problems the Proponent intends to rehabilitate the breakwater, extending the breakwater to provide protection for the harbour entrance, constructing revetment on the northern and southern ends of the harbour adjoining the land, maintenance dredging of shallow areas within the harbour basin and the entrance channel.
6. The Consultants assessed the potential environmental impacts using sound scientific methodology, literature review and experiences from the past projects of similar nature. In addition views and opinions of the key stakeholders have been reflected in the report. The main findings have been summarised in the following sub-paragraphs.
 - a. Due to the critical role the harbour plays in the socio-economic development of the island, the existing problems associated with the harbour need to be addressed as a matter of priority.
 - b. Environmental impacts assessment carried out for the project indicates that the project can be successfully implemented without an irreversible significant damages to the environment and that the socio-economic benefits to the community and the region far outweighs minor damages that may arise out of the project.
 - c. The project, however, has inevitable low magnitude negative impacts, including, sedimentation over parts of the reef, noise and vibration due to piling and construction activities, pollution from solid and hazardous waste. Hence, the project shall put in place the mitigation measures prescribed in the report while undertaking the project activities.

7. The Inguraidhoo harbour maintenance and rehabilitation project is of utmost importance to the people of the island. The project is in line with the government's policies and can be implemented in fully compliance with the relevant laws and regulations. The Proponent has given full commitment to undertake mitigation measures given in the report during the project implementation. Hence the negative impacts can be effectively mitigated through the prescribed actions and the project could be implemented successfully.

2 INTRODUCTION

2.1 BACKGROUND

The Ministry of Housing and Infrastructure (MHI) (the Proponent) requested the services of the Maldives Energy and Environmental Company (MEECO) to undertake the Environmental Impact Assessment (EIA) for the harbour maintenance and rehabilitation at Inguraidhoo Island, Raa Atoll.

MEECO prepared this document in accordance with the EIA Regulations (2012) and Regulation on Dredging and Reclamation (Regulation 2013/R-15) (Copy of the dredging permit is given in Annex 3). This EIA provides a focused assessment of the proposed dredging in terms of existing environmental conditions and potential environmental impacts to the surrounding near shore marine environment and shorelines as detailed in the Terms of Reference (ToR) for undertaking EIA for this project (ToR is given in Annex 1).

On 5 May 1998 a harbour facility was developed to ease the access problem faced to the people of Inguraidhoo. The harbour underwent a rehabilitation process during 2005. However, due to structural issues, the facility deteriorated rapidly and the community had to face difficulties are using the harbour. The social and economic problems associated with degrading harbour structure resulted in rehabilitation and repair of the harbour in the island. In this regard, the Government of Maldives represented by MHI has commissioned a contractor and EIA consultant for undertaking this harbour works in 2014. The project is financed from the National Budget with estimation of project value 2.5 million Maldivian Rufiyaa. The current EIA mainly builds on the findings of the similar EIAs carried out in the Maldives along with new information collected.

The Proponent intends to expand the harbour basin to 650 by 251 ft. In addition to this work, the project aims to construct breakwaters, provide breakwater protection on either side of the entrance channel, coastal revetment on eastern and western side of the harbour and maintenance dredging of the shallow areas within the harbour basin and the entrance channel to maintain an average depth of -3 m from the mean sea level. These interventions will greatly improve the existing harbour and is expected to alleviate difficulties encountered by the harbour users.

2.2 PURPOSE OF THE EIA

Given the potentially adverse environmental impacts associated with dredging and the other works in the marine environment at Raa Inguraidhoo, the proponent has requested MEECO the preparation and submission of an Environmental Impact Assessment (EIA) report to EPA to comply with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The objective of the EIA study is:

- a) To provide an assessment of the potential environmental effects of the proposal and to determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating and or compensating the perceived negatives effects of the project;
- b) To provide necessary information to EPA applicable to the proposed development; and
- c) To assess how the proposals have been developed to achieve a satisfactory level of environmental performance in line with the EIA Regulations

2.3 PROJECT SETTING

Inguraidhoo harbour is approximately located north east of the island. The harbour that was constructed in year 1998 adopts similar shapes of as many of the harbours constructed in the Maldives. The harbour comprises of a rectangular basin of 630 ft. by 230 ft., with a short approach channel (210 ft in length and 80 ft. in width). On the eastern and western side of the channel, poor rock bolder revetment is undertaken. The breakwater on the eastern side of the harbour measures approximately 138 m, with an angled extension of 16 m to provide the entrance with partial protection from the waves. Analysis of aerial images shows that the channel has narrowed over the years primarily due to the sediment accumulation. The narrowing of the entrance channel have created an extremely difficult situation for the boat making passages through it. Western and the eastern ends of the harbour have also been left without any protection. As a result these “open” areas have been eroding and sediments falling onto the reef slope and into the entrance channel. The breakwater has been constructed slightly higher than the high tide level. As a result during abnormal weather waves can overtop the breakwater creating a “rough” environment within the harbour basin. In addition, due to the poor arrangement of rock boulders making the breakwater, water can seep through the wall and into the basin. Poor engineering of the breakwater has resulted individual blocks to fall apart further weakening the wall. The original width of the entrance channel was However, the southern edge of the entrance channel has no protection and is exposed to waves. The existing features of the harbour offers very little protection to the harbour users particularly in rough weather.

Visual observations and studies conducted for similar environment suggest in the areas to be dredged, the substrate to be consisted mostly of loose calcareous sand. In the areas of the harbour basin and approach channel where maintenance dredging is planned to be undertaken only loose sediment is expected to be encountered. The breakwater will be rehabilitated on the existing footprint and this means the impact zone will be strictly limited to the existing harbour boundaries. In undertaking maintenance dredging the maximum depth of dredging will not exceed -3m with respect to mean sea level (msl).

The project has three main components as follows;

2.3.1 Areas Needing Maintenance Dredging

Harbour was originally dredged in 1998 to a depth of -3 m with respect to msl. The average depth within the turning basin and jetty areas have become too shallow for the boats to securely use. Either sides of the approach channel have accumulated sediments making it very narrow compared to its original width. Additionally inside edges of the harbour have also accumulated sediment needing removal. Since the proposed project would not go deeper than the original dredged depth, no consolidated material is expected to be encountered during dredging. The old dredged areas contain unconsolidated fine silt, sand and rubble.

2.3.2 Rehabilitation of the Breakwater

One of the most critical feature of the island’s harbour is the breakwater constructed on the eastern and western boarder of the harbour. The breakwaters were constructed from rock boulders. It was constructed to create a calm and comfortable environment for the harbour users. However, due to its low height and poor engineering, the breakwater has failed to achieve the purpose. The breakwater wall needs to be completely rehabilitated with increase in its height. The breakwater have also been proposed on either sides of the entrance channel to provide a safe passage for the vessels.

2.3.3 Construction of Revetments

Revetments are planned for constructed on eastern and western areas of the harbour that adjoins with the Island. On the eastern side 82 m long revetment will be constructed with cement sand bags, while on the eastern 32 m long rock boulder revetment has been planned. These revetments will prevent erosion of the sand near harbour areas and would firm the footing of harbour.

2.4 SCOPE OF THE EIA

This EIA is concerned with the proposed rehabilitation and repair of existing harbour at Inguraidhoo Island. The details of the scope are given in the ToR given in Annex 1.

2.5 PROJECT JUSTIFICATION

The geological and geomorphological setting of Inguraidhoo Island inherently makes its accessibility extremely difficult. The new harbour project that commenced in early 1998 and which has undergone maintenance during 2005, was much anticipated to alleviate the hardship people had to go through due to the lack of a safe harbour. However, the harbour program when completed failed to meet the peoples' expectation of having safe and reliable access to their Island.

Inguraidhoo harbour is approximately located north east of the island. The harbour that was constructed in year 1998 adopts similar shapes of as many of the harbours constructed in the Maldives. The harbour comprises of a rectangular basin of 630 ft. by 230 ft., with a short approach channel (210 ft. in length and 80 ft. in width). On the eastern and western side of the channel, a poor concrete breakwater is carried out. The breakwater on the eastern side of the harbour measures approximately 138 m, with an angled extension of 16 m to provide the entrance with partial protection from the waves. However, not the entrance channel has not been protected by breakwaters along its entire length. On the eastern edge of the channel a breakwater structure measuring 16 m has been constructed while on the western side a very short structure of few feet in length was developed. During development of the entrance channel some extremely hard substrate that couldn't be removed was left intact, creating potentially dangerous situation for the vessels during the passage particularly during low tide. The average depth in the harbour basin and the entrance channel was originally kept at -3 m with respect to the MSL. Similar to the breakwater, other three sides of the harbour have been fitted with concrete quay walls.

The assessment of the existing environmental conditions of the island as described in Section 3.2 clearly show, the harbour location makes it highly exposed to prevailing winds and wind generated waves. The design features of the harbour do not seem to fit well into the harsh weather conditions that prevail around the Island. This is particularly evident during the rough weather conditions. Low height of the breakwater failed to act as an effective barrier against waves. Over-topping of waves into the harbour has become a recurring incident during southwest monsoon. These overtopping waves create a very rough condition within the harbour basin making it unsuitable for the safe navigation and anchorage for the vessels during rough weather. The entrance channel being left virtually "open" also make travellers and boat owners uncomfortable during approach to harbour. Several accidents that occurred as a result have cost millions of Rufiyaa worth of damage to the people. Further, accumulated sediments in the entrance channel and the edges of the harbour basin over the past years have made the harbour unsuitable for proper and effective use for the people. The jetty area developed being lower than the island elevation have caused regular flooding of the coastal areas causing inconveniences to the people. *Figure 1* shows current conditions of the harbour.



Figure 1: Condition of the existing harbour of Inguraidhoo Island compared during different weathers (A) Western side of the harbour damaged (B) Front side of the harbour as seen during calm conditions (C) submerged breakwater and overtopping waves during rough weather (D) Vessels moored in the harbour during a calm day

The harbour is a vital lifeline infrastructure, which plays a critical role in the socio-economic development of the Island. A proper harbour is required to provide safe passage and shelter for the vessels operating to and from the island.

3 DESCRIPTION OF THE PROJECT

3.1 THE PROPONENT

The project is proposed by the Ministry of Housing and Infrastructure of the Government of Maldives, Male’ (the Proponent). The project will be funded under the government budget for 2015. The project would be executed by Maldives Transport and Contracting Company (MTCC).

3.2 PROJECT LOCATION

The proposed project is planned to be undertaken in Inguraidhoo Island situated in Raa Atoll located at 73°02' 10" E 05°28' 39" N. The Island measures an area of 14.27 Ha (Figure 2 and Figure 3). The island is 11.02 km from the Atoll Capital of Ungoofaaru. The closest inhabited island to R. Inguraidhoo is Fainu, which is of 1.11 km south. Inguraidhoo is located 143 km from the closest airport at Ibrahim Nasir International Airport at Hulhulé Island.

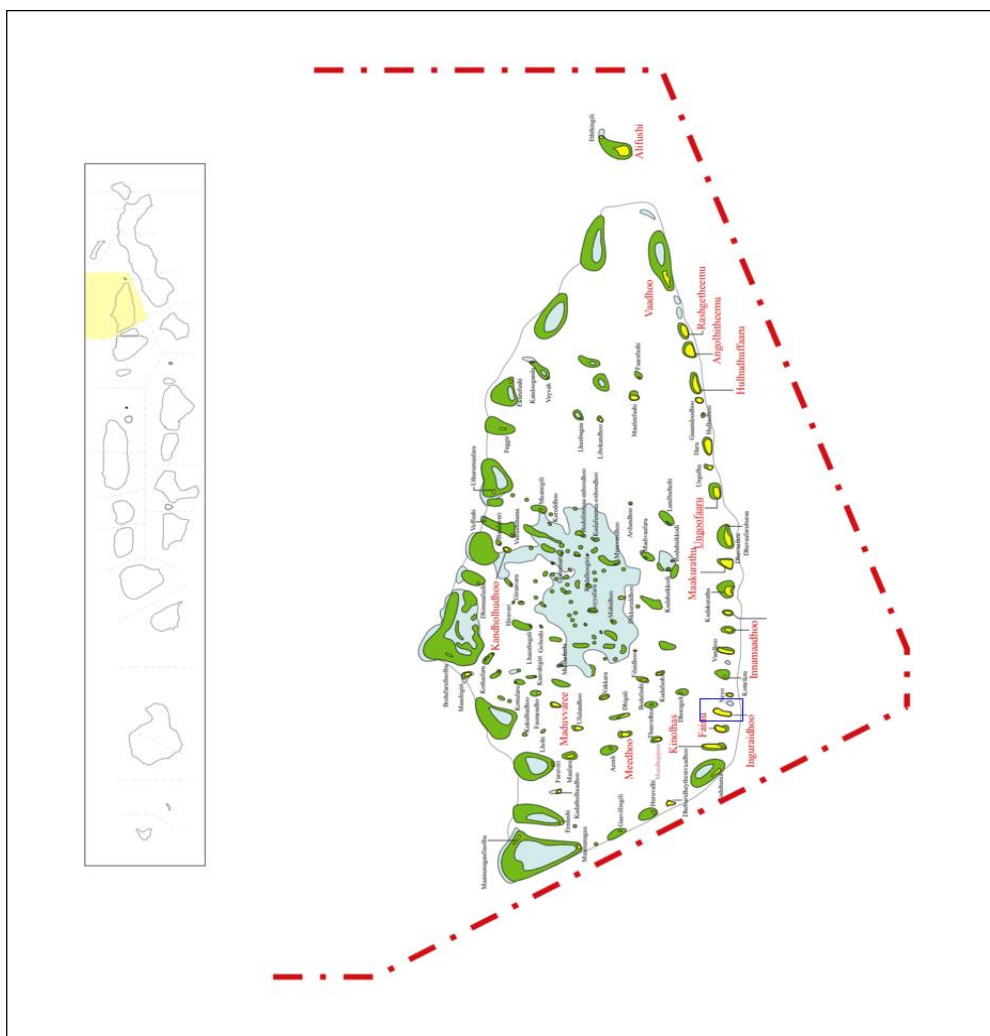


Figure 2: Location of R. Inguraidhoo Island



Figure 3: Aerial photo of R. Inguraidhoo (Source: Google Earth, 2015)

3.3 PROJECT OUTLINE AND SITE PLAN

The proposed rehabilitation works can be divided into two main parts maintenance dredging and repair works;

A. Maintenance Dredging

Shoaling of the harbour due to siltation will be addressed during the rehabilitation. Inguraidhoo Harbour dredging project when completed in 1998 and maintained during 2005, was believed to have maintained an average depth of -3 m with respect to MSL within the basin and at the entrance channel. However, over the years due to shoaling of the entrance channel and certain areas of the harbour basin navigating through the harbour has become increasingly difficult particularly during the low tide. Hence areas near the edges of the quay wall and the breakwater, the entrance channel and the areas near the jetty will need deepening due to sediment accumulation. Since maintenance dredging under the proposed project would not go deeper than the original dredged depth, no consolidated material is expected to be encountered during dredging. The old dredged areas contain unconsolidated fine silt, sand and rubble. However, certain spots within the entrance channel is believed have hard rock structures that may need breaking during the dredging of the entrance channel. All efforts will have to be made to remove such structures using mechanical methods such as hammers. A separate permission will have to be sought should there be an absolute requirement for dynamite blasting when all other options have exhausted.

