ADB

Technical Assistance Consultant's Report

Project Number: 36111
April 2016

Maldives: Kulhudhuffishi Harbor Expansion Project
(Financed by the Technical Assistance Special Fund)
Main Report

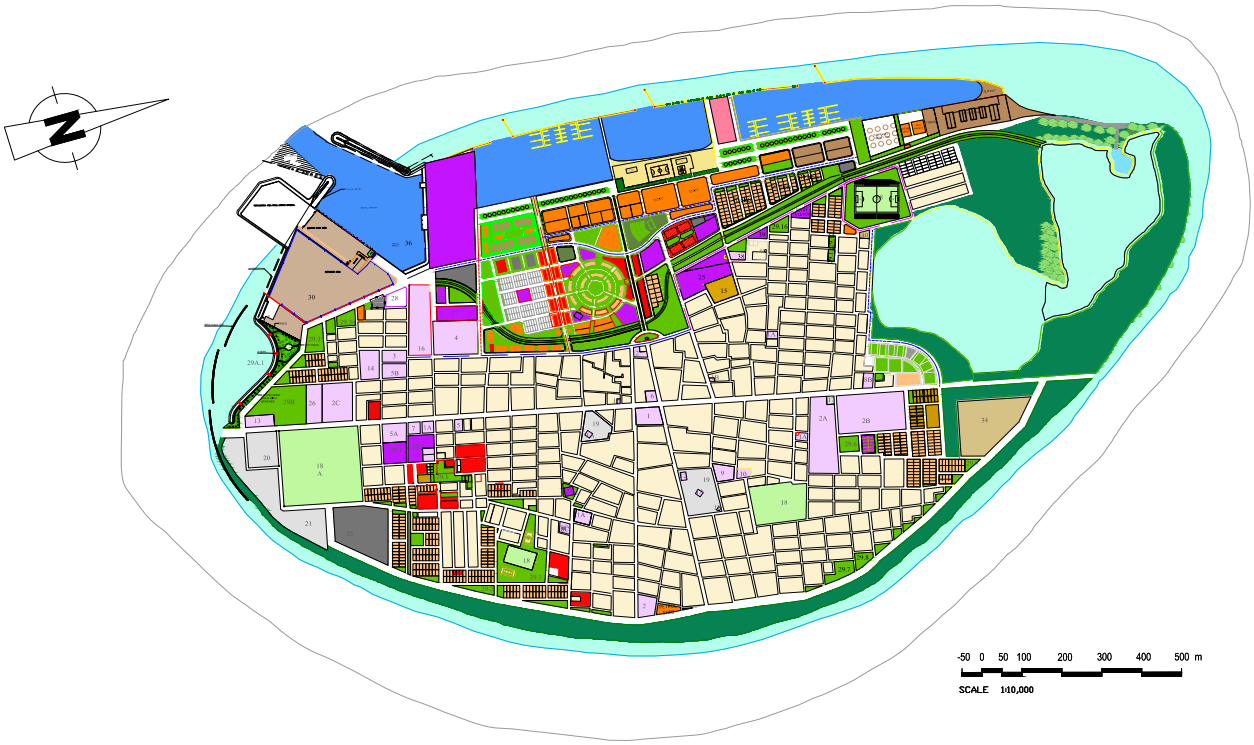
Prepared by PADECO Co., Ltd., Japan in association with Ryan Private Limited, Maldives

For Ministry of Finance and Treasury
Ministry of Housing and Infrastructure

Asian Development Bank

Technical Assistance Consultant's Report

TA-8829 MLD: Kulhudhuffushi Harbor Expansion Project



Final Report

PADECO CO., LTD.

In association with

RIYAN PRIVATE LIMITED
REG: C-235/2006

01 April 2016

ABBREVIATIONS AND ACRONYMS

AC	Average Cost
ADB	Asian Development Bank
AG	Auditor General
AGO	Auditor General's Office
AP	Accounts Payable
ARI	Annual Recurrence Interval
ASB	Annual Safety Benefit
ATM	Automated Teller Machine
CBA	Cost Benefit Analysis
CD	Chart Datum
CDTA	Capacity Development Technical Assistance
CIF	Cost-Insurance-Freight
CoA	Chart of Accounts
CPAM	Certified Practicing Accountants of Maldives
DFR	Draft Final Report
DHL	Delft Hydraulics Laboratory
DWT	Dead Weight Tonnage
EA	Executing Agency
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPA	Environmental Protection Agency (of the Maldives)
FAD	Fish Aggregating Devices
FAR	Fixed Asset Register
FIRR	Financial Internal Rate of Return
FMA	Financial Management Assessment
FNPV	Financial Net Present Value
FR	Final Report
FY	Financial Year

GDP	Gross Domestic Product
GL	General Ledger
GMDSS	Global Maritime Distress and Safety System
GoM	Government of the Maldives
GPS	Global Positioning System
GRM	Grievance Redress Mechanisms
GRT	Gross Registered Tonnes
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HWOST	Highest Water level of Spring Tides
IA	Implementing Agency
IALA	International Association of Lighthouse Authorities
ICZM	Integrated Coastal Zone Management
IFRS	International Financial Reporting Standards
ILO	International Labor Organization
IMDG	International Maritime Dangerous Goods (Code)
IMO	International Maritime Organization
IPCC	International Panel for Climate Change
IR	Inception Report
IsDB	Islamic Development Bank
ISPS	International Ship and Port Security (Code)
JICA	Japan International Cooperation Agency
KC	Kulhudhuffushi Council
KII	Key Informant Interviews
KPL	Kulhudhuffushi Port Limited
LAT	Lowest Astronomical Tide
LHI	Lanka Hydraulics Institute
LPI	Logistics Performance Index
LSCI	Liner Shipping Connectivity Index
LUP	Land Use Plan

LWOST	Lowest water level of spring tides
MARPOL	Maritime Pollution (International Convention for the Prevention of Pollution from Ships)
M&E	Monitoring & Evaluation
MHI	Ministry of Housing and Infrastructure
MLLW	Mean Lower Low Water
MM	Materials Management
MMA	Maldives Monetary Authority
MoED	Ministry of Economic Development
MoFT	Ministry of Finance and Treasury
MOU	Memorandum of Understanding
MPL	Maldives Ports Limited
MRC	Marine Research Center
MRF	Maldivian Rufiyaa
MSL	Mean Sea Level
MSMEs	Micro, Small, and Medium-Sized Enterprises
MTC	Ministry of Transport and Communication
MTMP	Maritime Transport Master Plan (of the Maldives)
NDP	National Development Plan
NE	North East
NPV	Net Present Value
NT	Net Tonnage
PA	Port Authority (ies)
PDR	Preliminary Design Report
PIU	Project Implementation Unit
PO	Purchase Orders
PPP	Public Private Partnership(s)
PPTA	Project Preparatory Technical Assistance
PS	Permanent Secretary
PSA	Poverty and Social Assessment

PSIP	Public Sector Investment Program
PV	Payment Voucher
ROPAX	Roll on Roll off and Passenger
RORO	Roll on / Roll off
RTK	Real Time Kinematic
SAP	Systems and Applications in Data Processing
SAR	Search and Rescue
SCF	Standard Conversion Factor
SDDR	Social Due Diligence Report
SDR	Social Discount Rates
SEA	Strategic Environmental Assessment
SoE	Statements of Expenditure
SOE	State Owned Enterprises
SOLAS	Safety of Life at Sea (International convention on the safety of life at sea)
STCW	Standards for Training Certification and Watch keeping
STO	State Trading Organization
SW	South West
SWL	Still Water Level
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TA	Technical Assistance
TEU	Twenty-Foot Equivalent Unit
TOR	Terms of Reference
TPAD	Treasury and Public Accounts Department
TSA	Treasury Single Account
TSA	Treasury Single Account
UKC	Under-Keel Clearance
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
USD	US Dollars
WACC	Weighted Average Cost of Capital

MATHEMATICAL AND TECHNICAL ABBREVIATIONS

H_{sig}	Significant Wave Height – Average of the Highest One Third
$kN/_{m^3}$	Weight Density
$m^2;\ sqm$	Square Meter
m^3	Cubic Meter
$\emptyset$	Soil Angle of Internal Friction
Δrc	Reduction in Accident Risk
$\sim$	Approximately
d	Day
h	Hour
Hrs	Hours
ha	Hectares
hp	Horsepower
kg	Kilogram
L	Liter
C	Degree Celsius
m	Meter
mm	Millimeter
mo	Month
N	Annual Number of Passengers (Dis)Embarking
s	Seconds
t	tonne(s)
T, t	Time (Also Wave Period, Where Applicable)
y	Year
Υ	Soil Density
%	Percentage

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1. INTRODUCTION

1.1. Country and Sector Overview

1. The Maldives is a country of South Asia situated in the Indian Ocean South-Southwest of India, comprising 1,192 coral islands grouped in a double chain of 26 atolls along a north-south axis. With a total land area of approximately 298 square kilometers contained within a region of approximately 90,000 square kilometers (m^2) between latitudes 1°S and 8°N and longitudes 72° and 74°E, the Maldives is one of the most dispersed countries in the world.

2. The atolls consist of live coral reefs and sand bars, situated on a submarine ridge approximately 960 km in length, rising steeply from the floor of the Indian Ocean. The Maldives is the lowest country in the world, with a maximum natural ground level of 2.4 m and an average ground level of 1.5 m above Mean Sea Level (MSL). In this order, 80% of the land area is less than 1 m above MSL.

3. The Maldives is divided into seven regions over the length of the country. The 2014 national census puts the population of the Maldives at 341,256 inhabitants, making it the smallest country in Asia in terms of both area and population. The population figures, taken from the Population and Housing Census (2014) are given in Table 1 along with those of 2006. The table also gives the inter-census growth rates, highlighting the fact that Malé is growing at almost twice the rate of the other atolls.

Table 1: Population Figures – 2006 and 2014 Census Data

Region	Maldivian Population		Additional Foreigners (2014)	Total (2014)	Inter-Census Growth Rate (%pa)
	2006	2014			
Maldives	298968	341256	51078	392334	1.56
Malé	103693	133019	20360	153379	2.93
All Islands excluding Malé	195275	208237	33804	242041	0.76
Haa Alifu	13495	13175	1289	14464	-0.28
Haa Dhaal	16237	18300	1014	19314	1.41
Shaviyani	11940	12310	819	13129	0.36
Kulhudhuffushi	6998	8011	213	8224	1.68

4. The resulting unique geographical and demographic characteristics poses major development challenges for the Maldives including in areas such as transport connectivity and infrastructure development as well as the provision of basic social services and access to equitable economic opportunity.

5. Over a third of the Maldives' population resides in and around the capital Malé (including Villingili and Hulhumalé); thus making the country's capital one of the most densely populated cities in the world. In stark contrast to Malé, there is a widely sparse dispersion of the population in other islands of the Maldives. Of the 1,190 islands of the country, only three islands have a population in excess of 5,000 inhabitants, and a third of the country's islands have each a population of less than 500 inhabitants.

6. Another challenge for the Maldives is the number of people leaving the islands to seek work in Malé. This has put great pressure on Malé, evident in the traffic situation and the extent of high rise construction taking place. This trend is also seen in Table 1 where the population's growth rate in Malé is almost four times that in the atolls.

7. To relieve pressure on Malé, it has been seen as necessary to increase employment opportunities in the islands. Increasing transport connectivity will be a significant factor in doing so. At policy level, the Government of the Maldives' (GoM) development planning strategy includes allowance for increasing regional prosperity, including:

   i. Goal 3 of the 7th National Development Plan (NDP) is to 'Invest in strategic and state of the art infrastructure, to enable ease of movement, enhanced access to services, and build competitive advantage'.

   ii. The same plan notes that regional development goals are to 'increase the range of economic and employment opportunities in the atolls; make the atolls more prosperous, livable and sustainable; and make the population living in the atolls healthier, more educated and more resilient'.

   iii. The transport strategy 2.4 at 'establishing ports and logistics clusters to facilitate the movement of goods, including food and consumer products to all the inhabited islands, and strategically locating regional ports and storage facilities for easy access and prompt distribution".

8. Furthermore, the need for development outside Malé was earlier recognized with the establishment of regional development centers in Hithadhoo in the south and Kulhudhuffushi in the north, complete with regional offices and ports capable of berthing medium-size overseas vessels.

1.2. Kulhudhuffushi Island Overview

9. With the geographical coordinates of 6° 37' 0" North and 73° 3' 0" East, Kulhudhuffushi is located 275 km north of Malé and has an area of approximately 235 hectares (ha) following a recent reclamation of about 35 ha of land from the

lagoon on the western edge of the island. Kulhudhuffushi is the capital of Haa Dhaalu atoll, with the islands of Nolhivaramu and Kumundu as its nearest inhabited neighbors.

10. Kulhudhuffushi is a major population center in the north of the Maldives and is currently being developed as an urban center under the GOM's development plans. Kulhudhuffushi is home to major state institutions, both civil service and public enterprises, the regional hospital, and the northern regional secondary school, and a future airport.

11. The 50 bed hospital, which is earmarked for expansion, provides general medical services, specialist care, surgery (minor), emergency services, dental services, and services of the intensive care. Existing education facilities in the form of a preschool, two primary schools, one secondary and higher secondary school, and a vocational training center; are all designed to cater for students from Kulhudhuffushi and nearby islands. There is also a small a branch campus of the national university. A project to build a new air strip and airport facilities in Kulhudhuffushi has been recently approved, and will replace the existing airport in neighboring Hanimaadhoo island.

Figure 1: Location Map of Northern Region

A- Map of Maldives B- Northern Region C. Kulhudhuffushi
(adapted from Detailed Island Risk and Vulnerability Assessment for Kulhudhuffushi, 2013)

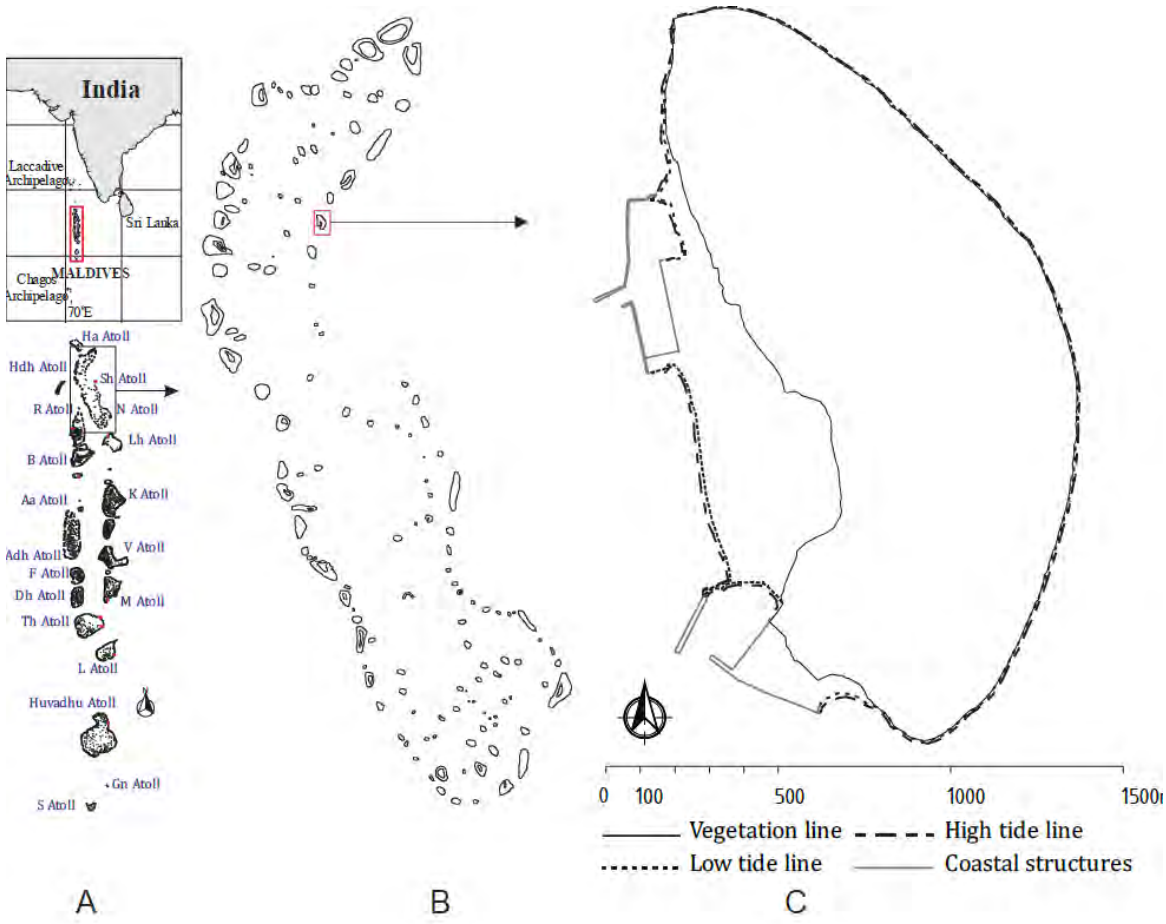


Table 2: Physical Attributes of Kulhudhuffushi

Physical attributes	Measurements
Length of the reef (visible extent)	2,870m
Width of the reef (visible extent)	1,780m
Length of the island	2,530m
Width of the island	900m
Wet land area (north and southern side wetlands)	33.46ha
Reclaimed land area (harbor area and west central area)	36.13ha
Total land area (average of HWL and LWL)	236.85ha

12. Kulhudhuffushi acts as a major passenger and cargo hub in the Northern region of the country. On the one hand, it receives a daily influx of residents from other islands who make visits in order to access proper health and education facilities or simply visit for recreational purposes. On the other hand, it acts as a key regional

maritime connection and cargo interchange point for the Haa Dhaalu atoll and other Northern atolls.

13. A historical growth hub in the North of the country, inward migration to Kulhuduffushi from other islands in the region has meant there is a net positive migration pattern when many islands of the nation have negative migration as a result of migration to Malé. As per the 2014 Census, the total registered national population is 8,011 inhabitants increasing to 8,224 inhabitants with enumerated expatriates, thus an inter-census growth rate of 1.68 %. As the center for the 45 islands of the northern region, the overall population of the region, including Kulhudhuffushi, is over 45,000 inhabitants.

Table 3: Population of Kulhudhuffushii (2014 Maldives Census)

	1985	1990	1995	2000	2006	2014
Male	1,695	2,033	2,571	3,131	3,299	3,712
Female	1,993	2,427	2,896	3,450	3,699	4,299
Total	**3,688**	**4,460**	**5,467**	**6,581**	**6,998**	**8,011**

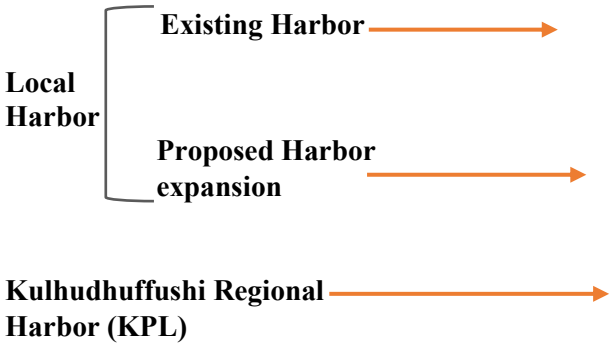
1.3. Kulhudhuffushi Transport Infrastructure and Services

14. The main transport infrastructure in Kulhudhuffushi are the local harbor and the regional harbor. Furthermore, a regional airport project was recently approved by the GoM in addition to an on-going road development project has been recently completed, which includes the provision of asphalt road surface and the necessary drainage for the main roads of the island.

15. Commercial shipping services connecting Kulhudhuffushi to the rest of the Maldives include weekly services to-from Malé; public ferry services to-from smaller islands in the Northern atolls, and several non-regular cargo/passenger services. In addition, Kulhudhuffushi is currently accessed from Malé and elsewhere via Hanimaadhoo airport followed by approximately a half-hour transfer by speedboat.

16. Figure 2 shows the proposed project location on the West Coast of the island, between the existing local harbor to the North and the Kulhudhuffushi regional harbor, also referred to as Kulhudhuffushi Port Limited (KPL), to the South.

Figure 2: Kulhudhuffushi harbors



17. The existing local harbor is located on the North-Western corner of the island and caters to all domestic vessels based in or visiting Kulhudhuffushi. Rubble mound breakwaters provide protection from waves along the Northern and Western perimeters, and to the Northern side of the harbor entrance. The entrance is approximately 45 m wide on a bearing of approximately 30 degrees south of East.

18. The Southern and Eastern harbor perimeters have quay walls separating the harbor from the onshore reclamation, approximately 115 m and 300 m in length, respectively. To the North of the 300 m long quay wall is a beach of length approximately 190 m, which currently accommodates a slipway and maintenance area. The Southern perimeter of this area has a quay wall approximately 70 m in length joining the 300 m long quay wall. The total area of the harbor is approximately 47,000 m^2. At present, the boats that transport passengers and cargo share the existing harbor with fishing boats.

19. The proposed harbor expansion lies on the West of the existing local harbor and will include a passenger harbor component, which can also accommodate multipurpose cargo operations; and a waterfront and mooring component for small crafts, which can be developed in the future for further port expansion. This will allow the existing local harbor to operate as a dedicated fishing harbor in the medium and long-terms.

20. Adjacent to the proposed harbor expansion is the Kulhudhuffushi Regional Harbor which is owned and operated by Kulhudhuffushi Port Limited (KPL). As a regional harbor, International ships calling KPL benefit from a 30% duty concession on goods discharged in the port. KPL has also plans to develop the regional harbor into a major national transit center for vegetables and perishable goods. KPL is outside the scope of this project; however, the proposed

Reclamation Area 2 and the related proposed revetment lie at the intersection between KPL and the passenger component of the proposed harbor expansion.

2. THE PROJECT

2.1 Background

21. This project preparatory technical assistance (PPTA) is funded under TA-8829 MLD (Kulhudhuffushi Harbor Expansion Project) and financed by the Asian Development Bank (ADB). The Ministry of Housing and Infrastructure (MHI) is the Implementing Agency (IA), and the Ministry of Finance and Treasury (MoFT) is the Executing Agency (EA). ADB oversaw and monitored the implementation of this PPTA.

22. The project is being undertaken by PADECO in association with national firm Riyan. The Consultants Team is comprised of 4 international and 3 national experts:

- Harbor Specialist / Team Leader: ***Khalid Bichou*** *(international)*
- Civil Engineer / Deputy Team Leader: ***Ismail Ibrahim*** *(national)*
- Civil Engineer Harbor: ***John Dimock*** *(international)*
- Transport Economist: ***Steve Moynihan*** *(international)*
- Financial Management Specialist: ***Jayath Atukorola*** *(international)*
- Environmental Specialist: ***Hussein Zahir*** *(national)*
- Social Development Specialist: ***Sofoora Kawsar Osman*** *(national)*

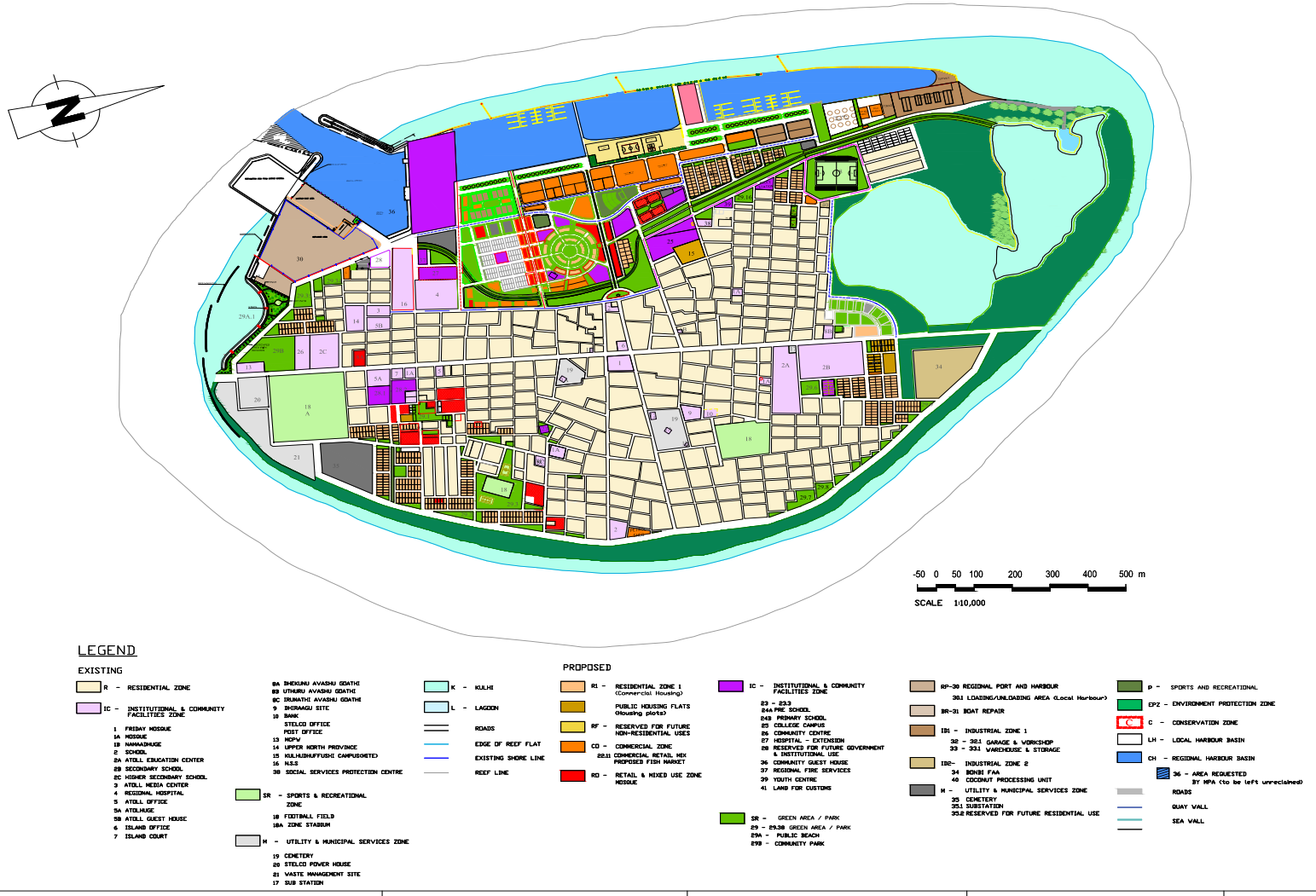
2.2 Scope and Objectives

23. The overall objective of this project is to bring about inclusive socio-economic benefits to the inhabitants of Kulhudhuffushi and the Northern region as a whole through improving the island's connectivity to regional and national markets and promoting local and visiting populations' accessibility to key services such as health, education, and housing. The specific objective of this project is to *conduct feasibility, design, and due diligence work for the development of a new passenger harbor and related ancillary facilities in Kulhudhuffushi*.

24. The scope of this project has been altered slightly to incorporate the requirements of the Land Use Plan (LUP) provided by MHI as shown in Figure 3 and the needs of various stakeholders most notably the Kulhudhuffushi Council (KC), fishermen, ship operators, and other harbor users. The proposal shown in Figure 4 includes a mooring waterfront area as a place to congregate and a safe point of access for small boats and water crafts.

25. Throughout this PPTA, there have been changes and amendments to the scope of work of the Consultant, as well as additional technical advisory tasks supporting ADB, MHI, MoFT, MoED, and other project stakeholders.

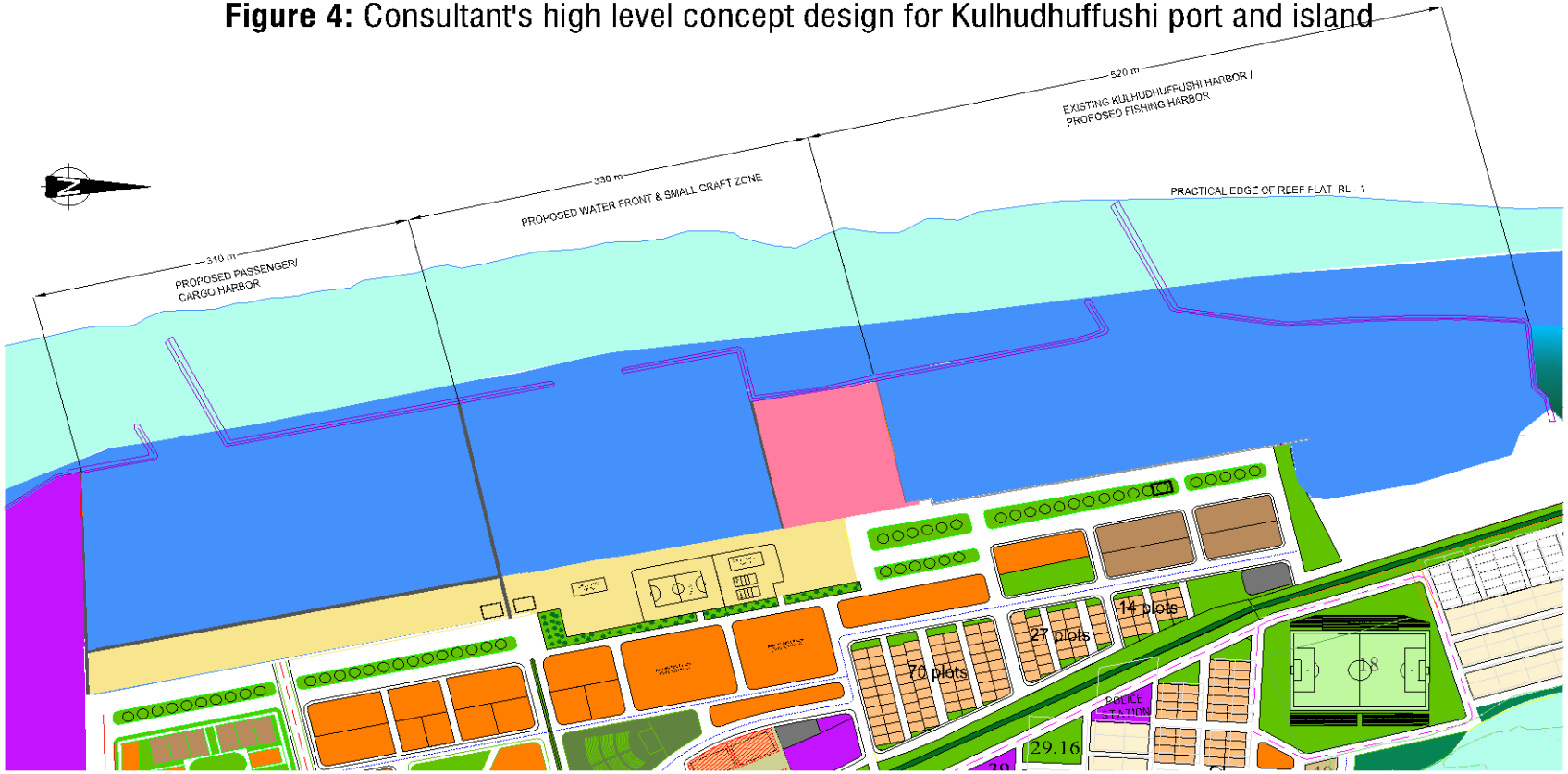
Figure 3: Initial LUP and Concept Design for Kulhudhuffushi Port and Island (source: MHI)



MINISTRY OF HOUSING AND INFRASTRUCTURE AMEENEE MAGU, MAAFANNU 20392, MALE', REPUBLIC OF MALDIVES TEL: 3004300 FAX: 3004301 email: planning@housing.gov.mv	**TITLE:** HDH.KULHUDHUFFUSHI LAND USE PLAN	**PROJECT:** CONCEPT PLAN FOR KULHUDHUFFUSHI RECREATION BEACH AREA	**DRAWN BY:** MA/NAA **CHECKED BY:** ZS	**SURVEYED BY:** **SCALE:** **DATE:** 19 March 2015

Figure 4: Consultant's High Level Design for Kulhudhuffushi Port and Island

Figure 4: Consultant's high level concept design for Kulhudhuffushi port and island



2.3 Project Tasks and Deliverables

2.3.1 Tasks

26. The Terms of Reference (TOR) for this project requires the Consultants' team to undertake the followings main tasks:

i. **Technical feasibility**. The project design including identification of key civil works components and estimation of preliminary project costs; incorporation of climate change adaptation measures; and incorporation of viable engineering options taking into account international best practice and the recommendations from other project components such as the environmental and social assessments, and the economic and financial analyses.

ii. **Economic and financial analysis**. The project's economic and financial feasibility including demand analysis, costs and benefits, economic impacts and distribution effects, financial appraisal, charging and cost recovery mechanisms, and revenue and financial sustainability.

iii. **Poverty and social impact assessment**. Poverty and social assessment in accordance with ADB's guidelines and referenced Government policies including on aspects related to social inclusion, gender assessment, labor impacts, and health and safety.

iv. **Environmental safeguards.** Environmental assessment according to ADB's guidelines and the prevailing Government policies.

v. **Governance and institutional assessment**. Institutional assessment of the port operators' and stakeholders' existing and required capacity to operate, manage, and maintain operational and financial sustainability of the harbor; including the identification and development of capacity needs and development programs. The PPTA will also propose measures to strengthen financial management, procurement, anticorruption, policy and legal, governance and institutional capacity where necessary.

vi. **Technical advisory and project management support to PIU (project implementation unit)**. Support the IA on technical, project management and procurement matters for preparatory works, including assessment of implementation plans and challenges and recommendation of appropriate mitigation actions during implementation phase.