B. Areas that need Repair Work

The breakwater and facing the seaward side of the harbour and the short breakwater structures proposed to provide protection at the entrance will be developed during the rehabilitation. This will not only provide a calm environment within the harbour basin but also to a large extent control siltation carried in by over-topping waves and water that seeps through loosely placed boulders into the harbour basin. Construction of breakwaters at either side of the entrance channel will also control sedimentation drifted through the harbour mouth. The turbulence inside the harbour is also considered as high enough to cause damage to approaching boats and operational difficulties. In addition boat crew also complain of navigational difficulties at the harbour entrance due to turbulence. The primary areas of concerns in the rehabilitation of this harbour are:

1. Poor navigational safety at harbour entrance
2. Inadequate depth inside the harbour
3. Damage to the breakwaters
4. Low height of the jetty

The harbour rehabilitation does not involve changing the length or the width of the existing harbour. The finished harbours with the detailed measurements are given in *Figure 4*.

Reconstruction of the breakwater of total length 248 m which will cover ocean ward side of the harbour wall and the either side of the entrance mouth with rock boulder pieces weighing of 600-800 kg. It is also proposed to raise the height of the breakwater to another 1.5 m from the present level. The breakwater base will be widened to support the increase in height for stability.

Reconstruction will be undertaken using excavators placed on a barge and also excavators working along on the shallow rocky bed west of the existing breakwater. Additional boulders will be placed using the excavators along its length and the breakwater will be reconstructed by rearranging the existing boulders. Highly skilled operators will place and rearrange the breakwaters to the required length and height.

At the entrance channel, the breakwater constructed on the eastern side had a length of approximately 13 m. Similarly on the western side 22 m long breakwater has been planned to protect the entrance channel. During the community consultations, further lengthening of the entrance channel structures have been suggested. The consultants are of the view, given the rough wave conditions and prevailing wind waves in the area, the breakwaters on either side of the entrance need to be extended and that the height of these structures should be in par with the wave height in the location.

C. Construction of Revetments

A cement sand bag and rock bolder revetment is proposed at the two side of the harbour. The first one amounts for 82 m of sand bag revetment along the western side of the harbour, while the later one of 32 m is constructed at eastern side of the harbour with rock boulders. These structures will hold the position of the coastline adjoining the harbour and prevent further erosion.

Inguraidhoo Island Council has stressed on the importance of the raising segment of the seawall where harbour jetty has been developed. This is to offset flooding due to wave overtopping. Since the jetty area has been constructed at the elevation of the water level, the Consultants recognise the importance of taking into consideration by the project Proponent.



HARBOUR LOCATION	
SCALE	NTS
PROJECT	R.INGURAI DHOO HARBOUR
CONTENT	HARBOUR LAYOUT
DATE	11 October 2014

Figure 4: Layout plan of the proposed development

3.4 DREDGING AND SEDIMENT DISPOSAL

Dredging works under this project involves maintenance dredging of the existing turning basin and the approach channel. The process involves the following three steps; excavation, transport and disposal. Excavation

It involves dislodgement of and removal of sediments and/or rocks from sea bottom of the dredge areas. An excavator will be used to dredge the material by mechanical actions. The dredging will be performed utilizing a hydraulic excavator equipped with a hydraulic bucket. Dredging will be conducted from a work barge platform and placed into position with a tug boat and anchored in specific locations using spuds deployed from the work barge.

The excavated materials will be dumped into Lorries placed on a side by barge. The barge will move the shore from where Lorries will transfer the materials for dumping area. Although exact volume of the dredged material can be derived only after the depth surveys prior to beginning the construction activities, large volume of materials are not expected since the dredging will only be carried out in shallow spots. It is estimated from the very preliminary survey conducted during this EIA process approximately 5092 cubic meter of materials can be excavated during the dredging. The excavated materials will be dumped into exact locations where dredged materials from the existing harbour construction were laid. The dredged material will be places on two sides of the island harbour and if more volume is extracted the material will be placed at erosion zones of the islands. No impacts to vegetation and terrestrial environment are anticipated from temporary placement of dredged materials at the designated sites.

3.5 PROJECT SCHEDULE

The project is expected to take approximately 12 months to complete including the time needed for seeking necessary approvals. The main milestones and tentative duration for each of those are given in *Table 1*. Additionally, major inputs of the proposed project is also outlined in *Table 3*.

Table 1: Project Schedule - Indicative

S. No	Description	Days
1	Preliminary works	7
2	Mobilisation	14
3	Site setup	15
4	Survey and setting out	7
5	Dredging	15
6	Breakwater construction	100
7	Revetment construction	5
8	Pavement	10
9	Out survey	7
10	Site clearance	14
11	Demobilisation	14

Table 2: Matrix of major inputs to the project

Input resource(s)	Source/type	How to obtain resources
Workers	Skilled and semi-skilled labour, Manager (1) Supervisor (1) Excavator Operator (2), Loader operator (1), Welder (1), Driver (2), Carpenter (2), Bar bender (2), Masons (2) Labourer (11) Cook (1) Cook helper (1) total of 27 people, skilled and semi-skilled 16 and unskilled labourers 11.	Trained and licensed staff of the contractor
Machinery (excavator, barge, operational tools)	02 excavator 02 dump trucks 01 loader 01 Concrete machine 01 Crane 01 Workshop container 01 Office Container 03 Diesel tank 5000 l 02 Water tank 5000 l 01 Welding Gen-set 20KvA	To be obtained and operated by the contractor. Contractor will be required to bring to the site machines in good working conditions to avoid loss of time due to breakdown of machines, vehicles and equipment.
Output	Anticipated quantities	Comments
Entrance channel	Dredged channel will measure 63 m long and 24 m wide with an average depth of -3 m	Dredged material will be placed at the two ends of the harbour. Some may be used for levelling low elevation areas near the harbour and replenish the eroded areas at both ends of the harbour.
Breakwater on eastern side of the harbour Two breakwaters on either side of the entrance channel.	Total length of breakwater sections 194 m.	Built using rock boulders.
Two revetments, one on the eastern end and the other on the western end of the harbour.	Revetment total length 114	Built using rock boulders (eastern side 32 m) and sand-cement bags (western side 82 m) respectively.
Dredged material	Volume to be determined following pre-construction survey. Volume not expected to be significant.	Reclamation of both ends of the harbour excess material will be used to replenish beach on the western and eastern side.
Solid wastes	Minor amounts	Inguraidhoo does not have a good waste management system in place. The project should not burden the existing arrangements in the island in dealing with waste. All wastes generated on project site shall be collected and temporarily stored for transfer and disposal at Thilafushi at intervals determined by the Contractor. The site manager will require to maintain

		records of waste materials transferred from the project site.
Hazardous waste	Minor amount	Hazardous waste generated such as waste oil, lubricants, chemicals, batteries etc. shall be stored and disposed off in Thilafushi in fully in compliance with the waste management regulations
Noise and light	Localized	Excavator and truck operation will generate some noise during the project execution. If work is carried out in the night lights will be necessary in the harbour area. Work will not be carried out late into the night to avoid disturbance to local population.

4 ADMINISTRATIVE AND REGULATORY FRAMEWORK

This section highlights relevant government stakeholders, their roles and reviews relevant legal framework applicable to the proposed project.

4.1 MINISTRY OF ENVIRONMENT, ENERGY AND WATER

The Ministry of Environment and Energy (MEE) is key Ministry in the government mandated with the protection of the environment. Environmental responsibilities assigned to MEE includes formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93). Under Article 5(a) of EPPA, Environmental Impact Assessment (EIA) is mandatory for projects that may cause potential harm to the environment. The EIA report has to be submitted to the EPA for approval before commencement of a project. As per this legislation, any project that has any undesirable impact on the environment can be terminated without compensation by MEE.

4.2 ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA is the key regulatory body on environment, which is an autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MEE, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. Also, it is responsible for developing environmental standards and guidelines in the country.

4.3 MINISTRY OF FISHERIES AND AGRICULTURE

The Ministry of Fisheries and Agriculture (MoFA) is mandated to ensure sustainable management of the nation's marine and terrestrial resources. The Ministry enforces fisheries and agriculture laws and regulations relating to the sustainable management of these marine and terrestrial resources. Regulations relating to protected marine animals are formulated under the Fisheries Law of the Maldives by the MoFA. All uninhabited islands and their ecological components are also management by the MoFA under agriculture laws.

Protected marine species include turtles, dolphins, black corals, the napoleon wrasse, sharks and rays, lobsters, sea cucumber, giant clams, and corals. Separate regulatory clause and notifications exist for all such species. Corals are the base of reef systems and their health and vitality is critical for the sustainable development of fisheries and tourism. Hence much importance has always been afforded for the protection of corals in the Maldives. Specific regulatory measures combined with well thought out education and awareness campaigns have almost phased out coral mining activities in the Maldives.

The Marine Research Centre (MRC) under the MoFA, through assistance from Climate Change Trust Fund formulated an innovative approach to coral reef monitoring. Given the government's policy on research and monitoring is to be trimmed down but delegate this responsibility to private sectors, the proposal is to entrust the coral reef monitoring to resorts. A web-enabled database will be created to enter, compile and disseminate the information. Tourist resorts are encouraged to take part in this activity by committing resources and its staff.

A major priority of the Ministry is fishery management. This has become more important with third party certification of Maldives pole-and-line tuna fishery.

4.4 LEGAL FRAMEWORK

Four regulations pertaining to the proposed project have been reviewed and the project's conformity to these have been assessed.

- a) EIA Regulations 2012
- b) Regulations on cutting down of Trees
- c) Regulation on Dredging and Reclamation
- d) Regulation and Waste Management

4.4.1 EIA Regulations 2012

The most important governing law as far as the environmental impact assessment is concerned is Environment Protection and Preservation Act (Law No. 4/93) (EPPA).

EPPA mandates all development projects in the Maldives to undertake an Environmental Impact Assessment prior to undertaking any such project.

Further the EPPA states an impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment.

It goes on to say that the relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above.

The law also gives power to the relevant Government authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation.

According to the EPPA waste disposal, oil and poisonous substances any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives.

Government of Maldives reserves right to claim compensation for all the damages that area caused by the activities that are detrimental to the environment.

Environment Impact Regulations, 2012 and other relevant regulations

Under the provisions of EPPA the Government of Maldives has formulated and gazetted Environmental Impact Assessment Regulations (2012) detailing the EIA process and the EIA preparation.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000.

The EPPA, EIA Regulations and other relevant regulations will be duly taken into consideration in preparing the EIA report and in the implementation of the project.

4.4.2 Regulation on Cutting down Trees

Cutting down and relocating of mature trees is regulated in Maldives under the by-law on cutting down, uprooting, digging out and export of trees and palms from one island to another. In the preamble of the law, made in pursuant to Law No. 4/93, it states the purpose of the law is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The law states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more than 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

The project does not involve removal of any tree from the island hence the regulation will be fully complied to.

4.4.3 Regulation on Dredging and Reclamation

Regulation on Reclamation and Dredging of Islands Lagoons (Regulation 2013/R-15) came into effect in April 2013. The regulation requires having permission of EPA on projects requiring alternation of the island, either by reclamation or dredging. Specifically the regulation requires producing scaled-maps of the island before and after the proposed intervention. Special provisions have been made on protected and sensitive area restricting changes to the environment of the islands.

Since any EIA submission shall be made only after successful clearance of the dredging and reclamation permit, the proponent has obtained clearance from EPA in advance as per this Regulation. A copy of the permit is given in Annex 2.

4.4.4 Regulation and Waste Management

Waste management Regulation (No. 2013/R-58) is more recent coming into effect on 6 February 2014. The regulation was gazetted on 05 August 2013. The regulation provides set of comprehensive guidelines on collecting, storing, transporting and managing waste. In the preamble its states the objective of the regulation is in line with the Article 22 of the Constitution which requires that development activities designed for achieving socioeconomic targets should ensure that environment and its constituent living component is not compromised and that resources are utilized effectively.

The regulation talks of the responsibilities of collection, transport, treating and storage of waste. It also talks of management centres and landfill sites and managing hazardous waste. Various sectors and

entities (including tourist resorts) encouraged having their own waste management plans consistent with the Regulation.