2.3.2 Deliverables

27. The main deliverables and timeline for this project as defined by the TOR and revised and agreed by the Consultant, ADB, the EA, and the IA, are listed below:

- Monthly Progress Reports (due and submitted at the end of each calendar month)
- Inception Report (due and submitted on 30 September 2015)

- Preliminary Design Report -PDR- (due and submitted on 16 December 2015)
- Draft Final Report –DFR (due and submitted on 20 January 2016)
- Draft Environmental Impact Assessment -EIA- Report (due on 29 Feb 2016)
- Final Report -FR- (due on 25 February 2016; but extended to 02 March 2016 following request of ADB)
- EIA Report (due on 30 April 2016)
- Any additional tasks requested by ADB as time extension after submission of the Final Report (till 31 May 2016, on a requirement basis only)

2.4 Project Work Plan and Activities

2.4.1 Methodology

28. The Consultant was not required to prepare a methodology as part of their proposal submission for this project. However, a draft methodology, work plan, and personnel schedule was prepared and included in the Inception Report (IR) and subsequently agreed with both ADB and MHI. However, due to the fluid nature of this project and the late mobilization of the environmental and social experts; the scope of some components of this PPTA have to be revised and their deliverables re-scheduled accordingly. Such changes were discussed with and approved by both ADB and MHI.

2.4.2 Team mobilization

29. The Consultant was mobilized in the last week of August of 2015 at the start of the project; except for the environmental and social development specialists who have only been mobilized in the last week of October 2015. The social development specialist then withdrew from the project on 15 November 2015, and a replacement was made on 15 December 2015.

2.4.3 Meetings and surveys

30. Throughout this PPTA, the Consultant has held regular meetings with the EA and the IA in addition to regular communications with ADB including through monthly Video Conference meetings and during ADB's country mission in December 2015 and fact finding mission in March 2016.

31. Furthermore, the Consultant held several meetings and carried out additional surveys and focus group discussions with various project stakeholders including KC, port operators in both Malé and Kulhudhuffushi, relevant Government Ministries, the Kulhudhuffushi harbor users and business stakeholders, and the wider social and resident community both in Kulhudhuffushi and in the islands of the Northern Atolls.

32. Several of the above meetings took place in Kulhudhuffushi as part of scheduled trips throughout the project in order to collect data and carry out the necessary surveys.

33. Appendix H of this Report provides the list and minutes of relevant meetings to-date. However, meetings held with ADB, the EA, and the IA are not included in this Appendix.

2.5 This Report

34. This is the *Final Report* (FR) of this PPTA and includes the following:

- Technical Feasibility; which is incorporated into the PDR taking into account the comments made by ADB and MHI;
- Economic Feasibility, addressing comments on the draft version submitted as part of the DFR;
- Financial Feasibility, which includes both the financial appraisal and the financial management assessment; addressing comments on the draft version submitted as part of the DFR;
- Institutional and Governance Assessment; addressing comments on the draft version submitted as part of the DFR;
- Social safeguards; including the Poverty and Social Assessment (PSA) and the Social Due Diligence Report (SDDR), addressing comments on the draft version submitted as part of the DFR;
- Environmental safeguards, namely relevant sections of the Environmental Impact Assessment (EIA) report; the latter is being submitted separately. The EIA TOR is shown in Appendix F in this Report.
- Detailed description of CDTA components as approved by ADB and MHI; and
- Draft Project Management Consultant (PMC) TOR, enclosed in this Report as Appendix G.

3. TECHNICAL FEASIBILITY AND PRELIMINARY DESIGN

3.1 Scope and Objectives

3.1.1 Objectives

35. The PPTA TOR states that *Technical Feasibility* entails 'project design including identification of key civil works components and estimation of preliminary project costs; incorporation of climate change adaptation measures; and incorporation of viable engineering options taking into account international best practice and the recommendations from other project components such as the environmental and social assessments, and the economic and financial analyses'.

36. The project lifecycle for engineering projects to the point of completion of the constructed works is a progression that includes development of the layout, scope of works, design criteria and capital costs. Although these stages of development may be called different things in different industries, they generally correlate with the following:

- Concept design
- Prefeasibility study
- Preliminary design/ Feasibility study
- Detailed design
- Construction/Commissioning

37. Since no project's previous engineering studies have been performed, the preparation for this feasibility also includes elements of the concept and prefeasibility stages, in particular, an extensive review of past study reports and project documents to establish design parameters and the economic balance between world's best practice and local custom.

38. A further objective is to provide a reference guide for future projects of similar scope, therefore a smoother path to arriving at suitable design parameters. As such, the technical feasibility subject of this section includes the followings:

- Project description
- Design criteria
- Design drawings
- Cost estimates

39. The above components and technical feasibility reported here are a revised and final version of the draft PDR submitted on 16 December 2015, the DFR submitted on 20 January 2016, and the FR submitted on 02 March.

3.1.2 Design Scope for Basic Infrastructure

40. As shown in Drawing 0050 included in Appendix A, the scope of the proposed civil works includes the following components:

- Area 1 Reclamation
- Waterfront Small Craft Zone
- Harbor Separation Wall
- Passenger/Cargo Harbor
- Area 2 Reclamation

41. Although the existing Kulhudhuffushi Harbor will be largely dedicated to fishing vessels, thus becoming a fishing harbor as part of the proposed project; the scope of works under this PPTA excludes the Fishing Harbor. Furthermore, considerations such as maintenance dredging, which is carried out under the GoM's budget and not included in the project's funding by ADB, are outside the scope of this feasibility. More detailed definition of the project's major components, basic and operational infrastructure, and the ancillary facilities, are provided in the following sections.

3.1.2.1 Area 1 Reclamation

42. The area will be approximately 100 m wide when completed and extends the existing reclaimed land adjacent to the southern quay wall of the existing Kulhudhuffushi Harbor by approximately 50 m. The required volume of reclamation material is estimated to be just under 15,000 m^3.

3.1.2.2 Waterfront Small Craft Zone

43. The immediate and short-term intended purpose of this development is to provide a waterfront zone for small and personal craft as the centerpiece of the overall development. Important in the consideration of options is to minimize capital cost (the do-minimum option) and maximize flexibility for future low cost development of the area into a boat harbor and protection of the land developments from sea water inundation.

44. The natural sea bed level is approximately RL -1 m MSL, which is adequate for the intended purpose and no dredging cost will be incurred. Three options are considered as follows:

- Option 1: Protected by breakwater and suitable for mooring small personal crafts, then larger ones if the area is later converted into a separate harbor. A beach profile is provided around the interior perimeter along a short revetment to prevent

undermining of the seaward revetment protecting Area 1. Refer to Drawing 0060 in Appendix A.

- Option 2: A shortened breakwater is provided, with shore protection provided by a revetment around the interior perimeter and on the seaward side of the reclaimed region of Area 1. Refer to Drawing 0070 in Appendix A.
- Option 3: As in Option 2, a shortened breakwater is provided; however, a quay wall replaces the revetment along the interior perimeter. Refer to Drawing 0080 in Appendix A.

45. Option 1 is preferred as it meets MHI's needs in the immediate term and is the least costly for future redevelopment into a separate harbor or extension of the proposed Passenger/Cargo harbor. If the breakwater in Option 1 was constructed to a depth suitable for future dredging, as shown in Section B-B on Drawing 0120, the cost would be higher than the cost of Option 2. Option 3 is the highest cost option irrespective of the breakwater adopted, due to the relatively high cost of the quay walls.

46. Using the Section B-B breakwater design shown on Drawing 0120, the cost of Option 1 and Option 2 will be similar, with Option 1 also having the immediate and long term advantages mentioned above. Section B-B shows how the breakwater could be modified in the event that future development requires dredging behind it.

3.1.2.3 Harbor Separation Wall

47. The harbor separation wall provides a physical barrier from the inherent dangers at the adjacent Passenger/Cargo harbor and to prevent sand migrating into the dredged harbor from the waterfront and small craft zone area. Three options were considered:

    - Option 1: Sand bund with armor protection on both sides
    - Option 2: Quay wall with sand beach on the waterfront mooring side
    - Option 3: Precast concrete box caisson, sand-filled with in-situ concrete topping.

48. Option 3 is preferred as it requires the least capital outlay and offers the greatest flexibility in terms of future development. Removal of this structure would be less costly than either of the alternatives, presenting less of a hurdle to future expansion of the proposed Passenger/Cargo harbor.

3.1.2.4 Passenger/Cargo Harbor

49. The existing sea bed level is fairly uniformly RL -1.0 m MSL and will be dredged to RL -4.0 m MSL. A quantity of just over 150,000 m^3 of dredged material is included in the estimate, of which approximately 40,000 m^3 will be used in reclamation works for Area 1 and Area 2, leaving approximately 110,000 m^3 surplus material for stockpiling.

50. The largest vessels to use the harbor will be approximately 30 m in length, with a draft of up to 3 m. However, it may be possible that vessels with a draft up to 3.4 m or even 3.5 m to use the harbor subject to a proper evaluation of the minimum under-keel clearance (UKC). The calculation of a 'safe' UKC not only depends on the harbor's draft, tide, current, and weather conditions, but also on the vessel's trim and list characteristics and motions when approaching and using the harbor. In the absence of compulsory pilotage in Kulhudhuffushi local harbor, the Consultant recommends an evaluation of the minimum UKC to be undertaken in the early weeks of harbor operations, in line with the siltation rate and the frequency of maintenance dredging.

51. The quay wall will comprise a higher version of the ubiquitous "L" precast concrete wall used for the 3 m deep harbors. Recent practice in harbor's construction in the Maldives relies almost exclusively on this method, the KPL regional port being one notable exception where a steel sheet pile wall, with in-situ reinforced concrete capping was used. The greater height of this wall may explain the basis for this choice.

3.1.2.5 Area 2 Reclamation

52. The Area 2 outline shown on Drawing 0090 in Appendix A is taken from MHI's LUP. The majority of this area has already been reclaimed in earlier work and only the seaward portion of approximately 25,000 m^3 remains to be completed. Erosion has occurred along the western edge of the reclamation and along the southern edge at the interface with the regional port. Reshaping of the reclamation into an apparently stable beach profile has occurred due to the action of waves passing through the Regional Port, principally from a south-westerly direction.

53. It appears from the Drawing 0130 – Google Earth Arial Photo and Level Contours included in Appendix A, that the intersection of the beach profile with the finished level of Area 2 (approximately RL 1.6 m MSL) is very close to the edge of the proposed Area 2 reclamation. To ensure that this edge is not eroded over time or washed out due to a one off event of greater intensity, a revetment has been included.

54. Further detailed consideration of this area is required, in particular with reference to a topographic survey, to ensure the future stability of Area 2 against erosion from wave action. It may be prudent to move the southern boundary of Area 2 north to minimize or eliminate the potential for erosion of an unprotected edge or undermining of a revetment. This decision would also require knowledge of the intended use of the land, as to whether a reduction in usable area is an acceptable option.

3.1.3 Operational Port Infrastructure

55. In addition to dredging, reclamation, quay-wall and other civil works on basic infrastructure, operational port infrastructure (sometimes referred to as infrastructure-plus) includes facilities necessary for the safe operation of the

harbor. Depending on the type, size, and use of the harbor, the scope and type of operational port infrastructure can vary widely. For this project, the main requirements for the Passenger/Cargo harbor in terms of operational port infrastructure are as follows:

3.1.3.1 Navigation Lights

56. The standard approach for the provision of navigation lighting in other recent projects includes a solar Sealite SL-60 unit mounted on the breakwaters either side of the entrance. They are suitable for illuminating hazards and come with 256 International Association of Lighthouse Authorities (IALA) flash patterns.

3.1.3.2 Timber Jetty

57. The existing harbor has a concrete quay wall length of approximately 300 m which has proven to be inadequate on some days, especially when visiting vessels moor there for several days at a time. A total of seven timber jetty finger piers are proposed perpendicular to the harbor separation wall, at a 15 m spacing to provide more berth space for convenient cargo unloading and passenger access to shore. The cost estimate includes 63m of jetty, based on a local rate for imported marine quality hardwood and built-up plant, equipment and labor rates, as no tender quotes for similar timber construction are available.

3.1.3.3 Harbor Pavement, Drainage, and Apron Lights

58. Consistent with other similar projects conducted by MHI, an allowance for a 6m wide paved apron is included for the length of the Passenger/Cargo harbor. An allowance for a continuous strip drain in the vicinity of the quay wall is included in the cost estimate.

59. It would be impractical to provide drainage for the entire land mass which could be drained to the sea. Local custom is to allow the majority surface water to permeate the sand rather than be collected and drained to the sea. Roadway/ Quay lighting at a spacing of approximately 15m is included in the cost estimate for the length of the Passenger/Cargo harbor.

3.1.3.4 Bunkering and Supply

60. Bunkering and supply facilities provide fuels to ships and vessels for their own use and range from large tank bunkering stations to small bunker barges. For the Passenger/Cargo harbor, and given the small scale of ships and ship operations, there does not appear to be a need for a bunkering station or a bunker barge at this stage. Further, if required, an existing gas/petrol station adjacent to the port, could store and supply marine diesel for ships using the harbor.

61. Ships also take on fresh water from bunkering facilities and occasionally require electricity supply. Rather than make provisions for supply at the harbor, these needs can be met by the existing suppliers in Kulhudhuffushi.

3.1.3.5 Fire and Emergencies

62. In ports, the scope o fire fighting and emergency services normally includes fire prevention and response to accidents and emergencies both in the harbor and on-board ships. As such, the response capability should include a wide range of services including attending fires, dangerous goods incidents, chemical leaks, and oil spills.

63. In Kulhudhuffushi, there is already a fire station just outside the harbor area (adjacent to the gas station) which is also responsible for attending fire and emergencies in the port. The extent to which such a facility has the necessary tools to deal with major port emergencies, such as a fire explosion or an oil spill is unknown; however, it is likely that further capacity building along with adequate equipment would be required once the new expansion becomes fully operational.

3.1.4 Port Superstructure and Ancillary Facilities

64. Port superstructure refers to port buildings, warehouses, and equipment and may also include a range of other ancillary facilities. In most port and harbors, a distinction is made between essential and non-essential ancillary facilities depending on the regulatory requirements in place and on the needs of the port users and community.

65. For the purpose of this report, we have listed and cost relevant superstructure and ancillary facilities based on our professional judgment, the preliminary feedback from economic and social surveys, and the requests of both MHI and ADB.

66. The extent to which some or all of those superstructure and ancillary facilities will be included in the detailed and final design will depend on the outcomes from the final project's scoping which will take place during ADB's final Fact-finding mission, currently scheduled on 28 February – 06 March 2016; as well as further investigation and detail design during the PMC's work.

3.1.4.1 Passenger Terminal

67. A building with a footprint of 14 m x 14 m is anticipated to be sufficient to house the passenger terminal and also provide space for the following:

- Seating area
- Passenger terminal/ ATM (Automated Teller Machine)
- Prayer room
- One ticketing office
- 2 administrative offices
- Amenities

3.1.4.2 Harbor Markets

68. The harbor markets will comprise separate fishing and vegetable markets to support the local fishing and produce trading industries. Currently fish processing is conducted in temporary and very modest circumstances. Similarly, produce and

vegetable trade takes place in an open area near the hospital, without appropriate shade or areas to congregate.

69. The 15 m x 10 m fish market would include an ice plant, enabling fishermen to go to sea for several days at a time. For the vegetable market, a 15 m x 10 m open structure is proposed to provide covered space for the market with room to congregate.

3.1.4.3 Buildings for Commerce and Business Activities

70. Additional buildings could be justified to complement the development of the harbor. The cost estimate includes an additional building with a footprint of 14 m x 11 m to house the following:

- General store
- 2 food and beverage outlets
- 2 retail outlets
- 2 business offices
- Amenities

3.2 Review of Coastal Protection Projects

3.2.1 Overview

71. A wealth of useful information has been obtained from previous projects in Maldives. In preparing this technical feasibility, several visits were made to the northern region make observations and to speak to locals about the performance of the harbors in the region. A first visit was made to Kulhudhuffushi on 21-22 September 2015, and other visits were made to the following harbors: Hanimaadhoo, Dhidhdhoo, Hoarafushi, Ivanandhoo, Utheemu

72. Many breakwaters were severely damaged or destroyed during the well documented Boxing Day Tsunami on 26 December 2004. Since then there have been programs implemented for reconstruction of harbors to reasonably uniform standards. One of the standards to have emerged is that the crest level of the breakwater is set to RL 1.4 m MSL; however, the technical reasons for this remain opaque.

73. Wave overtopping occurs throughout the year and although damage to the breakwaters seldom occurs, boats may be damaged either by the overtopping events or rough conditions within the harbors due to excessive wave energy entering the harbor though the entrance.

74. Each year, from early December until mid-January, rough seas and strong winds prevail from the north-east (NE), marking the commencement of the NE Monsoon season. During this time, sustained 25-30 knot winds may occur for several days at a time. The information garnered from the locals, including a crew member of the speed boat who has lived at Hanimadhoo for over a decade, was found to be consistent with the Nakaiy Calendar included in Table 13 further below.

75. The followings summarize the record of the visits and documentation available.

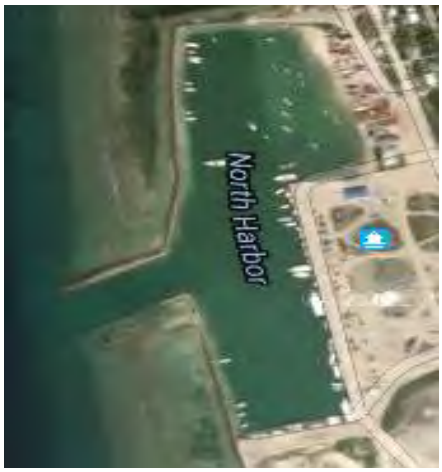
3.2.2 Kulhudhuffushi Domestic Harbor

76. The harbor was originally dredged to a depth of 2.45 m below MSL when completed in 2010. No hydrographic survey has been undertaken since that time; however, evidence of siltation exists particularly in the North-Western corner of the harbor. Discussions with operators and the KC did not reveal any constraints to use of the harbor due to siltation.

77. The breakwater shown on the undated, unreferenced As-Built drawing, has a level of RL 1.4 m MSL. No dimensions are provided to define batter slopes, rock armor layers or core material and the rock mass is unspecified. A literal interpretation of the drawings is that the breakwater is a random selection of rock that has been tipped rather than placed. Remarkably, the only damage apparent is at the western tip of the seaward-most breakwater protecting the entrance.

78. During visits to the harbor and meetings with stakeholders, it was revealed that the entrance was widened after one or more boats collided with the breakwater protecting the entrance. It is understood that waves incident from the west created the conditions that led to these events while entering the harbor. The orientation of the harbor entrance is South-South-West, meaning that the harbor is exposed to significant wave energy from south-west monsoons, the west and all directions in between. To demonstrate this point, during the visit to the harbor, small vessels moored at the quay wall, opposite the harbor entrance, were experiencing a very short period rolling motion although the water surface was ostensibly calm.

Figure 5: Kulhudhuffushi (existing) Harbor



3.2.3 Kulhudhuffushi Regional Port / KPL

79. The Kulhudhuffushi regional port was designed by Niras Port Consultant AS and construction was undertaken by Wakachiku Construction Co. Ltd in 2005. It was originally dredged to 5 m below Chart Datum (CD), which is 5.7 m below MSL.

80. KPL and its parent company Maldives Port Limited (MPL) have both advised that the available depth is now around 3m due to siltation from the adjoining reclamation works, meaning that the port is functioning at a significantly reduced capacity.

81. The As-Built drawings show that the breakwater protecting the harbor from the west has a crest level of 2.9 m CD (2.2 m MSL) and the breakwater protecting the harbor from the south has a crest level of 3.5 m CD (2.8 m MSL). The harbor has a quay wall at the land interface on the eastern side, comprising of sheet piling with a concrete capping beam finished at RL 1.7 m MSL.

Figure 6: Kulhudhuffushi Regional Port / KPL

3.2.4 Hanimaadhoo

82. This harbor was constructed in 2002, and while the breakwater has not suffered any significant damage, mooring lines are often broken and boats are damaged. The harbor is located on the western side of the island which is very close to the eastern edge of the atoll. Google earth image shows waves from the east refracting around the Northern tip of the island.

83. The entrance to the harbor faces approximately West-North-West and is dog-legged to provide protection from West to South quadrant, yet it is said that the harbor experiences the worst conditions during the South West (SW) Monsoon. This is due to overtopping events during June-July months when seas are described as rough and unsuitable for travelling. When these events occur, the boat owners employ two methods to protect their boats. One is to move to a more sheltered location and the other is to deploy additional mooring lines.

84. As a consequence of the harbor jutting out from the natural coastline, the littoral drift along the coastline has been interrupted, causing erosion on the southern side. The coastline is estimated to have receded approximately 50m in the time since the harbor was constructed.

Figure 7: Hanimaadhoo

3.2.5 Dhidhdhoo

85. The breakwater was replaced with a rubble mound breakwater in 2005. Around two years after completion, the ends of the harbor were opened up to reduce turbulence within the harbor. The main breakwater is oriented approximately North-South and the entrance faces due East. Being only 17km from the open water to the east, with little shelter from other islands, it is to be expected that significant wave energy from deep water swell waves would at times enter the harbor. When adverse events occur, owners either add mooring lines or move boats to a more protected area.

Figure 8: Dhidhdhoo

3.2.6 Hoarafushi

86. The harbor was originally constructed of coral rock and sand bags, but lasted only three years. It was rebuilt in 2006 and has not been damaged aside from the odd rock being dislodged on the seaward face and coming to rest at the toe of the breakwater. Locals mentioned the breakwater is overtopped at various times throughout the year:

    - June-July
    - First two weeks of January – Fura Halahala
    - Second two weeks of January – NE Monsoon.

87. According to the locals, the first two weeks of January present the worst conditions. Some breakwater overtopping events also overtop the quay wall. This flow of water is not fast enough or deep enough to endanger people or property.

Figure 9: Hoarafushi

3.2.7 Ivanandhoo

88. Built in 2006, the harbor is suffering from Algal growth which shows as a distinctly green appearance in the water. When approaching the harbor from the ocean, it is apparent that the quay-wall and breakwater is significantly higher than the other harbors discussed here.

89. A local complained that the quay wall was too high for practical access to small vessels; something we also experienced as the tide was very low. The harbor is orientated such that it experiences poor conditions including overtopping and mooring lines braking during NE and SW monsoon conditions. Occasionally, the quay wall is overtopped but this is infrequent and causes no damage to property or danger to people.

Figure 10: Ivanandhoo

3.2.8 Utheemu

90. The harbor works were constructed in 2013. The breakwater lies approximately on an East-West axis, with the entrance approximately SSE. There was a lot of large rock placed around the harbor, which we were informed will be used for the extension of the eastern side of the entrance by approximately 30 m.

91. The harbor is approximately 15 km from the eastern edge of the atoll, meaning that the entrance is quite open to swell waves from the east. The orientation of the entrance is reasonably well protected from monsoon waves from the SW, which would form over the 50 km fetch from the Western edge of the atoll.

Figure 11: Utheemu

3.3 Design Criteria

3.3.1 Overview

92. There is no available data from site measurement or site investigation specific to Kulhudhuffushi for determining the following design criteria:

- Geotechnical design parameters
- Maximum wave height and period
- Wind speed and duration
- Storm surge
- Wave setup

93. In the absence of this information being available in a prefeasibility report or equivalent, design criteria have been established with reference to:

- The existing harbors at Kulhudhuffushi
- Oriental Consultants, 2012, Developing guideline and database for the life-cycle management system of "vessel safe shelters" in the Maldives, final technical standard and design manual, Ministry of Housing and Infrastructure (Safe Shelters Design Guide)
- UNDP, 2007, Detailed Island Risk Assessment in Maldives Vol III: Detailed Island Reports, H. dh. Kulhudhuffushi – Part 1 (DIRAM 2007)
- RMSI 2006, Developing a disaster risk profile for Maldives Volume 1: Main Report, UNDP (UNDP 2006 Disaster Risk Report)
- JICA Main Report, 1992, The Development Study on the Seawall Construction Project for Malé Island in the Republic of Maldives, Main Report 1 (JICA 1992 Main Report)
- JICA Main Report, 1992, The Development Study on the Seawall Construction Project for Malé Island in the Republic of Maldives, Supporting Report (JICA 1992 Supporting Report)

3.3.2 Summary of Design Criteria

94. Table 4 below summarizes design criteria discussed in more detail.

Table 4: Summary of Design Criteria

Criterion		Recommendation	
Design Life		30 y	
Return Period of Event		50 y	
Geotechnical Parameters		Density (kn/m^3)	Friction Angle (ϕ^o)
Sand Backfill	Dry	18	30
	Saturated	20	30
	Submerged	10	35
In-situ Sand	Dry	19	35
	Saturated	20	35
	Submerged	10	35
Coral Rock		1.6	
Armor Rock	Saturated surface dry	2.6	
Level Datum	Offshore	MSL	
	Onshore	MSL	
Tidal Planes		LAT Datum (m)	MSL Datum (m)
Highest Astronomical Tide	HAT	+1.25	+0.55
Mean High High Water	MHHW	+1.0	+0.3
Mean Sea Level	MSL	+0.7	0.0
Mean Low Low Water	MLLW	+0.3	-0.4
Lowest Astronomical Tide	LAT	0.0	-0.7
Dredged Level (m MSL)	Passenger/Cargo Harbor	RL-4.0	
Storm Surge (m)		0	
Wave Setup (m)		0.2	
Sea Level Rise (m)		0.2	
Still Water Depth on Reef (m MSL)		1.82	
Wave Incident to Reef	Height H_{sig} (m)	1.6	
	Period T (s)	6.7	
Wind (m/s)	3 sec gust	27	
	Steady over 30 km fetch	15	
Current (m/s)	Nominal	0.5	
Earthquake		Non-seismic	
Breakwater	Crest width	1.6 m	
	Crest level	RL 1.6 m	
Quay wall	Live Load	15 kPa	
	Top of wall	RL 1.5 m	
Revetment	Crest Level	2.0 m	

3.3.2.1 Design Life

95. Table 6.1 of AS4997 Design of maritime structures, recommends a design life for a small craft facility of 25 y, which is similar to the Safe Shelters Design Guide of 30 y. The recommendation of the local reference has been adopted.

3.3.2.2 Return Period of Design Event

96. In Chapter 3 – Shore Protection Planning, section 3.1.1, p. 3-1 of the JICA 1992 Main Report for reconstruction of Malé after the 2004 Tsunami, states that the physical modelling was based on a '50-year probability wave and a storm wave in 1987, coupled with a high tidal level.'

97. This work was undertaken by Goda and Lanka Hydraulics Institute (LHI), both having impeccable credentials in the field of research, analysis and modelling of coastal processes. Although a higher return period could easily be argued for such an important application, that a 50 y return period event was chosen will have been based on thorough consideration of the economics involved and will therefore be adopted for this project, which represents a lower risk to property and life.

3.3.2.3 Geotechnical Parameters

98. A geotechnical investigation was to be commissioned by ADB during the term of this study; however, due to the confidence in the predictability of geotechnical conditions gained from past projects in Maldives, the planned investigation was cancelled.

99. Based on knowledge of the likely conditions being sand, cemented sand and coral rock, the design and cost estimate is based on the assumption that there will be adequate bearing capacity for the breakwater and quay walls and that dredging will not encounter rock. Bowles (1988) Table 2-6 is repeated in Table 5 below.

Table 5: Bowles Geotechnical Parameters

Soil	Type of Test		
	Unconsolidated - un-	Consolidated -	Consolidated -
	U	CU	CD
	ϕ^o	ϕ^o	ϕ^o
Gravel			
Medium size	40-55		40-55
Sandy	35-50		35-50
Sand			
Loose dry	28-34		
Loose saturated	28-34		
Dense dry	35-46		43-50
Dense saturated	1-2 less than dense dry		43-50
Silt or silty sand			
Loose	20-22		27-30
Dense	25-30		30-35

Soil	Type of Test		
Clay	0 if saturated	3-20	20-42

100. The Safe Shelters Design Guide in section 6.3.1 Design Conditions pp. 6-20, states that for subsoil and backfill material, the following geotechnical properties apply:

Coral sand

- Dry unit weight $\Upsilon = 1.8$ t/m^3
- Unit weight submerged $\Upsilon = 1.0$ t/m^3
- Angle of internal friction 35 ϕ^o

101. This accords with the recommendations by Bowles (1988), at the lower end of the dense saturated range and will be used in the design of the breakwaters, quay walls, pavements and jetties for in-situ material. Given that it is more difficult to ensure full compaction of submerged sand backfill, an angle of internal friction of = 30o will be adopted for backfill.

3.3.2.4 Level Datum

102. The documents and drawings prepared for the Kulhudhuffushi Regional Port and the Malé Reconstruction Project were prepared by international consultants and use Chart Datum (CD) of LAT for the hydrographic levels. It is usual that CD is set to a very low water level, such as LAT or Mean Lower Low Water (MLLW), so that mariners are able to ascertain the guaranteed minimum depth of water available without knowing the stage of the tide.

103. In Maldives, it is customary for both hydrographic and topographic survey levels to be shown relative to MSL datum and that norm has been observed in this report and the Preliminary Design Drawings.

3.3.2.5 Tidal Planes

104. The tidal planes in Table 2.2.3, pp. 2-10 of the Safe Shelters Design Guide, for the Upper Northern Region which includes Haa Alifu atoll where Kulhudhuffushi is located, are shown in Table 6 in meters (m) relative to MSL.

Table 6: Haa Alifu Tidal Planes – Safe Shelters Design Guide

Highest Astronomical Tide	HAT	+0.55
High Water of Ordinary Spring Tide	HWOST	+0.32
Mean Sea Level	MSL	0.00
Low Water of Ordinary Spring Tide	LWOST	-0.32
Lowest Astronomical Tide	LAT	-0.55

105. Table 7 shows the tidal planes noted on the undated Wakachiku Construction Co Ltd As-Built Drawing No. 405W- Breakwater and Revetment Sections for the Kulhudhuffushi Regional Port.

Table 7: Tidal Planes - Kulhudhuffushi Regional Port

		LAT Datum	MSL Datum
Highest Astronomical Tide	HAT	Not Stated	
Mean High High Water	MHHW	+1.0	+0.3
Mean Sea Level	MSL	+0.7	0.0
Mean Low Low Water	MLLW	+0.3	-0.4
Lowest Astronomical Tide	LAT	0.0	-0.7

106. Malé Tidal Planes: In Table 2.2.3 (replicated here as Table 8), pp. 2-10 of the Safe Shelters Design Guide, the North Central Region which includes Malé, shows the following tidal planes in meters (m) relative to MSL:

Table 8: Malé Tidal Planes – Safe Shelters Design Guide

Highest Astronomical Tide	HAT	+0.64
High Water of Ordinary Spring Tide	HWOST	+0.34
Mean Sea Level	MSL	0.00
Low Water of Ordinary Spring Tide	LWOST	-0.36
Lowest Astronomical Tide	LAT	-0.56

107. The JICA 1992 Main Report, pp.3-3, Figure 3.1.2 Tidal Diagram for Malé, is summarized in Table 9 below:

Table 9: Malé Tidal Planes – JICA 1992 Main Report

		LAT Datum	MSL Datum
Highest Astronomical Tide	HAT	Not Stated	
Mean High High Water	HWL	+1.34	+0.7
Mean Sea Level	MSL	+0.64	0.0
Mean Low Low Water	MLLW	Not Stated	
Lowest Astronomical Tide	LAT	0.0	-0.64

108. The forgoing demonstrates that for reasons unknown, there is inconsistency between sources of information for tidal planes. For the purposes of this report, the tidal planes stated for Kulhudhuffushi Regional Port shall be used, with the addition of HAT taken from the Safe Shelters Design Guide as summarized in Table 10.

Table 10: Kulhudhuffushi Project Tidal Planes

		LAT Datum	MSL Datum
Highest Astronomical Tide	HAT	+1.25	+0.55
Mean High High Water	MHHW	+1.0	+0.3
Mean Sea Level	MSL	+0.7	0.0
Mean Low Low Water	MLLW	+0.3	-0.4
Lowest Astronomical Tide	LAT	0.0	-0.7

3.3.3 Design Water Depths

3.3.3.1 Overview

109. The existing sea bed in the vicinity of the proposed project is generally at around 1m below MSL, as indicated in the bathymetric survey conducted by Maldives Land and Survey Authority on 20-21, April 2015 to a vertical level datum of MSL. The actual sea level at the shore to be used for design purposes, is dependent upon the combination of rainwater runoff, storm surge, wave setup, tide level and allowance for sea level rise due to climate change.

3.3.3.2 Dredged Level

110. The Passenger/Cargo harbor will be dredged to RL -4.0 m MSL; but the waterfront small craft zone area will remain un-dredged at a level of approximately RL -1.0 m MSL.

3.3.3.3 Storm Surge

111. Storm surge is a measure of the increase in the water level at the shore caused by strong winds associated with coastal storms - low pressure systems and cyclones, forcing the lateral movement of the water surface in an onshore direction over a localized length of coastline. To a lesser extent, the reduced barometric pressure associated with tropical lows and cyclones also causes a rise in sea level. The storm tide level is the addition of the normal astronomical tide and the increase in water level due to the storm surge. One of the consequences of an increase in water level, is that a larger wave height may occur.

112. The UNDP 2006 Disaster Risk Report states in Table 11 on page 47 that the calculated storm surge for the Northern islands is 0.84 m for a 100 year return period and 1.32 m for a 500 y return period. Adding 0.98 m for 'average

astronomical tide', gives storm tides of 1.3 m and 2.3 m respectively. The 0.98 m tide added to produce a storm tide water level, isn't explained or referenced.

113. The maximum tide range stated in section 4.1, taken from the Safe Shelters Design Guide is 1.1 m based on +0.55 m HAT and -0.55 m LAT. If the "average astronomical tide" is 0.98 m, clearly MSL is not the datum; however, this is not stated. Assuming the datum is LAT, a tide height of 0.43 m doesn't equate to a particular tide level. Perhaps the intended meaning of the "average astronomical tide" is the average of HWOST (RL 0.87 m LAT) and HAT (RL 1.1 m LAT), which is 0.985 m.

114. An unfortunate consequence of this ambiguity is that further alarmist conclusions have been drawn in (Ministry of Environment, Energy and Water, 2007), where it is stated that: 'A storm surge at high prediction could cause a 3.18 m wave that could inundate even the largest of islands. These surges do not take into account regular monsoonal wind generated flooding which is considered the most common in Maldives (Shaig, 2006; UNDP, 2006).