EPA is the implementing agency of environmental law and the implementing agency of the EIA regulation.

Wastes produced from the project will be disposed in compliance to this regulation.

4.4.5 Summary

In summary, the proposed project will comply with all applicable environmental regulations requirements, relevant legislation, and legal and regulatory statutes. MEECO will work with the project proponent, the EPA and designated agencies during the EIA process to meet these requirements.

5 METHODOLOGIES

This section in brief describes various methodologies adopted in assessing the existing environment of the island and the environmental impacts. This section will also describe the methodology that the proponent intends to adopt in undertaking the works.

5.1 ASSESSMENT AND WORK METHODOLOGY

5.1.1 Rehabilitation of the Breakwater

Breakwater reconstruction will be undertaken using an excavator and a barge to place and rearranging the boulders.

5.1.2 Dredging Methodology

Dredging although is not expected to be a major activity under the proposed project, where deepening of the shallow areas are involved. The process involves the following three steps; excavation, transport and disposal.

5.1.3 Excavation

It involves dislodgement of and removal of sediments and/or rocks from sea bottom of the dredge areas. An excavator will be used to dredge the material by mechanical actions. The dredging will be performed utilizing a CAT 330 hydraulic excavator equipped with Young's 3-yd³ hydraulic bucket. Dredging will be conducted from a work barge platform and placed into position with a tug boat and anchored in specific locations using spuds deployed from the work barge.

5.1.4 Transport of Excavated Material

Transporting materials from the dredging area to the site of utilisation, will be achieved as follows. Sediments will be dumped into trucks placed on a barge; when the truck is full, barge will carry the truck to the shore from where the truck move out of the barge to transport the sediment to the location of replenishment meanwhile the barge will transfer a second empty truck to the location of work barge.

Excavator with appropriate bucket size has been recommended due to the relatively small size of the area requiring dredging and due to relative simplicity of the methodology for not having to do much pre-work preparation and to shorten the job schedule.

5.2 MARINE ENVIRONMENT STUDY

Baseline assessment for the project site was conducted recently. It was found that most of the coral reef that's is surrounding the area is largely coral rubbles and fine sand materials. Therefore, a visual observation was carried out to estimate the condition of live coral cover on the reef. The conclusion from the visual observation shows that surrounding reef area comprises of sand and rubbles. However, water quality assessment was carried and results are shown below.

5.2.1 Waves and Currents

Generalised wave predictions and wave pattern predicted using hindcast for the Indian Ocean was obtained from weather information providing sites. Wave height for R. Inguraidhoo was estimated using wind frequency data for N. Irufushi Island.

5.2.2 Coastal Dynamics

Coastal dynamics has not been assessed under the current project since the proposed interventions mainly involve rehabilitation of the existing harbour and the activities are confined to the existing harbour environment only.

5.2.3 Geology, Sediment, Marine Benthic Assessment

Due to the homogenous nature of the geological characteristics of Maldivian Atolls, site specific investigation for reef and lagoon geomorphology was not conducted whereas coring studies conducted elsewhere in the Maldives was reviewed.

5.2.4 Terrestrial Environment

As far as vegetation is concerned the project impact zone has no vegetated area hence vegetation has not been assessed.

5.3 CLIMATE

Official meteorological observations services in Maldives are limited to airports. A total of 10 airports are in operation, however meteorological observation takes place only on 5 airports. They are Hanimaadhoo in the north, Ibrahim Nasir International Airport in the centre, Kadhdhoo, in the south centre, Kaadedhdhoo, in the south, and Gan Island in the extreme south. Observation routinely monitored and measured include, wind speed and direction, daily minimum and maximum temperature, humidity, cloud cover. Monitoring of sea-level height takes place only in Hulhule (central), Hanimaadhoo (North) and in Gan Island (in south). Apart from the official meteorological observations, number of resort islands and individuals are installing portable mobile weather stations. Such weather stations are providing real time measurements to famous weather forecasting sites such as www.wunderground.com and www.windfinder.com. Data collected from these stations are now publicly available from those internet sites.

In the absence site specific weather data the normal procedure is to obtain whatever is available from the nearest weather station in an airport and apply it to the site assuming that average climate conditions do not show much variation between different islands. For the purposes of R. Inguraidhoo EIA, the meteorological observations from H Dh. Hanimaadhoo, which is located approximately, 148 km north of Inguraidhoo was used for description of the general weather conditions expected for Inguraidhoo.

5.4 IMPACT ASSESSMENT METHODOLOGY.

Following data analysis and literature review and stakeholder consultations, a system called Rapid Impact Assessment Matrix (RIAM) was used to organize the EIA. RIAM brings together the individual multi-disciplinary parts of an EIA in a transparent and semi quantitative manner. It keeps transparent control of the components in a distinct semi quantitative manner allowing direct comparison of different problems, and above all it allows a holistic and coherent anticipation of problems. This methodology has been found be effective for EIA involving coastal development projects.

The process of defining the components, which are of importance in evaluating the possible changes due development, is called scoping. In the RIAM these components are considered in a holistic manner and fall into four groups. These groups represent the issues relating to the Physical/Chemical environment (P/C); those relating to Biological/Ecological (B/E) concerns; human issues defined as Social/Cultural (S/C); and issues dealing with the Economic/Operational (E/O) aspects of development.

In the RIAM analyses, all problems are analysed according to five characteristic criteria as outlined in *Table 3* and *Table 4*. Two criteria relate to properties that are of singular importance to the condition, and three criteria to properties that are of value to the situation. The first type of criteria is: the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect; and the magnitude, which is defined as a measure of the scale of benefit/dis-benefit of an impact of a condition.

For the importance of condition (I) the scale is defined as:

- 4 = important to national/international interests
- 3 = important to regional/national interests
- 2 = important to areas immediately outside the local condition
- 1 = important only to the local condition
- 0 = no importance

For the magnitude of a change or effect (M) the scale is defined as:

- +3 = major positive benefit
- +2 = significant improvement in status quo
- +1 = improvement in status quo
- 0 = no change/status quo
- 1 = negative change to status quo
- 2 = significant negative dis-benefit or change
- 3 = major dis-benefit or change

Criteria that are of value to the situation are defined as permanence, reversibility and cumulative properties. Permanence defines whether a condition is temporary or permanent, e.g. an embankment is a permanent condition even if it may one day be breached or abandoned, whilst a coffer dam is a temporary condition, as it will be removed.

Reversibility defines whether the condition can be changed and is a measure of the control over the effect of the condition.

Cumulative property is a measure of whether the effect will have a single direct impact or whether there will be an accumulated effect over time, or a synergistic effect with other conditions.

Table 3: The scale used for the criteria that are of value to the situation

Score	Permanent (P)	Reversible (R)	Cumulative (C)
1	no change/not applicable		
2	temporary	reversible	non-cumulative/single
3	permanent	irreversible	non-cumulative/single

Table 4: Range bands used for RIAM

RIAM Environmental Scored (ES)	Range Value (RS) (Alphabetic)	Range Value (RS) (Numeric)	Description of range band
108 to 72	E	5	Major positive change/impact
71 to 36	D	4	Significant positive change/impact
35 to 19	C	3	Moderate positive change/impact
10 to 18	B	2	Positive change/impact
1 to 9	A	1	Slight positive change/impact
0	N	0	No change/Status quo/Not applicable
-1 to -9	-A	-1	Slight negative change/impact
-10 to -18	-B	-2	Negative change/impact
-19 to -35	-C	-3	Moderate negative change/impact
-36 to -71	-D	-4	Significant negative change/impact
-72 to -108	-E	-5	Major negative change/impact

The assessment of the different problems that have been selected for evaluation by the scoping process gives a value ascribed (by the consultants) to each of these criteria. By the use of a simple formula a score (the environmental score) for the individual components was calculated:

$$ES = I * M * (P + R + C)$$

To use the evaluation system described, a matrix of cells showing the criteria used, set against each defined component, is produced for each project option. From the formulae given above each ES number is calculated and recorded. To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. The ranges cover impacts from a major positive change/impact (+5/E) to similarly negative effect (-5/-E). Conditions that have neither importance nor magnitude will score a zero and be banded together (0/N); and any condition in this band is either of no importance or represents the status quo, or a non-applicable situation.

6 EXITING ENVIRONMENTAL CONDITIONS

6.1 OBJECTIVES

The purpose of this was to assess the existing environmental conditions of the island, including marine and land environment. This is critical in assessing potential impacts and to determine the actual extent of damage should an unforeseen impact occur during the project implementation phase. Understanding existing environmental condition is also important in better planning for the project as such the project implementation can be planned to coincide with the period of the year with most favourable weather conditions. However, in making weather assessments long term site specific data will be needed. This is not to be the case with this assessment since no such data is available. In the absence of site specific data the information available from the closest source have been applied to make the predictions as accurate as possible. Hence relevant information from the past EIA and other relevant literature have been used the subsequent sections.

6.2 METEOROLOGY AND CLIMATE

6.2.1 Temperature

The daily average temperatures rarely drop below 25 °C and rarely go above 32 °C. The warm period of the year is from March to May with an average daily high temperature above 31 °C.

The “cool” periods lasts from October/November to January with an average daily high temperature below 30 °C. The coldest day of the year is around mid-December, with an average low of 26 °C and high of 30 °C.

6.2.2 Rainfall

The rainfall pattern in the Maldives is largely controlled by the Indian Ocean monsoons. Generally the NE monsoon is dryer than the SW monsoon. Rainfall data collected by the Met Office in Hulhule', Island for the period between 1998 and 2012 indicates the mean annual rainfall to be 1,761.6 mm while the average monthly rainfall to be 146.8 mm. The 15 year rainfall data showed 2,209.3 mm of rain as the highest recorded and the lowest being measured at 1,346.5 mm. Rainfall varies throughout the year. From the results it was also determined 95% if the time, the daily rainfall limit was less than 50 mm while measurements higher than 50 mm is considered as heavy rain. Extrapolating this information to Inguraidhoo, it is predicted that within a year 14 days would experience heavy rainfall potentially causing flooding.

Month by month analysis of rainfall data for the period 2011 - 2012 shows lowest chances of precipitation for the period January to April while the chances of precipitation being greatest for the period between May to October (see *Figure 5*).

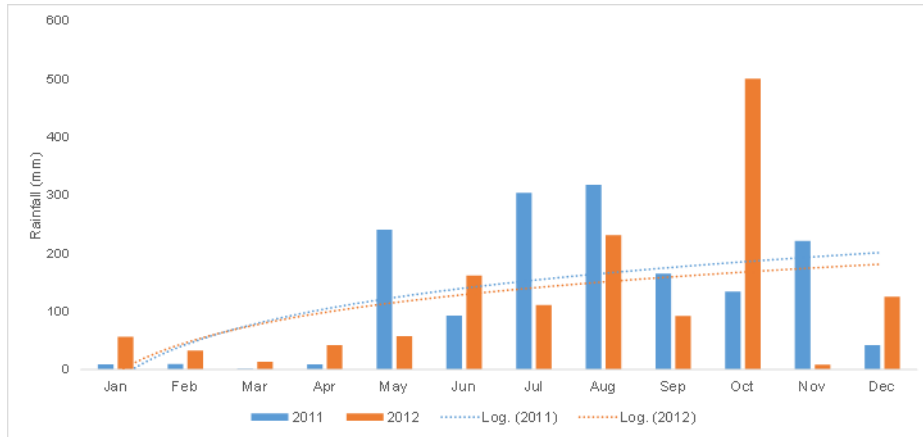


Figure 5: Rainfall for H Dh. Hanimaadhoo by month 2011 – 2012

6.2.3 Monsoons

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

6.2.4 Winds

In the absence of wind data for Inguraidhoo, wind data obtained from HDh. Hanimaadhoo airport and N. Iruvushi located to south of Inguraidhoo to understand possible wind pattern for Inguraidhoo. (See Figure 6).

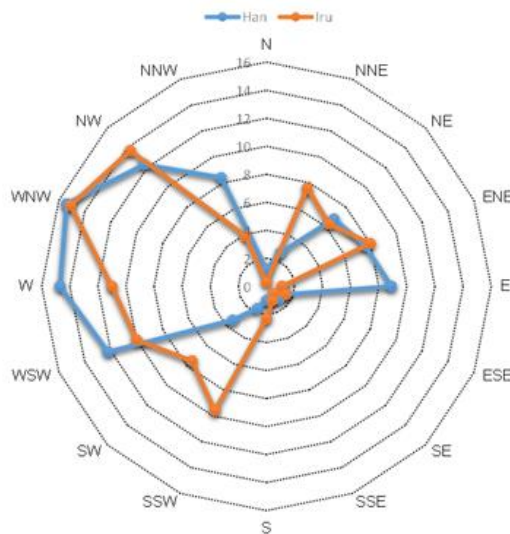


Figure 6: Wind data analysis for N. Iruvushi Island and H.Dh Hanimaadhoo Island; closest islands to R. Inguraidhoo for which weather data is available

The comparison showed similar patterns with the wind records for both Hanimaadhoo and Irufushi Island as far as wind direction and speed are concerned.

Wind data comparison shows that 73 % of the wind is blowing between SSW and NW directions in Irufushi while 69 % of the wind direction is concentrated between SWS - NNW directions in the case of Hanimaadhoo. Also 15% of the westerly wind has WNW direction in Irufushi while 15-12 % of the dominating wind direction in Hanimaadhoo is W and WNW direction.

Wind speed recoded from Irufushi shows that the average wind speed is lower than Hanimaadhoo throughout the year except in June and July, where wind speed is similar or very close between the two islands during this period.

Figure 7 shows monthly local variations in wind characteristics between HDh. Hanimaadhoo and N. Irufushi. Considering the distances between R. Inguraidhoo and Hanimaadhoo and Irufushi weather conditions in Hanimaadhoo is more likely to prevail in Inguraidhoo.