115. The 3.18 m "wave" is the sum of:

- 1 in 500 y storm surge of 1.32 m
- "average tide height" of 0.98 m
- maximum projected sea level rise by 2100 of 0.88 m.

116. While this event would indeed have horrific consequences, the calculation mixes return periods and wrongly labels the result as a wave. Further, the statement that the storm surges do not take account of monsoonal conditions is misleading or perhaps poorly worded, because the extreme low pressure system or cyclonic event that would cause the stated 30 hpa pressure drop to create the 1in 500 y storm surge, and a monsoonal wind generated event, are mutually exclusive.

117. In contrast with the foregoing prediction of storm surge (Titus, 1989), stated as the case for Maldives: 'Because storm surges are rarely over 30 cm, it has been safe to develop land that is only 40 cm above high tide.' The statement was made at a conference discussing sea level rise, after touring several islands in the Maldives, accompanied by engineers from Delft Hydraulics Laboratory (DHL).

118. The 1992 JICA Report for Malé in Figure 3.3.1 Design Waves, states a design water level for the East and South coasts of +1.64 m and +1.63 m respectively. Both coasts are exposed to swell waves of Ho = 3.0 m. The North and West coasts which are sheltered from swell waves, have design water levels of +1.34 m which corresponds to MHHW relative to LAT datum.

119. The wave and water level modelling was performed by Goda in association with Lanka Hydraulics Institute (LHI) for a 1 in 50 year return period event. It follows that the 0.3m additional maximum still water level for the East and South coasts represent the upper bound for storm surge and some if not all of this increase will be attributed to wave set up. The reason for the higher still water level is not stated in the reports.

120. The UNDP 2006 Disaster Risk Report states in Section 5.3 - Results and Discussion - Storm Climatology: 'The islands of Maldives are less prone to tropical cyclones. The northern islands of the country were affected by weak cyclones that formed in the Southern part of the Bay of Bengal and the Arabian Sea. Figure 14 shows the tracks of cyclones affecting Maldives during the period 1877 - 2004. The number of cyclones directly crossing Maldives is small. Only 11 cyclones crossed the islands over the entire span of 128 years. Most of the cyclones crossed Maldives north of 6.0o N and none of them crossed South of 2.7o N during the period.'

121. It is clear that Maldives is not a renowned cyclonic region and that the predicted surge levels for the 100 and 500 ARI events don't appear to have been experienced to date. It is possible that a storm surge level of something around 300 mm for a 50 y ARI is appropriate; however, based on the evidence available to inform this report, the 1 in 50 y design event is non-cyclonic with no allowance for still water level increase due to storm surge.

3.3.3.4 Wave Setup

122. The Safe Shelters Design Guide includes an empirical method for calculating the height of a reformed wave after breaking on the edge of a reef as well as the increase in water level associated with wave setup. The original work, which has not been sighted, is attributed to Takayama et. al (1977).

123. Many other examples of the calculation are provided for harbors in the Maldives in Oriental Consultants (2008) and the amount of wave setup calculated in this manner is generally around 0.15 m - 0.18 m. For the purposes of this feasibility, an increase in water level of 0.2 m due to wave setup has been adopted.

3.3.3.5 Sea Level Rise

124. Allowing for sea level rise due to climate change is not straight forward, because it lies within a range from 0 to around 1 m by the end of the century. AS4997 Table 4.1- Allowance for sea level rise, has adopted a linear growth in sea level rise with a projected rise of 400 mm over the next 100 y based on IPCC recommendations.

125. The UNDP 2006 Disaster Risk Report in Table 19, p57 recommends an allowance of 19.9 cm for sea level rise by year 2050 and 48.9 cm by year 2100, based on the HadCM2 IS92a (med) model.

126. These two recommendations are similar and the more conservative estimate of sea level rise of 200 mm has been adopted for the still water level applicable to the breakwater and revetment designs. The height of the quay walls has not been adjusted as any overtopping will be infrequent and of a minor nature.

3.3.3.6 Water Depths

127. It is usual to combine an average high tide level rather than an extreme high tide, with a wave height of a particular return period, or the return period of the

combination increases. A conservative approach is to adopt a tide level between MHHW and HAT, which gives a tide level of RL 0.42 m MSL. Therefore, for the design of the breakwater, the water depth is calculated as:

Tide level + wave setup + sea level rise – sea bed level =0.42+0.2+0.2+1.0 = 1.82 m

128. For these conditions, the water depth inside the waterfront and small craft zone area will also be 1.82 m and the water depth inside the Passenger/Cargo Harbor will be 4.82 m.

3.3.4 Wave Height

129. The protection offered by the coral reef flat is not just to provide depth limited conditions. The effect of shoaling at the edge of the reef ensures that the maximum wave height to reach the breakwater or revetment is less than the depth limited wave height. Further, in both cases, the wave is a non-breaking wave. As explained in the remainder of this section, Hsig = 1.6 m and T = 6.7 s have been adopted from the JICA 1992 Supporting Report for the incident wave from the SW.

130. Although the wave period appears conservative, this wave height is supported (using reasonable combinations of fetch length, storm duration and wind speed), by Figure 3-23 of US Army Corps of Engineers 1984, Shore Protection Manual Vol I, Coastal Engineering Research Center, Washington DC - Nomograms of deep water significant wave height:

Table 11: Wave Period As Calculated From USACE

Fetch (km)	30	50
Duration (h)	3-4	5
Wind speed (m/s)	15	14
Period T (s)	4.5 – 5	5 – 5.5
Wave Height Hsig (m)	1.25 – 1.5	1.5 – 1.75

131. The empirical method stated in the Safe Shelters Design Guide, for calculating the reformed wave height after breaking at the edge of the reef, gives a significant wave height at the breakwater of approximately 0.75m. Another case to consider is where the height of the incident wave is small enough after shoaling, not to exceed the limiting depth for breaking and is able to traverse the reef until impacting the breakwater.

132. The shoaling coefficient for these conditions is calculated to be approximately 1.15. This means that the wave incident to the reef edge, Hs = 1.6 m becomes 1.84 m high due to shoaling as it passes the edge of the reef. The maximum wave height that can be sustained without breaking in a water depth of 1.82 m on a flat sea bed, is approximately 1.5 m. Therefore, the Hsig = 1.6 m wave shoals and then breaks after passing the edge of the reef and then to a greater or lesser extent, depending

on the distance travelled over the reef, reforms before reaching the breakwater. Calculations show the reformed wave height for a 100 m distance from the edge of the reef to the breakwater is 0.75 m.

133. The maximum wave height that shoals without breaking at the edge of the reef has an approximate height of 1.5 m /1.15 = 1.3 m; which is less than the 1 in 50 y H_{sig} = 1.6 m chosen as the design wave incident to the reef. In the case of the seaward end of the entrance breakwater 20 m from the edge of the reef, the calculations show that the design significant wave height will by coincidence, also be about 1.3 m in height.

134. The maximum wave height identified in the JICA 1992 Main Report was a 50 y return period Hsig = 3.0 m from the east and the South. Malé is well protected from swell waves from the west and north. In the same report, the Malé West coast states an incident 50 y return period wave of, Ho = 1.2 m and T = 4.6 m. In Table 3.2.1, the JICA 1992 Supporting Report summarizes extreme wave heights for Malé, that is not in the main report, shown below in Table 12.

Table 12: Malé Significant Wave Heights – from JICA 1992 Supporting Report

Return Period (y)	Significant Wave height $H_{1/3}$ (m)		
	NW T = 4.6 s	SW T = 6.7 s	SE T = 14.5 s
1	0.95	1.00	1.85
2	1.00	1.10	1.95
5	1.05	1.25	2.15
10	1.1	1.35	2.25
20	1.15	1.60	2.60
50	1.2	1.60	2.60
100	1.25	1.70	2.70

135. It is interesting to note that the 20 y and 50 y return period waves from SW and NW directions are identical. At approximately 30 km, the fetch length within the Atoll for the SW wave is approximately the same for Malé and Kulhudhuffushi, so the incident wave for the design of breakwaters and revetments shall be Hsig = 1.60 m (T = 6.7 s).

136. In section 3.4.4 - Nearshore Wave Statistics, the report investigating the design wave climate for Dhuvaafaru Harbor Development Project in Maldives by (Department of Civil Engineering, University of Peradeniya, Sri Lanka, 2007) refers to the work done for the Malé Seawall Project and data collected specifically for the Dhuvaafaru Harbor Project, to conclude that: 'The maximum wave height simulated at the near-shore location of the harbor site is about 1.3 m having two-year return period. The wave heights predicted for higher return periods reaching from the same wave direction appear to be lower than that with two-year return periods indication possible wave breaking when propagating large waves over the shallow reef.

137. UNDP, 2007, Detailed Island Risk Assessment in Maldives Vol III: Detailed Island Reports, H. dh. Kulhudhuffushi – Part 1 (DIRAM 2007) states: "The western coastline is particularly exposed to abnormal swell waves approaching from the South-West of South Indian Ocean. Waves could penetrate through the open reef passes along the western rim and cause flooding. Wave height could reach 1.0-1.5 m during severe events and could penetrate 300m inland. The high intensity zone is predicted to be the first 50-100 m."

138. Unfortunately, the above statement is anecdotal and at odds with the approach outlined in the Safe Shelters Design Guide, which ignores swell waves and only considers wind waves for the length of the fetch within the atoll. That said, the statement gives some comfort as to the wave height to be expected at Kulhudhuffushi.

3.3.5 Wind

139. In the last two years, wind records at 10 minute intervals have been recorded at Hanimaadhoo, which would be very useful for performing a wave hind-cast; however, this data was unavailable for this report. Wind records are available in the JICA 1992 Main Report; however, duration is not recorded with wind speed in the available information, meaning that wave hind-casting requires an element of guessing.

140. DIRAM 2007 states in Section 2.2.3 – Wind storms and cyclones, p 21: 'Winds exceeding 35 knots (gale to strong gale winds) were common occurrences during South-West (SW) monsoon over the last 7 years'. In general, the wind speeds are higher in the north than the central and Southern areas during SW monsoon (DoM, 2005). Peak wind speeds in Hanimaadhoo between 2006 and 2007 showed 10 events above gale to strong gale winds (above 35 knots) and within them 6 events were above 40 knots.

141. During the past 7 years the highest peak wind speed was recorded as 46 knots on 21 June 2007. On this basis, a reasonable upper-bound wind speed which may be sustained for several hours over a 30 km fetch would be around 30 knots or 15 m/s. The Safe Shelters Design Guide states in Chapter 3 – Design Criteria, p3-17, that the wind speed used for structural design of buildings in Maldives is 27 m/s; however, the height and duration is not specified. It is assumed in this context that this value is for a 3 s gust at 10 m above ground level as is the norm for wind speeds stated for structural design in Australian standards. The wind speed is consistent with a non-cyclonic event.

142. Table 13 provides the Nakaiy Calandar which appears to give very accurate predictions of wind and sea conditions, calibrated by information provided by locals.

Table 13: Nakaiy Calendar

SW MONSOON – HULHAN'GU MOOSUN		
DATE	NAKAIY	WEATHER
08 April- 21 April	Assidha	Dry and hot. Very little rain. South-West monsoon starts.
22April- 05 May	Burunu	Rather dry and stormy with rough seas.
06 May- 19 May	Kethi	Dry with very little rain. Seven storms occur.
20 May- 02 June	Roanu	Stormy with heavy rain, strong winds and rough seas.
03 June- 16 June	Miahelia	Stormy with rough seas. Not suitable for travelling.
17 June- 20 June	Adha	Calm seas with little rain. Wind blowing from South-West.
01 July- 14 July	Funoas	Little rain with strong winds and rough seas. Not suitable for
15 July- 28 July	Fus	Cloudy with a lot of rain.
29 July- 10 Aug	Ahuliha	Calm and dry with a lot of sunshine.
11 Aug- 23 Aug	Maa	Generally calm with a lot of rain.
24 Aug- 06 Sept	Fura	Rainy season ends. Wind starts to blow from north-west.
7 Sept- 20 Sept	Uthura	Seas are generally calm with very little rain.
21 Sept- 03 Oct	Atha	Calm seas accompanied with small storms and a westerly wind.
04 Oct-17 Oct	Hitha	Isolated showers with weak westerly winds.
18 Oct-31 Oct	Hei	Lots of rain with winds generally blowing from west.
01 Nov-13 Nov	Vihaa	Calm seas with some rain.
14 Nov-26 Nov	Nora	Wind blowing from north-west. Currents change to north-east.
27 Nov-09 Dec	Dhosha	Calm with rain and sunshine.
NE MONSOON – IRUVAI MOONSUM		
10 Dec-22 Dec	Mula	Strong winds with rough seas. Wind blows from the North-
23 Dec-05 Jan	Furahalha	Strong winds with rough seas.
06 Jan-18 Jan	Uthura-	Strong winds with rough seas.
19 Jan-31 Jan	Huvan	Rough seas with moderate winds form North-East.
01 Feb-13 Feb	Dhinasha	Moderate seas with little blowing.
14 Feb-26 Feb	Hiyavihaa	Calm seas with little rain. Wind blowing from South-West.
27 Feb-11 Mar	Fura-	Small storms accompanied with thunder and lightning.
12 Mar-25 Mar	Fas-	Storm on 3rd and 4th day with moderate winds and thunder.
26 Mar-07 April	Reyva	Good. Mainly in the north of Maldives.

3.3.6 Current

143. No data is available; however, with a relatively small tidal range, it is anticipated that the tidal current will be small also, meaning less than 0.5 m/s.

3.3.7 Earthquake

144. There have been no recorded earthquakes in the Maldives.

3.3.8 Climate Change and Climate Resilience

145. A lot has been written about the possible impacts of climate change in the Maldives, where so much of the usable land is vulnerable to inundation from the sea. The main considerations for this project include:

- Sea level rise
- Increase in storm surge frequency and magnitude
- Increasing wave heights and current

146. Based upon the majority view written about global warming, sea level rise seems all but inevitable and it is only the rate and magnitude of the rise that remains contentious. Persuasive as this argument may be, at the time of preparing this report there were no official tide gauge records available to quantify the rate of sea level rise or demonstrate that the sea level is actually rising in the Maldives.

147. Further, although some alarmist predictions exist in relation to storm surge, specific work beyond the scope of this project is necessary to quantify a 1 in 50 y storm surge height. As discussed in the following, there is a very low frequency of occurrence of cyclones in the Maldives (non-cyclonic) and none of the design calculations uncovered for existing harbors and shore protection works, included an allowance for storm surge. This indicates that such events are very unlikely to be relevant to the design of the breakwaters and revetments. Unfortunately, this does not address the matter of how to ameliorate the effects of higher water levels and wave heights, should they occur in the future.

148. How to improve the resilience of any exposed shoreline and the island's interior against the possible impacts of climate change is a difficult question without a simple answer. Consideration of the solutions must be given in the context that this project does not represent a unique concept in the Maldives. In fact, given that there are over 150 similar harbors already in existence in the Maldives, a universal rather than unique solution is required to cope with the consequences of climate change if and when they appear in the years to come.

149. There is an immediate need, irrespective of the proposed harbor expansion project, to protect the recently reclaimed shoreline on the west coast of Kulhudhuffushi from further erosion. This can be achieved with a rock revetment and at a minimum, the proposed harbor expansion project will protect the shoreline from erosion.

150. The economics of minimizing/ eliminating the incidence of sea water inundation suggests that the correct approach is an incremental one of allocating capital only as required. Increasing the height of the quay wall before it is necessary has two readily identifiable negative impacts. Firstly, scarce resources will be allocated without an immediate or proven long term need. Secondly, the operation of the harbor with an unnecessarily high quay wall is undesirable and to be avoided if possible, for reasons of safety and practicality.

151. Breakwaters are necessary to provide calm conditions for boats moored in the harbor they protect. Even then, there will be times that boats are at risk due to waves overtopping the crest of the breakwater or potentially destructive levels of wave energy entering the harbor though the entrance. These are the conditions that the locals manage and accept in the existing harbors, and this approach appears to be sustainable so long as the breakwater structure is able to withstand the design conditions without significant damage.

3.4 Breakwater Design

3.4.1 Overview

152. Sound breakwater design requires physical model testing to ensure that the armor is stable for design wave conditions, the level of damage predicted for the armor size is not significantly exceeded, and the rate of overtopping is acceptable.

153. With over 150 harbors in the Maldives and a recent program of reconstruction after the 2004 Tsunami, a pragmatic approach to designing breakwaters which stretches scarce capital as far as possible has been adopted, meaning that calm conditions are not provided 24/7/365 and that at mostly predictable times of the year, extra mooring lines are required or boats are moved from the affected harbors. It is common practice for boats to be temporarily anchored on the opposite side of the island for shelter from rough seas and strong winds.

3.4.2 Armor Selection

154. Armor selection based on Hudson's formula, depends upon the wave height as a critical input. The mass of individual armor units is given by:

$$W = w_r H^3 D/(k_D X^3 \cot\alpha)$$

where

- w_r = specific gravity of rock
- H_D = design wave height (typically H_{sig}, but may be higher)
- k_D = 2 and 4 for breaking and non-breaking waves respectively, for random placed angular rock
- $X = w_r/w_w - 1$
- $\cot\alpha$ = inverse tan of slope, e.g. for slope of 1 vertical to 2 horizontal; $\cot\alpha = 2$.

155. The drawings in Appendix A show three breakwater sections as follows:

- Section A – Passenger/Cargo harbor (dredged to RL -4 m)
- Section B –Waterfront and Small Craft Zone Area (un-dredged)
- Section C–Seaward 60 m of entrance breakwater to the Passenger/Cargo Harbor

156. The armor size for Sections A and B are the same based on the Hsig = 1.3 m non-breaking wave, requiring an average mass of individual armor units of around 270 kg. A nominal average size of 400 kg has been adopted, equating to a double layer thickness of approximately 1,100mm based on the equivalent cube dimension.

157. The breakwater shown in Section C is subjected to a breaking wave of Hsig = 1.3 m, for which an average mass of armor rock units adopted is 600 kg, with a double layer thickness of approximately 1250 mm.

3.4.3 Crest Level

158. There are two main criteria used for choosing the crest level of a breakwater:

- Level of damage to the breakwater
- Disturbance within the harbor caused by overtopping

159. In the absence of model testing to verify that the level of damage to the breakwater from wave overtopping is acceptable, the crest elevation has been chosen in accordance with page 4-5 of the Safe Shelters Design Guide - (3) Crest Height of Breakwater, which recommends a crest level of RL 1.6 m MSL for all wave heights, provided that the breakwater is located a sufficient distance (around 100 m) from the edge of the reef.

160. All incident waves shoal (increase in height) as they pass from the deep water into the comparatively very shallow water over the coral reef flat, ensuring that all wave breaking will only occur at the edge of the reef. The reef therefore controls the maximum wave height in proportion to the depth of water, allowing a prescriptive approach to setting the breakwater crest level. In setting the crest level, Oriental Consultants who prepared the Safe Shelters Design Guide, have demonstrated that the rate of overtopping is satisfactory by use of a hand analysis.

161. By comparison, the local custom for such circumstances has been to use a breakwater crest level of RL 1.4 m MSL which although similar and possibly adequate, will allow greater volumes of water to enter the harbor at times of overtopping. It is recommended that physical model testing be performed to verify that the proposed crest level of RL 1.6 m is suitable.

3.4.4 Typical Sections

162. Drawing 0120 - Breakwater sections included below show the proposed breakwater sections for the waterfront waterfront and small craft zone area and the Passenger/Cargo harbor. Figures 12 and 13 below show Sections A and B respectively.

Figure 12: Breakwater - Section A

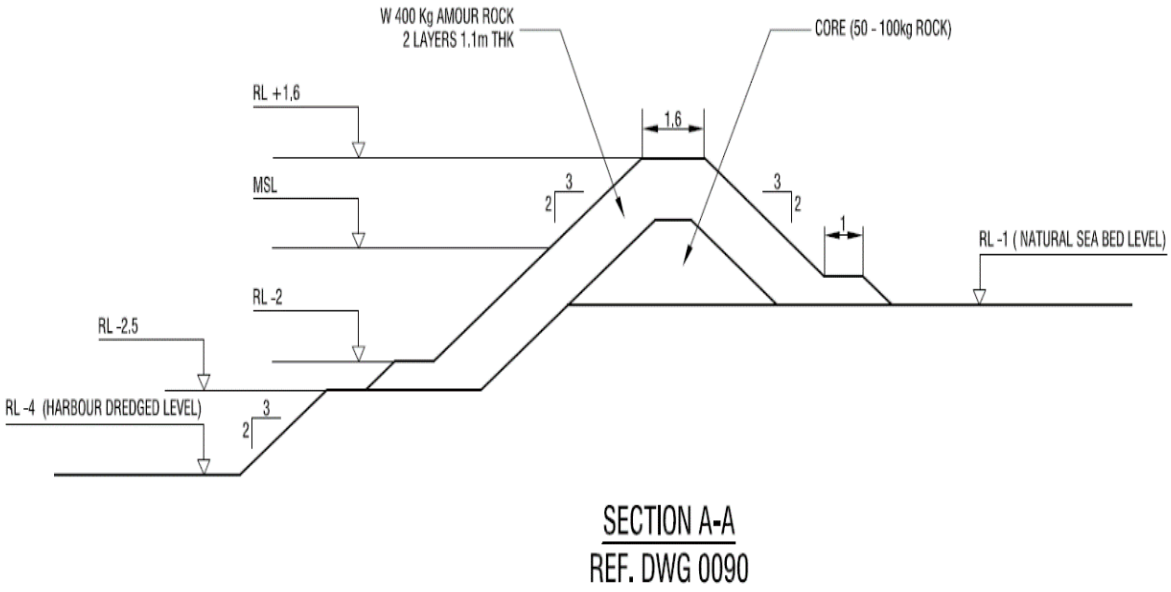
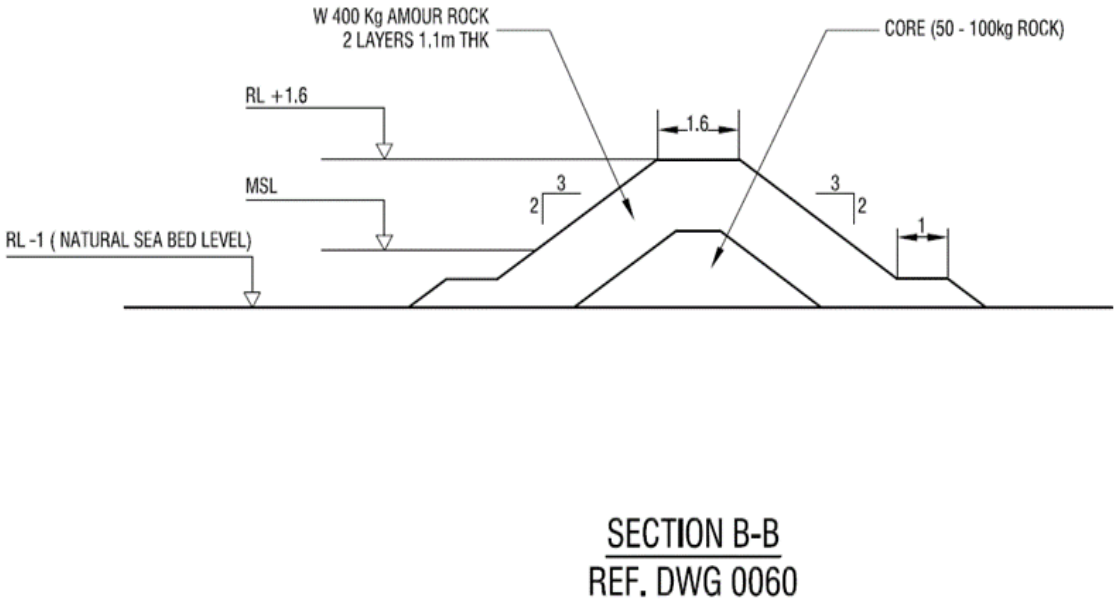


Figure 13: Breakwater – Section B



3.4.5 Harbor Entrance

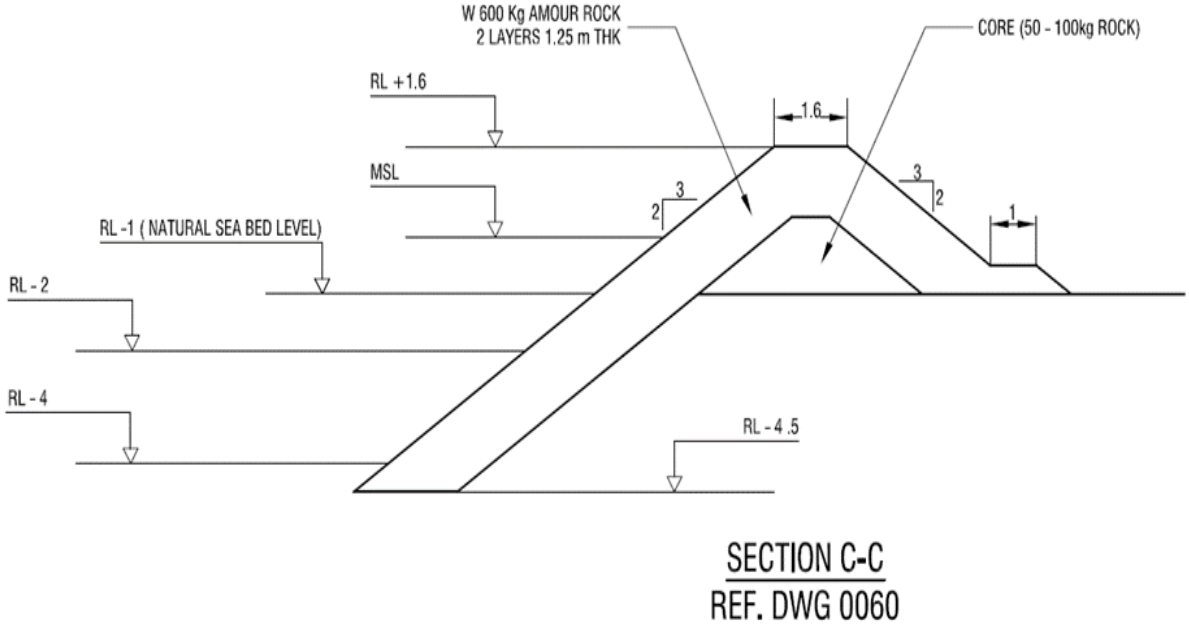
163. Choosing the orientation and width of the harbor entrance requires balancing competing requirements. Depending on the stage of the tide and prevailing wind velocity, a vessel entering the harbor through a relatively narrow may go off course with the possible consequence of impacting the breakwater.

164. On the other hand, if the opening is made too wide, the wave energy entering the harbor during more severe weather events, may be unacceptably high. The existing Kulhudhuffushi Harbor entrance was widened and the breakwater on the northern side of the entrance extended to approximately 100 m in length after the original configuration led to damaged vessels.

165. In accordance with the Safe Shelters Design Guide, the clear width of the entrance has been set at one boat length or 30 m and the orientation of the entrance breakwaters for the Passenger/Cargo Harbor shall be replicated from the existing harbor. There are no entrance breakwaters proposed for the waterfront and small craft zone area. Figure 14 shows the entrance breakwater cross section.

166. The toe of the armor on the channel side of the breakwater has been taken to 0.5 m below dredged level, rather than to a sand berm at a higher level, to minimize the width of the opening for the seaward 60 m length of the breakwater and to avoid exposing a sand berm to breaking waves.

Figure 14: Breakwater – Section C



3.4.6 Material Quantities

167. Rock volumes for the respective cross sections mentioned above are summarized below. The rates are based on the volumes calculated from the drawn outline, so there is no need to consider porosity.

Table 14: Breakwater Rock Quantities

Section		A	B	C
Core Vol	m^3/m	4.7	4.7	3.9
Armor Vol	m^3/m	13.6	10.6	18.9

168. Geotextile is included over the length of the interface between the rock and supporting sand and core material, to prevent subsidence from the migration of small particles through the interstices of the rock formation. The lengths exclude laps along the length of the breakwater, and overlaps required to anchor the fabric, as these allowances are made in the rates.

3.5 Quay Wall Design

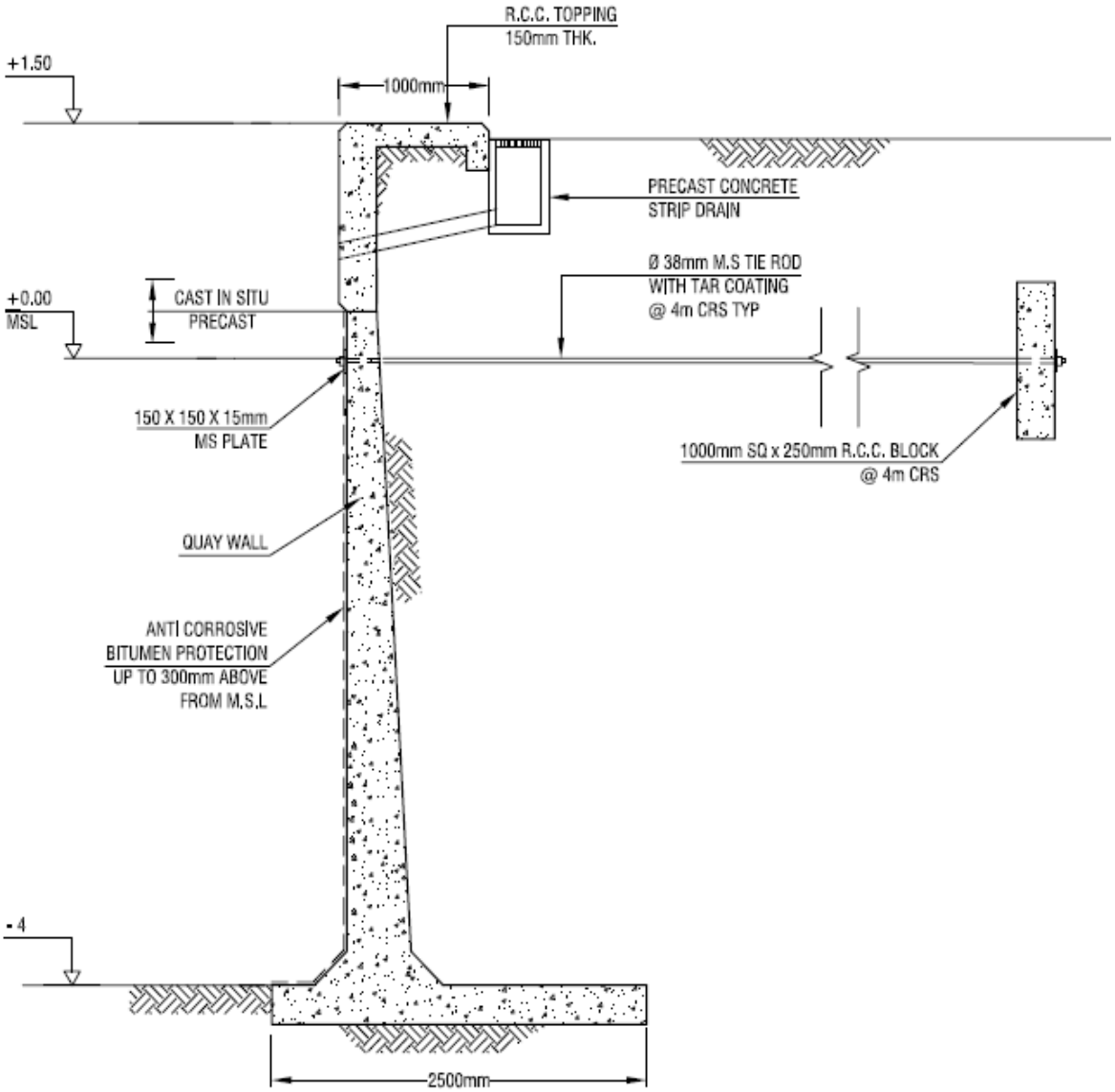
3.5.1 Overview

169. There are several suitable options available to provide a quay wall at the harbor/land interface; however, it is understood that the most prevalent solution adopted in the Maldives in recent times, is the L shaped precast concrete wall. Sheet piles with a concrete capping beam have been used in the past, but are understood to cost 30-40% more, and come with an ongoing maintenance obligation to keep corrosion in check.

3.5.2 Typical Cross Section

170. Figure 15 is an extract of Drawing 0110 – Wall Sections, included in Appendix A showing the general arrangement of the typical wall cross section.

Figure 15: Quay Wall Cross Section



3.5.3 Material Quantities

171. Drawings available for other harbor designs managed by MHI have a harbor dredged level of no more than -3 m MSL. For the purposes of this exercise, a linear prorate based on -4m MSL basin level and RL 1.5 m MSL top of quay wall to estimate the construction cost.

172. The rate used in the cost estimate is intended to include for steps and landings at 20 m centers, for access to and from boats with low freeboard at low tides. The estimate also includes a continuous strip drain and mooring rings at 5 m centers. Structural analysis of this arrangement is required to ensure that it is correctly proportioned and the rate used in the estimate is adequate.

3.6 Revetment

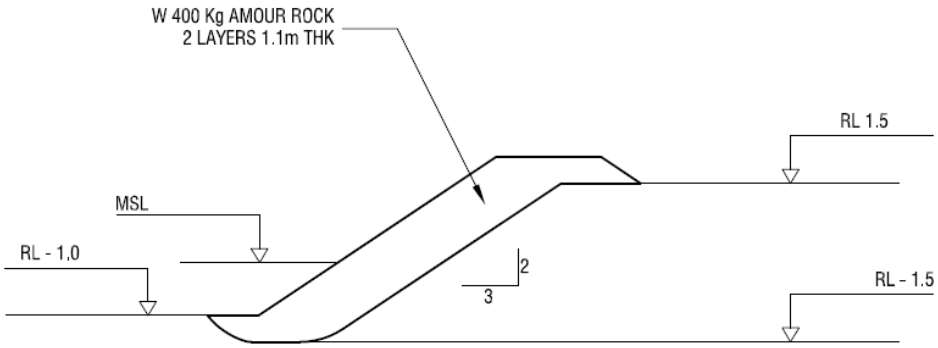
3.6.1 Overview

173. Both the passenger/cargo and the waterfront small craft zone require revetments. The seaward facing revetments in both locations use the Section I arrangement shown below. As a precaution, a smaller revetment – Section J has been included with toe level at MSL for the protection of the Southern edge of Area 2. Further consideration of this area is required once the topographic survey is received.