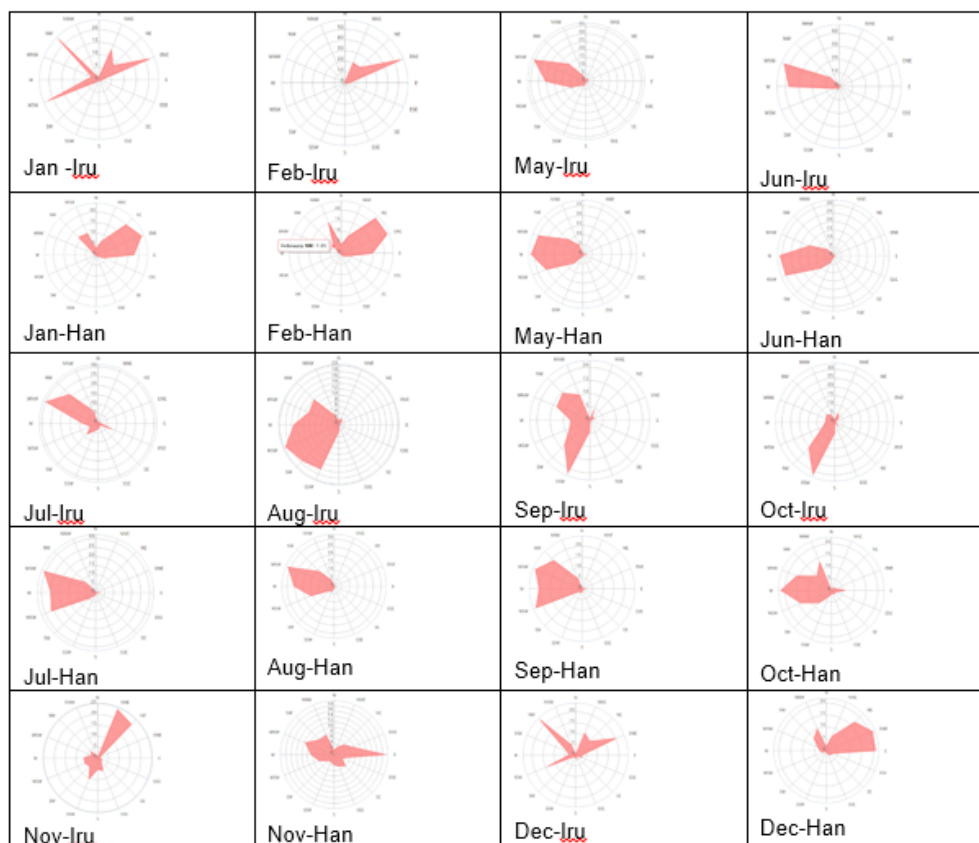


Figure 7: Monthly local variations in wind characteristics between HDh. Hanimaadhoo and N. Irufushi (Han=Hanimaadhoo, Iru=Irufushi)

Considering the predominant wind directions for both islands studied, the following can be generalised for the expected wind directions prevailing in R. Inguraidhoo.

- a) January to July: Winds are primarily from the NW to ENE.
- b) August to October: Winds are mainly from the NW to SSW.
- c) November to December: Winds are primarily from the NNE to ENE.

Accordingly the period between the month of January to July wind is directly facing the harbour hence it is believed to be most unfavourable period of the year for the project activities (see *Figure 8*).

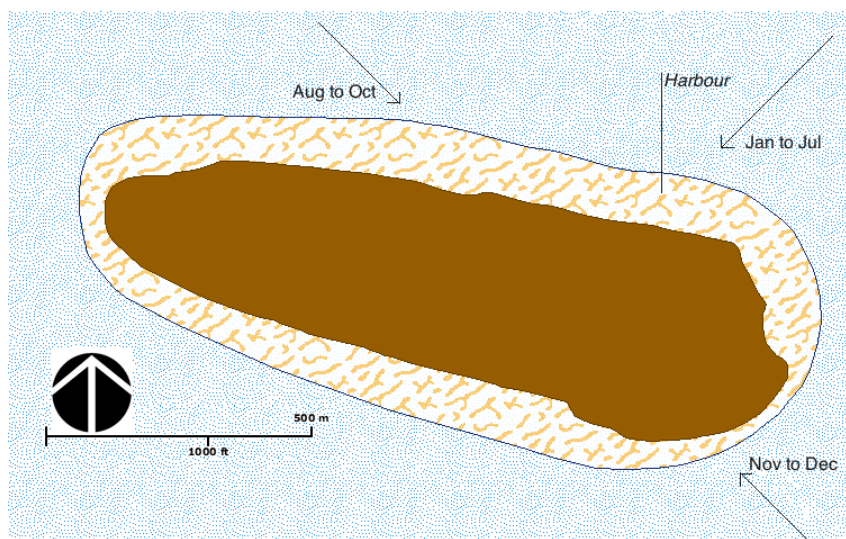


Figure 8: Diagrammatic representation of the predominant wind directions in relation to Inguraidhoo Island during the year (Source: www.ngis.gov.mv)

Inguraidhoo falls within the most hazardous zone for cyclone related hazards in Maldives and has a maximum predicted cyclonic wind speeds of 96.8 kts (UNDP, 2007). There are no records of such high wind intensity resulting from a cyclone for the northern region in the recent past, although a number of gale force winds have been recorded due to low depressions and South west monsoon in the region. Winds exceeding 35 knots (gale to strong gale winds) were common occurrences during south west monsoon in the recent years. In general the wind speeds are higher in the north than the central and southern areas during SW monsoon (DoM, 2005).

Wind and rain fall pattern expected for Inguraidhoo show that the higher wind speed during southwest monsoon is coincided with higher precipitation. Period between May to October is believed to be associated with strong westerly winds and heavy precipitation. During the planning for the project expected weather conditions for the island need to be considered to avoid delays, avoid damages to the machines and accidents.

6.3 TIDES, CURRENTS AND WAVES

6.3.1 Tides

Tides experienced in Maldives are mixed and semi-diurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0 m and 0.3 m, respectively. Maximum spring tidal range in the central atolls is approximately 1.1 m. There is also a 0.2 m seasonal fluctuation in regional mean sea level, with an increase of about 0.1 m during February to April and a decrease of 0.1 m during September to November. Like in most other atolls, semidiurnal tides are experienced in Noonu Atoll - that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in *Table 5*.

Table 5: Tidal variation observed at Ibrahim Nasir International Airport (Mean levels reported by the Maldives Meteorological Services).

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

Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country. Tidal fluctuations (rise and fall of tides) cause changes in current flow pattern around the island and bring subsequent changes in physical aspects of the shoreline. At low tide water movement is very slow, therefore low tide period is considered to be a good time to conduct dredging and reclamation work.

6.3.2 Currents

Currents which affect the sea area around the Maldives are caused by one or more of the following systems:

- a) Oceanic currents
- b) Tidal currents
- c) Wind-induced currents
- d) Wave-induced currents

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. In the Arabian Sea, as one gets closer to the equator, the prevailing winds become more and more indicative of the oceanic surface current. Thus, wind (especially during monsoons) can be a major factor affecting current velocity and direction, and currents can be of great strength (wind-induced currents). For example: currents in the channels near Male' have been recorded at 4 knots or more. Inside an atoll, current speeds are more settled. Oceanographic currents are driven by two monsoonal winds, namely the westerly and easterly wind. The westerly flowing current tend to dominate from January to March while the easterly currents dominate from May to November. The changes in current flow patterns occur in April and December. The current velocities are about 0.5 m/s, only in May values may increase to 0.8 m/s.

The vertical water movements associated with the rise and fall of the tide are accompanied by horizontal water motion termed tidal currents. These tidal currents have the same periodicities as the vertical oscillations, but tend to follow an elliptical path and do not normally involve simple to- and-from motion. Generally the tidal currents are eastward in flood and westward in ebb. Tidal currents, which flow according to the height of the tide, are generally not strong. There is a strong diurnal influence, which governs the tides in the Maldives, but in general the tidal range is less than 1 m.

On a more local scale, especially on the reef flats, wave-induced currents (cross-shore and/or long-shore) also form an important factor affecting the current regime.

6.3.3 Swell Waves and Udha

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically strongest during April - July in the south-west monsoon period. During this season, swells generated north of the equator with heights of 2 - 3 m with periods of 18 - 20 seconds have been reported in the region.

Studies on wave patterns around the country reports a predominantly southwest to a southerly direction for swell waves (Kench et. al (2006), Young (1999), DHI (1999) and Binnie Black & Veatch (2000)). Being located on the eastern rim of Thiladhunmathi Atoll, and on the eastern line of atolls with the archipelago, Inguraidhoo is believed to be relatively protected from predominant swell waves in the region. However, the island is still exposed to abnormal swell waves originating from intense storms in the southern hemisphere between 73°E and 130°E. Waves generated from such abnormal events could travel against the predominant swell propagation patterns in the Indian Ocean (Goda, 1998), causing flooding on the eastern rim island of Maldives.

Inguraidhoo is also partially exposed to residual swell waves approaching from a south westerly direction. Such waves could penetrate through the wide western reef passes and reach the western shoreline of the Island. Even though some degree of protection may be offered by the western rim of the atoll, such swells can significantly impact the western side of the island.

In addition to swell waves, both the oceanward and lagoonward coastlines of the Island are exposed to monsoonal wind waves. During the NE monsoon between November and March, the eastern (oceanward) coastline may receive strong waves. Wave studies done in similar settings have reported wave heights less than 2.0 m and with wave periods of 2-4 seconds in the eastern side. The west coast is exposed to wind generated waves during SW monsoon, originating within the atoll lagoon. It is also likely that monsoonal wind waves originating in the open ocean may propagate through the wide reef passes and fuel the waves generated within the atoll lagoon. Wave heights are predicted to be less than 0.5 m.

Due to the fact that approximately 85% of the wind in a year approaching the Island are NNW –W-SWS in direction, for much of the year the western coast of the Island is expected to experience rough wave conditions due to wind effect.

General swell wave pattern prediction for Inguraidhoo is shown in *Figure 9*.

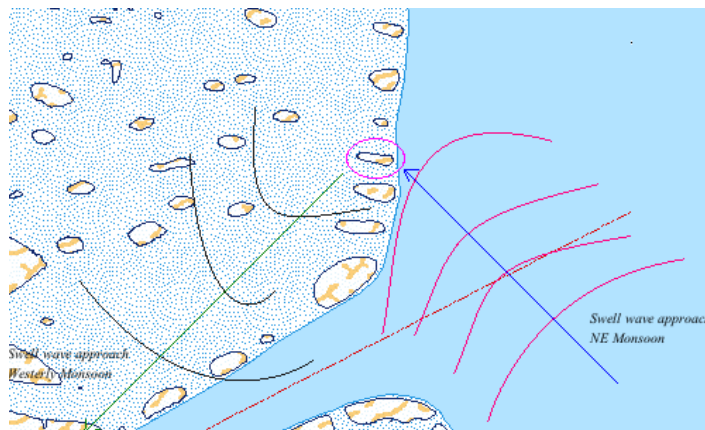


Figure 9: Diagrammatic representation of the predominant wind directions in relation to Inguraidhoo Island during the year

Based on these observations it is proposed to carry out the dredging activities during SW monsoon in order to allow wind generated currents to push the sediment plume out the reef system within the shortest possible time.

6.4 ISLAND MORPHOLOGY

Historic Digital Globe, Google Earth images (2006-2014) were comparatively evaluated to observe coastal changes that have occurred after the construction of the harbour compared to pre-harbour status. Co-georeferencing technique of historical digital globe images taken in various months of the year was used to map the beach end of the island and overlaid to quantify long term changes in island area. Both seasonal and monthly changes in beach erosion, accretion and sediment dynamics were quantified using this technique.

Figure 10 show that very little change that occur around the coastline of Inguraidhoo as far as sediment movement is concerned. Sand accumulated on the western tip of the island is believed to undergo a small degree of movement from NNE to NNW and vice-versa depending on the monsoon conditions. It is believed that due to the saturated nature of the island its elongated shape sediment does not get transported along the entire perimeter of the island and is believed to be in fairly stable state.



Figure 10: Comparison of the coastline (Images: Google Earth)

6.5 MARINE WATER QUALITY

Even though the Marine coral cover not undertaken at detailed level, the marine water quality is assessed. The main reason for not assessing coral cover near the harbour area is mainly because visual observation indicated that the surrounding marine area comprises of coral rubbles and sand sediments. Moreover, this is verified by the recent studies undertaken to which was made prior to construction of the harbour in the island. The average values of the data for the island lagoon are given in *Table 6*. *Figure 11* also shows the site locations.

Table 6: Baseline for Inguraidhoo seawater

Parameter	Basin	Outside Basin	Channel
Physical appearance	Clear	Clear	Clear
Temperature (°C)	20.8	21.0	21.0
pH	7.93	8.24	8.30
Total Dissolved Solids (mg/l)	2400	25100	24200
Turbidity (NTU)	0.190	<0.1	0.172
Salinity (mg/l)	31.53	32.79	32.60
Nitrate (mg/l)	2.3	2.5	1.8
Nitrite (mg/l)	<0.002	0.014	0.013
Sulphate (mg/l)	2900	2800	2800
Phosphate (mg/l)	0.12	<0.05	<0.05
Biological Oxygen Demand (mg/l)	1	1	1

Water quality assessed for this EIA for Inguraidhoo was compared with seawater assessments undertaken for similar studies elsewhere in the country and no significant differences were observed. It is recommended to use the monitoring data during the project implementation against the baseline information in assessing the environmental impacts.



Figure 11: Sea water sample locations.

6.6 BIOLOGICAL ENVIRONMENT

6.6.1 Terrestrial Ecology

No terrestrial assessment was deemed necessary since the project impact zone does not consist of natural terrestrial environment of the island.

The dredged material will be disposed off the coastal vegetation belt on the northeast side. The dump trucks carrying sediments will travel a short distance on the beach before reaching vegetated part of the island. Once the trucks reach the vegetated part of the island it will travel through existing walkways without having to disturb existing vegetation.

6.7 REEF ENVIRONMENT

Healthy coral reef is essential for island ecosystems to maintain its integrity, structure and proper functioning of its ecosystem services. Reefs provide the physical protection to the island from waves and nourishes the beach by the sand its produces. The composition and its abundance of live forms on coral reefs is an indication of the health of the reef. In its simplest form substrate cover and composition and abundance of fish is a good starting baseline amenable for rapid forms of assessment.

The proposed reef rehabilitation of harbour including construction of breakwater and revetment will only be carried out on the existing footprints of the harbour structures. Hence no new reef area will be impacted as a result of the project.

The project site notes distinct demarcation of the dredged area from the shallow rock base of the reef crest, which is clearly visibly from above the water. The assessment notes good visibility of the area and healthy live corals, mostly juvenile species of *Acropora* species. Towards the reef slope, the percentage of live corals increased and their density is high in comparison to the areas close to the existing breakwater. The site selected from south of the existing harbour composed of mostly a rock base with juvenile as well as fully grown colonies of hard corals growing on them. The site was reported to have groove like formations. Fish population was not considered abundant and diverse, but surgeon fish population was stated to be high.

6.8 SOCIO-ECONOMIC SETTING

Inguraidhoo has a population of 1842 people by the end of 2014 according. The population occupies relatively a small area of the island. The majority of the people earn their income through fishing and employment in the tourism sector. Fishing being the mainstay of the island economy the island presently maintains 55 ocean-going vessels, the hull length of these vessels ranges between 75 – 90 feet.

The socio-economic setting of the island is intrinsically linked to the sea transport which in turn is related to the maintaining a good harbour at the island.

People of Inguraidhoo since time of initial inhabitation of the island had been facing significant challenges due to difficulties in accessing to the island. The island lacks a natural harbour and the saturated nature of the island on its house reef platform with relatively small lagoon space had been seen a further challenge to creating a harbour basin at the island. Poor access to island had long seen to be one of the major impediment to the socio-economic development of the island. After several years of planning and evaluating environmental and cost options, the government constructed a basic facility at Inguraidhoo Island in 1998. Although the harbour brought a lot of convenience to the people, due to the structural issues associated with the design, the facility had not been found to be appropriate during rough weather conditions. During rough weather conditions, several vessels had run into accidents

while approaching to the harbour and had caused severe damages to the several vessels. These have caused financial and economic losses due to direct damages to the vessels and costs incurred in repair and maintenance of damaged vessels. Since the people of Inguraidhoo depends on fisheries, agriculture, as major economic activities, a dependable harbour facility is an absolute necessity to run island's local economy. For the socio-economic reasons alone it is easy to justify the importance of the proposed harbour rehabilitation project.

Hence, through harbour rehabilitation one of the major issue related to the socio-economic development of the island can be addressed and the population as a whole will benefit from the project. The project is one of the most important projects currently needed for the island, aimed at improving the functionality of the harbour.

7 POTENTIAL IMPACTS AND MITIGATION MEASURES

The proposed dredging project will entail dredging of loose substrate in and on the approach channel and the turning basin and extending the turning basin to the west at Inguraidhoo harbour so as to increase the capacity of the turning basin and deepen the approach channel.

This section of the report identifies the potential environmental impacts and possible issues that could arise from implementation of the dredging works using an excavator mounted on a floating barge. Their identification of potential impacts does not mean that they would necessarily occur or that they could not be successfully mitigated. The proposed other works include nourishment of the eroded coast of the island, setting up of a barrier to protect the beach, construction of barrier on the west and east of the harbour to protect the harbour during the rough weather and constructing a piled jetty to enhance accessibility to the island. These are also mentioned below but would have minimal impact as compared with the dredging aspect of this project.

The assessment of environmental impacts (positive and negative) had been carried out during EIA process and the resulting RIAM matrix is given in *Table 7*.

Table 7: The assessment of environmental impacts by RIAM methodology

		ES	RS	I	M	P	R	C
PC1	Coastal morphology	0	N	0	0	1	1	1
PC2	Hydraulic conditions	14	B	1	2	3	3	1
PC3	Water quality	-5	-A	1	-1	2	2	1
PC4	Natural disasters	6	A	1	2	1	1	1
PC5	Persistent pollutants	0	N	0	0	1	1	1
BE1	Coral reefs	-6	-A	1	-1	2	2	2
BE2	Sea grass beds	0	N	0	0	1	1	1
BE3	Mangroves	0	N	0	0	1	1	1
BE4	Endangered species	0	N	0	0	1	1	1
BE5	eutrophication	0	N	0	0	1	1	1
BE6	Terrestrial ecosystem	0	0	0	0	1	1	1
SC1	Aesthetic and cultural value	10	B	1	2	1	2	2
SC2	Income	81	E	3	3	3	3	3
SC3	Fishery	81	E	3	3	3	3	3
SC4	Recreational value	0	N	0	1	3	3	3
SC5	Employment	81	E	3	3	3	3	3
SC6	Public health and safety	27	C	1	3	3	3	3
EO1	Infrastructure	81	E	3	3	3	3	3
EO2	Navigation	81	E	3	3	3	3	3
EO3	Regional economy	81	E	3	3	3	3	3

Range of values (RS) given in the table in alphabetic are as follows;

- E = Major positive change
- D = significant positive change
- C = moderate positive impact
- B = positive impact
- A = slight positive impact
- N = no change/Status quo/not applicable
- A = slight negative impact
- B = negative impact
- C = moderate negative impact
- D = significant negative impact
- E = major negative impact

Class totals for four major categories are given in Table 8.

Table 8: Class totals for major categories of environmental impacts

Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	0	1	1	2	1	1	0	0	0
BE	0	1	0	0	1	4	0	0	0	0	0
SC	0	0	0	1	0	1	0	1	1	0	3
EO	0	0	0	0	0	0	0	0	0	0	3
Total	0	1	0	2	2	7	1	2	1	0	6

As per Table 8 no major change or impact is expected as a result of the project (-E=0). While the project can yield major positive change for the community. Negative impacts of the project (-B) are few and so are the slight negative impacts (-A). Slight negative change and impact is expected for water quality and coral reef environment.

7.1 IMPACTS TO CORAL REEF

Dredging of the shallow areas in the harbour is not expect to have significant impact due to the fact that existing “walls” surrounding the harbour will contain the sediment plume reaching areas beyond the harbour boundaries. However, if the dredging happens to coincides with the rough weather conditions, due to the low height of the existing breakwater sediment may spread to other areas of the reef. If this happens it will result in the short-term irreversible loss of the existing coral communities living on the affected area. Over time, recruits of the same coral species are likely to recolonize the fresh rock face of the now deepened plateau and a similar ecosystem would become established. Thus, the immediate negative impact of sedimentation would be reversed over the long-term period.

The potentially negative impacts on the associated fish species are thought to be less severe given that that there are adequate reef ecosystems on the island house reef to which they may retreat.

The proposed rehabilitation of the breakwater has been planned to be carried out on the footprint of the existing breakwater. Hence careful re-construction of the breakwater will not affect unaffected areas of the existing reef.

Without turbidity barriers the currents and the wave action mostly generated by wind particularly during the easterly monsoon in and around the harbour would promote rapid sediment transport of turbid waters away from the immediate area and into the downstream areas. This will tend to reduce the time period over which undisturbed coral species would have to endure deteriorated water clarity.

Dumping of sediments on the reclaimed land near the harbour will not have a negative effect on the environment, since the area is artificial land and have no connection with the sea. Noticeable numbers of crabs have been observed to live the coral crevices.

7.2 MODIFICATION OF WAVE AND CURRENT PATTERN INSIDE THE HARBOUR

Proposed breakwater will greatly will reduce wave energy and wave heights within the harbour basin. It will also prevent overtopping of waves into the harbour basin creating a “calmer” condition in the harbour.

Dredging of the channel approach may have slight increase in wave heights due to increase in depth however, it will be a highly localised effect and the breakwaters on either sides of the channel is expected to offset this effect. Current speed within the channel and the harbour is expected to decrease due to proposed interventions.

7.3 IMPACTS TO COASTAL MORPHOLOGY AND AESTHETIC VALUE

Harbour rehabilitation will not result in any negative impact to the aesthetic value of the environment since, the project does not involve any interventions beyond the existing harbour area.

Re-construction of the seawall will change the image of a damaged harbour and therefore the activity is expected to have a positive impact on the artificial vista of the harbour setting.

7.4 IMPACTS TO SEA-WATER QUALITY AND HYDROLOGICAL CONDITIONS

The toothed-bucket action of the excavator on the sea floor head will disturb the substrate and place sediments into suspension. In addition movement of the bucket while lifting the sediments out of the water will also place sediments into suspension. These suspended sediments may then smother nearby corals, bottom-living flora and fauna as and when they settle. The effect will be greatest in those areas with fine sediments, which are more easily placed into suspension. The effect will be most severe if the dredging of the channel and the harbour starts before breakwater rehabilitation and if the work coincides with westerly monsoon. The severity of the impact would also depend very much on the direction of the sediment plume which in turn would depend on the direction of the currents and wind. The direct impacts of sedimentation, could be moderate to severe on those communities close to the dredging site. It is very unlikely that the coarse sediments brought into suspension in the channel would be carried very far to adversely impact reef as these would be expected to settle fairly rapidly.

The suspension of fine sediments in the water column creates turbidity, which scatters and attenuates light levels and potentially affects the growth of plants and corals indirectly by reducing the availability of light and consequently the photosynthetic process in plants and coral symbionts. High levels of localised turbidity can be expected during dredging.

Most of the turbidity generated by dredging operation is usually found in the vicinity of the toothed bucket. The levels of turbidity are related to the type and quantity of material dislodged by the excavator, but not picked up. The ability of the dredger to pick up bottom material determines the amount of dislodged material that remains on the bottom or suspended in the water column. In addition to the dredging equipment used and its mode of operation, turbidity may be caused by inefficient operational techniques; poor workmanship, carrying out dredging in rough weather.

There is no legislation in the Maldives with regards to permitted levels of turbidity, we propose under the project’s monitoring program to set up geo-referenced monitoring stations. In this regard, at least 3

monitoring stations shall be set up. The Consultants will assist the proponent in setting up the monitoring station or the compliance station, sample collection and data analysis.

Samples is to be taken at a depth of 3 feet from the surface at each station and at a frequency of every six daytime hours during initial operations (no more than 10 days) and once per day thereafter. Nephelometric Turbidity Units or NTU's so that during construction, the turbidity level to be maintained below 29 NTU's against the associated background turbidity levels as prescribed in the Monitoring Section. NTU upper limit has been set based on compliance limits set is based on practices in some countries.

Measurements will be taken prior to commencing dredging in order to determine the background turbidity level whilst turbidity is affected movement of vessels in the harbour. These measurements will be taken over a two day period and averaged to determine a background turbidity level of 2.3 NTU against which the 29 NTU rule is to be applied during dredging. The pre-determined limit of turbidity levels at the compliance stations will therefore be $2.3 + 29 = 31.3$ NTUs.

However, if background measurements exceed the pre-determined limit of 31.3 NTUs, the background measurement shall be used for comparison of compliance measurements. In other words, compliance measurements shall be compared with the daily background measurement or the pre-determined limit of 31.3 NTUs, whichever is higher. If monitoring reveals turbidity levels at the compliance sites in excess of the limit of 31.3 NTUs or the background measurements, whichever is higher, construction activities shall cease immediately and not resume until corrective measures have been taken and turbidity has returned to an acceptable level. Any such occurrence shall also be immediately reported to the Project Manager.

It must be clear that 29 NTU above background is the absolute maximum we recommend and any exceedance of this value must result in the suspension of dredging/disposal operations. In an attempt to prevent instituting serious mitigatory measures (cessation of activities) due to the 29 NTU (above background) maximum being exceeded, a graded system of turbidity concentrations is recommended. Instead of relying on a single turbidity concentration, a maximum at the monitoring sites of 20 NTU (above background) should be used as an early warning indicator. The contractor would thus be in more of a position to initiate mitigatory measures to avert exceeding the 29 NTU (above background) threshold if he has sufficient warning that this level is being approached. Once the 20 NTU (above background) level is attained or exceeded, the contractor should ensure that the necessary mitigatory steps are taken and documented to prevent a further increase in suspended solids concentration, which could lead to suspension of the operation when 29 NTU (above background) is exceeded.

Mitigatory steps would normally involve a slower rate of progress to control the over flow from the bucket. It should be noted that these mitigation measures will add to the cost of dredging. If 29 NTU (above background) is attained or exceeded there should be no debate and dredging operations must be immediately suspended until levels are reduced to below the threshold mark. A report on the exceedance incident should be prepared and only after the environmental officer is satisfied that the situation has been rectified should the operation be resumed.