3.6.2 Typical Cross Sections

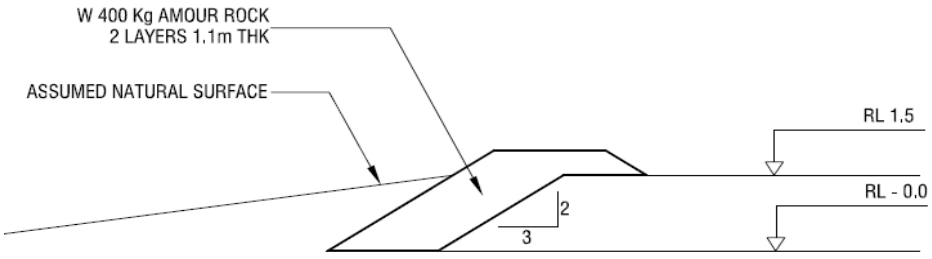
174. Two revetment cross-sections, I and J are included in the proposed works as shown on Drawing 0130 of which extracts are included in Figures 16 and 17.

Figure 16: Revetment - Section I



SECTION I-I
REF. DWG 0070 & 0090

Figure 17: Revetment - Section J



SECTION J-J
REF. DWG 0090

3.6.3 Material Quantities

175. The design of the armor is the same as for the breakwater Section A shown on Drawing 0120 – Breakwater Sections, using rock with an average mass of 400 kg in two layers approximately 1,100 mm overall. The theoretical volume for Section I and Section J are 6.9 m3/m and 4.4 m3/m respectively. The rates are based on the volumes calculated from the drawn outline, so there is no need to consider porosity.

176. Geotextile is included over the length of the interface between the rock and supporting sand to prevent subsidence from the migration of small particles through the interstices of the rock formation. The lengths exclude laps along the revetment and overlaps required to anchor the fabric, these allowances are made in the rates.

3.7 Cost Estimate

3.7.1 Overview

177. The rates used to determine the capital cost of most of the components of the proposed harbor development works, were provided by MHI in the form of two tenders submitted by two Contractors for a recent project of a similar nature. Cost rates for the breakwaters were provided on the basis of volume of core and volume of armor rock, rather than a rate per meter as provided in other tenders.

178. Tender prices and cost estimates were also made available by MHI for other projects; however, in the case of the breakwaters in particular, drawings were unavailable to convert the rate per meter to a volume rate. Without this information, it was impossible to determine a cost rate per meter for the various breakwater cross sections included in the Preliminary Design Drawings for this project.

179. Preliminaries were calculated as a % of the total for each tender and then applied to the respective cost estimates. For this reason, the presentation shows preliminaries below the subtotal rather than at the top of the estimate as is usually the case.

3.7.2 Basis of Rates

180. The total cost in the two tenders mentioned above were approximately 35% apart. One possible reason for this is that the lowest tender included reduced margins to ‘buy’ the project, reflecting a shortfall in forward work orders. Conversely, the high tender may have included opportunistic margins.

181. To establish a more representative market rate applicable to any similar project, two complete cost estimates were produced based on each Contractor’s rates and the quantities for this project. The difference between the two converged to 8.7%.

Three quarters of the difference was added to the lowest cost to produce the final market cost estimate, representing the upper quartile of the two estimates. The rates in the lowest estimate were then increased by just over 6.5% to arrive at market rates used in the final cost estimate.

3.7.3 Contingency

182. A contingency of 10% is included, based on the level of precision in the calculated quantities and rates available from similar projects. As discussed elsewhere in this report, the contingency may not truly reflect the risks associated with:

- The revetment along the southern edge of Area 2
- Lack of engineering design of the quay walls
- Lack of geotechnical information

3.7.4 Summary of Cost Estimate

183. The cost estimate has been prepared with the waterfront small craft zone area and the Passenger/Cargo harbor costs shown separately and then aggregated. The summary is provided in Table 15 below. Detailed cost estimates are shown in Appendix B (B1 and B2).

184. The cost estimates in both Table 15 and Appendix B include import duties and value added tax (VAT), where applicable. However, they do not include Project Management Consultants (PMC) and Ancillary (mitigation) costs, estimated at USD 800,000 and USD 200,000 respectively.

Table 15: Cost Estimate Summary

ITEM	DESCRIPTION	COST	
		(MVR)	(USD)
Waterfront Small Craft Zone			
	Site Clearance	32,815	2,131
	Breakwater	9,856,378	640,025
	Revetment	1,372,215	89,105
	Reclamation	521,303	33,851
	Subtotal	11,782,710	765,111
	Preliminaries	1,767,407	114,767
	Total (excl. contingency)	13,550,117	879,878
	Contingency (10%)	1,355,012	87,988
	TOTAL	14,905,129	967,865
Passenger/Cargo Harbor			
	Site Clearance	32,815	2,131
	Dredging	15,498,166	1,006,374
	Breakwater	21,540,426	1,398,729
	Revetment	6,917,978	449,219
	Quaywall	23,660,046	1,536,367
	Harbour Separation Wall	4,666,342	303,009
	Finger Piers	2,067,367	134,245
	Reclamation	615,288	39,954
	Solar powered navigation beacons	65,631	4,262
	Survey and compaction	66,500	4,318
	Pavement	1,727,153	112,153
	Buildings (Retail and Admin + Passenger Terminal	4,594,148	298,321
	Market (Fish and Veg)	2,461,151	159,815
	Ice Plant	410,192	26,636
	Quay lighting	575,334	37,359
	Subtotal	84,898,537	5,512,892
	Preliminaries	12,734,780	826,934
	Total (excl. contingency)	97,633,317	6,339,826
	Contingency (10%)	9,763,332	633,983
	TOTAL	107,396,649	6,973,808
	GRAND TOTAL without contingency	111,183,434	7,219,703
	GRAND TOTAL with contingency	122,301,777	7,941,674

4. ECONOMIC FEASIBILITY AND EVALUATION

4.1 Scope and Objectives

185. The PPTA TOR states that Economic and Financial Feasibility entails 'an economic analysis for the development of the passenger harbor. The assessment includes review of macroeconomic context, review of sector context, demand analysis, review of economic rationale, identification of project alternatives, identification and comparison of costs and benefits, assessment of project sustainability, distribution of project effects, sensitivity and risk analysis, and identification of indicators for project performance monitoring system. The analysis will include estimation of proposed harbor user charges and development of cost recovery mechanism for sustainable operation and to minimize subsidy will be provided. As the proposed project expects to generate revenue, the financial analysis will also be carried out by calculating the financial internal rate of return (FIRR)'.

186. In his work, the Consultant has interpreted that the 1st part of the above task relates directly to the economic analysis; which is reported in this section, whereas the 2nd part relates to the financial feasibility, the latter is reported in Chapter 5 below.

187. Given the above, the economic feasibility and evaluation subject of this Chapter includes the followings:

- Review of the economic background for the Maldives, Kulhudhuffushi and the North region in general,
- Brief scoping of the economic context of this project both from a national, urban and transport policy objectives,
- Analysis of transport demand in Kulhudhuffushi and the northern region,
- Analysis of trans(port) supply and port capacity in view of future demand,
- Identification and evaluation of economic benefits of the project, its various components and main scenarios,
- Analysis of project costs and prices for the calculation of the EIRR and CBA,
- Sensitivity and risks analysis, and
- Summary of the benefits and their distribution.

188. The above components and economic feasibility reported in this section are a revised and final version of the draft version submitted on 20 January 2016 as part of the DFR.

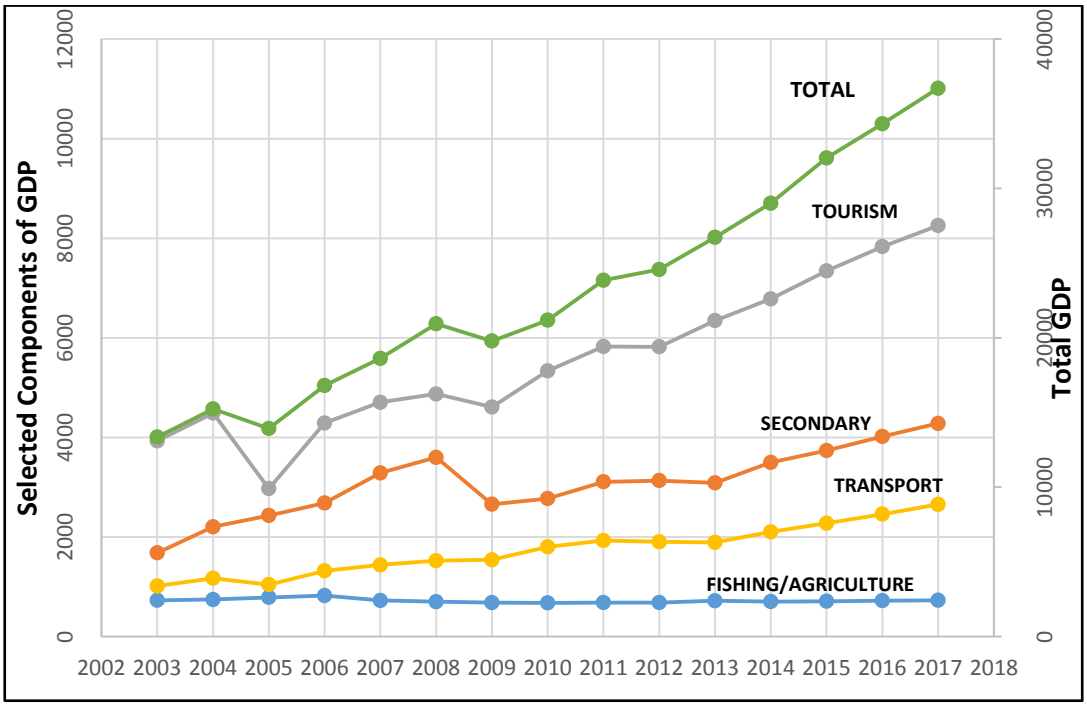
4.2 Economic and Project Context

4.2.1 Economic Context

189. The Maldives economy is strongly related to returns from tourism. The component of Gross Domestic Product (GDP) provided by tourism is approximately one quarter of total GDP. However, other sectors of the economy such as agriculture, transport, and construction are linked to tourism to some degree, and the direct and indirect impact of tourism is significantly higher than noted above. This heavy reliance means that the country is vulnerable to outside influences that affect tourism.

190. Figure 18 shows selected components of GDP, including the total shown against a secondary axis. The chart includes figures forecasted beyond 2014 by the National Bureau of Statistics. The total GDP in 2014 (at 2003 constant prices) was million MVR 29,006.

Figure 18: Sector and Total GDP (million MVR in 2003 prices)



191. The graphs show the fall in GDP following the Indian Ocean tsunami in late 2004, as well as the effect of the global financial crisis in 2008. The only sector did not suffer from the tsunami's effect was transport while the secondary sector which includes construction grew strongly after the tsunami. This contributed to a higher than normal rate of growth in total GDP between 2005 and 2008, but a subsequent readjustment to normal activity has produced a normal and steady growth rate from 2009. This translated into an annual average GDP growth of 7.5% over that period. Table 16 shows the distribution of GDP by sector.

Table 16: GDP Components (in million MVR - 2014 figures in 2003 prices)

GDP at market price	29,006
Primary	**702**
Agriculture and mining	379
Fisheries	323
Secondary	**3,495**
Manufacturing	773
fish preparation	*323*
Electricity and water supply	756
Construction	1,967
Tertiary	**19,144**
Wholesale and retail trade	1,020
Tourism (Resorts, etc.)	6,780
Transport	2,100
Communication	2,474
Financial services	557
Real Estate	1,748
Business services	237
Government Administration	2,546
Education	882
Health	625
Social services	176

192. The use of natural resources shown by fisheries and agriculture is low and also static. This reflects limitations in the abundance of fish stock or approach, and to some extent the effect of small island size on agriculture.

193. In terms of income and expenditures, the IFAD website notes the following: "Compared to neighboring countries, income distribution in Maldives is relatively unequal. Between 1997 and 2005 there was a noteworthy increase in inequality between Malé, the capital island, and the atolls. During that period the median per capita income per day in Malé increased from 1.7 times to 2.3 times the income of people living in the atolls.

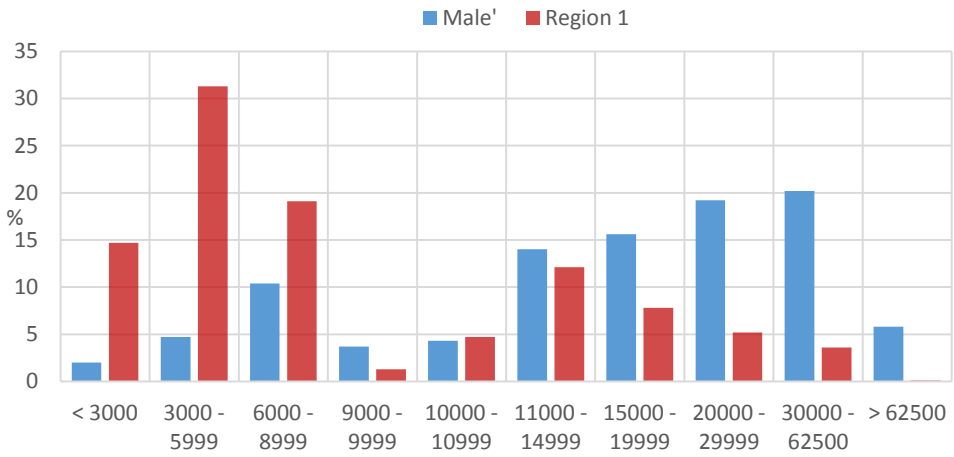
194. The islands that comprise Maldives are indeed widely dispersed and have a low population density. This increases the cost of living, including transport costs, and the cost of delivering essential social and administrative services to people in the outer, remote atolls."

195. This is seen in the GoM Report on Household Income and Expenditure Survey (2009/2010), the main observations of which are presented in Table 17 and graphed in Figure19, covering both Malé and Region 1 (the latter covers the atolls/islands grouped around Kulhudhuffushi).

Table 17: Percentage of Households by Monthly Household Income Class

	Income Class	Malé	Region 1
Monthly Household Income (MVR)	< 3000	2	14.7
	3000 - 5999	4.7	31.3
	6000 - 8999	10.4	19.1
	9000 - 9999	3.7	1.3
	10000 - 10999	4.3	4.7
	11000 - 14999	14	12.1
	15000 - 19999	15.6	7.8
	20000 - 29999	19.2	5.2
	30000 - 62500	20.2	3.6
	> 62500	5.8	0.1
No. of Households in Survey		14,789	7,513

Figure 19: Percentage of Households by Monthly Household Income Class



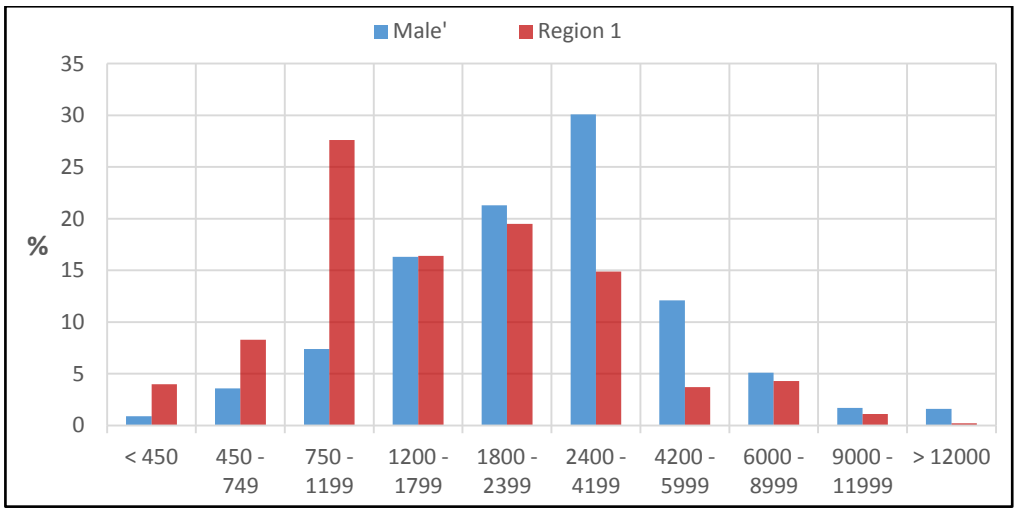
196. The values given in Table 17 above show a mean household income of MVR 24000/month in Malé and MVR 9600/month in Region 1. This disparity carries through to expenditure figures, shown in Table 18 and Figure 20.

Table 18: Percentage of Households by Monthly per Capita Expenditure Groups

Expenditure Group (MVR/month)	Malé	Atolls	Region 1
< 450	0.9	3.4	4
450 - 749	3.6	11.8	8.3
750 - 1199	7.4	22.2	27.6
1200 - 1799	16.3	22.5	16.4
1800 - 2399	21.3	15.3	19.5
2400 - 4199	30.1	16.8	14.9
4200 - 5999	12.1	4.4	3.7
6000 - 8999	5.1	2.7	4.3
9000 - 11999	1.7	0.5	1.1

> 12000	1.6	0.4	0.2
No. Households in Survey	15,637	33,684	8,149

Figure 20: Percentage of Households by Monthly Household Expenditure Group



4.2.2 Project Context

197. The GoM is addressing two major issues:

- The concentration and rapid build-up of economic activity in Malé, and the associated high rate of population growth, have placed great pressure on the island's infrastructure. This is evident in population density figures, the traffic situation, and the rapid and crowded growth in high-rise buildings.
- The atolls have lagged behind Malé in economic and welfare development, aggravated by the attraction of Malé as a center for employment opportunities.

198. Referring back to Table 1, data from 2006 and 2014 census shows that Malé is growing at almost four times the rate of the atolls. At a more local level in Region 1, the Malé rate is twice that in Haa Dhaalu while the population in Haa Alifu has been static.

199. To assist islands' development and relieve pressure on Malé, it is necessary to increase employment opportunities in the islands. The GoM development plans include allowance for increasing regional prosperity.

200. At present, however, Malé remains the focal center for all the islands. Even the most distant islands from Malé send boats to the capital for transporting cargo imported through the Malé's commercial harbor. The goal then is to emulate the self-sustaining growth that Malé has experienced by developing the regional centers. This requires a change in transport patterns so that, in the northern region, the Islands - Malé link is replaced by Islands-Kulhudhuffushi and Kulhudhuffushi-Malé links; thus making Kulhudhuffushi the main hub for the Northern region and a transit center between the Northern Atolls, Malé, and the rest of the country. This

would be potentially improved by a greater activity at KPL, making the northern region more self-sufficient.

201. The main objective of this project is to increase people's access and connectivity between Kulhudhuffushi and the Islands while supporting the GoM's development plans for Kulhudhuffushi and the Northern region in general.

202. Providing the islands' population with appropriate access to basic public services such as health and education requires regular and frequent maritime services between Kulhudhuffushi and the Islands as well as sufficient and adequate harbor infrastructure and facilities to accommodate and support those services.

203. Furthermore, other forthcoming developments such as the construction of a new airport and the upgrading of the regional hospital and the university's regional campus will lead to greater focus on Kulhudhuffushi as the main hub in the Northern region, and will generate more frequent travel and in greater numbers.

204. Currently, a major hindrance in the link between the Islands and Kulhudhuffushi is the lack of frequent and reliable transport services available to the islands' populations. The resulting mismatch between the need to travel without an undue time penalty (unconstrained demand) and the service offered (constrained supply) limits the frequency of travel.

205. This situation has prompted the GoM to take active intervention to change the status-quo. Currently, the Ministry of Economy and Development (MoED) is reviewing concession requirements and arrangements for public maritime services between Kulhudhuffushi and the Islands with a view to increase transport frequency and reliability. At the same time, shipowners operating outside 'regulated' public maritime services have also expressed their desire to increase the amount and frequency of services to-from Kulhudhuffushi; but their demand is currently constrained by limited harbor facilities, both in size and availability.

206. Another demand stream for additional harbor infrastructure and facilities comes from development plans by the adjacent KPL Kulhudhuffushi regional port, the latter is considering establishing KPL as a major transit hub in the Maldives for imported perishable cargo. This will generate additional demand for the domestic harbor as goods unloaded and stored in KPL will then need to be loaded in the domestic harbor for distribution to other islands and destinations in the country.

207. The harbor expansion project will enable adequate access and improved connectivity between Kulhudhuffushi and the Islands. Without the harbor expansion, there will be limited access and more congestion; thus restricting access to public services, discouraging frequent transport links, adding extra costs to transport operators, and delaying other infrastructure and economic development projects.

208. The proposed expansion of the harbor will then be required to improve citizen's access to public services and other facilities, prevent congestion and delays, allow for dedicated facilities for fishing, passenger, cargo, and small craft operations, and

enable access of larger ships to berths and mooring basins while ensure safe mooring and handling for passenger and cargo operations.

209. The need for increased connectivity in the atolls and the GoM's intention to address this need have been recognized in the ADB's study on the challenges of small island states country diagnostic (2015), which notes:

- 'Poor transport infrastructure and connectivity remain a major constraint on investment. Transport costs are high because of the long distance between islands and atolls, underinvestment in critical sea transport infrastructure, and heavy reliance on imported fuel.'
- 'Inadequate transport infrastructure is a serious constraint for micro, small, and medium-sized enterprises (MSMEs) and private individuals on the atolls. To get around this constraint, some small and medium enterprises have been resorting to chartering private ferries when the need arises, which increases the firms' operating expenses.'
- 'The GoM recognizes the need for a maritime transport plan to handle the recent increases in sea transport activities, and sought technical assistance from ADB to draft the Maritime Transport Master Plan (MTMP), which was finalized in 2013.' One of the main strategy elements of the MTMP address the goal of improving passenger accessibility by stating 'Aside from implementing a hub and spoke network, frequencies of ferry services are to be improved'.

4.3 Economic Evaluation

4.3.1 Data Issues and Limitations

210. The existing harbor in Kulhudhuffushi is operated with minimal supervision. As such, there is no data available on passenger and cargo traffic, ships' calls, waiting and berthing times, loading and unloading operations, ship's and passenger's safety data, etc.

211. During the curse of this PPTA, the Consultant has requested relevant data on ship and port operations in Kuhudhuffushi and the Northern region to be readily available. However, despite receiving partial information from various stakeholders; the data received only show public ferry systems in the northern region but no information is given on the routes plied by the various ferries go or the islands called in each route. Some ferry route information is available online from the old Ministry of Transport but it is neither current nor reliable; as an example the route numbers do not correspond to the ones shown in the tables.

212. In the absence of reliable and detailed secondary data, the Consultant used questionnaires and face-to-face discussion on site to try to extract primary data and relevant information on port traffic and operations, however the responses were often incomplete, anecdotal and sometimes contradictory.

213. While there is good oversight of boats berthing in Malé and other MPL port, due in particular to the use of a tariff system, this is not the case for other ports in the Maldives. The great number and turnover of boats serving all the nation's islands, the piecemeal loading and unloading of cargo, and the absence or lack of qualified port staff in local ports mean that it is not possible to routinely collect and track harbor, cargo and vessel data. Consequently, data required for the analyses made in this study has been derived by inference and rational evaluation of the broader data that was obtained and could be verified.

214. The absence and/or lack of updated and reliable maritime and port data in Kulhudhuffushi and other local ports has been a major impediment in this PPTA. To this end, we have recommended the establishment of a maritime/port data warehouse across the country to tackle this issue. For the purpose of this project, the Consultant has recommended this action to be part of CDTA 2 on institutional development, as outlined in Chapter 6 of this Report.

4.3.2 Transport Demand at Kulhudhuffushi and the Islands

4.3.2.1 Population Growth

Kulhudhuffushi

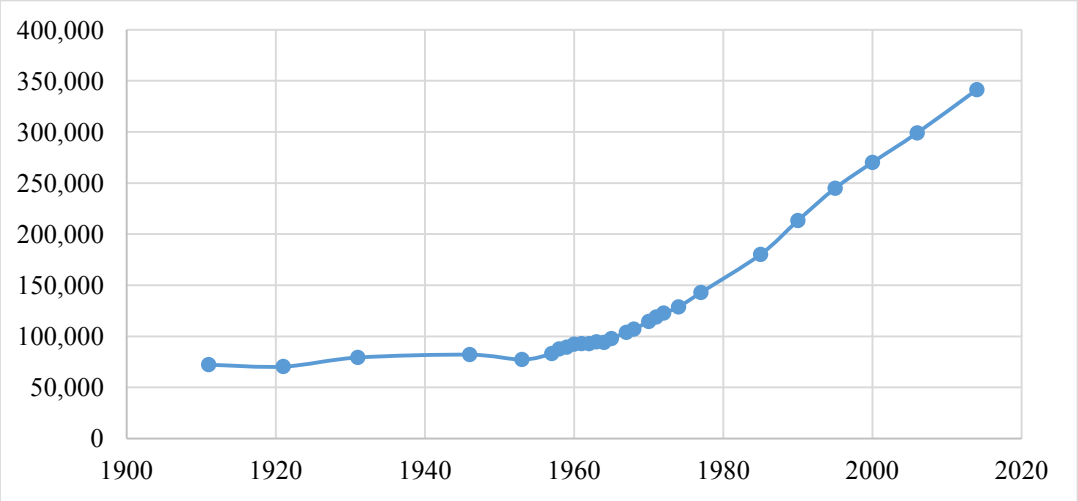
215. The growth in transport service needs will most significantly be influenced by the growth in population. In this respect it is not continued growth at the current rate that is at issue, but growth that takes account of the expected focus on Kulhudhuffushi as a regional center. This focus includes the proposed development of an airport on Kulhudhuffushi instead of the existing regional airport on nearby Hanimaadhoo Island, and an upgrading of the Kulhudhuffushi hospital.

216. The GoM's strategy is to expand the population of Kulhudhuffushi, from the present 8,440 to an ultimate figure of 50,000. No timeframe is given, but this would have to be over a considerable period and would require the development of infrastructure similar to the build-up of Malé (including increased activity in the Kulhudhuffushi overseas port).

217. One way to determine the possible rate of growth in Kulhudhuffushi is then to assume that it would be similar to that in the earlier days of Malé, the population growth figures for which have included the impacts of infrastructure development as well as migration.

218. In its Yearbook 2015, the GoM gives figures for the growth of population in the Maldives from 1911 to 2014, as shown in Figure 21. The first available count of population was in 1911. The first general census that can be viewed was taken in 1931 (Census, 1931). The early low growth rate shows the impact of the two world wars in which there was considerable hardship in the Maldives.

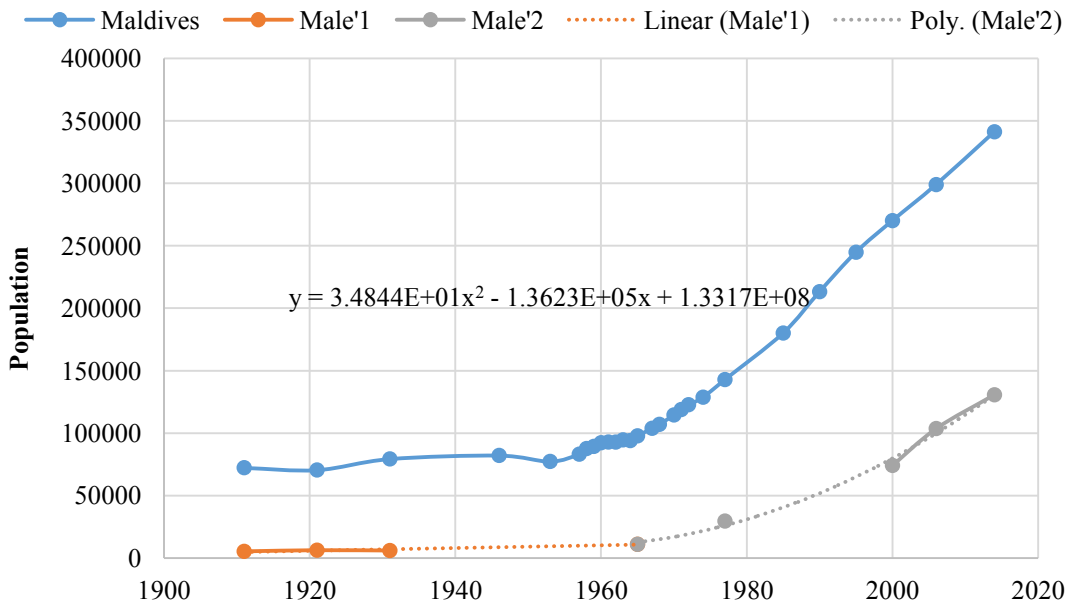
Figure 21: Maldives' Population Growth



219. The dramatic growth in the 1960's reflects the post-war changes around the world, followed by the impact of tourism development near to Malé and the Government establishing health, education, and business facilities there. It is therefore the growth in Malé that contributes the major part of the rise in the country.

220. Until recently there has been only a limited measure of the division in population between Malé and the other islands. The 1931 census gives the population of Malé in 1911 as 5,236, rising to 6,172 in 1921, then falling to 5902 in 1931. The population was 10,900 in 1965. However, the data available for Malé reflects the growth in the total Maldives, as noted above, and shows a similar division into two parts. The overall Malé growth rate from 1965 to 2015 is 5.2%; but the rate has varied from 8.7% (between 1965 and 1977) and 3.9% between 1980 and 2014.

Figure 22: Population Growth in the Maldives and Malé



221. The early growth rate in Malé is related to the circumstances of that time. Prior to 1965 there was very limited growth over the whole of the Maldives. Subsequently Malé has established itself as the focus of business, finance, and government – attractive to the whole of the country. At the present time Kulhudhuffushi will be developing in the northern region only, against that Malé background, and is unlikely to achieve the momentum of the early days.

222. In the light of this we have assumed that the growth rate in Kulhudhuffushi will approach the current rate in Malé, and have chosen a figure of 3.5% per year. However, the current growth rate in Kulhudhuffushi is 1.68% per year (Census 2014), and it would be reasonable to increase from near this value at the start of the period, and increasing steadily over a number of subsequent years. Therefore, the assumption has been made of a population growth rate of 2% per year in 2019, the first year of harbor oeration, rising to 3.5% over the next ten years.

223. The number of nationals in Kulhudhuffushi in 2014 was 8011 and the number of foreigners was 213, i.e. 2.7% of the nationals. This ratio has then been assumed to apply constantly over the project years. The following figures have finally been used in the analysis.

Table 19: Kulhudhuffushi Population Assumed in the Economic Analysis

2014	2019	2024	2029	2034	2039	2044	2048
8,224	9,027	10,189	11,926	14,165	16,823	19,981	22,929

Atoll Islands

224. Population growth rates between 2014 in Region 1 are given in Table 20. The future rates are based on the following assumptions:

- Ha Alifu to continue losing population to the south but will simply change in part from Malé as a destination to Kulhudhuffushi. The current rate is kept constant.
- Haa Dhaalu to supply part of the future Kulhudhuffushi growth, and the rate falls from 1.41%/y to 1.0%/y over 10 years.
- Part of the population loss to Malé will switch to Kulhudhuffushi, with a slight increase in this direction (the growth rate in Shaviyani falls from 0.36%/y to 0.30%/y over 10 years).

Table 20: Atoll Population Growth Rates (without Kulhudhuffushi)

Atoll	2014	Assumed Future
Haa Alifu	-0.57 %/y	-0.3 %/y 2019 onwards
Haa Dhaalu	1.37 %/y	1.37 %/y falling to 1% /y by 2029
Shaviyani	0.32%/y	0.36%/y falling to 0.30% /y 2019 onwards

225. The assumed future growth rates (excluding Kulhudhuffushi from Haa Dhaalu) give the following figures shown in Table 21. The 'total' values approximate a growth rate of 0.35% per year from 2019.

Table 21: Atoll Island Population Assumed in the Economic Analysis

	2014	2019	2024	2029	2034	2039	2044	2048
Haa Alifu	13,412	13,141	12,945	12,752	12,562	12,375	12,190	12,045
Haa Dhaalu	10,983	11,691	12,332	12,961	13,622	14,317	15,047	15,658
Shaviyani	12,669	12,860	13,054	13,251	13,451	13,654	13,860	14,027
Total	45,288	46,719	48,520	50,891	53,800	57,169	61,078	64,658

4.3.2.2 Freight Growth

Freight from Malé to Region 1

226. Almost all the nations goods are imported in the Maldives and almost all freight is landed at the Malé Commercial Harbor. From there the share taken by all other islands goes via the Malé North and South West Harbors either directly to each island or to an atoll capital such as Kulhudhuffushi and then to the island. There is no record of the freight volumes going to the islands and an estimate must be made.

227. From the limited information available the assumption made was that the division of freight between Malé and all other islands is proportional to the total household expenditure in the two sectors, as published in Household Income and Expenditure report (2009/10) which gives household expenditure in 10 bands and the % of households in each band. As a large number of households were surveyed, it can be assumed that the results are reasonably representative of each sector.

228. Accordingly, if an average expenditure is assumed for each band then use of the proportion percentages for these bands gives a total expenditure for one hundred households in each of the Malé and 'all other islands' regions. In turn this gives an average expenditure per single household in each. The results can be multiplied by numbers of households in the two, giving the divide proportion for the two which can be applied to freight. The evaluation is shown in Table 23 below.