Turbidity barriers or silt curtains are often used to limit the impact of turbidity. In some cases where relatively quiescent current conditions (0.2 ft/sec or less) are present, turbidity levels in the water column outside the curtain can be 80 to 90 percent lower than the levels inside or upstream of the curtain. While there may be a turbid layer flowing under the curtain, the amount of suspended material in the upper part of the water column, as a whole, is substantially reduced. However, the effectiveness of turbidity barriers can be significantly reduced in high energy regimes characterised by currents and turbulence. High currents cause turbidity barriers to flair, thus reducing the curtain's effective depth; in fact, in a current of 1 knots the effective skirt depth of a 5ft curtain is approximately 3 ft. Increased water turbulence around the curtain also tends to suspend the fluid material layer and may cause the

turbid layer flowing under the curtain to resurface just beyond the curtain. However, even under moderate currents (up to 0.5 knots), a properly deployed and maintained center tension curtain can effectively control the flow of turbid water (under the curtain). In other cases, where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and may cause re-suspension of the fluid material as the curtain sweeps back and forth (over the fluid material) with changes in the direction of the current, the turbidity levels outside the curtain can be as much as 10 times higher than the levels inside the curtain. With respect to overall effectiveness and deployment considerations a current velocity of approximately 1.5 ft/sec appears to be a practical limiting condition for turbidity curtain use.

The statistical reliability of the monitoring data set is improved with increased monitoring frequency. To determine if guidelines have been exceeded during dredging, ideally, for long-term exposures, initially, measurements should be taken every six daytime hours during initial operations (no more than 10 days), less frequent monitoring may commence once the likely levels of turbidity during operations have been established and found to be within the guidelines. Measurements can then be taken on a gradually less frequent period though never to be less than once daily during operations.

Daily monitoring reports will include the following information for each sample: a) time of day; b) antecedent weather conditions; c) tidal stage and direction of flow; and d) wind direction and velocity. Reports shall be compiled daily even when no sampling is conducted. When sampling is not conducted, a brief statement shall be given to explain the rationale, such as “dredge not working” or “no sampling due to high seas”. Weekly summaries of the daily turbidity monitoring data will be submitted to the Project Manager within one week of analysis with documents containing the following information: 1) dates and times of sampling and analysis; 2) state plane coordinates (X and Y) of the sampling stations and the dredge and discharge locations, and the distance between the sampling stations and the dredge/discharge for each sample to demonstrate compliance with the above required distances; 3) a statement describing the methods used in collection, handling, storage, and analysis of the samples, as well as the authenticity, precision, limits of detection, and accuracy of the data; 4) results of the analysis; and 5) a description of any factors influencing the dredging or disposal operation or the sampling program. The summaries shall be submitted in Excel Spreadsheet.

7.5 CONSTRUCTION OF BREAKERS

Construction of a breakwater is the most important intervention proposed under the project. The existing breakwater does not seem to serve the purpose of breaking incident wave energy offshore so that the harbour basin is protected from wave attack. The new breakwater will main appropriate height in par with the wave heights prevailing in the area. It will reduce the wave energy in the harbour, control infilling of the harbour due to sediments carried by the overtopping waves into the harbour basin.

7.6 DREDGED SEDIMENT DISPOSAL

Sea disposal of sediments shall be completely avoided and uncontrolled spread of sediments shall be checked through appropriate mitigation measures and through responsible workmanship. The dredged material is recommended to be utilised as much as possible for various purposes related to the project. Certain coastal areas around the harbour being lower than the average elevation of the island, some dredged sediment can be used for levelling. Use of dredged materials for levelling can eliminate flood prone areas and therefore this is expected to have a beneficial impact. After sieving and sorting dredged materials, it can also be utilised for construction purposes. Any additional dredged material will be stockpiled at locations where area for use by the island community for construction and backfilling purposes. The areas where dredging materials were stockpiled during the harbour construction will be used for placing sediments (*Figure 12*).

Deep sea disposal is an alternative option for disposal of the dredged material. One of the main concerns with regards to the dredged material disposal is the impacts on water quality, which include those associated with increased turbidity, decreased dissolved oxygen levels, and visual impacts. Dredged material disposal typically has a short term (several hours to days) impact on the water column following discharges of solids and solutes from a barge. The greatest proportion of dredged material consists of negatively buoyant solids that sink as a turbid suspension through the water column to the sea floor. Dissolved constituents of dredged material are entrained in the turbulent water associated with the convective descent. For this reason deep sea disposal is not recommended.



Figure 12: Proposed two locations for temporary placement of dredged materials

7.7 NOISE

The dredging operation will inevitably generate some noise. The noise generated by the dredging vessels may cause a level of auditory discomfort, especially at night, which is difficult to evaluate in the absence of any noise measurements for dredging operations. However, given that the closest homes are some 350 m away from the harbour dredging noise is not expected to be a concern. Since the dredging will be conducted during the day time resident population is not expected to experience any inconvenience.

7.8 SUMMARY OF POTENTIAL IMPACTS

The potential impacts of the project are summarized below. Measures can be taken to avoid or reduce the severity of the impact, and the appropriate mitigation measures are identified below in Section 9. Those potential impacts relevant to the proposed project are:

On the positive impacts, RIAM assessment shows that project has a number of positive socio-cultural impacts as well as economic and operational impacts.

7.8.1 Positive Impacts

The positive and negative impacts as indicated in the RIAM analysis are on the following categories;

1. Better income to the region;
2. Improvement to fishery due to improved access and navigational safety and transport at local level;
3. Better employment opportunities in the region;
4. Improved safety due to avoided accidents causing damages to boats and to people;

5. Improved infrastructure;
6. Improved regional economy as a result of the improved facility and reducing loss of productive time; and
7. Reliable and predictable transport arrangements to and from the island.

7.8.2 Negative Impacts

8. Solid waste and hazardous waste generated during the construction phase has the potential to pollute the environment;
9. Short-term sedimentation and turbidity over coral along harbour due to suspension and dispersal of fine sediments;
10. Minor damages to the corals during breakwater construction and maintenance dredging;
11. Impaired visual/seascape impacts from the presence of the dredging equipment; and
12. Increased noise levels in the harbour due to dredging and rock boulder breakwater construction.

8 STAKEHOLDER CONSULTATION

During the EIA process, the Island Council assisted in carrying out community consultations with the members of the community. This was done in order to obtain their feedback on the problems and issues they encounter in the usage of the harbour and find out about their recommendations on specific changes to infrastructure to improve and rehabilitate the facility. The following highlights the issues raised by the Island community with regards to the harbour rehabilitation:

1. The entrance to the harbour is difficult at present, and needs to be made safer. Adjusting the rock boulders appropriately and increasing the height of the breakwater, extending and increasing the height of the breakwater on either side of the entrance channel were suggested to resolve the problems;
2. The basin is of inadequate depth to accommodate the potential and current uses;
3. The height of the quay wall needs to be increased up to the level of the coastline to prevent overtopping of waves and flooding the coastal areas;
4. Add a pavement of 15 feet at the landing from the jetty to prevent silt from falling into the harbour basin;
5. A beacon light is needed to illuminate the harbour passage;
6. Lights are required at the harbour for safe and effective utility of the facility at night; and
7. Constructing revetments at the harbour at both ends of the harbour.

A stakeholder consultations was conducted by the consultants in the form of interview based questionnaire. The following highlights the view of council members towards the rehabilitation and repair of harbour infrastructure in the island.

1. The council members have greater consensus of using the dredged materials from the harbour to areas of the island where it is prone to flood. However, priority will be given on placing the material first to the sides of the harbour.
2. The island advocates for increasing the length of the harbour basin by 100 ft, which in accordance to them would enable easier accessibility of the island vessels.
3. The average size of the marine fleets used in the island is approximately, 75 feet with the increasing number of the vessels in the island the harbour basin became small for the purpose it was used.
4. The general concepts for the repair and maintenance of the harbour works was submitted to the MHI and council entrust that all the works undertaken by the project proponent would take into consideration of the recommendations proposed by the council on this matter.

9 ALTERNATIVES

9.1 NO DEVELOPMENT OPTION

The harbour construction was completed in 1998 and undergone a significant repair a decade ago. Since then no maintenance activities have been carried out. During the initial construction, the breakwater was developed much lower than the required height. As a result since the time of opening of the harbour for services people had been experiencing much difficulties associated with “rough” condition that prevail within the harbour basin during bad weather condition. Consequently damages to the vessels and goods have been recorded on several occasions. Over time, the breakwater has deteriorated due to wave action further worsening the problem. Due to lack of harbour basin maintained, sediments have accumulated within the basin creating shallow areas both within the entrance channel and the harbour basin creating additional navigation issues during the low tide. These problems with continue to persist without the proposed rehabilitation project. There is no alternative to achieving the project objective apart from dredging and extending the harbour capacity.

9.2 DEVELOPMENT OPTIONS

Relocation options for the harbour has not been considered in this study since the proposed activities only involve rehabilitation activities. Strong, durable breakwater constructed to appropriate height is essential for a proper functioning harbour. In addition a proper approach channel with required depth along with the depth of the harbour basin is required.

9.2.1 Construction of the breakwater

Rehabilitation of the breakwater can be carried out using tetrapods or using rock boulders, the cost of these two options are almost the same. Their effectiveness in high energy wave environments have been proven locally. In terms of environmental effects, damage incurred on the reef will be not significant since new breakwater will mostly lie on the footprint of the existing breakwater. Onsite construction of tetrapod will be more time consuming, can increase project duration and would require more kinds of different resources and potentially more waste generation. Hence, rock boulders of appropriate weight is preferred over tetrapod.

9.2.2 Dredging Methods

Bucket excavator is proposed for the planned maintenance dredging. The methodology equipment to be used is determined by the Contractor. Alternative technology would be using cutter suction dredger which may be more suitable in terms of controlling the sediment. However, using cutter suction dredger over bucket dredger would mean additional costs. Funding available to the project does not allow change in dredging technology. On the other hand limited dredging that is required and small working space available for the dredger, cutter suction may cause logistical and operational difficulties. Based on these, a small bucket dredger is chosen over cutter suction for the project.

9.2.3 Material Disposal

The proponent recognises that the dredged material is a valuable resource and wish to utilise it to the coastline on the island. The reclaimed piece of land adjoining the harbour and the original coast line of the island is at a lower elevation and therefore needs levelling to avoid flooding during heavy rain. Having to bring sand from elsewhere would be costly and will require additional procedures to follow. It is therefore intended to use the sediment for this purpose.

Deep sea disposal and stockpiling on land are other possible options. Sea disposal is not desirable due to the undesirable impact this has on the marine environment and the high value of this material.

The disposal of fine dredged materials in shallow inshore waters may be problematic if not carried out properly in that it can lead to the re-suspension of the materials in the water column and the generation of turbidity, both with attendant adverse consequences for marine biota. It also causes the direct smothering of any sedentary biota at the disposal site.

9.3 IMPACT MITIGATION MEASURES

Table 9 below lists the potential impacts identified above in Section 9 and describes the corresponding mitigation measures that should be put in place during implementation of the proposed dredging works at R. Inguraidhoo harbour maintenance dredging and harbour extension. In summary the impact mitigation measures proposed should entail:

- 1) Good dredging practice to minimise sediment suspension and dispersal at the dredging sites.
- 2) Coinciding the dredging activity during calm weather to minimise spread of sediments.
- 3) Deployment of a turbidity barrier across at the work site as appropriate depending on location and currents. The contractor shall be mandated as such during dredging, activities. The type of barriers selected should take into consideration the depth of the area and the prevailing wave and current conditions. The extent of each area ringed should also be carefully determined in order to maximise the effectiveness of the barrier, especially during the proposed dredging activities. Monitoring of the turbidity prior to, during and for a short period after the dredging activities. Prior to these activities, measurements should be taken at the proposed monitoring locations whilst turbidity is affected by vessel movements. These measurements will be used to establish the background or baseline turbidity values at these locations. During and after these activities the turbidity levels are to be monitored. Should turbidity readings during or after dredging exceed the prescribed limits, then remedial actions such as redeployment of the turbidity control devices, should be taken. Should this reading exceed the prescribed limits in the vicinity of a significant resource (i.e. a coral head), then operations should be temporarily halted.
- 4) Independent environmental monitoring of the project to ensure use of turbidity barriers, disposal of dredged material only at approved sites, and turbidity level do not exceed the recommended levels.
- 5) Blasting shall be avoided.
- 6) During the project activities and operational phases, all efforts should be made to prevent the intentional or accidental spill of oil, waste oil and hazardous materials release into the environment which could lead to further damage to the marine environment.
- 7) Construction of the breakwaters at the harbour shall be at an angle to provide a stable slope where marine growth can establish itself.
- 8) Contractor should take steps to ensure that there is no waste littering, careless disposal of waste or dumping of oily waste from dredging vehicles or land-based activities related to the project. Careful consideration should be given to the requirements for storage and appropriate disposal of all waste generated from the project in such a manner the project does not burden existing waste management practices.
- 9) Construction of breakwater structures to protect the harbour from wave attack shall be constructed as a new hard substrate for coral growth.

9.3.1 Mitigation Cost Elements

The mitigation measures associated with significant costs, beyond those of dredge equipment rental and deployment, and good dredging practice, are identified below in Table 9 along with the major cost elements.

Table 9: The mitigation measures associated with significant costs

Activity	Potential Impacts	Phase of the project	Impact magnitude	Nature of Impact	Impact Mitigation Measures
1. Excavation	Disturbance to benthic environment Disturbance to marine organism Accidental spills from dredger	Construction phase	Not significant	Reversible	<p>Planning to conduct dredging during the calm weather.</p> <p>Deploying double layer silt curtain system around dredging work areas where necessary.</p> <p>Good dredging practices by engaging skilled operators to ensure minimising sediment resuspension and dispersal at the dredging locations.</p> <p>Seawater quality monitoring program as given in the Monitoring Section shall be fully implemented in order to maintain the TDS level close to the background level.</p> <p>In order to control the sediment escape to into the reef, the breakwater shall be rehabilitated prior to any dredging begins.</p> <p>Proper protocols developed to attend in case of emergency spills.</p>
	Modification of current and wave behaviour	Mostly operational phase	Not significant		<p>At the entrance channel this would be a positive impact since the wave activities and current patterns makes it extremely difficult for the boats to pass through during rough weather.</p> <p>Wave heights will slightly increase within the harbour basin due to dredging but is expected to be of no concern.</p>

1.2 Sediment disturbance	Settlement of suspended solids on corals and benthic organisms			Reversible	Do not allow overfilling of dredger bucket to control spillage. Deploy turbidity barriers to prevent sedimentation on corals
	Attenuation of light in water column				Apply above measures to control sediment dispersion
	Potentially unstable edges to dredged channel				Dredge sides of channel at an angle to be determined by geotechnical engineer that will prove stable.
	Increased ambient noise level				Movement of vehicles and handling of rock boulders during construction phase will generate noise. Given the adequate separation of the work areas from the resident population noise may not be concern to most people. However, work shall be planned to stop after 11 pm in order to avoid complaints from sensitive population.
2. Dredged material disposal					Material shall only be disposed at designated site as given in the EIA report.

<p>2.1 Leakage of sediments during transport to disposal site</p>	<p>Increased turbidity over lagoon</p>				<p>Not overloading the trucks with sediments. Employing good practices and good workmanship in transporting sediments.</p>
	<p>waste</p>	<p>Construction and operation phase</p>	<p>Construction and operational phase of the harbour would generate waste. The major waste types that would be generated by construction activities would include materials from excavation works, reclamation works, seawall construction, revetment works as well as from marine sediments dredged, and marine sediments excavated from the foundation / piling / and buildings; small quantity of chemical waste from the maintenance and servicing of construction equipment; general refuse from the workforce; and floating refuse trapped / accumulated on the</p>	<p>Reversible</p>	<p>The approach for development of the project is to avoid or to reduce the volume of waste generated and to re-use where possible and disposed of according to the legislative requirements. No waste generated from the project will add to the waste stream of the island. Project waste management protocol shall be developed in line with the Regulations and will be strictly followed and monitored. Arrangements will be made for handling, temporary storage and final disposal. Waste transfer vessels shall be available for the timely removal of waste from the site.</p> <p>No large scale recyclable waste materials (e.g. metal) are expected from the project. Priority will be given for segregation of such waste from the non-inert construction waste for stockpiling at a designated site which has the potential for selling to vendors re-exporting such materials. The remaining non-recyclable waste materials will be disposed of at Thilafushi.</p> <p>Similarly waste generated from the workforce shall be managed giving priority to waste separation to maximise the diversion of construction waste from being sent to Thilafushi. Non-recyclable waste will be disposed of at Thilafushi landfill sites.</p> <p>It is expected that small quantity of chemical waste will be generated during</p>

			<p>newly constructed seawall.</p> <p>During the operational phase anchored vessels and people using the harbour will generate waste.</p> <p>Floating waste may get accumulated in the harbour and may create an eyesore.</p>		<p>construction, which would be properly handled, stored, labelled and disposed of in accordance with the Waste Disposal Regulations at Thilafushi.</p> <p>Provided that all the identified waste materials are handled, transported and reused / disposed of in strict accordance with the relevant legislative and recommended requirements, and that the recommended good site practices and mitigation measures are properly implemented, no unacceptable environmental impacts are expected during the construction and operational phase.</p> <p>Floating wastes that may accumulate in the harbour will be regularly collected and managed by the Island Council during the operational phase.</p>
	<p>Service disruptions to harbour</p> <p>Potential accidents</p>	Construction phase	Not significant	Reversible	<p>Vessel owners and harbour users will have to be informed of the harbour re-habilitation schedule. The project activities will have to be carried out in a manner that does not result in total closure of the harbour.</p> <p>Dredging equipments positioned to minimize disruptions to harbour users</p> <p>Safety measures during the construction phase will have to place on a sign board near the harbour to avoid potential accidents.</p> <p>Workers shall be provided with safety gears.</p>

Through the implementation of the proposed mitigation measures, the potential residual impacts due to the construction and operation of the project would be reduced to levels that are not predicted to cause significant population-level impacts on the population. Similarly, the potential construction and operation phase impacts on marine fauna would also be mitigated to acceptable levels.

10 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include water quality (turbidity, TDS and BOD), sediment deposition on corals.

The environmental monitoring plan (EMP) is presented here in outline form. It should be detailed and completed when the final dredging action plan has been determined. The purpose of the EMP is to monitor or control the environmental effects of the dredging process. It should be based on compliance, verification, feedback, and know-how. It is therefore suggested that the environmental consultants are recruited for proper implementation of the EMP during the construction and operational phase. In the case of the proposed dredging works, environmental monitoring is particularly necessary to ensure that suspended sediments generated during excavation and during disposal of the dredged materials, do not adversely affect the health of the coral reef ecosystem.

Since the bulk of the project works is related to the dredging of marine sediments and creation of land in the open water in a sensitive environment, environmental monitoring is particularly necessary to ensure that these activities do not adversely affect the health of the coastal ecosystems in vicinity of the project environment. In addition to undertaking the EMP outlined in the report, good project planning, preparations, are important to avoid delays during the construction phase. Unnecessary delays in project implementation has the potential to create serious negative perception of the project causing not only environmental damages but also financial losses. The following measures shall be ensured prior to the onset of the construction phase;

1. Use of appropriate dredging equipment for the dredging;
2. Clear demarcation of the dredging to ensure dredging does not go beyond what is required;
3. Adequate materials supplied to the site so as to avoid delays;
4. Ensuring skilled labour availability for the operation of the dredger and operating other machineries; and
5. Good workmanship applied in all project related activities.

The turbidity compliance standards are set out above. The standards set take into account normal prevailing water quality conditions and the duration of the dredging works. The results of the turbidity measurements, which should be taken independently, should immediately be recorded formally and made available to the dredging supervisor so that any corrections and adjustments to dredging operations can be made quickly. The environmental monitor must have the authority to halt dredging and/or sediment disposal operations should this become necessary to protect the reef ecosystems at risk.

Table 10 below shows the details of the proposed monitoring aspects including the monitoring parameters, indicators, baseline, proposed methods, frequency and estimated costs

Table 10: Monitoring of the reef environment

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
<p>Benthic cover by major life forms (live, dead, rock rubble and sand).</p> <p>Method shall include, visual inspection of the selected sites, photography and line intercept transect to assess the life-form cover.</p>	<p>Baseline to be established in the pre-construction phase (just before construction begins), monitoring shall be conducted at least once during construction, post construction on the southern house reef of Inguraidhoo. Operational phase monitoring shall be conducted one year after the operation begins.</p>	<p>Indicative of the changes in the live coral cover</p>	<p>2000/trip</p>
<p>Fish population / visual census</p>	<p>During the reef monitoring program, fish census shall be undertaken</p>	<p>To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc.)</p>	

Table 11: Monitoring of the sea water quality

Type	Parameters	Locations	Frequency	Estimated cost (USD)
<p><i>In situ</i> monitoring / sampling and testing from a laboratory</p>	<p>Dissolved oxygen Turbidity (NTU) COD TDS</p>	<p>All locations marked.</p> <p>The turbidity compliance standards are proposed in the report. The proposed standards take into account normal prevailing water quality conditions and the duration of the dredging works. The results of the turbidity measurements, which should be taken independently, should immediately be recorded formally and made available to the dredging supervisor so that any corrections and adjustments to dredging operations can be made quickly. The environmental monitor</p>	<p>Turbidity to be monitored daily during the dredging period and once six months for a year after dredging is completed.</p>	<p>200/ set of tests + other expenses.</p>

		must have the authority to halt dredging and/or sediment disposal operations should this become necessary to protect the reef ecosystems at risk.		
waste management	<p>Waste generated All waste generated shall be documented and logs maintained. Any waste sent to Thilafushi will have to be accounted for through proper audits.</p> <p>Project site shall be kept clean at all times with waste bins placed at locations easily accessible to workers.</p>	Construction site	Logs updated daily	
Equipment and vehicle maintenance	Equipments and vehicles shall be regularly maintained to avoid unnecessary breakdown to avoid delays and accidental leaks.		Frequency determined by the engineers	

10.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the proponent. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment letter confirming compliance on mitigation measures is given in Annex 5.

11 CONCLUSIONS

This EIA has been carried out on the basis that it is necessary to carry out maintenance dredging of the harbour since no such activity has been carried out since it began services in 2007. In addition due to its initial poor design features, the harbour to date has failed to provide the much anticipated safe and easy access to the island in a predictable manner.

The main conclusions arising from the EIA study are:

- a) The existing turning basin and its approach channel at Inguraidhoo have become in effective and have failed to provide safe manoeuvring and passage for the vessels.
- b) Breakwater of the harbour has not been effective against waves attack and therefore needs immediate rehabilitation;
- c) The jetty height is not adequate enough to prevent overtopping of waves into the coastal areas causing flooding during rough weather;
- d) The rehabilitation of the existing harbour will greatly ease hard condition prevailing in getting easy access to the island without which the socio-economic development of the Island will be greatly constrained
- e) The proposed interventions for harbour rehabilitation is not accepted to generate significant negative impacts on the environment.
- f) With appropriate mitigation measures the minor negative impacts will be prevented, avoided and minimised.

Considering the importance of the Island's harbour for the socio-economic development of the Island proposed project is clearly justifiable. The EIA has been undertaken to assess the proposed project, evaluate various alternatives, and to determine potential impacts and respective mitigation measures. The EIA was carried out in a participatory manner where views collected from stakeholders have been incorporated in to the EIA where appropriate. The potential impacts have been assessed in a comprehensive manner under this EIA with effective and practicable mitigation measures recommended to minimise the potential impacts. The EIA study has identified and assessed the potential environmental impacts that may arise from the construction and operation of the project in accordance with the EIA ToR. A summary of the outcome of the technical assessments is shown in Table 12.

Table 12: Summary of impacts mitigation expected effectiveness

Environmental aspects	Construction phase		Operation phase	
	Without mitigation	With mitigation	Without mitigation	With mitigation
Air quality	some impacts	acceptable	N/A	
Noise	some impacts	acceptable	N/A	N/A
Marine water quality	some impacts	acceptable	acceptable	N/A
Waste	some impacts	acceptable	some impacts	acceptable
Coral reef ecology	some impacts	acceptable	N/A	N/A

Based on the results of the assessments, the EIA study concludes that the project would be environmentally acceptable and in compliance with the relevant environmental legislation, regulations and relevant international conventions. With implementation of the recommended environmental mitigation measures, no unacceptable adverse residual impacts from the project are anticipated. A proper monitoring programme will be implemented to check the implementation of mitigation measures and environmental compliance and to take necessary precautionary measures in the event of an unforeseen environmental impact.

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13 ANNEXURES

- Annex 1: Terms of Reference (ToR) for the Project
- Annex 2: Approved Site Plan
- Annex 3: Dredging Permit from EPA
- Annex 4: Commitment Letter from the Proponent
- Annex 5: Letter from R. Atoll Inguraidhoo Council
- Annex 6: List of people Consulted
- Annex 7: Water Quality Test Report

ANNEX 1: APPROVED TERMS OF REFERENCE (TOR) FOR THE PROJECT



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Environmental Protection Agency



ނަންބަރު: 203-ADMIN/138/2015/90

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Environmental Protection Agency

EPA/ToR/2015/61

Terms of Reference for Environmental Impact Assessment of Maintenance Dredging and Harbour Repair at Inguraidhoo, Raa Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 05 May 2015 for undertaking the EIA of the proposed at R. Inguraidhoo

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 and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is link other activities that are carried out or that is being carried out within the project boundary. Identify the donors and the institutions arrangements relevant to this project. .
2. **Study area** – Submit a minimum A3 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** – Identify and number tasks of the project including preparation, construction and decommissioning phases.
 - **Task 1. Description of the proposed project** – Provide a full description and justification of the relevant parts of the dredging works, using maps at appropriate scales where necessary. Information on the following activities should be provided where appropriate: Dredging of material from burrow area and depositing at appropriate site(s);
 - Clearing dredged material from temporary site(s);
 - Harbour construction and surrounding infrastructure which may include land reclamation works;
 - Measures to protect environmental values during construction
 - 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)

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Details of the Harbour/channel

- Location of the harbour/channel on an A3 scaled map
- Design parameters of the harbour /channel (size, depth, profile of channel)
- Justification for the location of harbour/channel

Dredging/Excavation:

- Location and size of burrow areas (s) on a scaled map;
- Justification for the selection of the location, depth and size of burrow 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 (eg: details of the use of sand beds or use of barge mounted excavation)
- 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, and
- Dredge material disposal Design of the disposal/reclamation area(s), including justification(s) (from a socio-economic and environmental point of view) for the choice of design criteria;
- Quantity, quality and characteristics of dredged material;
- Indication for sufficient availability of fill material;
- Method and equipment for transport(including distance) of fill material and hydraulic filling;
- Justification and location of temporary stockpile (s) if required;
- Location and design of the containment measures;
- Location (s) and methods of discharging water from the reclamation area where applicable;
- Description of safety measures during the construction phase and Justification and design of drainage measures if required

The EIA should investigate possibilities for alternative:

- Alternative disposal sites
- Alternative containment measures;

Coastal structures

- Locations and designs of the seawall and quay wall
- Locations and designs of additional coastal protection measures (if required)
- Method and equipment used for construction of coastal structures

Task 2. Description of the environment – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the study (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.



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ގްރީން ބިލްޑިންގ، 3^{ވަނަ} ފެލޯ، ހަންދުވަރީ ހިންގުނު
މާލެ، ރިޕަބްލިކް އޮފް މާލްދިވެހިރާއްޖެ، 20392
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The baseline data will be collected before construction and from at least two benchmarks. All sampling/survey locations shall be geo referenced including but not limited to water sampling points, reef transects/photo quadrats, vegetation transects, soil profiles, and manta tows sites for monitoring data comparison. Information may be divided into the categories shown below:

Climate

- Temperature, rainfall, wind, waves,
- Natural Hazard Risks including storm surges;

Geology and geomorphology

- Island geomorphology including presence of beach rocks and any special characteristics (use maps);
- Bathymetry of the required sites (use maps);
- (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction;

Hydrography/hydrodynamics (use maps)

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity, sedimentation rate, phosphate, nitrate, ammonia, sulphate, BOD and COD.