229. One issue with the evaluation is that the data applies only to Maldivian nationals and does not include foreign workers. The numbers of these are substantial. However, it is assumed in this evaluation that a large portion of their income is repatriated to their homeland and their combined expenditure is low, sufficiently to not greatly influence the outcome of the evaluation.

230. The number of households in Malé in 2009/2010 (HIES) was 15,637, and that in the atolls was 33,684. The tourism yearbook (Ministry of Tourism, 2014) notes over 7,000,000 tourist arrivals in 2013, giving the equivalent of a resident population of 19,300 over the year. This equates to an additional 3,200 households in the islands. These people would not require the same import freight levels as a local resident, but on the other hand, any less amount would be more than balanced by the import requirements of resort staff.

231. Therefore, the island household number has been increased by 10% to 37,050. Total expenditure in Malé is then MVR 49,714,700, while total expenditure in the atolls was MVR 75,826,500. The ratio to be applied to freight tonnes is then 49,714,700 to 75,826,500, i.e. 40% to Malé and 60% to the other islands.

Table 22: Total National Expenditure Divided between Malé and all other Islands (Atolls)

Expenditure (MVR/HH/month)		% of Each Band		Evaluation of Expenditure for 100 Households (MVR/month)	
Bands	Average	Malé	Atolls	Malé	Atolls
<450	350	0.9	3.4	315	1190
450-749	600	3.6	11.8	2160	7080
750-1199	975	7.4	22.2	7215	21645
1200-1799	1500	16.3	22.5	24450	33750
1800-2399	2100	21.3	15.3	44730	32130
2400-4199	3300	30.1	16.8	99330	55440
4200-5999	5100	12.1	4.4	61710	22440
6000-8999	7500	5.1	2.7	38250	20250
9000-11999	10500	1.7	0.5	17850	5250
>12000	13700	1.6	0.4	21920	5480
Total %		100.1	100		
		per 100 Households (MVR)		317930	204655
		per one Household (MVR)		3179.3	2046.6

232. Imported cargo in 2009/2010 was 917,000 freight tonnes. The proportion going to the other islands is 60% of this, i.e. 550,200 freight tonnes. The amount per household is 550,00/37,050, i.e. 14.85 freight tonnes per year. With an average

number of 6 per household the freight per person is 2.5 tonnes per year. This figure has been used in the analysis to evaluate the weights of cargo required in Kulhudhuffushi and the islands.

4.3.2.3 Numbers of Vessel Calls to Kulhudhuffushi Harbor

Cargo

233. The number of trips between Kulhudhuffushi and Malé made by cargo boats depends on the yearly amount of cargo required by Kulhudhuffushi, and grows progressively with population growth. It also depends on the size of the boats and the average amount of cargo they carry.

234. From interviews at Kulhudhuffushi the cargo boat fleet has been assumed to consist of the sizes given in Table 23.

Table 23: Assumed Boat Characteristics Kulhudhuffushi - Malé

	Kulhudhuffushi		
Length	30 m	28 m	20 m
Horsepower	450	397	208
Cargo Capacity (tonnes)	93	81	42
Number of Crew	8	8	6

235. The cargo required each year in Kulhudhuffushi includes an amount for those from the islands who shop at Kulhudhuffushi as well as the needs of Kulhudhuffushi itself. This is assumed to be carried from Kulhudhuffushi by the fleet set out below.

Table 24: Assumed Boat Characteristics Kulhudhuffushi – Islands

	Other Islands
Length	17 m
Horsepower	154
Cargo Capacity (tonnes)	30
Number of Crew	5
Number of Boats in Fleet	20

236. It is considered that the islands of Haa Alifu, being the furthest from Malé, would be the readiest to shop from Kulhudhuffushi. Shaviyani would be the most willing to travel to Malé. Haa Dhaalu would divert a higher proportion from Malé to the

Kulhudhuffushi hub. The assumptions shown in the following table have been made.

Table 25; Freight into Kulhudhuffushi (Tonnes per Year)

	Population (2014)	Freight/y (tonnes)	% via Kulhudhuffushi	Total Cargo into Kulhudhuffushi (tonnes/y 2014)
Haa Alifu	13,412	33,532	25.00%	8,383
Haa Dhaalu (less Kulhudhuffushi)	10,983	27,458	30.00%	8,237
Shaviyani	12,669	31,673	15.00%	4,751
Kulhudhuffushi	8,224	20,650	100%	20,560
TOTAL				41,931

237. Sufficient boat visits were made (in 2014) to transport 41,931 tonnes into Kulhudhuffushi, but the same harbor received boat visits from the islands to take away 21,3571 tonnes. In the analysis it is assumed that this latter cargo is taken by a fleet of twenty boats of 17 m length.

238. Each boat can make an average of 70 return trips per year between Kulhudhuffushi and Malé. The fleet capacity therefore has to be sufficient, considering both percent of capacity carried on average and the number of boats in the fleet, to transport 608 tonnes per fleet trip. The assumption has been made that each boat carries 50% of capacity.

239. The analysis has been carried out over a range of assumptions for the unloading rate. The following table gives the fleet assumptions and an example of the parameters for boat trip numbers and inter-arrival times (based in the example case on the average cargo being 50% of capacity, and an unloading rate of 5 tonnes/hour). These details are for the future situation with part of the freight to the islands diverted via Kulhudhuffushi, as detailed in Table 26.

Table 26: Cargo Boat Visits to Kulhudhuffushi per Year (2014)

	Kulhudhuffushi-Malé Fleet			**Islands Fleet**
Length	30 m	28 m	20 m	17 m
Fleet size	4	6	8	20
Capacity of each (t)	93	81	42	30
Cargo at 50% of capacity (t)	47	42	21	15
Fleet capacity (t)	608			300
Individual boat trips	276	414	552	1425
Inter-arrival time (hrs)	32	21	16	6

Increase in Freight Demand

240. The growth in freight demand over the analysis period is based on population growth * GDP per capita growth * GDP elasticity of freight travel demand. GDP growth has been 7.5% from 2005 to 2014. GDP per capita growth has averaged 4.6% and population growth 2.5% over 2005-2015. GDP growth is intuitively higher in Male' than in the atolls (no data is available to determine the difference) and consequently the atoll growth rate is lower than the above national averages. Therefore, a conservative GDP growth forecast of 4.5% for 2016-2025 and 3% onwards. This results in a GDP per capita forecast of 2.45% (2016-2025) falling down to 1.45%.

241. The GDP elasticity of freight travel demand is estimated, from experience, to be 0.8.

Passengers Current Travel

242. The ADB 2005 study carried out a survey that included information on the number of trips made by households, given in the report's Table 27.

Table 27: Number of Individual Return Trips per Household for 2004-2005

Island		#Hhs.	Within Atoll		Between Atolls		To Malé	
			Mean	Median	Mean	Median	Mean	Median
HA	Ihavandhoo	42	4	3	6	4	2	1
HDh	Kulhudhuffushi	136	8	2	11	2	5	1
Sh	Bileffahi	11	6	3	8	5	6	2

243. It is assumed that a number of visits to Kulhudhuffushi from the atolls are for the purpose of transiting on to Malé in the relatively large purpose-built ferries. Assumptions made and travel numbers are given in the following table for 2019.

Table 28: Passenger Visits per Year to Kulhudhuffushi

Atoll	Households	Within Atoll	Between Atoll	To Malé	Total
Mean trips per household					
Haa Alifu		4	6	2	
Haa Dhaalu		8	11	5	
Shaviyani		6	8	6	
% of trips to Kulhudhuffushi					
Haa Alifu		0%	100%	10%	
Haa Dhaalu		100%	30%	70%	
Shaviyani		0%	50%	10%	
Weighted number of trips per household to Kulhudhuffushi					

Atoll	Households	Within Atoll	Between Atoll	To Malé	Total
Haa Alifu		0	6	0.2	
Haa Dhaalu		8	3.3	3.5	
Shaviyani		0	4	0.6	
Total number of trips					
Haa Alifu	2,235	0	13,412	447	13,859
Haa Dhaalu	1,831	14,644	6,041	6,407	27,091
Shaviyani	2,112	0	8,446	1,267	9,713
		14,644	27,899	8,121	50,663*

*Note: These numbers do not include travel between Kulhudhuffushi and Hanimadhoo Airport.

244. At an assumed 40 passengers per boat the total of 50,663 trips per year gives 1266 trips per year which equals 3.5 per day on average. It is probable, however, that many of these trips would be made on the Saturday. If 800 people arrive on the Saturday, there would be 20 boat visits within a two hour period. This has not been surveyed but the steady stream of island boats on a Saturday morning has been observed and the assumption seems reasonable.

245. If these occupy a 6-meter width by berthing bow-on and berth for 30 minutes each, a quay length of 30 m is required. This width will increase with population growth. If this related solely to the growth in the islands the extent over 30 years would be minimal. However, with the growth in the islands assumed to be kept low by population being drawn to Kulhudhuffushi, there is likely to be a continued demand for travel from Kulhudhuffushi to home islands. In addition, the airport development on Kulhudhuffushi will bring additional visitors from the islands. Population growth in Kulhudhuffushi over the project period expands by 2.6 times. The 30 m quay length is then assumed to extend to 80 m.

246. The proposed airport in Kulhudhuffushi will alter the pattern of small boat visits as the new airport will replace the existing nearby facility at Hanimaadhoo. The Statistical Yearbook (Bureau of Statistics, 2014) notes that in 2013 there were approximately 42,500 passenger movements in and out. We estimate that 70% of these would relate to travel by Kulhudhuffushi residents. Accordingly, the travel of 30,000 between Kulhudhuffushi and Hanimaadhoo would cease.

247. At the same time, however some 12,500 from the islands would switch from Hanimaadhoo to Kulhudhuffushi, leaving a net loss of trip-making by 17,500 to and from Kulhudhuffushi. These people travel either by the Kulhudhuffushi-Hanimaadhoo ferry or by speedboat. The boats are small boats and affect the category discussed above. However, they are spread evenly through the week and would not significantly affect congestion in the 'without project' case, and will not significantly affect the critical Saturday morning/afternoon period requiring space on the quay to be set aside, as discussed above, in the 'with project' case. We have therefore not included these in the analysis.

Passengers Future Travel

248. At present there is a ferry service operating in the northern region atolls with Kulhudhuffushi as a destination. This comprises 11 ferries, with Kulhudhuffushi as a hub. Trips generally start at the furthest island on the route at 5.30 am to 6 am and end in Kulhudhuffushi at 10 am to 11 am.

249. These services transport some 400-500 passengers daily according to the operator. Not all of these would end in Kulhudhuffushi. However, if half of these are visiting or leaving Kulhudhuffushi, the total of return trips based on Kulhudhuffushi would be around 41,000 return trips.

250. However, the service on any one island is still constrained in frequency of trips provided by ferries, and this imposes costs on the people in the islands. One ferry a day is similar to one bus a day into town, and there is time lost in meeting appointments, business commitments, education, health, shopping, plane travel etc.

251. Consequently, there is a pressing need for more frequent trip services. This is borne out by the survey carried out in the ADB 2005 study, where respondents were questioned on their willingness to travel more frequently. Table 29 is a summary of responses in Table 11.5 of the 2005 study report.

Table 29: Increases in Frequency of Travel in Response to Improved Regularity

Island	No. Hh	No.	%WTP	2-3 x More		4-5 x More		> 5 x More	
				No.	%	No.	%	No.	%
Ihavandhoo	42	16	38.10%	12	75.00%	1	6.30%	1	6.30%
Kulhudhuffushi	136	74	54.40%	55	74.30%	11	14.90%	5	6.80%
Bileffahi	11	8	72.70%	7	87.50%	1	12.5%		

252. Note that in the 1st half of the above Table, the 3rd column (No.) refers to responses from the total of households that are willing to pay a higher fare for existing travel (given some improvement that would justify this increase). The second half of the table is considered to deal separately with willingness to travel more frequently, given the provision of an increased number of ferry sailings per week.

Increase in Passenger Travel Demand

253. The growth in passenger travel demand over the analysis period is also, as for freight travel demand, based on population growth * GDP per capita growth * GDP elasticity of travel demand. As before, the analysis uses a GDP per capita forecast of 2.45% (2016-2025) falling down to 1.45%.

254. The GDP elasticity of passenger travel demand is estimated, from experience, to be 0.6.

4.3.3 Evaluation of the Benefits

255. Direct benefits of the project are those that arise from the construction of the new harbor and its necessary ancillary works. The benefits evaluated are:

i. Benefits gained by increased connectivity with the islands
ii. Savings by avoiding future harbor congestion
iii. Time saved by fishing boats through unloading alongside the quay to a new fisheries market
iv. Economic (employment) value added by amenities
v. Indirect employment
vi. Safety benefits for both ships and passengers
vii. Environmental benefits
viii. Waterfront small craft zone benefits
ix. Non-quantified health benefits
x. Future benefits of an import base for Region 1 for certain commodities.

256. Three scenarios have been evaluated:

i. Base Scenario – containing benefits (i) to (vii) above.
ii. Base scenario with the inclusion of waterfront small craft zone benefits.
iii. Scenario 2 with the further inclusion of import base benefits.

4.3.3.1 Connectivity Benefits

257. There are two main benefits arising from greater connectivity. The 1st is a time/ opportunity saving gained by being able to travel with a minimum of mismatch between the travel time available and the desired length of time to be spent in Kulhudhuffushi. The 2nd is the benefit gained by the opportunity to travel more often, as surveys have shown that current travel services limit people's desire and opportunity to do so.

Connectivity benefits (1)

258. Given that ferries leave early in the morning and return in the late afternoon and that preferred appointment times are not met (given the high demand for medical treatment, flights, etc.), there is time lost due to the rigidity of a transport system with infrequent service. This is exacerbated by the fact that ferry trips generally start at the most distant island, stopping at each island on-route, and take a long time.

259. With 24 hourly periods in a day, of which periods 9 to 17 are available for appointments, the time lost can be evaluated by considering appointments in each

of the available periods. The fact that travel is usually made in daylight means that early appointments require a day-before trip. The evaluation of all periods gives the following analysis of time lost.

260. In the analysis, sleep-time has been deducted and leisure time for workers has been assumed to be valued at half the average wage rate. Time lost by non-workers is assumed to be valued at 25% of the average wage rate. The wage rate is taken to be MVR 4000/month/176 hours = MVR 23/hour/worker. A shadow wage rate of 0.75 is used, giving the value of the average worker hour to be MVR 17.25.

A. Travelers to Kulhudhuffushi for an appointment: 33%.

B. Of which workers: 25%, non-workers 75%.

C1. Time lost for an appointment at 9-11am:
- Workers: Lost 16 hours of work, at MVR 17.25/hour
- Non-workers: lost 16 hours of leisure, at MVR 5.75/hour.

C2. Time lost for an appointment at 1pm-5pm:
- Workers: Lost 8 hours of work, at MVR 17.25/hour
- Non-workers: lost 8 hours of leisure, at MVR 5.75/hour

C3. Average time lost by workers and non-workers: 16 * 3/8 + 8 * 5/8 = 11 hours

D. Value of time lost: 50663 * 0.33 * 11 8 (0.25 * 17.25 + 0.75 * 5.75) = MVR 1,586,195.

261. The total from the above is MVR 1,586,195 or USD 103,403 in 2014. This value to increase over time with population growth and passenger travel demand increase.

Connectivity benefits (2)

262. The estimated passenger trips from the islands to Kulhudhuffushi are shown below.

Table 30: *Passenger Trip Per Year to Kulhudhuffushi (2014)*

Year	Haa Alifu	Haa Dhaalu - intra atoll	Haa Dhaalu - inter atoll	Haa Dhaalu - Male	Shaviyani	Total
2014	13859	14644	6041	6407	9713	50663

263. In Sections 249-253 (Passengers Future Travel), it has been noted that there is a willingness to travel more frequently, with a conservative estimate being twice the current frequency of travel, if there was a more frequent service. This reflects the current mismatch between transport demand and transport supply, resulting into significant waiting time. It also reflects the increase in demand for a more frequent service as the population and development increase rapidly in Kulhudhuffushi.

264. This willingness to increase travel frequency highlights the GoM's concern over connectivity and the need for improvements. However, more frequent travel could not take place with the existing harbor as the increasing trip visits would quickly congest the harbor. The proposed harbor is an essential part of the GoM's strategy.

265. The benefit gained from a trip is difficult to estimate. However, the value can be regarded as being at least equal to the cost of travel plus the cost of travel time, or the trip would not be made. The return trip cost is MVR 50 within an atoll and MVR 75 between atolls. The weighted average value of time is:

0.25 * worker wage rate/hr * Shadow Wage Rate + 0.75 * non-worker wage rate/hr, i.e. 0.25 * 23 * 0.75 + 0.75 * 5.75 = MVR 8.63/hr

266. The following table gives the values used in the analysis

Table 31: Passenger Trips per Year to Kulhudhuffushi (2019)

	Haa Alifu	Haa Dhaalu intra-atoll	Haa Dhaalu inter-atoll	Haa Dhaalu Male	Shaviyani
Travel Time	8.58	3.24	8.80	3.24	9.11
Fare (MVR)	75	50	75	50	75
Value of Time (MVR)	8.63	8.63	8.63	8.63	8.63
Benefit per trip MVR	148.96	77.93	150.88	77.93	153.62
Benefit per trip USD	9.71	5.08	9.84	5.08	10.01
Generated demand	1.00	3.00	1.00	1.00	1.00

267. The benefit is assumed to increase yearly with population growth, and with passenger travel demand growth.

268. This is assumed to begin in 2019 at 20% of the value calculated in accordance with the above analysis, and to increase over five years to the full amount, giving the following summary.

Table 32: Value of Increased Trip Frequency (in USD)

2019	2024	2029	2034	2039	2044	2048
$121,781	$675,744	$727,555	$783,895	$845,185	$911,885	$969,479

4.3.3.2 Benefits due to reduction of congestion

269. Vessel calls are assumed to alter with population changes as shown in Table 33. The changes in inter-arrival time are given in Table 34.

Table 33: Assumed Population Changes

Year	Kulhuhuffushi	Haa Alifu	Haa Dhaalu	Haa Dhaalu excl. Kulhudhuffushi	Shaviyani
2014	8224	13412	19207	10983	12669
2019	9027	13141	20718	11691	12860
2024	10189	12945	22520	12332	13054
2029	11926	12752	24887	12961	13251
2034	14165	12562	27787	13622	13451
2039	16823	12375	31140	14317	13654
2044	19981	12190	35028	15047	13860
2048	22929	12045	38586	15658	14027

Table 34: Change in Inter-arrival time (hrs) of Cargo Ships per Population & Fleet Change

	Boat Length				Assumed Quay Length (m)
	30 m	28 m	20 m	17 m	
2014	31.0	21.0	16.0	6.0	
2019	29.3	19.9	15.1	5.7	280
2024	27.5	18.6	14.2	5.3	276
2029	24.9	16.9	12.9	4.8	270
2034	22.4	15.1	11.5	4.3	263
2039	19.9	13.5	10.3	3.9	254
2044	17.6	11.9	9.1	3.4	244
2048	15.5	10.5	8.0	3.0	230

270. Table 34 gives the assumed quay length reduced over the project period by 30 m in 2019 to 80 m in 2048 from the constructed total of 310 m, to provide space for passenger vessels from the islands to berth.

271. These figures have been placed in a queuing program to determine and cost the amount of time that boats would spend waiting for space for berthing to become available at the quay if the harbor extension project did not proceed. As the development of Kulhudhuffushi increases towards government targets, the population will increase significantly. This will generate a much greater freight demand and correspondingly more boat trips from Malé. The impact on congestion is much greater than being directly proportional to population growth, and has to be evaluated by use of the queuing program which carries out the following actions:

- Simulation of ship arrivals to the port according to the actual pattern of real arrivals;
- Checking of the quay for berthing space;
- Berthing what boats can be berthed and placing those that can't in a queue;
- Unloading the berthed boats and releasing those that are empty;

- Recording the time spent queuing by ships, which can be quantified as a cost to the 'without project' case, and therefore a benefit to the 'with project' case.

272. The results for the value of waiting time costs vary considerably according to the assumptions made about each of the ratio of cargo actually carried on average in relation to the boat capacity, and the rate of unloading in Kulhudhuffushi. The results for assumptions of boats carrying 50% of capacity and an unloading rate of 5 tonnes per hour have been used.

273. From the above, Table 35 shows little congestion in the early years. However, it should be noted that the analysis assumes that boats will unload without delay then leave the quay as soon as this has finished. This can be achieved voluntarily with a time-related tariff for use of the quay, but is unlikely to be reached without a tariff, leading to much higher congestion costs.

Table 35: Waiting Time Costs

	Waiting Time Cost (USD per Year)
2019	0
2024	0
2029	0
2030	3,292
2034	12,807
2039	37,581
2044	98,377
2048	263,962

4.3.3.3 Benefit to Fisheries

274. There are 8 fishing boats belonging to Kulhudhuffushi. On average 6 are working each day. In addition, there are boats from other islands using the Kulhudhuffushi harbor. From a count taken on Friday 20/11/2015 there were 15 boats in the harbor, of a wide range of sizes. In Google Earth there are three historical images back to December 2010 that show the fishing harbor in use. Measurement of the lengths has been made, using the Google Earth ruler facility. There are between 16 and 21 boats in the harbor, varying in length from 6 m to 21 m.

275. The fishing harbor is in the northern part of the existing harbor where there is no quay wall. The boats moor there to be closer to the fish market where fish are cut up, cleaned, and sold. It is likely also that there is a desire to keep this activity separate from the cargo/passenger activity which takes place along the existing quay wall, both because of the nature of the work and because the quay wall is often fully occupied by cargo/passenger boats (simply moored there and not unloading or loading). Therefore, the fish have to be unloaded onto small boats and taken to the shore. This is time-consuming, taking 3 to 4 hours to complete. The process also can lead to fish damage. If the boats are berthed alongside a quay unloading can be carried out in 15 minutes.

276. In the 2013, the Basic Fishery Statistics report it is noted that the number of fishermen in Haa Dhaalu was 420 in 2013. The table below shows that labor numbers have fallen by more than a fifth since 2007.

Table 36: Number of Fishermen in Region 1 Atolls

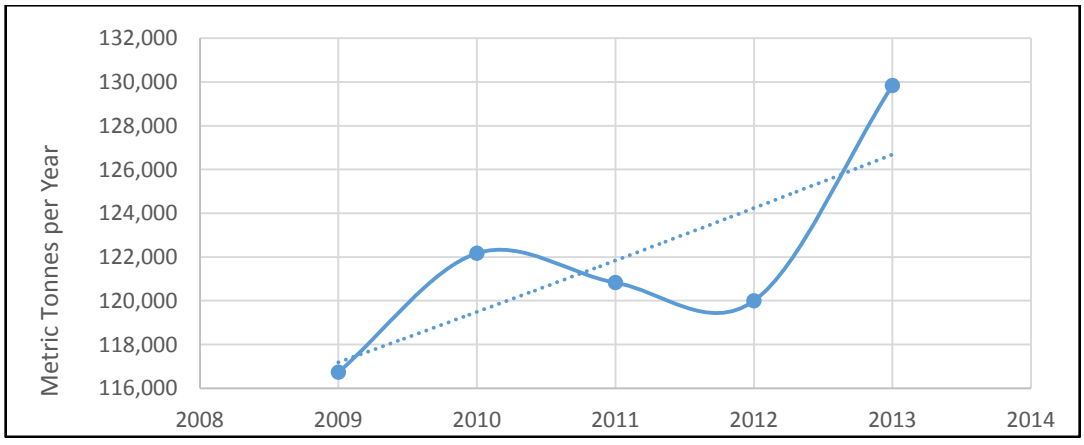
	Haa Alifu	Haa Dhaalu	Shaviyani
2007	778	533	1077
2008	843	553	949
2009	873	526	1003
2010	751	513	954
2011	706	482	896
2012	660	451	838
2013	614	420	780

Source: Fishery Statistics, Table 1

277. Earlier in this report, we noted that there were 25 fishing boats operating in Haa Dhaalu. These undertook 5489 trips in 2013, i.e. an average of 220 trips (days) each. Both fishermen numbers and boat numbers have declined over time. This is explained by the World Bank as a result of the fishing fleet shifting to larger mechanized vessels with greater capacity. From government statistics the number of vessels operating in the fishery industry has remained relatively stable, but output volume has increased substantially. While primary fishing labor has decreased, capital use appears to have increased by up to 20 percent. Labor productivity has likely increased due to capital investments in boat capacities and power, increased human capital in the crews as general education levels rise, and subsequent improvement in knowledge about fishing, and fishing conditions, supported by better location gear and the use of Fish Aggregating Devices (FAD).

278. The fish catch per year in the Maldives, from Ministry of Fisheries and Agriculture (2013), is shown and plotted in Figure 23 below showing that the catch is variable but on average rose by 2% per year.

Figure 23: Fish Catch per Year (Maldives)

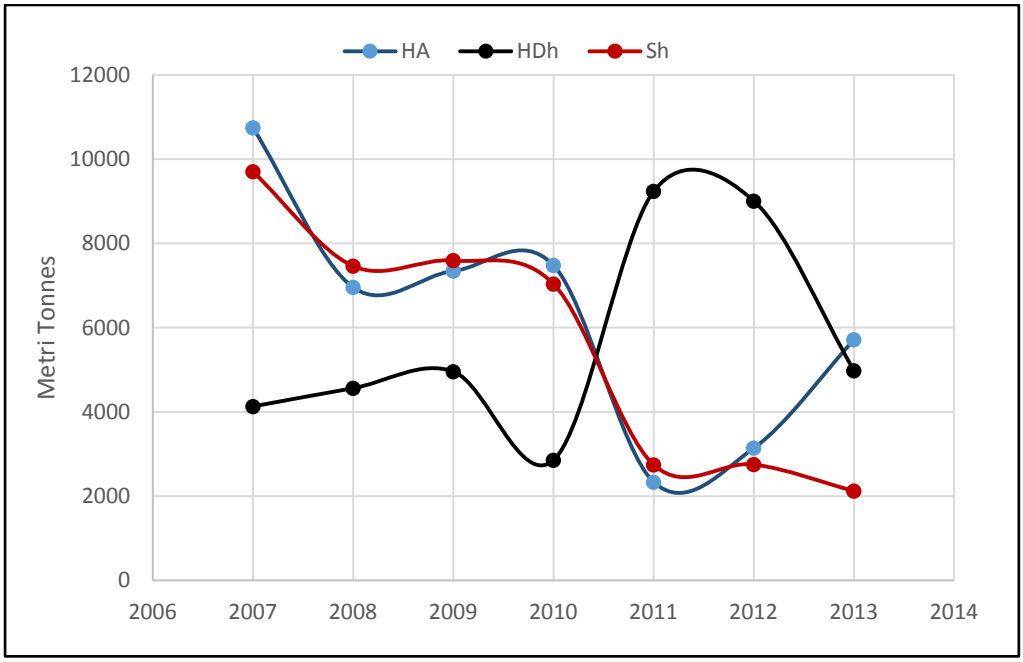


279. Table 37 taken from the 2014 Yearbook gives the following values for fish catch in Region 1. These numbers are plotted in Figure 24, showing a decline in Shaviyani, a decline on average in Haa Alifu, and a rise, on average in Haa Dhaalu. The Haa Dhaalu rate of increase is 9.5% per year. This is affected by the high level in 2011 and 2012 (which corresponded with a drop in the other two atolls) and is unlikely to be a sustainable or representative rise (as evidenced by the drop in 2013). If the 2011-2012 numbers are omitted, the rise is 2.6% per year, which is close to the national average of 2% per year.

Table 37: Fish Catch (Metric Tonnes) in Region 1 Atolls

	Haa Alifu	Haa Dhaalu	Shaviyani
2007	10747	4127	9704
2008	6958	4560	7462
2009	7346	4955	7594
2010	7479	2852	7036
2011	2331	9238	2742
2012	3143	9005	2751
2013	5715	4977	2120

Figure 24: Annual Fish catch in the Three Atolls of Region 1



280. In the questionnaire to fishermen, ten of the fifteen fish boat captains surveyed thought that fishing would rise in the future. Two responded that it would not, one

stating a lack of interest by young people. It is assumed in this report that the fish catch will rise by national average of 2% per year.

281. From an interview with a fishing boat captain the assumption has been made that daily fish catch will on average vary between 300 kg for a 6 m boat to 800 kg for a 21 m boat. With 16 boats of the full range of sizes unloading to shore, the time taken in total is 72 boat hours per day. This would reduce to 4.5 hours per day if unloading alongside a quay to an adjacent market.

282. The value of the time saving of 67.5 hours per day depends on the number of crew involved and the value of time per crew member. The latter is likely to be high as the daily operation lasting from 10 pm to 3.30 pm the next day leaves little time for sleep or home activity, and is assumed to be the same as the wage rate spread over the 16-hr daily trip. Under the assumption of an average monthly wage of MVR 5000 over 16 hours per day 25 days per month, this amounts to MVR 12.50 per hour.

283. With an assumed average of 6 crew per day involved in unloading, the value of the saving in unloading time with the proposed new harbor (and fishing activity moving to the existing quay) would be MVR 1,113,759 per year, or USD 72,600 in 2014, rising at 2% per year to give USD 80,161 in 2019, increasing thereafter at the same rate.

4.3.3.4 Employment Benefits

284. The facilities that will be provided along with the harbor are:

i. Passenger (and cargo) terminal with a combined floor area of 196 m^2, including:

Table 38: Passenger Terminal Employment Numbers

Item	Number Employed
Ticketing office	4
2 Administrative offices	8
Cleaners	4
TOTAL	13

ii. Harbor markets, comprising separate fishing and vegetable markets to support the local fishing and produce-trading industries. The fish market would include an ice plant. The employment of 4 workers is assumed.

iii. A building of floor area 150 m^2 to complement the Passenger/Cargo harbor and related activities, and to provide an attraction for those visiting from the islands (thereby assisting in the development of connectivity). This would contain:

Table 39: Port Activity Center Employment Numbers

Item	Number Employed
General store	4
2 food and beverage outlets	6
2 retail outlets	6
2 business offices	4
TOTAL	19

285. The overall number employed from the above is 36.

286. From an economic point of view, the mode of construction and operation of these facilities is not relevant; although the assumption is made that there will be sufficient patronage to make these self-sufficient in operation. The economic benefit is then the total value of employment generated, plus the rent from lease of the land.

287. The total numbers employed are 36 at an average wage of MVR 4000 per month. The benefit then amounts to MVR 1,728,000 per year, or USD 112,646 per year. This is assumed to increase every 5 years in accordance with population growth.

288. The value of the land resource used for buildings is at least equal to the rent achievable for use, which is MVR 45/m^2/year (from surveys by the team's social expert). The total area of buildings and markets is 660 m^2, giving an annual rental of MVR 29,700, or USD 1936 per year. This is assumed to increase every 5 years in accordance with population growth, and is added to the employment benefits.

4.3.3.5 Indirect Employment Benefits

289. In the absence of input/output models or formal multiplier ratios for passenger ports in Kulhudhuffushi and the Maldives in general, we have used a 2.5 multiplier to calculate indirect employment derived from passenger port activities. This is a conservative estimate widely used in the industry and quoted in the specialist literature; see (Bichou, 2009), (Bichou/OECD, 2008), (Carriou, 1999), (UN ESCAP, 2002), and (Bichou/UNCTAD, 2004), among others. The total from the previous paragraphs then becomes USD 286,457; increasing yearly in accordance with population growth.

4.3.3.6 Safety Benefits

290. A major observed shortcoming of the existing Kulhudhuffushi harbor is the lack of safe infrastructures, equipment, rules and practices required for the safe shelter, operations and management of ships, cargo, and passengers.

291. In this section, we estimate the safety benefit of the expanded Kulhudhuffushi harbor with a particular focus on ship's and passenger's safety. The safety benefits to cargo from an expanded/improved harbor have not been quantified here for the simple reason that the estimation of such benefits would require detailed information about the value and classification of cargo carried to-from Kuhudhuffushi as well as the P&I (protection and indemnity) insurance and

limitation of liability thresholds applied to such cargo. Unfortunately, none of these data is available especially with local ships and traders not contracting any form of insurance or cover against cargo loss or damage during carriage and handling.

Ship Safety

292. Ports and harbors provide a safe shelter for ships and their crews in adverse events such as extreme weathers, Tsunamis, and hurricanes. As such, the expansion of the Kulhudhuffushi port, including through additional breakwater, will generate safety benefits for ships not able to berth or shelter in the existing harbor because of capacity constraints either by design (i.e. when ships of particular sizes and dimensions cannot be accommodated in the existing port, for instance ships with a draft of over 3m) or by congestion (e.g. when the accumulated number of ships requesting shelter exceeds the berth capacity of the port).

293. Here, the safety benefits of the Kulhudhuffushi harbor expansion would be at least equal to the risk of damage or loss to ships not able to berth or shelter, and estimated as follows:

$$ASB\ (V) = T \times \Delta rc \times AC$$

where

ASB (V) = annual safety benefit for vessels (in USD)

T = annual number of vessel calls/shelters

Δrc = reduction in accident risk due to new port/breakwaters

AC = average cost associated with vessel damage due to lack of harbor/breakwater.

294. One example of vessel damage at Kulhudhuffushi is that of the passenger boat that sank twice in 2010 on colliding with the channel edge while entering the existing harbor in strong cross-currents. This caused approximately MVR 1,600,000 in repairs and MVR 1,400,000 in damage to goods each time (site interview and news items). In addition, the vessel was out of service for three months each time.

Passenger Safety

295. Good design and operations of ports and harbors should allow for the safe handling and transfer for cargo, crews, and passengers from ships to shore and vice versa. Unfortunately, neither the existing harbor in Kulhudhuffushi has built-in passenger access points ashore such as finger piers and link-span bridges; nor the ships and boats currently calling at the harbor are equipped with appropriate on-board access points such ramps and gangways.