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.
- Benthic and fish community monitoring around the island (see appendix for monitoring guidelines);
- Landscape integrity, and
- Include ground water monitoring (See appendix for parameter healthy ranges);

Socio-economic environment

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

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge.

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

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

- Approval from the Housing and Environment Ministry;
- Approval from the Transport Ministry;
- Tourism Ministry, if tourism ventures.

Task 4. Potential impacts (environmental and socio-cultural) 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;
- Loss of marine bottom habitat, both in the borrow area as well as due to enlargement of the islands, resulting in loss of bottom life, which may impact fish stocks and species diversity and density of crabs, shellfish etc.;
- Sediment dispersal in water column (turbidity at the dredging site (overflow), the reclamation areas 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.;
- Impacts of noise, vibration and disturbance;
- Impacts on ground water table and quality (leaching of salts in the deposited sediments and change in ground water quantity);
- Impacts on unique or threatened habitats or species (coral reefs, sea turtles etc.), and
- Impacts on landscape integrity/scenery.

Impacts on the socio-economic environment

- Benefits and impacts of the works in fishing activities;
- Impacts of the dredging and reclamation works on resource users (adjacent businesses, nearby resorts and dive sites);
- Impacts on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the works;
- Impacts of the reclamation works (diminished) access to groundwater and risks of covering up hazardous materials, and
- Level of protection against hazards like sea level rise, storm surges, etc.
- Employment and economic opportunities and diversification;
- Increased demands on natural resources and services (domestic water supply, waste water disposal, treatment systems, solid waste disposal systems, energy supply, etc);
- Social destabilization of the island community, and
- Monitoring of socioeconomic and demographic development.

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Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers and local population, and
- Impacts on social values, norms and belief due to presence of workers of dredging company on local population.

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Alternatives to proposed project – Describe alternatives including the “no action option” should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the “no action alternative”. This should include alternative location, technologies, materials, designs, timing, etc. environmental, social and economic factors should be taken into consideration. The report should highlight how the location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. temporal sediment control structures, coastal protection structures to reduce erosion, coral reconstruction, temporary docking jetty and MPA replacement areas. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan– Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island. 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. Monitoring is required in:

- Coastal erosion around the island;

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- Water quality assessments (ground water and surrounding seawater quality);
- Marine ecosystems monitoring (coral reef, seagrass and fish and invertebrates communities), and
- Socio-economic monitoring for project success or improvement requirements.

Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government authorities such as Ministry of Housing and Infrastructures, Island Council, NGOs, engineers/designers, development managers, staff and members of the general public. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes.

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 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

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.



 14 May 2015

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**ANNEX 3:
DREDGING PERMIT FROM EPA**

1940/2014/10655





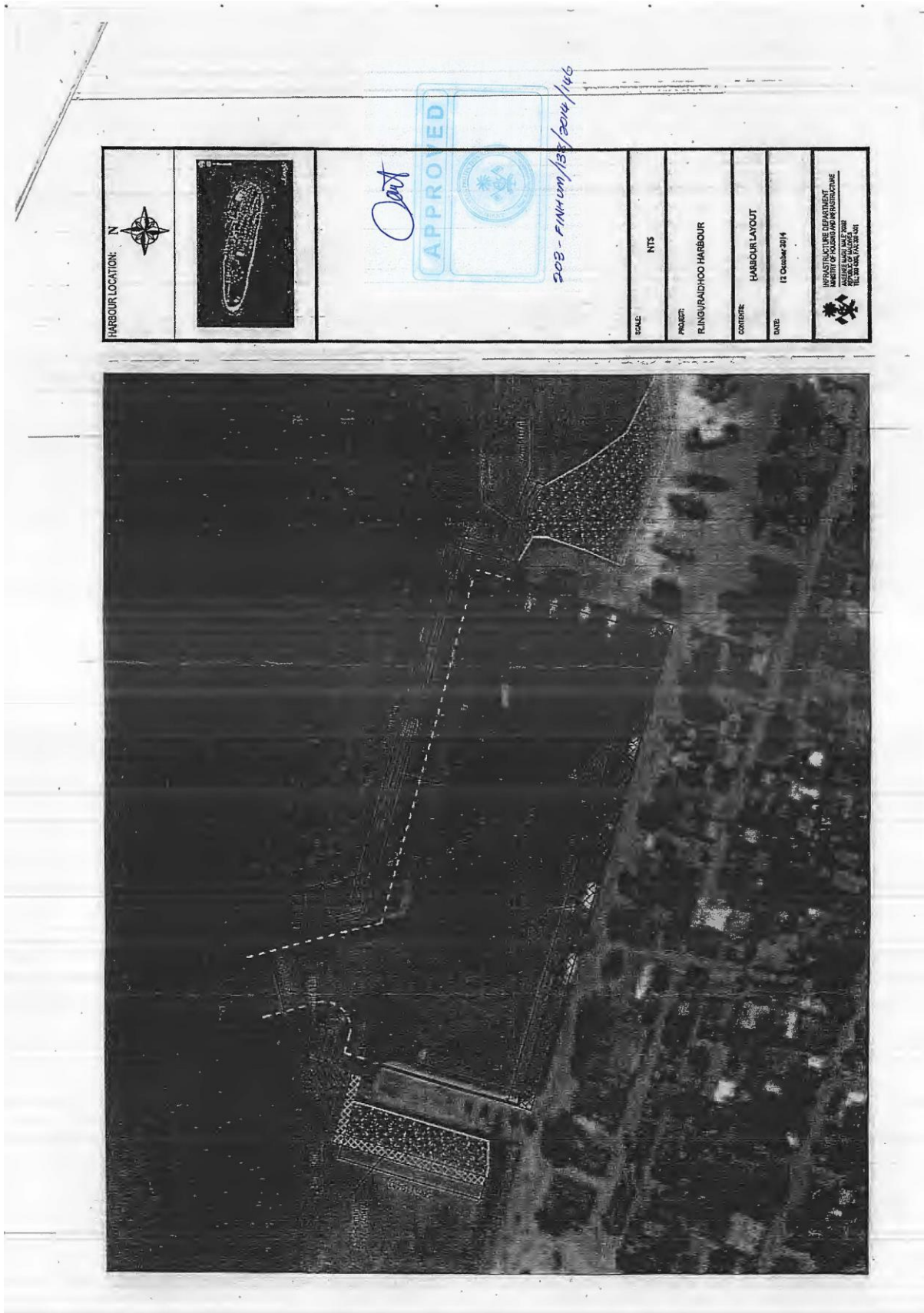
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 Ministry of Housing and Infrastructure
 Name: *Ujashu* Sign: *[Signature]*
 Date: 5/11 Time: 12:38
 Entry number: 1940/2014/10655
 Remarks: ES

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Ministry of Housing and Infrastructure
Male', Republic of Maldives.

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Date: 16th September 2015

No: 138-PIS2/203/2015/215

Environmental Protection Agency
Ministry of Environment and Energy,
Ameene Magu, Maafannu, Male', 20392,
Maldives.

Sub: EIA to the Proposed Construction of Harbour in R.Inguraidhoo0:

As the proponent of the project, we guarantee that we have read the report and to the best of our knowledge all non-technical information provided here are accurate and complete. Also we confirm our commitment to finance and implement all construction mitigation and the monitoring program as specified in the report.

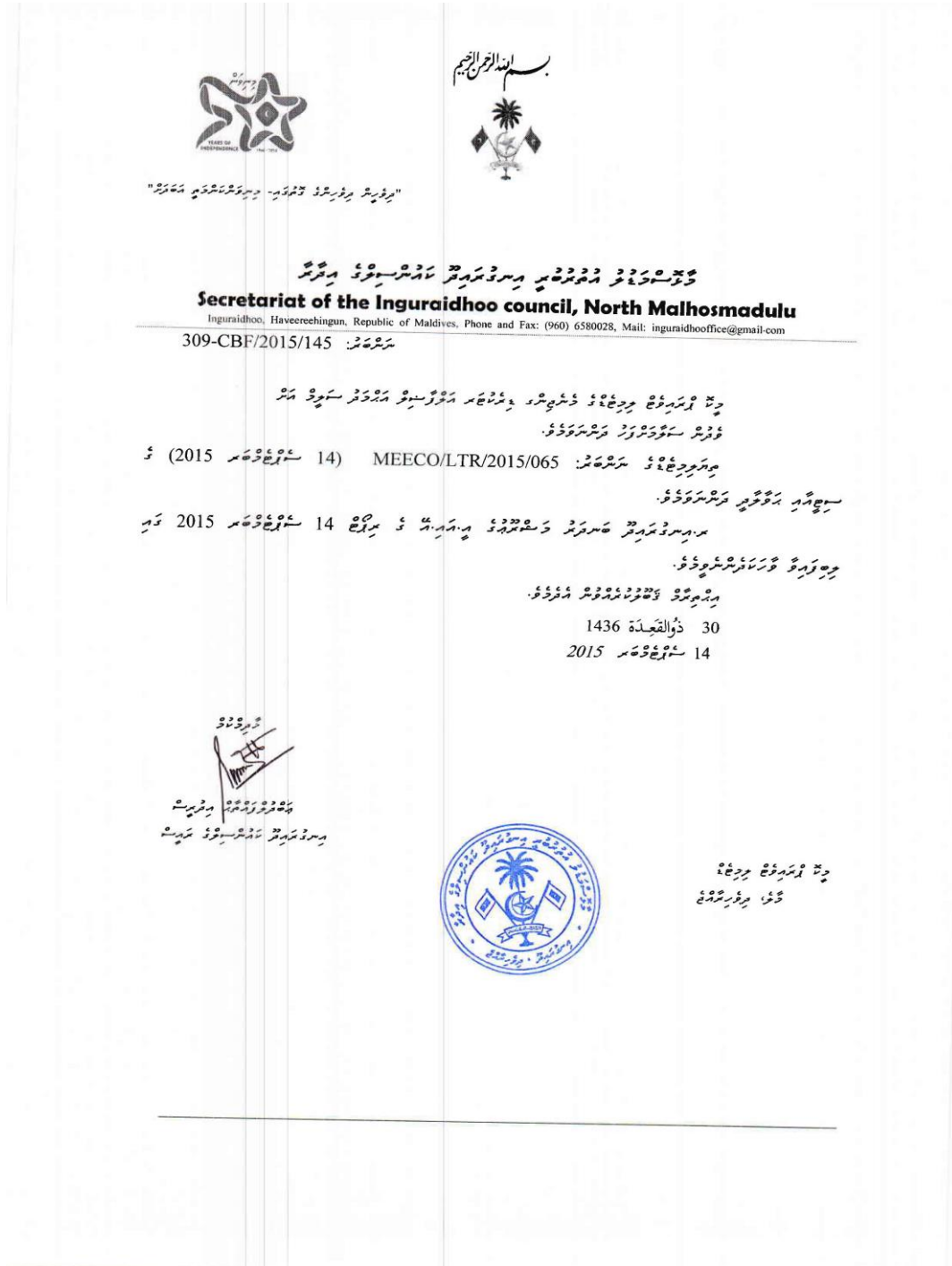
Signature:




Name: Fathimath Shana Farooq

Designation: Director General

ANNEX 5: LETTER FROM R. ATOLL INGURAIIDHOO COUNCIL



**ANNEX 6:
LIST OF PEOPLE CONSULTED**

Abdulla Abdul Rahmaan	Vice President of the council	9874264
Abdulla Hussain	Council Member	7981214
Ibadhulla Mohamed	Council Member	9888776
Mohamed Yasir	Council Member	7960678

ANNEX 7: WATER QUALITY TEST REPORT



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

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Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

WATER QUALITY TEST REPORT Test Report No: 301032/2015/10

Customer Informations :

Meeco,
G. Aakakaage-1, 2nd Floor,
Aikilege/aaanu Magu,
Male'
Rep. of Maldives



Date: 15/06/2015

Sample Description / Location*	R. Inguraidhoo			TEST METHOD	UNIT
	Harbour Basin	Beaching Channel	Outside Harbour Basin		
Sample Type**	Sea water				
Sampled Date**	31/5/2015				
Sample Received Date	8/6/2015				
Test Requisition Form No.	900159963				
Sample No.	816614				
Date of Analysis	8/6/2015 -14/6/2015				
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Clear			Visual	
Nitrate	2.3	1.8	2.5	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
pH	7.93	8.30	8.24	Method 4500-H ⁺ B. (adapted from Standard methods for the examination of water and waste water, 21 st edition)	
Nitrite	<0.002 (LoQ 0.002mg/L)	0.013	0.014	Method 8507 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	2900	2800	2800	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Salinity	31.53	32.60	32.79	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	%
Phosphate	0.12	<0.05 (LoQ 0.05mg/L)	<0.05 (LoQ 0.05mg/L)	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Temperature	20.8	21.0	21.0	Electrometry	°C
Biological Oxygen Demand (BOD)	1	1	1	HACH Method 8043	mg/L
Total Dissolved Solids (TDS)	24200	24900	25100	Conductivity Method	mg/L
Turbidity	0.190	0.172	<0.1 (LoQ 0.1NTU)	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU

KEYS:

UNITS: mg/L: Milligrams per litre, NTU: Nephelometric Turbidity Unit, %: Parts per thousand, °C: Degree Celsius

LoQ: Limit of Quantification

<p>Checked by:</p>  Afnan Farooq Water Quality Assurance Officer	<p>Approved by:</p>  Mohamed Eyma Senior Quality Control Officer
--	--

Notes:

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

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