296. Clearly, the lack of such facilities in the existing harbor increases the risk of safety incidents during passenger embarkation and disembarkation, while limiting and at times restricting access mobility of passengers especially the elderly, the sick, and the disabled. Furthermore, due to current and future congestion in the existing harbor, many vessels will be unable to moore with whole length alongside

berths; which in the absence of appropriate onshore gates and ramp facilities poses safety risks and operational challenges for passenger embarkation and disembarkation as well as the risk of vessels and boats moving away from the berth.

297. The new passenger harbor in Kulhudhuffushi will include a dedicated finger pier for passenger transfer and where applicable shore passenger access facilities such as ramps. Here, the safety benefits of the new harbor would be equal to the direct and restitution value(s) of Preventing Port's Accident (VPA).

298. In the absence of (i) a national/Maldivian VPF (value of preventing a fatality) figure from which a reasonable VPA can be calculated, and (ii) statistical data that records safety incidents and accidents (especially passenger-related) in the Maldives' local ports; a simple approach would be to use the port industry safety guidelines whereby the installation and safe use of access points would reduce safety incidents by 20% to 50% compared with a non-safe scenario [See for example Ports Safety Skills -PSS- standards, 2006; IMO, 2004; and Bichou/OECD, 2008]. Using the very conservative assumption of a 10% probability of accidents due to inexistent or unsafe access points, and a widely accepted assumption of 50% reduction in accidents due to the installation and safe use of harbor access points; the value of safety benefits can be calculated as:

$$\mathbf{ASB\ (P)= T \times \Delta rc \times AC}$$

where

- ASB (P) = annual safety benefit for passengers ($)
- T = annual number of passengers (dis)embarking in Kulhudhuffushi
- Δrc = reduction in passenger accident risk due to safe harbor = 0.5*0.1(T)
- AC = average cost associated with passenger accident = $ value of loss productivity due to injury (conservatively approximated to average local wage).

299. The injury cost is taken to be equal to one day's wage, i.e. MVR 4000/22 = MVR 182 each. This provides the following (summarized) benefits.

Table 40: Value of Accident Prevention

	Annual Trip Numbers	Accidents Prevented (per year)	Value of Increased Safety (USD/year)
2019	56,234	2,812	33,359
2024	62,260	3,113	36,934
2029	66,887	3,344	39,679
2034	71,912	3,596	42,660
2039	77,372	3,869	45,899
2044	83,305	4,165	49,418
2048	88,423	4,421	52,454

4.3.3.7 Prevention of Ships' Damage

300. Ports and harbors provide a safe shelter for ships and their crews in adverse events such as bad weather, and in extreme events such as extreme Tsunamis, and hurricanes. As such, the expansion of the Kulhudhuffushi port, including the additional breakwater, will generate safety benefits for ships not able to berth or shelter in the existing harbor because of capacity constraints. These may be either by design (i.e. when ships of particular sizes and dimensions cannot be accommodated in the existing port, for instance ships with a draft of over 3 m) or by congestion (e.g. when the accumulated number of ships requesting shelter exceeds the berth capacity of the existing port).

301. Here, the safety benefits of the Kulhudhuffushi harbor expansion would be at least equal to the risk of damage or loss to ships not able to shelter. With the existing harbor this increases greatly with time as more-and-more ships have to wait for access to the quay. The existing harbor cost/ new harbor safety benefits are calculated as follows:

$$ASB\ (V) = T \times \Delta rc \times AC$$

where

ASB (V) = annual safety benefit for vessels ($)
T = annual proportion of harbor time
Δrc = reduction in accident risk due to new port/breakwaters
AC = average cost associated with damage due to lack of harbor/breakwater.

302. This approach applies for both shorter term events of severe storms and the longer term damage such as by the 2004 Tsunami.

Short-term events

303. Short-term events are defined here as both high-frequency / high-impact events, such as high storm surges, and high-frequency / low-impact events, such as slow erosion.

304. The ADB (2005) study gathered information on vessel damage in a number of islands in the north which had either no harbor or a harbor with a damaged and ineffective breakwater. The report notes information from the Island Office that fishing boat damage at these islands averaged MVR 3,900 ($325) per vessel in the fleet per year, and cargo boats an average of MVR 6,500 ($540) per vessel in the fleet per year. One island reported 5 boats lost to storm damage in 35 years, and another 5 boats in living memory. These records already account for the time that boats spend at their moorings instead of at sea, and the value of T in the above formula is not required.

305. With a multiplier for USD inflation from 2005 to 2015 is 1.23; or an average of 18 fishing vessels and 26 cargo vessels now in Kulhudhuffushi the repair damage amounts to $24,500 per year (using a MVR/USD conversion of 12:1 for 2005).

306. The report also notes that downtime costs for repairs averaged twice the repair cost, giving a total of $73,500 per year. This is an overestimate of damage costs as it applies to the proportion of the fleet that will lack proper shelter outside the harbor or effective moorings within the harbor. The cost is then taken to be 50% of the above value, or $36,750 per year, initially – but is also assumed to increase with the rate of increase of cargo required (fleet number increase) over time.

Long-term events

307. Long-term events are defined here as low-frequency / high-impact events such as damage the 2004 Tsunami which has been used here a reference for the calculation of safety benefits against low-frequency / high-impact events.

308. The Ministry of Planning and National Development (2005) details the projects and investment costs required to recover damage caused by the December 2004 Tsunami. The report notes that 140 fishing vessels were lost or damaged, some 12% of the fishing fleet. Replacement/repair costs were estimated to be 50 new vessels at $7.84 million, and repairs to 100 vessels at a total cost of $120,000. Tsunami damage then totaled $7.96m for 150 vessels, or an average of $53,000 per vessel.

309. The reference above gives the cost of a new fishing boat, when inflated to 2015 values, of $193,000 each.

310. The total value of the fleet using Kulhudhuffushi is $7,809,000 (2 @ $230,000, 1 @ $215,000, 3 @ 180,000, 20 @ $156,000, and 18 fishing boats @ $193,000). The cost of lost boats is taken to be 4% of this, i.e. $312,400.

311. The damage cost is taken as $1200 each for the fleet, i.e. 44 x 1200 = $52,800, giving a total (per tsunami) of $365,200.

312. UNDP (2006) gives the return period of the December 2004 tsunami as 219 years. Therefore, the probability of experiencing this in any one year is 1/219, or .0046. This type of risk is included in cost-benefit analysis by attributing the damage x .0046 each year of the analysis period – a value of $1,680 per year. The UNDP report also lists other potential sources of tsunami of similar damaging properties, and the actual risk cost is assumed to be twice the above, $3,360.

313. This has to be reduced by the value (T) of time that the fleet spends at Kulhudhuffushi. It is known that fishing boats spend 30% of time at the harbor and 70% at sea. It is assumed that cargo boats spend 30% of time at Kulhudhuffushi, 40% of time at sea, and 30% at the other port on their journey, giving a 30% time at Kulhudhuffushi in both cargo and fishing boat cases.

314. The proposed new harbor is not designed to turn back a Tsunami wave. However, this is understood in the Maldives context to be manifest as a rise in water level, inland flooding, and an outpouring of water, rather than a catastrophic breaking wave. Never the less this is still damaging, as noted above, but it is probable that boats moored within the harbor will be more protected than boats

stationed outside, which would be the case with the future increase in boat numbers and no new harbor. Because of the uncertainty associated with this assumption the estimated savings in damage have been reduced by 50%, as for storm damage.

315. Final annual costs, allowing also a factor of 3 to account for downtime costs, are 3,360 x 3 x 0.3 x 0.5, i.e. $1500 per year.

316. Both the short-term storm damage saving of $36,750/y in 2014 and the long-term damage saving of $1500/y in 2014 are converted to savings per tonne of cargo (63,300 freight tonnes) transported in 2014. The short-term benefit is $0.58/tonne and long-term is $0.024/tonne.

Table 41: Benefit of Saved Boat Damage Costs

2019	2024	2029	2034	2039	2044	2048
$44,064	$51,320	$58,468	$67,371	$78,107	$91,108	$103,499

4.3.3.8 Environmental Benefits

Benefit from Erosion Prevention

317. The exposed face of the reclamation is being eroded gradually by wave and current action. A breakwater and quay would prevent this loss. Figure 25 shows the reclaimed area of Kulhudhuffushi on 11-12-2010, shortly after construction. The red line is drawn as an extension of the seaward edge of the existing quay. Figure 26 shows the same area on 29-12-2014.

318. In the four years between photos the northern half of the sea face has eroded and the southern half has accreted. It is probable that the average line of the face lies slightly to the east of the red line. Comparison of the two figures shows that there has been an overall erosion of approximately twelve meters, i.e. three meters per year. This has taken place over a length of 650 m, giving an erosion rate of 4875 m^3/y. The value of this in terms of construction cost of USD 6 per m^3 (ignoring dredge mobilization costs) is USD 29,250/year. If dredge mobilization costs are included the value is USD 39,000/y.

319. This assumed that mobilization costs are averaged over the whole of the completed reclamation, and is not based on the cost of replacing a small part of the original. This latter figure has been used in the analysis.

Figure 25: Kulhudhuffushi Reclamation (from Google Earth 2010)

Figure 26: Kulhudhuffushi Reclamation (from Google Earth 2014)

Provision of a Sand Stock

320. The harbor basin will be dredged to the required depth for cargo/passenger boats. This will produce a surplus of sand/coral, which is a valuable resource that will find a use and will save the need to obtain the material from elsewhere. The surplus amount is 110,000 m^3. It is assumed that the material has no value until it is actually used, and further assumed that use will take place over the subsequent five years. The unit value is taken as \$8 per m^3, giving a benefit of \$176,000/y for 5 years.

4.3.3.9 Waterfront small Craft Zone Benefits

321. A waterfront and small craft zone is being formed at a cost of USD 967,865 for mooring and berthing small personal crafts. The benefits of this harbor include:

a. Safety benefits provided to small crafts and their users

b. Operational benefits due to separating small and personal crafts away from ship and passenger boats, and

c. Only buffer development area for future port expansion; thus providing the flexibility required in port planning and development.

4.3.3.10 Provisional Benefits – Direct Imports

322. At present almost all goods are imported into the Maldives through the Malé Commercial Harbor. The portion destined for all other islands then goes out in smaller vessels from the Malé North Harbor. Part of these goods goes to the capital island of each atoll, for internal consumption and for purchase by visitors from neighboring islands. However practically all islands also have a cargo boat which links directly with Malé. The current transport pattern for cargo is then that goods come to Malé and then go out to the islands, either directly or via a capital island.

323. Kulhudhuffushi has a commercial (overseas) port that has been placed there as part of the development of the region, with the intention being that an increasing amount of the regions goods come directly to Kulhudhuffushi. The port is managed by Kulhudhuffushi Ports Limited, which is a subsidiary of Maldives Ports Limited. At present imports are in the order of 3000 to 4000 freight tonnes per year.

324. Large benefits would be gained in terms of saved fuel costs and saved time costs for crew if the transport pattern changes so that goods from overseas come directly to the commercial harbor in Kulhudhuffushi. The savings would result from the fact that no further transport would be required for goods consumed in Kulhudhuffushi, and transport to the other regional islands would be shortened in distance to that between each island and Kulhudhuffushi instead of each island and Malé. The incentive for this to happen will become stronger as population numbers increase.

325. Details of the cargo boats travelling from Malé to the northern region, and cargo volumes, are required for an evaluation of the savings that would eventuate. There are no records available of the cargo volumes and vessels for individual islands. An evaluation has therefore been made as described in the following.

Sailing Times

326. Sailing times have been assessed by assuming travel at the rate of 22 km/h, which is approximately 12 (nautical) knots.

Fuel Consumption

327. The rate of consumption has been assumed to be 0.25 liters per Horsepower per hour. The cost has been calculated at MVR 8.50 per liter.

Crew Costs and Value of Time

328. Crew wages have been calculated as MVR 5000 per month, divided by 10 hours and 25 days to obtain an hourly rate of MVR 20.

Results

329. The analysis results are shown in Table 42 to 45. These give the total value of fuel and time savings if it is assumed that the transport pattern for all cargo destined to Region 1 is altered from supply via an overseas import base in Malé to supply from an overseas import base in Kulhudhuffushi.

330. It is, however, unlikely that all cargo will alter in this way, given that much arrives at Malé in container ships which provide cargo aggregated for all the islands and have significant economies of scale in freight costs. However, there will be advantages in cargo being transported from the north which now bypasses Kulhudhuffushi. Therefore, the analysis has been carried out for the cases of various fractions of the total of cargo being evaluated, with the outcome given above.

Table 42: Total Fuel & Time Cost Savings by changing Region 1 Import Base to Kulhudhuffushi

Factor	Haa Alifu		Haa Dhaalu		Shaviyani		Total (MVR/y)	Total (USD/y)
	Fuel	Time	Fuel	Time	Fuel	Time		
1	19369725	10654088	25301606	18537562	12581416	6920260	93,364,660	6,082,390
0.9	17432752	9588680	22771445	16683806	11323275	6228234	84,028,190	5,474,150
0.8	15495780	8523271	20241285	14830050	10065133	5536208	74,691,730	4,865,910
0.7	13558807	7457862	17711124	12976293	8806991	4844182	65,355,260	4,257,670
0.6	11621835	6392453	15180963	11122537	7548850	4152156	56,018,790	3,649,430
0.5	9684862	5327044	12650803	9268781	6290708	3460130	46,682,330	3,041,190
0.4	7747890	4261635	10120642	7415025	5032567	692026	35,269,780	2,297,710
0.3	5810917	3196227	7590482	5561269	3774425	2076078	28,009,400	1,824,720
0.2	3873945	2130818	5060321	3707512	2516283	1384052	18,672,930	1,216,480
0.1	1936972	1065409	2530161	1853756	1258142	692026	9,336,470	608,240

Table 43: Fuel and Time Cost Savings by Changing Region 1 Import Base to Kulhudhuffushi – Haa Alifu Atoll

Factor	1.0	Distance (km)		Travel Time @ 22 km/h		Return Trip Fuel Use @ 0.25 L/hp/h		Cost/trip (MVR @ 8.5/L)		Tonnage	No. of Fleet Trips	Annual Cost (MVR)		Fuel Cost Saving (MVR)	Time Saving (MVR)
Island	Pop.	to Malé	to Khf	to Malé	to Khf	to Malé	to Khf	to Malé	to Khf			to Malé	to Khf		
Hathifushi	101	347	62.3	15.8	2.8	8502	1526	72263	12974	253	2	173775	31199	142575	78422
Mulhadhoo	172	334	46.7	15.2	2.1	8183	1144	69556	9725	575	5	380899	53257	327642	180215
Uligamu	267	343	57.6	15.6	2.6	8404	1411	71430	11995	958	9	651371	109385	541986	298113
Thakandhoo	340	316	42	14.4	1.9	7742	1029	65807	8747	885	8	554659	73721	480939	264535
Thuraakunu	347	347	61.3	15.8	2.8	8502	1502	72263	12766	1053	10	724348	127961	596387	328036
Muraidhoo	451	318	36.1	14.5	1.6	7791	884	66224	7518	1168	11	736342	83591	652751	359038
Vashafaru	471	325	33.2	14.8	1.5	7963	813	67681	6914	1123	11	723545	73913	649632	357322
Utheemu	521	316	33.8	14.4	1.5	7742	828	65807	7039	1423	14	891528	95360	796169	437923
Maarandhoo	530	317	42.8	14.4	1.9	7767	1049	66015	8913	1678	16	1054672	142397	912275	501786
Filladhoo	548	328	41	14.9	1.9	8036	1005	68306	8538	1460	14	949779	118722	831056	457113
Kelaa	1,200	334	41.5	15.2	1.9	8183	1017	69556	8642	2685	26	1778634	220998	1557636	856759
Baarah	1,203	320	41.2	14.5	1.9	7840	1009	66640	8580	3038	29	1927800	248204	1679596	923842
Hoarafushi	2,204	332	54	15.1	2.5	8134	1323	69139	11246	4565	43	3005900	488912	2516989	1384440
Ihavandhoo	2,447	328	49.8	14.9	2.3	8036	1220	68306	10371	6438	61	4187808	635832	3551976	1953723
Dhidhdhoo	2,512	322	30	14.6	1.4	7889	735	67057	6248	7135	68	4556649	424533	4132116	2272822
										34433	159	TOTAL	MVR	19,369,725	10,654,088

Table 44: Fuel and Time Cost Savings by Changing Region 1 Import Base to Kulhudhuffushi – Haa Dhaalu Atoll

Factor	1.0	Distance (km)		Travel Time @ 22 km/h		Return Trip Fuel Use @ 0.25 L/hp/h		Cost/trip (MVR @ 8.5/L)		Tonnage	No. of Fleet Trips	Annual Cost (MVR)		Fuel Cost Saving (MVR)	Time Saving (MVR)
Island	Pop.	to Malé	to Khf	to Malé	to Khf	to Malé	to Khf	to Malé	to Khf			to Malé	to Khf		
Kuburudhoo	85	295	6.1	13.4	0.3	7228	149	61434	1270	213	2	124330	2571	121759	136071
Faridhoo	87	310	18.3	12.9	0.8	6962	448	59178	3811	218	2	122582	7894	114688	128168
Maavaidhoo	190	276	12.2	11.5	0.6	6199	299	52687	2541	475	5	238347	11493	226854	253518
Nolhivaranfaru	260	297	10.2	12.4	0.5	6670	250	56696	2124	2703	26	1459249	54672	1404577	1569668
Finey	291	308	13.8	12.8	0.6	6917	338	58796	2874	1023	10	572560	27986	544574	608583
Hirimaradhoo	351	302	12.5	12.6	0.6	6782	306	57651	2603	838	8	459832	20763	439069	490676
Naivaadhoo	375	305	20.3	12.7	0.9	6850	497	58223	4227	1043	10	578073	41973	536101	599113
Kuribi	430	297	9.4	12.4	0.4	6670	230	56696	1958	1158	11	625007	21580	603427	674352
Nellaidhoo	717	302	17	12.6	0.8	6782	417	57651	3540	2148	20	1179091	72407	1106684	1236762
Neykurendhoo	835	282	13.4	11.8	0.6	6333	328	53833	2791	1858	18	952325	49366	902959	1009090
Kumundhoo	889	285	6	11.9	0.3	6401	147	54405	1250	2215	21	1147693	26359	1121335	1253134
Vaikaradhoo	923	283	15.3	11.8	0.7	6356	375	54024	3186	1958	19	1007153	59400	947752	1059149
Makunudhoo	1,045	296	46.7	12.3	2.1	6648	1144	56505	9725	3205	31	1724753	296852	1427901	1595733
Hanimaadhoo	1,184	314	19	13.1	0.9	7052	466	59941	3957	4878	46	2784416	183800	2600615	2906286
Nolhivaramu	1,554	298	4.6	12.4	0.2	6693	113	56887	958	4730	45	2562622	43153	2519469	2815602
Kulhudhuffushi	6,998	292	0	12.2	0.0	35563	0	302287	0	21100	35	10683842	0	10683842	2201657
									Excl. Khf	28658	104	TOTAL	MVR	25,301,606	18,537,562

Table 45: Fuel and Time Cost Savings by Changing Region 1 Import Base to Kulhudhuffushi – Shaviyani Atoll

Factor	1.0	Distance (km)		Travel Time @ 22 km/h		Return Trip Fuel Use @ 0.25 L/hp/h		Cost/trip (MVR @ 8.5/l)		Tonnage	No. of fleet Trips	Annual Cost (MVR)		Fuel Cost Saving (MVR)	Time Saving (MVR)
Island	Pop.	to Malé	to Khf	to Malé (h)	to Khf (h)	to Malé	to Khf	to Malé	to Khf			to Malé	to Khf		
Bilehffahi	398	261	22.4	11.9	1.0	6395	549	54353	4665	1210	12	626357	53756	572600	314952
Noomaraa	412	267	22.8	12.1	1.0	6542	559	55603	4748	870	8	460709	39341	421367	231768
Goidhoo	416	272	11.9	12.4	0.5	6664	292	56644	2478	1288	12	694563	30387	664176	365322
Narudhoo	426	248	47.7	11.3	2.2	6076	1169	51646	9934	1228	12	603766	116128	487639	268220
Maroshi	495	244	53	11.1	2.4	5978	1299	50813	11037	1098	10	531117	115366	415751	228679
Lhaimagu	529	235	59	10.7	2.7	5758	1446	48939	12287	1493	14	695629	174647	520982	286560
Feydhoo	695	260	27.3	11.8	1.2	6370	669	54145	5685	1853	18	955273	100304	854969	470266
Feevah	746	255	38.8	11.6	1.8	6248	951	53104	8080	1650	16	834488	126973	707515	389160
Maaugoodhoo	795	217	75.3	9.9	3.4	5317	1845	45190	15681	2005	19	862919	299437	563482	309937
Kaditheemu	1,148	274	10.6	12.5	0.5	6713	260	57061	2207	2735	26	1486290	57499	1428791	785890
Foakaidhoo	1,201	253	37.8	11.5	1.7	6199	926	52687	7872	3415	33	1713590	256023	1457568	801718
Komandoo	1,333	228	71	10.4	3.2	5586	1740	47481	14786	2778	26	1255986	391118	864867	475710
Funadhoo	1,599	230	63	10.5	2.9	5635	1544	47898	13120	5260	50	2399437	657237	1742200	958276
Milandhoo2	1,637	248	46.8	11.3	2.1	6076	1147	51646	9746	4710	45	2316692	437182	1879510	1033802
										31590	146	TOTAL	MVR	12,581,416	6,920,260

4.3.3.11 *Potential Imports to Kulhudhuffushi*

331. Goods from Sri Lanka and India to the north now by-pass Kulhudhuffushi and discharge at Malé, after which they are re-shipped in smaller boats to be brought north again to Kulhudhuffushi.

332. From customs data (2014), freight quantities from India and Sri-Lanka that are recorded by weight (not numbers or packets) are given below.

Table 46: Freight Quantities from India and Sri Lanka

		% of Customs Total
All from India and Sri Lanka	383,890 tonnes	68
All 'fresh', 'frozen', 'chilled', 'dried'	135,211 tonnes	24
Total metric tonnes from customs	560,350 tonnes	
Total metric tonnes from MPL	588,663 tonnes	
Total Freight Tonnes from MPL	1,292,495 tonnes	

333. There is a factor of approximately 2 between metric tonnes and freight tonnes.

334. The total of 'fresh', 'frozen', 'chilled', 'dried' foods is therefore 270,000 freight tonnes. While a major portion of this amount could be imported directly into Kulhudhuffushi, part of this would be destined for islands south of the northern region. It is possible that the north could become a buffer storage facility for frozen foods destined to the south. In this analysis however that additional benefit has been omitted.

335. It has been assumed that one-third of the total of 119,000 freight tonnes required by the northern region is fresh or frozen food, and that two-thirds of this can be imported directly to Kulhudhuffushi. The relevant factor for the results is therefore 2/9 or approximately 0.2.

336. The benefits from Table 46 with a factor of 0.2 have been used in Scenario 3.

337. The above has been taken as USD 1,216,500 in the 10th year of harbor operation, building linearly to this level over years 6 to 9. Benefits are then assumed to increase in accordance with population growth.

4.4 Economic Analysis

338. The analysis weighs the economic benefits against the capital and operating costs of the development, and is carried out in accordance with the requirements of the Asian Development Bank Guidelines for the Economic Analysis of Projects, Economics and Development Resource Center, February 1997 (ADB 1997)

4.4.1 Construction and Maintenance Costs

339. The total construction cost is USD 7,941,673, including contingencies. This is divided into USD 6,973,808 for the passenger/cargo harbor, and USD 967,865 (refer to Chapter 4) for the waterfront small craft zone. The costs have been divided equally into the two-year construction period.

340. In the base scenario the project cost is taken to be USD 7,941,673 but the benefits of the small craft zone have not been included in the economic evaluation. Both costs and benefits of this zone are included in scenarios 2 and 3.

341. The design life of the project infrastructure is 30 years. The economic life is that after which it is more expensive to continue with use of the infrastructure than to dismantle it. The main components of the harbor will have a long economic life, possibly more than seventy years. The only part requiring significant regular maintenance is the basin, which will gradually silt up and require periodic dredging. It has been assumed that an area of 300 m x 75 m will require 1m depth of dredging every 5 years. The dredging rate has been taken as USD 8 per m^3, giving a cost of USD 180,000 per 5 years.

342. The assumed annual maintenance costs, as a percentage of construction costs, for other items of infrastructure are shown in the table below. The total cost is applied annually in the analysis.

Table 47: Infrastructure Maintenance Costs

	Cost (USD)	Annual Maintenance %	Annual Maintenance (USD)
Quay-wall	1,536,367	0.25	3,841
Finger Piers	134,245	1.00	1,342
Beacons	4,262	10.00	426
Pavement	112,153	6.00	6,729
Buildings	298,321	1.00	2,983
Market	159,815	0.50	799
Ice Plant	26,636	2.00	533
Quay Lighting	37,359	2.00	747
Total			17,400

4.4.2 Additional Costs

4.4.2.1 Project Management Company

343. The overall project includes the establishment of a project management company (PMC). This has an additional cost to be included in the economic appraisal. The estimated cost is USD 800,000.

4.4.2.2 Ancillary Costs

344. A further cost of USD 200,000 has been added to the project cost to cover activities beyond the scope of the civil works and consulting services under the project, such as salaries for project management unit and environmental officers (under MHI).

4.4.3 Shadow Prices

4.4.3.1 *Shadow Exchange Rate*

345. Standard practice in economic analysis requires the use of a shadow exchange rate. Previous studies in the Maldives have adopted a value of 0.9 for the Standard Conversion Factor (SCF). This is based on the ratio of total trade to (total trade + net trade taxes). The value of 0.9 is relevant for the period in the Maldives when all imports were taxed at a rate of 10%. Currently, however, changes have been made to tariffs, which now range between zero and 25%. In particular, all construction materials apart from steel are zero rated. As the SCF is intended to apply to goods, and construction materials are the goods involved in the analysis, the SCF is assumed to be 1.0. Steel is treated by deducting the tariff from the price used in the construction cost estimate.

4.4.3.2 *Labor Costs*

346. Howard (2001) notes that labor is often imported to carry out a project. This is most likely to be the case in Kulhudhuffushi as it is common in the Maldives for an overseas construction company to carry out the works, and be essentially self-sufficient in labor. Howard then notes that in this case the labor has a cost to the local economy in terms of foreign exchange. This labor will repatriate a significant part of earnings, giving a loss in foreign exchange. Goods consumed by this labor within the Maldives will mostly be imported as well, providing a further loss in foreign exchange. The Shadow Wage Rate of foreign labor equals expatriated wages plus domestic consumption by foreign labor in terms of foreign exchange. This is assumed to be the full wage in the Kulhudhuffushi project and no adjustment has been made to labor costs.

4.4.3.3 *Adjusted Construction Costs*

347. The ADB Guidelines require the use of the Cost-Insurance-Freight (CIF) or border price plus transport costs for construction materials. This means that duty costs must be subtracted. However, there is only one item of the main construction materials that has an impost, being steel with a 5% import duty. The amount of steel used in the construction is 300 tonnes.

348. From Custom's data the average CIF cost of steel is USD 0.77 per kilogram. The duty applied to this is $ 11,550. This is taken from the construction cost in proportion to the division of costs between the harbor and the small craft zone, giving total costs of $ 7,930,123, divided into $ 6,963,666, and $ 966,457 respectively.

4.4.3.4 Analysis Period

349. The analysis period is 32 years, with construction assumed to start on 01 January 2017. The project then comprises 02 years of construction and 30 years of operation.

4.4.3.5 Base Date for Monetary Values

350. Costs & benefits are expressed in current monetary values as at 31 December 2015.

4.4.3.6 Base Date for Analysis

351. The analysis discounts all costs & benefits to 1 July 2016. It is assumed that yearly costs and benefits are summed for the year and occur as a single value at the mid-point of the year.

4.4.3.7 Inflation

352. The analysis is carried out in real terms (values as at the base date) and inflation does not feature. When it comes to actual expenditure on construction and the value of tariffs over time, these need to be adjusted in practice for inflation. However, this concerns financial considerations and not the economic evaluation.

4.4.3.8 Discount Rate / Economic Internal Rate of Return

353. The analysis guidelines (ADB, 1997) note that the standard practice is to use the EIRR criterion for project viability. However, it is difficult to estimate what the value of the economic opportunity cost of capital is in each country, and hence the appropriate minimum rate of return required. Therefore, a rate of 10% to 12% is used in all member countries. The latter is used for projects containing predominantly quantifiable benefits, while the former is used where unvalued benefits additional to the quantified can be demonstrated.

354. ADB (2003) reinforces that 'a discount rate of 12% in constant economic prices is generally used as a proxy for Economic Opportunity Cost of Capital in the economic analysis of ADB-financed projects. Where significant unquantifiable net benefits are believed to be likely, the discount rate or EIRR may be between 10% and 12%.

355. ADB (2013) gives a discussion on the many different theoretical approaches to determining the required minimum EIRR, and the values chosen for use in practice around the world. It is found that there is a considerable variation in discount rate

policies, with developing countries in general applying higher Social Discount Rates (SDRs) (8%–15%) than developed countries (3%–7%).

356. The discussion notes that 'these variations reflect the different analytical approaches followed by various countries in choosing the SDR. But more fundamentally, it can be argued that the divergence reflects differences in the perceived social opportunity cost of public funds across countries and in the extent to which the issue of intergenerational equity is taken into consideration in setting the SDR.' The reference also notes 'Finally, for Multilateral Development Banks that provide development assistance to developing countries through capital investment, there could be a case for reviewing their decades-old practice of applying a uniform discount rate of 10%–12% to all projects to see whether this practice is still appropriate in a changing world.'

357. A rate of 12% is used in this analysis.

4.4.3.9 Residual Value

358. The analysis assumes an ongoing expenditure on maintenance. The nature of the main harbor items is such that if kept in good condition by this expenditure they will have a long physical and economic life.

359. One method for evaluating the residual value is to acknowledge that the benefits of the project will carry on after the 30-year period of the economic analysis. This gives the harbor a value at year 30, estimated to be the summed present value at year 30 of ongoing annual benefits. If the economic life is taken to be 60 years, there are 30 years of continuing net benefits to be discounted and summed for the RV; values beyond 30 years after the analysis period will be insignificant after discounting.

360. However, the benefits have generally risen to a high value by year 30 and the analysis then shows an extremely high residual value when calculated in this way. At that time there will be many other factors affecting benefits and it would be more appropriate to state that the future benefits after year 30 will be at least equal to the construction cost; if the harbor was not there in year 30 another would be built as the benefits would easily justify this. The conservative assumption has been made, however, of straight-line depreciation over a life of 50 years, giving a residual value of 40% of construction cost.

4.4.3.10 Timing of Project Costs and Benefits

361. Project costs are assumed to occur over the years 2017 and 2018. The first year of project benefits is assumed to be 2019.

4.4.4 Cost-Benefit Evaluation

4.4.4.1 Results

362. The cost-benefit analysis results are shown in Table 48. The spreadsheet analysis is shown in Tables 49-51.

Table 48: Cost-Benefit Analysis Results

	EIRR	NPV @ 12%
Scenario 1 – Base scenario	13.55%	USD 1,123,476
Scenario 2 – (1) above with waterfront small craft zone	14.59%	USD 1,774,530
Scenario 3 – (1) above with direct imports	18.38%	USD 5,625,322

Table 49: Scenario 1, Without Waterfront Small Craft Zone, EIRR Spreadsheet Result

year		Costs			Benefits												Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront Small Craft	Direct Imports	Total	
1	2017	4465062		4465062												0	-4465062
2	2018	4465062		4465062												0	-4465062
3	2019		17400	17400	114773	121781		286457	80161	44064	39000	176000	33359			895595	878195
4	2020		17400	17400	117172	248779		292616	81764	45380	39000	176000	34057			1034768	1017368
5	2021		17400	17400	119603	381095		299346	83400	46759	39000	176000	34763			1179965	1162565
6	2022		17400	17400	122063	518824		306680	85068	48206	39000	176000	35478			1331318	1313918
7	2023		197400	197400	124553	662060		314654	86769	49724	39000	176000	36202			1488961	1291561
8	2024		17400	17400	127071	675744		323307	88504	51320	39000		36934		0	1341880	1324480
9	2025		17400	17400	128899	685763		332682	90274	52598	39000		37465		0	1366681	1349281
10	2026		17400	17400	130756	695951		342829	92080	53946	39000		38005		0	1392567	1375167
11	2027		17400	17400	132645	706310		353800	93921	55370	39000		38554		0	1419600	1402200
12	2028		197400	197400	134565	716843		365652	95800	56876	39000		39112		0	1447847	1250447
13	2029		17400	17400	136516	727555		378450	97716	58468	39000		39679		0	1477384	1459984
14	2030		17400	17400	138500	738448	3292	391696	99670	60120	39000		40256		0	1510981	1493581
15	2031		17400	17400	140517	749525	5671	405405	101664	61834	39000		40842		0	1544457	1527057
16	2032		17400	17400	142568	760790	8049	419594	103697	63611	39000		41438		0	1578747	1561347
17	2033		197400	197400	144653	772245	10428	434280	105771	65456	39000		42044		0	1613877	1416477
18	2034		17400	17400	146772	783895	12807	449480	107886	67371	39000		42660		0	1649872	1632472
19	2035		17400	17400	148928	795743	17762	465212	110044	69359	39000		43286		0	1689333	1671933
20	2036		17400	17400	151119	807792	22716	481494	112245	71424	39000		43923		0	1729713	1712313
21	2037		17400	17400	153347	820046	27671	498346	114490	73567	39000		44571		0	1771038	1753638
22	2038		197400	197400	155612	832509	32626	515788	116779	75794	39000		45229		0	1813338	1615938

	year	Costs			Benefits											Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront Small Craft	Direct Imports	Total	
23	2039		17400	17400	157915	845185	37581	533841	119115	78107	39000		45899		0	1856642	1839242
24	2040		17400	17400	160257	858077	49740	552525	121497	80510	39000		46579		0	1908186	1890786
25	2041		17400	17400	162638	871189	61899	571864	123927	83008	39000		47271		0	1960796	1943396
26	2042		17400	17400	165059	884525	74058	591879	126406	85604	39000		47975		0	2014506	1997106
27	2043		197400	197400	167522	898089	86218	612595	128934	88302	39000		48691		0	2069350	1871950
28	2044		17400	17400	170025	911885	98377	634036	131513	91108	39000		49418		0	2125362	2107962
29	2045		17400	17400	172571	925918	139773	656227	134143	94025	39000		50158		0	2211816	2194416
30	2046		17400	17400	175160	940192	181170	679195	136826	97059	39000		50911		0	2299513	2282113
31	2047		17400	17400	177793	954711	222566	702967	139562	100215	39000		51676		0	2388490	2371090
32	2048		197400	-3378706	180470	969479	263962	727571	142354	103499	39000		52454		0	2478789	5857495
		Residual Value		3576106												**EIRR**	**13.55%**
																Net Present Value	**$1,123,476**

Table 50: Scenario 2 – Waterfront Small Craft Zone Benefits Included

year		Costs			Benefits												Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront Small Craft	Direct Imports	Total	
1	2017	4465062		4465062												0	-4465062
2	2018	4465062		4465062												0	-4465062
3	2019		17400	17400	114773	121781		286457	80161	44064	39000	176000	33359	483229		1378824	1361424
4	2020		17400	17400	117172	248779		292616	81764	45380	39000	176000	34057	483229		1517997	1500597
5	2021		17400	17400	119603	381095		299346	83400	46759	39000	176000	34763			1179965	1162565
6	2022		17400	17400	122063	518824		306680	85068	48206	39000	176000	35478			1331318	1313918
7	2023		197400	197400	124553	662060		314654	86769	49724	39000	176000	36202			1488961	1291561
8	2024		17400	17400	127071	675744		323307	88504	51320	39000		36934		0	1341880	1324480
9	2025		17400	17400	128899	685763		332682	90274	52598	39000		37465		0	1366681	1349281
10	2026		17400	17400	130756	695951		342829	92080	53946	39000		38005		0	1392567	1375167
11	2027		17400	17400	132645	706310		353800	93921	55370	39000		38554		0	1419600	1402200
12	2028		197400	197400	134565	716843		365652	95800	56876	39000		39112		0	1447847	1250447
13	2029		17400	17400	136516	727555		378450	97716	58468	39000		39679		0	1477384	1459984
14	2030		17400	17400	138500	738448	3292	391696	99670	60120	39000		40256		0	1510981	1493581
15	2031		17400	17400	140517	749525	5671	405405	101664	61834	39000		40842		0	1544457	1527057
16	2032		17400	17400	142568	760790	8049	419594	103697	63611	39000		41438		0	1578747	1561347
17	2033		197400	197400	144653	772245	10428	434280	105771	65456	39000		42044		0	1613877	1416477
18	2034		17400	17400	146772	783895	12807	449480	107886	67371	39000		42660		0	1649872	1632472
19	2035		17400	17400	148928	795743	17762	465212	110044	69359	39000		43286		0	1689333	1671933
20	2036		17400	17400	151119	807792	22716	481494	112245	71424	39000		43923		0	1729713	1712313
21	2037		17400	17400	153347	820046	27671	498346	114490	73567	39000		44571		0	1771038	1753638
22	2038		197400	197400	155612	832509	32626	515788	116779	75794	39000		45229		0	1813338	1615938

year		Costs			Benefits												Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront Small Craft	Direct Imports	Total	
23	2039		17400	17400	157915	845185	37581	533841	119115	78107	39000		45899		0	1856642	1839242
24	2040		17400	17400	160257	858077	49740	552525	121497	80510	39000		46579		0	1908186	1890786
25	2041		17400	17400	162638	871189	61899	571864	123927	83008	39000		47271		0	1960796	1943396
26	2042		17400	17400	165059	884525	74058	591879	126406	85604	39000		47975		0	2014506	1997106
27	2043		197400	197400	167522	898089	86218	612595	128934	88302	39000		48691		0	2069350	1871950
28	2044		17400	17400	170025	911885	98377	634036	131513	91108	39000		49418		0	2125362	2107962
29	2045		17400	17400	172571	925918	139773	656227	134143	94025	39000		50158		0	2211816	2194416
30	2046		17400	17400	175160	940192	181170	679195	136826	97059	39000		50911		0	2299513	2282113
31	2047		17400	17400	177793	954711	222566	702967	139562	100215	39000		51676		0	2388490	2371090
32	2048		197400	-3374650	180470	969479	263962	727571	142354	103499	39000		52454		0	2478789	5853438
		Residual Value		3576106												**EIRR**	**14.59%**
																Net Present Value	**$1,774,530**

Table 51: Scenario 3 Waterfront Small Craft Zone and Direct Import Benefits Included

year		Costs			Benefits												Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront and Small Craft zone	Direct Imports	Total	
1	2017	4465062		4465062												0	-4465062
2	2018	4465062		4465062												0	-4465062
3	2019		17400	17400	114773	121781		286457	80161	44064	39000	176000	33359	483229		1378824	1361424
4	2020		17400	17400	117172	248779		292616	81764	45380	39000	176000	34057	483229		1517997	1500597
5	2021		17400	17400	119603	381095		299346	83400	46759	39000	176000	34763			1179965	1162565
6	2022		17400	17400	122063	518824		306680	85068	48206	39000	176000	35478			1331318	1313918
7	2023		197400	197400	124553	662060		314654	86769	49724	39000	176000	36202			1488961	1291561
8	2024		17400	17400	127071	675744		323307	88504	51320	39000		36934		243300	1585180	1567780
9	2025		17400	17400	128899	685763		332682	90274	52598	39000		37465		486600	1853281	1835881
10	2026		17400	17400	130756	695951		342829	92080	53946	39000		38005		729900	2122467	2105067
11	2027		17400	17400	132645	706310		353800	93921	55370	39000		38554		973200	2392800	2375400
12	2028		197400	197400	134565	716843		365652	95800	56876	39000		39112		1216500	2664347	2466947
13	2029		17400	17400	136516	727555		378450	97716	58468	39000		39679		1242660	2720044	2702644
14	2030		17400	17400	138500	738448	3292	391696	99670	60120	39000		40256		1269700	2780681	2763281
15	2031		17400	17400	140517	749525	5671	405405	101664	61834	39000		40842		1297630	2842087	2824687
16	2032		17400	17400	142568	760790	8049	419594	103697	63611	39000		41438		1326500	2905247	2887847
17	2033		197400	197400	144653	772245	10428	434280	105771	65456	39000		42044		1356330	2970207	2772807
18	2034		17400	17400	146772	783895	12807	449480	107886	67371	39000		42660		1387170	3037042	3019642
19	2035		17400	17400	148928	795743	17762	465212	110044	69359	39000		43286		1419030	3108363	3090963
20	2036		17400	17400	151119	807792	22716	481494	112245	71424	39000		43923		1451960	3181673	3164273
21	2037		17400	17400	153347	820046	27671	498346	114490	73567	39000		44571		1486000	3257038	3239638
22	2038		197400	197400	155612	832509	32626	515788	116779	75794	39000		45229		1521180	3334518	3137118

year		Costs			Benefits											Net Benefits
		Construction	Maintenance	Total	Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront Small Craft Benefits	Direct Imports	Total	
23	2039		17400	17400	157915	845185	37581	533841	119115	78107	39000		45899		1557540	3414182	3396782
24	2040		17400	17400	160257	858077	49740	552525	121497	80510	39000		46579		1595130	3503316	3485916
25	2041		17400	17400	162638	871189	61899	571864	123927	83008	39000		47271		1633980	3594776	3577376
26	2042		17400	17400	165059	884525	74058	591879	126406	85604	39000		47975		1674130	3688636	3671236
27	2043		197400	197400	167522	898089	86218	612595	128934	88302	39000		48691		1715650	3785000	3587600
28	2044		17400	17400	170025	911885	98377	634036	131513	91108	39000		49418		1758560	3883922	3866522
29	2045		17400	17400	172571	925918	139773	656227	134143	94025	39000		50158		1802920	4014736	3997336
30	2046		17400	17400	175160	940192	181170	679195	136826	97059	39000		50911		1848770	4148283	4130883
31	2047		17400	17400	177793	954711	222566	702967	139562	100215	39000		51676		1896180	4284670	4267270
32	2048		197400	-3374650	180470	969479	263962	727571	142354	103499	39000		52454		1945190	4423979	7798628
		Residual Value		3374650												**EIRR**	**18.38%**
																Net Present Value	**$ 5,625,322**

4.4.5 Sensitivity Analysis

4.4.5.1 Assumptions Made

Table 52: List of Main Assumptions

Freight	Boat sizes (length m)	30, 28, 20, 17
	Capacity (tonnes)	93, 81, 42, 30
	Crew numbers	8, 8, 6, 5
	Average of capacity carried	33%
	Freight required per household	2.5 t
Connectivity (1)	Time value lost in service/appointment mismatch	
	Only 33% of trip makers value this time	MVR 117/trip
Connectivity (2)	Willing to travel 4 times more often	
	Benefit of trips > cost of trip (ticket + meal)	MVR 140/trip
Port congestion	Unloading rate	5 tonnes/hour
	% of capacity carried	50%
Fisheries	Hours to unload without a quay	3.5
	Hours to unload with a quay	0.25
	Rate of growth of annual catch	2% per year
	Catch size, crew cost	
Employment	Number	36
	Multiplier to include indirect employment	2.5
Waterfront small craft zone	Benefit > = cost	
Direct imports	Considered only fresh or frozen foods	
	One third of Region 1 freight is fresh or frozen food	
	Two thirds of this will be imported directly.	
	Benefits build over years 5 to 10 then rise with pop. growth	

363. Each of these assumptions has an effect on the analysis results. However, the assumptions made have been determined by analysis, interview, site knowledge, or reasoning. Each could, if questioned, be changed to illustrate the impact on results, but it is more appropriate to consider the benefits that most significantly contribute to the outcome. The following table gives the discounted present value of each of the benefit types at the base year, discounted at the rate of 12%.

Table 53: Relative Contributions to the Project Benefit ($ discounted to the base date)*

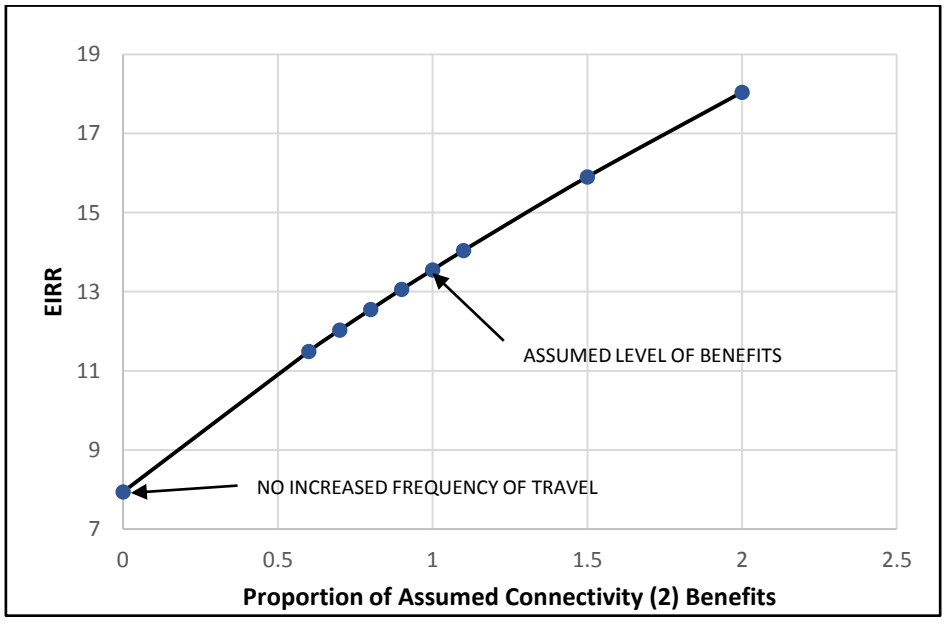
Benefit of Connectivity (1)	Benefit of Connectivity (2)	Congestion Relief	Employment	Fisheries	Boat Damage	Erosion Protection	Surplus Sand	Safety Benefits	Waterfront small craft zone Benefit *	Direct Import *
841,154	3,685,089	78,322	2,320,386	600,221	356,259	250,417	403,478	244,440	816,700	3,847,831

* Benefits that do not contribute to the base case

364. The most significant contributor to the result in the base case is the benefit of connectivity (2). This is the benefit gained by more frequent travel, as determined by the questionnaire results of a previous study indicating willingness to travel, and an estimate of the benefit gained by each trip. The result is reasonable given the desire for more travel, along with the widely-held belief that connectivity is a cornerstone of development. In addition, the value placed on each single trip has been conservatively estimated in this study.

365. The Figure below shows that the effect of adopting higher or lower rates of increased frequency of travel in relation to the assumptions made in Section 4.4.5.1.

Figure 27: Effect of Changes in the Value of Connectivity Benefit (2) on EIRR



4.4.5.2 Changes in all Cost-Benefit Values

366. Further sensitivity tests have been made by evaluating the effects on EIRR and NPV of changes in total costs and benefits. The results are set out in Table 54 below. Switching values are given in Table 55.

Table 54: Impact of Changes in Total Costs and Total Benefits

Costs	Benefits	EIRR	ENPV (USD million)
Base case	Base case	13.55	1.123
+10%	Base case	12.45	0.349
Base case	-10%	12.33	0.237
-10%	-10%	13.55	1.011
+10%	-10%	11.3	-0.538
1 year delay in construction			1.003

Table 55: Switching Values for Costs and Benefits

Costs	Benefits	EIRR
+14.5%		12.0
	-12.7%	12.0

4.4.5.3 Additional Factors in Support of the Benefits

Direct Imports

367. The analysis quantifies the fact that there are large cost savings to be made by offloading the northern region cargo from India and Sri Lanka at Kulhudhuffushi regional Harbor, rather than passing by, delivering this to Malé, then sending small boats to bring it back to the region. However, this benefit also has been kept separate from the base case as it requires further development of the Kulhudhuffushi harbor, and is included only in Case 3. Never the less the development of Kulhudhuffushi as a regional hub must logically bring this about at some future time, for the cost savings to be made and the resultant benefits for the region's population. Again part of these benefits could be included in the base case.

Connectivity

368. The (2005) survey of willingness to travel more frequently, indicating on average a wish to double the amount of travel, was carried out at a time when intensive development of Kulhudhuffushi was not well envisaged. That survey most certainly underestimated the impact that the growth of a regional hub and more frequent ferry services would have on the desire to travel to Kulhudhuffushi. It is considered that the benefits of connectivity are very conservatively estimated.

4.4.6 Distribution of Benefits

369. The main benefit is that given by increased connectivity [benefits (1) and (2)]. These benefits have been estimated to be at least equal in value to the costs of making the additional trips and will accrue in their entirety to the trip makers from the islands. They will gain by:

- Greater and more immediate access to health services and education. This includes a more beneficial response to health emergencies, improved schooling travel, and greater access to training for the island population.
- Improved access for shopping and for the transfer of goods and produce from the islands to Kulhudhuffushi.
- Improved connectivity for business development and business operation.
- Greater links for governance of the region.
- An improvement in the retention of population in the islands, particularly those with needed skills.
- More opportunities for young people to train for and gain local employment.

370. At the same time the follow-on effects of more trip-making will benefit boat owners through increased revenue and the support of increased demand enabling a growth in services. Ultimately, this will in turn lead to reduced fares and resulting further benefits to trip makers, particularly the poor.

371. The distribution of other benefits is as follows:

- Savings by avoiding future harbor congestion will lower the cost of transport, reducing the shipping cost of goods as well as fares. Lower transport costs will benefit the regional community.
- Time saved by fishing boats by unloading alongside the quay to a new fisheries market will aid fishermen and enable more family time. The use of a quay for unloading will reduce the damage to fish in unloading and allow a higher quality for sale.
- The additional employment opportunities provided by the shops and amenities, as well as the associated indirect benefits, will increase work availability and aid the economy of Kulhudhuffushi.
- The improvement in safety for boats will reduce costs for boat owners. Increased safety for passengers will assist all trip makers, particularly the elderly, the sick, and pregnant women in embarking and disembarking boats.
- The greater shelter given to boats will lessen damage and reduce owner costs and crew downtime.

- Environmental benefits include a sand stockpile that will replace the need to obtain this construction material from other more environmentally sensitive locations, as well as provide an income source. One other benefit is the stabilization of the reclamation face. The construction of a breakwater opposite the reclamation will also provide greater security to the reclaimed land itself against storm wave inundation.

- Savings from providing a separate waterfront zone for small crafts. In addition to direct benefits of safety and specialization, the immediate indirect benefits of this harbor component will stem from employment and through providing an attraction for visitors. In the long-term, this component will serve as the only possible development area for the harbor; thus providing a buffer for future port expansion.

- The future benefits of an import base for Region 1 for certain commodities will result from other projects that aim to change shipping patterns and increase activity in the KPL overseas harbor. However, that development will have an indirect effect on the proposed harbor by greatly increasing shipping from the islands to Kulhudhuffushi.

4.4.7 Risks

372. The project aims at providing an essential infrastructure for Kulhudhuffushi, with a view to reaching the GoM's goal of increased employment, reduced poverty, and raised welfare in Region 1, through improved connectivity with Kulhudhuffushi. As such, it is for the most part not a project that aims to fix existing constraints and problems, but rather one that paves the way for the future.

373. The project has therefore involved prediction of what can and will happen in the future, and the results show large benefits are possible for the region. However, the project on its own will not bring this about. Connectivity implies greater frequency of travel, with this providing the largest of the benefits. In turn, this requires an expansion of transport services. It also requires an increase by local business in services for visitors, including accommodation and integration of the island population into local activity.

374. The rise of Malé has demonstrated that there is a dynamic that, once started, takes over, with growth providing employment, and employment attracting further growth. In a lesser way this is a model for the change required in Kulhudhuffushi, and in that case further development of the KPL port will be important

375. Connectivity benefits provide the greatest benefit, and the greatest risk is that these not be realized by each of the other necessary steps not being planned and championed by the local population and by government. There is a need for the whole process to be outlined, and for training and assistance to be provided where necessary, particularly for solving the long-standing difficulties in ferry services. The risk that this is not followed outweighs any other risk from other benefit contributors.

5. FINANCIAL FEASIBILITY AND EVALUATION

5.1 Scope and Objectives

376. As highlighted in Chapter 4 of this Report, this PPTA TOR states that the *Financial Feasibility* '…will include estimation of proposed harbor user charges and development of cost recovery mechanism for sustainable operation and to minimize subsidy will be provided. As the proposed project expects to generate revenue, the financial analysis will also be carried out by calculating the Financial Internal Rate of Return (FIRR).'

377. In his work, the Consultant has carried out the financial analysis of the in accordance with ADB's Financial Management and Analysis of Projects, 2005 [The Guidelines]

378. [The Guidelines] require the financial analysis to be carried using cash flow analysis by projecting future revenues and cost streams from the project. The projections are made using assumptions for costs and benefits. Two streams of projected cash flows are required to be developed; "without project" and "with project" and the incremental cash flow used to discount to its present value and a Financial Internal Rate of Return (FIRR) and Financial Net Present Value (FNPV). The Weighted Average Cost of Capital (WACC) is determined based on the source and cost of financing and then used as a benchmark to compare with FIRR and FNPV.

379. [The Guidelines] distinguish between revenue generating projects and non-revenue generating projects. Whilst presentation of FIRR and FNPV is mandatory for a revenue generating project only the method of financing of operations and maintenance cost need be discussed for a non revenue generating project.

380. As such, the financial feasibility and evaluation in this report will include the followings:

- The financial analysis of the harbor as a non-revenue generating project,
- The financial analysis of a harbor's operating scenario with potential revenue generating activities,

381. The above components and the financial analysis reported in this Chapter are a revised and final version of the draft version submitted on 20 January 2016 as part of the DFR.

5.2 Financial Analysis of this Project

382. Domestic harbors in the Maldives do not levy port dues or cargo handling charges. The Gom's policy is that this is unlikely to change in the near future. The

economic objective is to improve connectivity among isolated islands and atolls, thereby improving the socio economic conditions of the residents.

383. The GoM has confirmed that all operations and maintenance costs of the Kulhudhuffushi harbor will be financed from the national budget.

384. MHI has a program of maintenance across the country's harbors. During the course of this PPTA, MHI has provided the budget of maintenance dredging up to 2013 and stated that the cycle of maintenance is about 5 years, which means that each of the country's 150 harbors is dredged every 10-12 days in 5 years. MHI has mentioned however that precedence is given to harbors that experience siltation problems, so the maintenance dredging program isn't strictly related to the calendar, but rather to the needs and priorities.

385. In terms of harbor's regular (daily/weekly) maintenance, Kulhudhuffushi Council's (KC) expenditure for the harbor is in respect of electricity cost for lighting of MVR 180,000 and the contracted out cost of cleaning of the harbor and fish market area of MVR 240,000. This out of a total expenditure of MVR 8.7 million incurred by the Council in FY2013; the revised estimate for FY2014 was also MVR 8.7million. The budget estimate for FY2015 is MVR 9.8 million. Therefore, the total expenditure on harbor maintenance incurred by the council is MVR 420,000 per annum. All major harbor maintenance is incurred by MHI as explained above.

386. During ADB's first mission in December 2015, KC has committed to increasing their harbor's expenditure on cleaning and housing commensurate with the size and needs of the proposed harbor's expansion. MHI has also committed to incorporating the expanded Kulhudhuffushi harbor into their maintenance program.

387. Based on the above and the Consultant's observations during this PPTA, we believe the current GoM/MHI harbor's maintenance progam and KC's harbor maintenance expenditures are sufficient and appear to be working, and this should also apply to the proposed Kuhudhuffushi's harbor expansion.

388. Even though, the Consultant's recommends that ADB gets assurances from both MHI and KC on their maintenance programs and expenditures' commitments with regards the proposed expansion. Furthermore, assurances should be given that income generated from (i) rentals of market and retail spaces and shops (see section below) and (ii) potential tariffs in the future, should be allocated towards recovering part of full cost of harbor's maintenance.

5.3 Financial Analysis of Potential Income Generating Activities

389. As stated above, this project is non-revenue generating since there are no harbor levies being collected from cargo or fisheries vessels at present. Nevertheless, a scenario was considered where space is rented out for fish and vegetable markets and shops/offices to demonstrate the potential for income generation.

5.3.1 Weighted Average Cost of Capital (WACC)

390. WACC has been calculated in terms of real terms. The sources of funds are the ADB grant funds and GoM funds. GOM funds are assumed to cost at the rate of raising long term domestic finance within the country. The longest tenure is the 364-day Treasury Bill with a coupon rate of 3.6%. Although ADB grant funds have a zero cost, they are assumed to have an opportunity cost equivalent to government funding. ADB forecasts average long term local inflation at 2.4% and foreign inflation at 1.2%.

Table 56: Weighted Average Cost of Capital

		ADB ADF Grant	Government	Total
A.	Amount (USD million)	7.8	0.4	8.2
B.	Weighting (%)	95%	5%	100%
C.	Nominal cost (%)	3.6%	3.6%	
D.	Tax rate	0%	0%	
E.	Tax-adjusted nominal cost [C x (1-D)]	3.6%	3.6%	
F.	Inflation rate (%)	1.2%	2.4%	
G.	Real Cost [(1+E)/(1+F)-1)]	2.4%	1.2%	
H.	Weighted component of WACC	2.3%	0.1%	
Weighted Average Cost of Capital (Real)				**2.3%**

5.3.2 Financial analysis of Rental of Market Space within the Harbor

391. Stakeholder consultations reveal that there is potential for a fish and vegetable market. The assumed area for the fish market is 185 m^2 and for the vegetable market 115 m^2 for a total of 300 m^2. The assumed monthly rental for the fish market is MVR 35,000/m^2 and for the vegetable market MVR 40,000/m2. The capital cost of the construction is assumed to be MVR 533/m^2 and the resultant total cost of USD 160,000. All operational costs are assumed to be borne by the leasee. The FIRR is presented in Table 57 and is 26% which is well above the WACC of 2.3%. Therefore, it a financially attractive investment for the project owner.

5.3.3 Financial analysis of Rental of Shops and Retail Space within the Harbor

392. These facilities are assumed to be business offices and retail outlets (cafes and stores) within the commercial area of the passenger terminal and shops and retail space outside the passenger terminal. The assumptions that have been made are as follows. (i) business offices and retail outlets assumed to be 154 m^2 (ii) cafes and general stores within commercial area of the terminal 49 m^2; (iii) construction cost at USD 852/m^2; (iv) rental income at MVR 60/m2/month; (v) larger shops outside the passenger terminal area with rentals from MVR 10,000/month to MVR

16,500/month. All operational costs are assumed to be borne by the leasee. The FIRR is presented in Table 58 and is 19% which is well above the WACC of 2.3%. Therefore, it is a financially attractive investment for the project owner.

Table 57Financial Analysis of Rental of Market Space within the Harbor

Detailed FIRR and FNPV Computation (Constant 2016 USD)
Incremental

Year	Net Cashflow (incremental)			
	Capital Cost	Revenues	O&M Costs	Net Cashflow
2015	-	-	-	-
2016	-	-	-	-
2017	(43,949)	-	-	(43,949)
2018	(87,899)	-	-	(87,899)
2019	(43,949)	-	-	(43,949)
2020	-	58,442	-	58,442
2021	-	58,442	-	58,442
2022	-	58,442	-	58,442
2023	-	58,442	-	58,442
2024	-	58,442	-	58,442
2025	-	58,442	-	58,442
2026	-	58,442	-	58,442
2027	-	58,442	-	58,442
2028	-	58,442	-	58,442
2029	-	58,442	-	58,442
2030	-	58,442	-	58,442
2031	-	58,442	-	58,442
2032	-	58,442	-	58,442
2033	-	58,442	-	58,442
2034	-	58,442	-	58,442
2035	-	58,442	-	58,442
2036	-	58,442	-	58,442
2037	-	58,442	-	58,442
2038	-	58,442	-	58,442
2039	-	58,442	-	58,442
2040	-	58,442	-	58,442
2041	-	58,442	-	58,442
2042	-	58,442	-	58,442
2043	-	58,442	-	58,442
2044	-	58,442	-	58,442
2045	-	58,442	-	58,442
2046	-	58,442	-	58,442
2047	-	58,442	-	58,442
2048	-	58,442	-	58,442
2049	-	58,442	-	58,442
		-		
			FIRR	**26.0%**
			FNPV (USD)	**955,133**

Table 58: Financial Analysis of Rental of Shops and Retail Space within the Harbor

Detailed FIRR and FNPV Computation (Constant 2016 USD)
Incremental

Year	Net Cashflow (incremental)			
	Capital Cost	Revenues	O&M Costs	Net Cashflow
2015	-	-	-	-
2016	-	-	-	-
2017	(43,257)	-	-	(43,257)
2018	(86,514)	-	-	(86,514)
2019	(43,257)	-	-	(43,257)
2020	-	39,491	-	39,491
2021	-	39,491	-	39,491
2022	-	39,491	-	39,491
2023	-	39,491	-	39,491
2024	-	39,491	-	39,491
2025	-	39,491	-	39,491
2026	-	39,491	-	39,491
2027	-	39,491	-	39,491
2028	-	39,491	-	39,491
2029	-	39,491	-	39,491
2030	-	39,491	-	39,491
2031	-	39,491	-	39,491
2032	-	39,491	-	39,491
2033	-	39,491	-	39,491
2034	-	39,491	-	39,491
2035	-	39,491	-	39,491
2036	-	39,491	-	39,491
2037	-	39,491	-	39,491
2038	-	39,491	-	39,491
2039	-	39,491	-	39,491
2040	-	39,491	-	39,491
2041	-	39,491	-	39,491
2042	-	39,491	-	39,491
2043	-	39,491	-	39,491
2044	-	39,491	-	39,491
2045	-	39,491	-	39,491
2046	-	39,491	-	39,491
2047	-	39,491	-	39,491
2048	-	39,491	-	39,491
2049	-	39,491	-	39,491
		-		
			FIRR	**18.9%**
			FNPV ($ m)	**595,946**

6. INSTITUTIONAL AND GOVERNANCE ASSESSMENT

6.1 Scope and Objectives

393. The TOR for this PPTA states that the *Institutional Assessment* entails 'the assessment of existing capacity of relevant stakeholders including at central level, particularly the current harbor operator and develop/implement capacity strengthening program focused on harbor operation, maintenance and financial management to maintain the sustainability of the harbor operation. Such recommendations shall be implemented during the course of the subsequent Capacity Development Technical Assistance.'

394. With regards *Governance Assessment*, the TOR states that in this task 'the business processes of existing harbor operation at Kulhudhuffushi will be reviewed, and the PPTA will propose measures to strengthen financial management, procurement, anticorruption measures, policy and legal matter, governance and institutional capacity as necessary.'

395. In interpreting the tasks involved in both institutional and governance assessment, the Consultant has carried out work related to three main areas of assessment which are reported in this Chapter:

- Institutional assessment of Kulhudhuffushi's harbor system, with a particular focus on the institutional and organizational structures in place and the operational and management capabilities of the organization(s) in charge of operating and managing the port.
- Financial due diligence, in the form of a Financial Management Assessment (FMA) of the project's stakeholders: the IA, the EA; and the Kuhudhuffushi Council.
- Recommendations for, and descriptions of, the main components of the Capacity Development Technical Assistance (CDTA) which have been identified throughout this PPTA and discussed with both ADB and MHI.

396. The above components as reported in this Chapter include a revised and upgraded version of the draft chapter submitted on 20 January 2016 as part of the DFR.

6.2 Institutional Assessment of Harbor Management and Operations

6.2.1 Overview of Institutional and Ownership Structures in Ports

397. Traditionally, ports have been owned, operated and regulated by state-controlled public organizations. However, both the introduction of private sector participation (PSP) in ports and the emergence of new forms of port administration have led to the adoption of new models of port ownership and institutional structuring.

398. Current models for classifying port organizational and institutional structures are categorized by one or a combination of the following criteria: the ownership

structure (public, private, or both), the administrative organization (national, regional, local, etc.), and the level of degree of devolution of port decision making (statutory independence, financial autonomy, etc.).

399. Due to the variety and dissimilarity in port assets, roles, functions and services; analyzing the ownership structure of ports and terminals is not always a straightforward categorization between public and private sector ownership. This has led to the emergence of generic port institutional models including the landlord, public service, private service and tool models, or a combination of some or all of these. The main difference between the three models refers back to the aspects of the ownership of port facilities (public or private), the management of port facilities (infrastructure or superstructure), the affiliation of port's workforce, and sometimes the regulation of port management and operations.

Table 59: Generic Institutional Port Models (Bichou, 2009)

	Infrastructure	**Superstructure**	**Workforce**	**Regulation**
Landlord	*Public*	*Private*	*Private*	*Public*
Tool	*Public*	*Public (Private)*	*Private (Public)*	*Public/ Private*
Service Public	*Public*	*Public*	*Public*	*Public*
Service Private	*Private*	*Private*	*Private*	*Private/Public*

400. In the service model, the port (public or private) owns, maintains and develops both infrastructure and superstructure, operates all handling equipment, and performs on its own all other commercial port functions. Both landlord and tool ports own and develop their infrastructure, which is leased to the private sector. However, while the superstructure is owned and operated by private operators in the landlord model, the tool port still owns the superstructure but may lease it for operational purposes to private companies. This distinction is not always obvious in that some ports may restrict superstructure assets to cargo handling equipment, while others extend them to storage, warehousing and logistics facilities. Even where a landlord structure is in place; the extent of the private sector involvement in port development, operations, and/or service provision can vary widely across port facilities as shown in Table 60.

Table 60: Variation of PSP in Landlord Port Models (Bichou, 2014)

<table>
<tr><td>Basic (nautical) infrastructure</td><td rowspan="5">Public sector</td><td rowspan="4">Public sector</td><td rowspan="3">Public sector</td><td rowspan="2">Public sector</td><td>Public sector</td><td rowspan="5">Private sector</td></tr>
<tr><td>Marine Services</td><td rowspan="4">Private sector</td></tr>
<tr><td>Terminal Infrastructure</td><td rowspan="3">Private sector</td></tr>
<tr><td>Terminal Operations</td><td rowspan="2">Private sector</td></tr>
<tr><td>Logistics Services</td><td>Private sector</td></tr>
</table>

401. Furthermore, the level of devolution of public decision making can vary widely between world ports and terminals. Here a variations of organizational port models exist; from centrally-controlled ports at national or state levels, to ports controlled at regional, local or municipality levels. Other models of port devolution include autonomous, trust, and corporatized ports:

- The autonomous port, a model widely applied in France and French-speaking Africa, is a public enterprise which enjoys a high degree of financial autonomy and administrative independence from the central government, but still pursues the objective of safeguarding the general public interest thus not necessarily pursuing commercial objectives.
- The trust port, a model mainly applied in the Great Britain and its former colonies, is an independent statutory corporation governed by its own legislation and controlled by an independent board of trustees. Although operating in a commercial way, trust ports do not necessarily seek profit maximization and have no requirement to distribute dividends to their shareholders;
- The port corporation, a model widely used in Canada, Australia, and several South East Asian countries, is a public company that can be either government-owned or statutory-owned depending on the legislation and regulatory regime that govern its operations and management. The thrust of corporatization is that it converts the traditional port organization into a public company operating commercially under the same legal rules as the private sector.

402. A common institution found across various port ownership models is the port authority or agency. The latter may take several roles ranging from a landlord function to a port developer, promoter, operator, and regulator. There are and have always been conflicting viewpoints about the nature and extent of the port authority's roles and functions. As pointed out by Bichou and Gray (2005), there is no best model that fits all ports, and consideration should be given to port and stakeholder specific factors when deciding on the appropriate ownership and management structure.

6.2.2 Port Institutional Framework in Kulhudhuffushi and the Maldives

403. Until recently, all ports in the Maldives followed the public service model where the development of port infrastructure, the operation of port superstructure, and the provision of port services were under the control of public port authorities.

404. In Malé, the main city and port's hub of the country, port operations have been assumed by the GoM after the two public companies in charge of managing the port (Orchid and the Maldivian National Trading Corporation) were dissolved in the mid 1980s. This was followed by a major rehabilitation and upgrade of port facilities in Malé's commercial harbor and paved the way to the establishment of the Maldives Ports Limited (MPL), a state corporation, which acts as both port operator and port authority for Malés harbor as well as other harbors under its helm, most notably Hulhumalé's and Kulhudhuffushi's regional harbors.

405. Given the limited space in Malé, a relocation of commercial harbor activities to the adjacent island of Thilafushi is currently underway. It is expected that MPL will operate the new port along with other international partners; talks currently being held with DP World, ICTSI, and other international terminal operators. Thilafushi is considered the 1st port project in the Maldives developed under a Public-Private Partnership (PPP) arrangement.

406. The separation between commercial port functions (under MPL) and regulatory port functions; previously under the Ministry of Transport and Communication but now under the Transport Authority which is part of the Ministry of Economic Development), has led to a port's institutional framework similar to the corporatized port model described above.

407. Outside Malé and other ports operated by MPL, local island ports such as the Kulhudhuffushi harbor subject to this PPTA are managed and operated by local councils. The development, upgrade and maintenance of those ports remain however the responsibility of central departments within the GoM.

6.2.3 Assessment of Port Institutional Framework

408. The success of any port depends heavily on the adequacy of the institutional structure in place and the capabilities of public agencies in charge of the port sector. This section assesses the adequacy of the current port institutional framework in Kulhudhuffushi, focusing mainly on fragmentation issues.

409. A major issue in developing, managing, regulating, and operating ports is the delineation of the functional roles and scope of responsibilities of the various stakeholders involved. In this respect, fragmentation has four distinct meanings:

- Industrial fragmentation means separating different activities according to the degree of industrial specialization such as in terms of basic infrastructure development, terminal operations and services, intermodal and logistics activities, etc. To a large extent, one of the outcomes of this project is to ensure industrial fragmentation by separating harbor facilities into dedicated activities; fishing, passenger / cargo operations, etc.

- Spatial fragmentation refers to the geographical and spatial organization of the sector, e.g. local versus national, decentralized versus centralized, etc. This form of fragmentation is already in place in the Maldives including in Kulhudhuffushi; but the delineation of responsibilities between central and local authorities does not match the pronounced separation between hub ports and local ports.

- Functional fragmentation means allocating policy (strategy) decisions, regulation, and operations to separate entities. This form of fragmentation is common and desirable, but the effectiveness of separating policy, regulation, and operations is often constrained by competition between various public agencies and the lack of clear rules as to who does what and why. This is a common issue in the Maldives, especially in the port sector.

410. The various forms of fragmentation observed above can be the cause of frictions and inefficiencies within a local port system such as that of Kulhudhuffushi's harbor.

- On the one hand, because the port sector serves wider national and policy goals (regional development, transport and logistics connectivity, etc.) and contributes in other sectors of the economy (trade and industry, regional development, fisheries, tourism, etc.); coordination among public agencies and governmental departments is essential.

- On the other hand, due to the geographical spread of local ports in the Maldives and their relative remoteness from the center, the ability of local councils acting as port agencies to implement Government's policies while ensuring safe and efficient port operations appears to be very limited. Indeed, the Kuldhuffushi Council does not currently have the necessary human capabilities for carrying out its potential mandate as the agency in charge of regular operations and management of the expanded harbor.

411. During this PPTA, and throughout the various meetings with both MHI, MoFT, and the Kulhudhuffushi Council, there seems to be a recognition from all parties that an appropriate program for institutional development and training skills be formulated and implemented during project's construction. The objective of this program, outlined in this report as a main CDTA component, is to ensure that the Kuldhuffushi council has the appropriate financial and human capacity to operate and manage the expanded harbor.

6.2.4 Assessment of Port Regulatory Framework

412. A major component of policy and regulatory intervention in seaports is the state of port safety, security, labour regulation, and environmental sustainability. Examples of regulated activities in the sector include, but are not limited to port state control, port health and safety, port and maritime security, port environmental management, nautical safety, port training and labour regulation. Several regulatory standards have been developed to ensure the safety, security, and environmental sustainability of maritime and port operations. Many of these regulations are set by international organizations such as the IMO, the ILO, and regional and national agencies; and should be supervised and monitored by the relevant maritime and port agencies.

413. Throughout this PPTA and in various sections of this report, the Consultant has pointed out several observed gaps in port and maritime safety, both in Kulhudhuffushi's harbor and in the other visited harbors. This is in addition to the non-satisfactory status of compliance of the Maldives vis-à-vis international maritime regulations (Table 61). The preliminary design developed in this PPTA has incorporated various components and facilities to ensure the safety of ships and passengers in the new harbor. Even though, there are major observed gaps in safety practices both at operational and management levels which would require an overhaul of safety systems and operational practices in place. To this end, the Consultant recommends a CDTA safety component which covers both required

safety management systems in ports and the human skills sets to ensuring safe operations of the harbor and its facilities.

Table 61: The Maldives Status of Compliance with Major Maritime Regulations (IMO, 2016)

IMO Convention 48	x	IMSO amendments 2006		PAL Protocol 76	
SOLAS Convention 74	x	IMSO amendments 2008		PAL Protocol 90	
SOLAS Protocol 78		FACILITATION Convention 65		PAL Protocol 02	
SOLAS Protocol 88	x	MARPOL 73/78 (Annex I/II)	x	LLMC Convention 76	
SOLAS Agreement 96		MARPOL 73/78 (Annex III)		LLMC Protocol 96	
LOAD LINES Convention 66	x	MARPOL 73/78 (Annex IV)		SUA Convention 88	x
LOAD LINES Protocol 88		MARPOL 73/78 (Annex V)	x	SUA Protocol 88	x
TONNAGE Convention 69	x	MARPOL Protocol 97 (Annex VI)		SUA Convention 2005	
COLREG Convention 72	x	London Convention 72		SUA Protocol 2005	
CSC Convention 72		London Convention Protocol 96		SALVAGE Convention 89	
CSC amendments 93		INTERVENTION Convention 69		OPRC Convention 90	
SFV Protocol 93		INTERVENTION Protocol 73		HNS Convention 96	
Cape Town Agreement 2012		CLC Convention 69	x	HNS PROT 2010	
STCW Convention 78	x	CLC Protocol 76	x	OPRC/HNS 2000	
STCW-F Convention 95		CLC Protocol 92	x	BUNKERS CONVENTION 01	
SAR Convention 79		FUND Protocol 76		ANTI FOULING 01	
STP Agreement 71		FUND Protocol 92	x	BALLASTWATER 2004	x
Space STP Protocol 73		FUND Protocol 2003		NAIROBI WRC 2007	
IMSO Convention 76		NUCLEAR Convention 71		HONG KONG CONVENTION	
INMARSAT OA 76		PAL Convention 74			

6.3 Financial Due Diligence- Financial Management Assessment

414. As the project financier, ADB is governed by its Charter which requires that:

- "in making or guaranteeing a loan, the Bank shall pay due regard to the prospects, that the borrower and its guarantor, if any, will be in a position to meet their obligations under the loan agreement;

- The Bank shall take necessary measures to ensure that the proceeds of any loan made, guaranteed or participated in by the Bank, are used only for the purposes for which the loan was granted and with due attention to considerations of economy and efficiency".

415. Financial due diligence is required for the ADB to meet the requirements of its Charter. Financial due diligence is required both from the project's perspective, i.e. that the project is financially viable and sustainable, and from the borrower's perspective, i.e., that its financial management systems and controls are in place to

ensure that funds will be utilized for the intended purpose and support monitoring and supervision of the project.

416. The Financial Management Report is the due diligence assessment or financial management assessment (FMA) of the borrower, the EA and the IA. The FMA is carried out in accordance with ADB's Financial Management and Analysis of Projects [The Guidelines], ADB, 2005 and Financial Due Diligence, A Methodology Note, ADB, 2009.

417. The FMA "is not an audit but a review designed to determine whether or not the entity's financial management arrangements are sufficient for the purposes of project implementation". [The Guidelines].

6.3.1 The Public Sector in the Maldives

6.3.1.1 Government Budget Process and Overall Budget Performance

418. The public sector is a significant sector of the Maldivian economic, with public expenditure accounting for almost 75% of GDP in real terms and about 47% of GDP in nominal terms. GDP was half what it is today ten years ago and the public sector accounted for 50% of GDP in real terms. The Government of Maldives (GoM) recurrent budget has expanded threefold and its capital budget six-fold in short span of ten years. The large expansion of the public sector within a short time creates stress on its management, in terms of manpower, systems and controls.

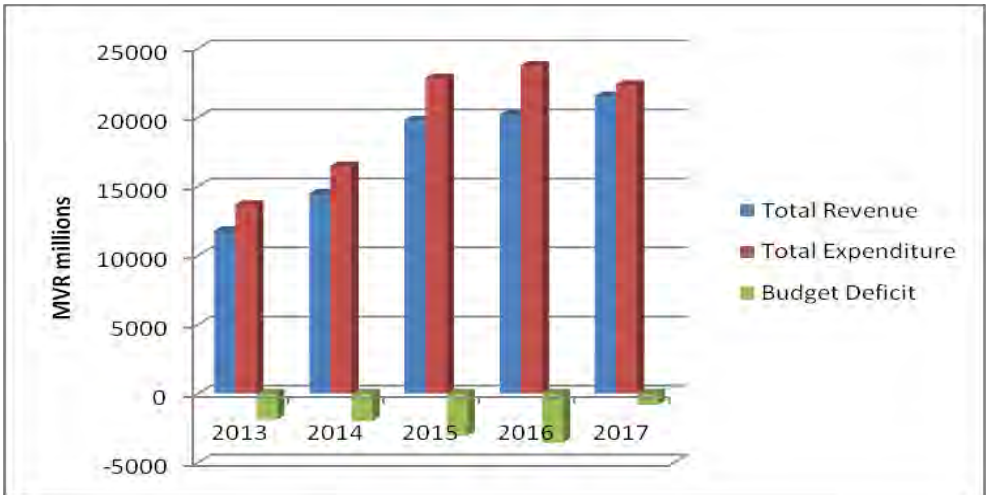
419. The present Constitution came in effect in 2008, repealing the earlier Constitution of 1998. Both the current and earlier Constitutions state that Maldives is democratic, unitary state with a republican form of government. The State comprises of the executive (President), legislature (Parliament of Peoples' Majilis) and the judiciary.

420. Both the EA and IA are public sector institutions financed entirely by the GoM budget. The government fiscal year (FY) is from 1 January to 31 December.

421. MoFT is responsible for preparation of the budget and presentation to Parliament and the Treasury and Public Accounts Department (TPAD) within MoFT prepares consolidated financial statements for the entire public sector.

422. In July each year, MoFT issues a Budget Circular requesting each Ministry/expenditure unit to submit estimates of expenditure for the following year. MoFT has an intensive period of work during August to November to consolidate the estimates provided by the various agencies and if necessary discuss and revise the original estimates sent in by each agency. A Budget Committee comprising of Ministers and a representative from the Maldives Monetary Authority (MMA) reviews and clears the budget before submission to the President's Office for approval and presentation to the People's Majlis, which usually takes place in December. The Majlis passes the budget on a vote and the Speaker informs the President of its approval. The Speaker then informs the Minister in charge of the MoFT to implement the approved budget.

Figure 28: Government Revenues, Expenditures and Budget Deficit

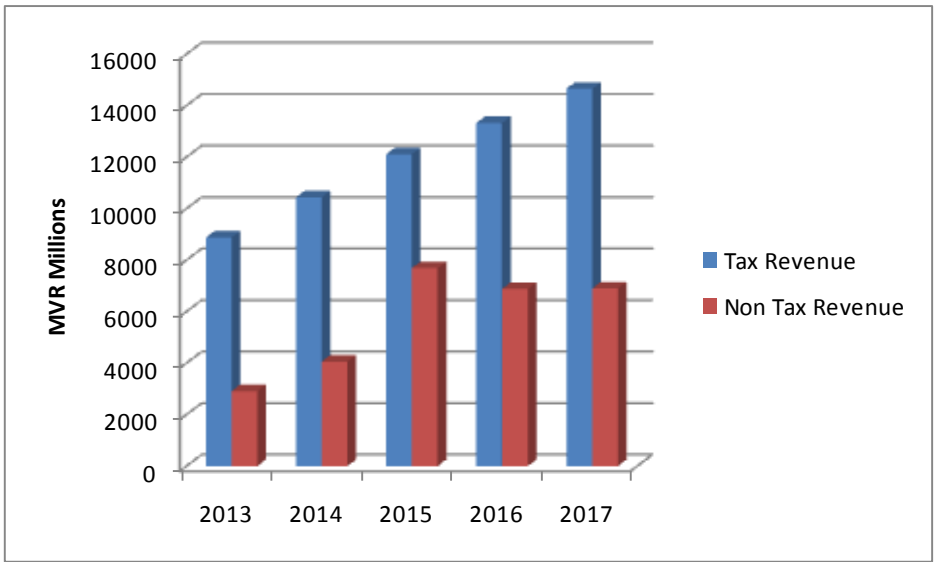


423. A budget deficit of 3-4% of GDP has been reported FY2013-FY2015 and the GoM's target under its Fiscal Policy and Medium Term Fiscal Framework is to reduce the deficit and move towards a budget surplus.

6.3.1.2 Government Revenues

424. Government revenue is in the form of tax and non-tax revenue. Tax revenue accounts for approximately 75% of total government revenue. Goods and Services Tax (GST) accounts for 40% of tax revenue, import duty 17% and business profit tax 20%. Rental income, mainly from resorts, accounts for the largest share of non-tax revenue. As seen in Figure 29, non-tax revenues are expected to increase in the coming years, due to an amendment to the Tourism Act extending the lease period up to 50 years. Increased projected revenues at an annual average of 16%, if realized will turn the budget deficit into a surplus by FY2017.

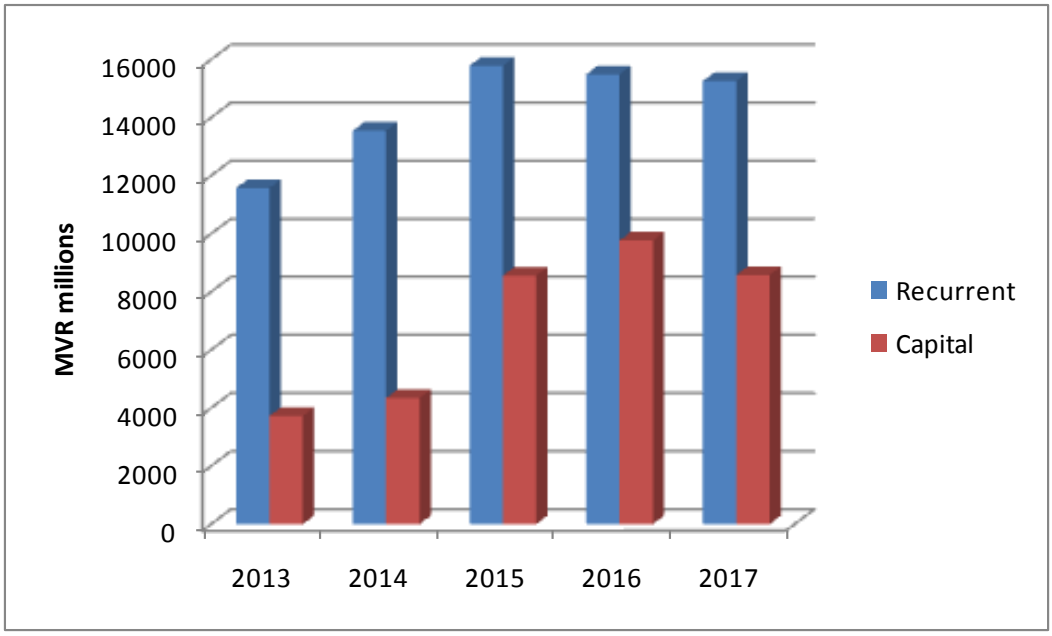
Figure 29: Government Tax and Non-Tax Revenues



6.3.1.3 Government Expenditure

425. Government expenditure is in the form of recurrent and capital expenditure. In FY2015, recurrent expenditure accounted for 65% of total expenditure and capital expenditure 35%.

Figure 30: Government Expenditure



426. Salaries and personal emoluments account for 50% of the GoM's recurrent expenditure. Total recurrent expenditure was MVR 13.5 billion in FY2014 and estimated to increase to MVR 15.3 billion by FY2017 an annual average increase of 4% per annum, which is above the inflation which the ADB has projected to be 2.5%. Therefore, there is a real term increase by way of expansion of the public sector. Over the last 10 years from FY2006 to FY2015, recurrent expenditure increased by an average of 10% per annum which has lead to the expansion of the public sector in a short time.

427. Salaries, wages, pensions and retirement benefits were MVR 7.2 billion in FY2014 and estimated to increase to MVR 8 billion by FY2014. It also employs 11% of the total population, high by international standards.

428. Capital expenditure comprises of the Public Sector Investment Program (PSIP) and debt amortization. In FY2014, PSIP accounted for 56% of capital expenditure. PSIP was MVR 2.4 billion in FY2014 and estimated to increase to MVR 6.5 billion a threefold increase by FY2017. Debt amortization is estimated to be at around MVR 1.3-1.4 billion by FY2017. This is due to the several infrastructure projects in the pipeline such as harbor construction, sewerage networks, harbor construction, housing units at Hulhumalé, improvements to the Malé international airport and the Malé-Hulhulé bridge project.

429. During the last 10 years from FY2006 to FY2015, capital expenditure increased by an average of 17% per annum. Of this the PSIP increased by an average of 12% per annum and debt amortization by an average of 5% per annum.

6.3.1.4 Government Debt and Debt Servicing Cost

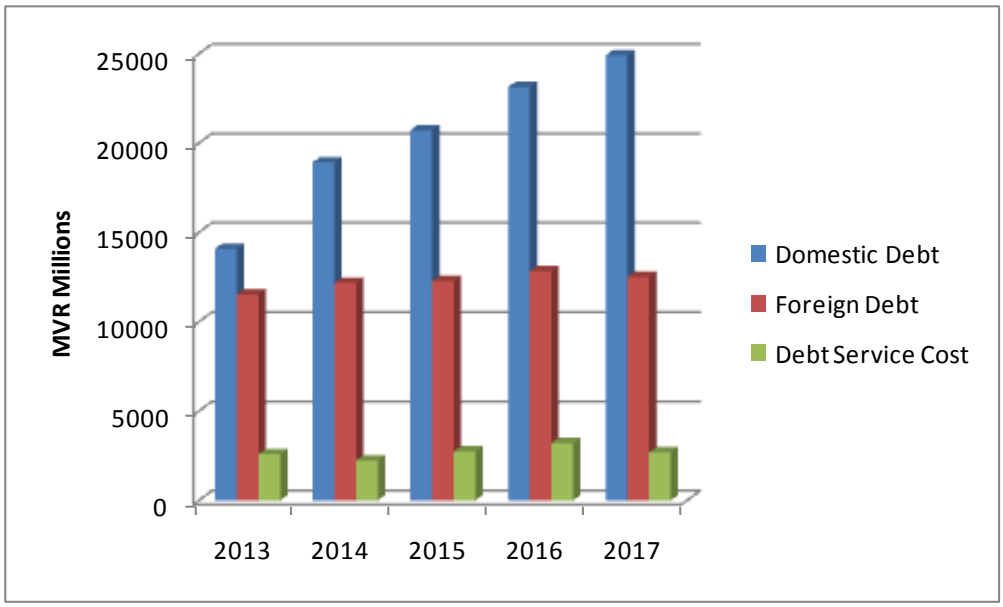
430. Total debt in FY2014 was MVR 31 billion, 60% of which was domestic debt and 40% foreign in the form of debt to multilateral agencies, bilateral agencies and banks. Total debt is estimated to rise to MVR 37 billion by FY2017. Domestic debt is used to finance the budget deficit as well as part finance the PSIP. Total debt as a percentage of GDP was 67% in FY 2014 and is estimated to be 62% by FY2017.

431. Debt service cost (both interest and capital) was MVR 2.2 billion in FY2014 and is estimated to be MVR 2.7 billion by FY2017. Debt service cost accounted for 15% of government revenues in FY2014 and is estimated to be 13% of revenue by FY2017. This is quite high and if unchecked can severely undermine fiscal stability.

432. The Maldives has enjoyed sustained economic growth in the last three decades, with real GDP per capita increasing from USD 800 in 1984 to USD 6,154 in 2014, led by the private sector and tourism sector. The public sector needs to facilitate this growth by sound public financial management policies.

433. The Peoples' Majilis in FY2013 passed the Fiscal Responsibility Act. Under this Act, the GoM cannot finance recurrent expenditure through debt, nor can it finance debt service cost by debt. Furthermore, public debt cannot exceed 60% of GDP and domestic borrowing cannot exceed 7% of revenue and be repaid within 6 months. Conforming to the provisions of this Act will be a challenge for the GoM.

Figure 31: Government Debt and Debt Service Cost



6.3.2 Public Financial Management (PFM) Initiatives in the Maldives

6.3.2.1 World Bank Funded Public Financial Systems Strengthening Project

434. The World Bank is currently implementing the Public Financial Systems Strengthening Project at the MoFT. The project cost is USD 6.5 million and the implementation period is from 2015-2020. This project has three components for (i) PFM environment; (ii) budget execution and (iii) project management.

435. Under the strengthening of the PFM environment component, the project will strengthen the legislative and institutional framework for PFM development, improve macro fiscal planning and forecasting for credible budgeting and strategic planning, and strengthen debt and cash management.

436. Component 2 will have two subcomponents. The first will be to strengthen the public accounting system, especially the Systems and Applications in Data Processing (SAP) training on various modules and functions to staff and integrating fixed asset management, debt recording modules into the existing SAP operations. The second subcomponent will be for strengthening internal controls, internal audit and procurement management practices. It will also provide hands-on consultant support to the internal audit function of the GoM.

6.3.2.2 ADB funded Economic Recovery Program

437. The ADB funded a short term technical assistance under the above program in 2013/14 which assisted the MoFT to enhance its accounting and reporting systems.

438. The report highlights the significant changes that have taken place in PFM in the recent years. These are the changes from single entry to double entry accounting, manual accounting to automated systems, change of the chart of accounts and change in public cash management from multiple bank accounts to a treasury single account (TSA) system. The report comments that little has been done to review the structure and staffing requirements of MoFT to meet the challenges that these changes have brought about. There is also the lack of standard operating procedures within the different units and there is no single unit responsible for the overall supervision and coordination of at different units

439. The report goes on to assess in detail the implementation of SAP on which all government departments report financial results. An important observation is the selection and training of SAP users at the various government units. There is no screening of new users to ensure that they have the requisite skills. The training offered by MoFT is very short and in reality, much of the learning is on the job. MoFT manpower is simply not available to offer more support in training of new users and regular implementation support to the user units.

440. The use of off-system software such as MS Excel spreadsheets for financial reporting is a major internal control weakness that is highlighted since these are prone to errors, omissions and fraud. The report states that the payroll system has not undergone an internal audit to ascertain and correct internal control weaknesses. The payroll accounts for 50% of Government's expenditure.

441. Further internal control weaknesses highlighted are:

- Creditor balances are not reconciled. It is a standard internal control practice to reconcile individual creditor balances with the total accounts payable module balances;
- No check has been carried out to ensure that the fixed asset registers (FAR) are updated and that fixed assets are physically verified;
- No procedures are in place to ensure that work-in-progress in transferred to fixed assets once such work is completed;
- There are no procedures to ensure that any donated fixed assets are recorded;
- Bank reconciliations not prepared.

6.3.2.3 IMF Public Financial Management Performance Report

442. A Public Expenditure and Financial Accountability Assessment (PEFA) of the Maldives was carried out jointly by the IMF and World Bank in 2009. Although dated this is the last available country financial assessment, and an updated assessment is being prepared at the time of writing.

443. The PEFA points out that budget credibility is weak and demonstrates that actual expenditure exceeded budgeted expenditure by 20% on average for FY2005-FY2007. Budgeted revenue exceeded actual by an average of 10%.

444. The main findings of the PEFA were as follows:

- Lack of data relating to procurement at the ministerial/agency level. Although tenders are awarded competitively, the report states that data on the justification for the contract awards was not available.
- The public accounting system (PAS) was being developed at the time of writing and the PEFA envisaged that it would enable full financial statements to be prepared which were acceptable to international standards;
- The establishment of the Auditor General's Office (AGO) in 2008 has had a highly visible impact and with the implementation of the PAS it will bring in greater transparency to the public sector;
- More emphasis needs to be paid to the outputs and outcomes side of the budget rather than inputs. Although outcomes are identified in terms of national development plans and sector strategies these elements are not cost and the recurrent cost implications of capital investments in terms of maintenance costs are not assessed;
- Government expenditure has outpaced GDP growth;
- The PFM system has shifted from a decentralized model to a more centralized approach since 2008 with the implementation of the TSA;

- Parliament will take a more important role in the PFM with the country's first Parliamentary election in 2009;
- Strengthening of tax administration and customs legislation;
- Lack of development of internal audit in the government. MoFT has a unit but many government departments do not. Most internal audit activities are in the form of inspections only

6.3.3 The Public Sector Finance Environment in the Maldives

445. The Law on Public Finances No.3/2006 governs the public financial environment and establishes the principles and procedures related to the finances and property of the State.

446. The President's Office, Ministries and the Attorney-General's office are defined as "accountable government agencies" under the law 3/2006. The key aspects of the law relating to accountable government agencies are:

- All payments must be in accordance with the budget passed by the People's Majlis for that year (section 20);
- Payments within 30 working days after the end of the financial year may be paid from the budget for that year with approval from the relevant Minister (section 8);
- All public monies collected and received must be deposited in the Pubic Bank Account with the MMA (section 13);
- A statement of actual revenue and expenditure for each accountable government agency and a statement of the budgeted revenue and expenditure in the budget passed by the people's Majlis for that financial year, to be submitted within 3 months after the end of the financial year (section 35);
- The Auditor General (AG) must submit an audit report of the relevant government agency within 2 months of receiving the report from the agency. If the AG does not receive the statements specified under section 35 from the relevant government agency, the fact must be reported in writing to the People's Majlis and the President (section 36).

447. Law 3/2006 creates the position of Financial Controller for the supervision and administration of the State and accounting system of the State in accordance with the procedures laid down by the Auditor General. The Financial Controller is in charge of the TPAD of MoFT.

448. GoM used a single entry manual accounting and budgeting system until FY 2009. In FY 2010, it introduced a SAP based accounting system. SAP is a double entry, accrual based system used by the private sector but can be adopted to the needs of the public sector. However, the cash basis of accounting is still being used, modified to an extent for accrual based accounting to reflect accounts payable.

6.3.4 The Public Sector Audit Environment in the Maldives

6.3.4.1 The Audit Environment

449. The Sri Lankan offices of the international accounting firms; KPMG, PriceWaterhouse Coopers (PWC) and Ernst and Young (E&Y), established offices in the Maldives many years ago. Their work has mainly concentrated on the private sector, some large state-owned enterprises (SOE) and donor funded projects. Demand for services has outstripped supply given the country's rapid economic growth from a low-income to middle-income country over the last twenty years.

450. Unlike many countries, The Maldives does not have a professional accountancy organization. An initiative was made in 2007 with the association of 'Certified Practicing Accountants of the Maldives (CPAM)' formed by Maldivians who qualified from professional accountancy bodies in the UK and Australia. However, CPAM failed to function properly due to the lack of legal recognition.

451. There is a severe shortage of professional accountants and auditors. The few that qualify in the profession are absorbed by the private sector which offers salaries not matched by the public sector. This leaves a vacuum of skills in the public sector.

6.3.4.2 Audit Act 4/2007 and the Creation of an Independent AG

452. The enactment of the Audit Act resulted in the appointment of Auditor General (AG) and the creation of the Auditor General's Office (AGO). The President, on the recommendation of the Parliament (Peoples' Majlis) appoints the AG. This is different to many countries where the AG is appointed directly by the Parliament and is answerable only to the Parliament to ensure the independence of the office of AG. Parliament requires a two third majority to select the AG but only a simple majority of those present to dismiss him.

453. Several types of audit are conducted by the AGO. The most common is what is termed the financial statement audit where they express an opinion on the financial statements. These types of audit are carried out for large SOE's on a regular basis. Compliance and Special audits, where AGO expresses an opinion o whether rules, laws, establishment codes have been followed is generally what has been done for the government ministries. The AGO has carried out a few performance audits but is constrained due to the lack of skilled staff.

6.3.5 Financial Management Assessment of MoFT

6.3.5.1 Brief Description of MoFT

454. MoFT is the executing agency (EA) for the proposed project. A financial management assessment was carried out with the aid of the ADB Financial Management Assessment Questionnaire (FMAQ). The assessment covers a broad range of issues ranging from its legal status and statutory reporting requirements, fund flow arrangements, staffing, accounting policies and procedures, budgeting,

internal controls and internal audit. The FMAQ was administered primarily to the Treasury and Public Accounts Department (TPAD) of MoFT.

455. MoFT is headed by a Permanent Secretary (PS) who reports to the Minister of Finance. MoFT also encompasses the National Bureau of Statistics, National Pay Review Board and the Privatization and Corporatization Board reporting directly to the Minister. TPAD reports to the Financial Controller who in turn reports to the Minister. The other MoFT departments are corporate affairs, fiscal affairs, debt management, property management, SOE monitoring, internal audit, economic policy, public procurement and information technology. MoFT's recurrent expenditure accounts for about 25% of GoM's total expenditure since it carries what is termed as the Special budget (Khassa) which is for contingencies. These funds have already been approved in the budget and are not a part of the supplementary budget. MoFT's PSIP which at MVR 15 million (FY2014) is an insignificant share as compared with MHI.

456. The finance section at MoFT is headed by the Financial Controller, has had a total of 43 staff. The Public Accounts System is SAP (Systems, Applications and Products in data processing) used by the entire public sector. SAP is an on-line, real-time Enterprise Resource Planning (ERP) software used by many large organizations worldwide. TPAD overseas the PAS and well as provides limited SAP training and support to other ministries.

457. The Resource Mobilization and Debt Management section of MoFT has experience with implementing project financed by many donors including ADB. The division is responsible for checking all Withdrawal Applications and supporting documents sent in from current projects before submitting for signature and onward transmission.

6.3.5.2 Findings of the Financial Management Assessment (FMA)

458. Financial reporting is conducted monthly and annually at MoFT. Monthly reporting is in the form of actual and budgeted expenditure for the relevant month and cumulative up to the relevant month. The annual reporting is more detailed comprising of (i) a budget comparison statement, i.e., actual versus final budget (made up of approved budget, supplementary budget (if any) and budget control (for adjustments and transfers between budget items); (ii) income and expenditure statement; (iii) statement of financial position (balance sheet), and (iv) explanatory notes. Financial reporting is based on a single Chart of Accounts (CoA) across the public sector. CoA is the critical to the functioning of the accounting system as it collects, classifies and collates transactions to produce the end-product, financial reports. Although MHI operates a powerful accounting system, SAP, all reporting is through MS Excel spreadsheets which is time consuming and prone to errors. This was the practice prior to implementation of SAP in 2010 and needs to be discontinued and all reporting must be through the SAP system. The last available financial statements are for FY2012, which are very outdated.

459. Accounting Manual / Standard Operating Procedures. SAP was introduced in 2010 and is used by finance, procurement and payroll sections. Each new SAP user

receives a short training at MoFT, which is wholly inadequate and can result in errors such as the one discussed above. Although there is "SAP support" from MoFT through a helpdesk, they are often referred to the SAP user manual, which can be uploaded from the MoFT website. There is no screening of an employee to assess suitability of being a SAP user and once the employee starts using SAP, there is little formal support except from peers.

460. Accounting system. In order to use SAP effectively, staff must be properly trained and assisted when such assistance is required. The SAP system that the MoFT operates is identical to other GoM ministries / departments where it is used. There are two modules which are in operation, (i) the accounts payable (AP) module and (ii) the materials management (MM) module.

461. AP relates mainly to contractor payments under the PSIP. For each vendor, a vendor master record is created and managed in a single database by TPAD. Therefore, all GoM entities will use the same assigned vendor number, bank details and payment methods and conditions for each vendor. All payments are centralized at MoFT which operates a Treasury Single Account (TSA) under its cash management and fund release section. Payments can be made through TSA by cheque, local or international bank transfer, foreign bank draft or cash. Vendor invoices are entered into SAP by the Entering Officer and when entered the transaction is "parked". The Authorizing Officer will review the "parked" invoice, and approved or "post" for payment. SAP will only "post" after checking for availability of funds through the budget. Therefore, SAP creates proper internal control through segregation between entering and approving transactions into the system. Furthermore, there are levels of authority also in place and any invoice above MVR 10,000 must be approved by two authorized signatories and the approval document needs to be scanned and uploaded

462. The MM module of SAP is used for payments with a Purchase Order (PO) generated by the procurement division. Each invoice must originate from a PO. PO is generated by SAP and the system ensures that there is sufficient budget before a PO is created. The procurement division of MoFT[1] calls for quotations from suppliers, selects the suppliers and creates a PO based on the requisition from the department concerned. Once the Entering Officer enters a PO from the vendor invoice, SAP with match the invoice, PO and goods receipt. This is also a good internal control check by the system itself.

463. Fixed assets purchased through the MM module can be only recorded on SAP once MHI requests MoFT to create a unique asset master number. The procurement division will lead the process from quotations to the creation of PO for an asset. MHI maintains a Fixed Asset Register (FAR) off system, on MS Excel. The FAR is maintained in Dhivehi with the asset number, date of purchase, location within MoFT and cost being recorded. Asset verification is done annually but no depreciation is reported in the financial statements. Donated assets remain unrecorded, as in the case of all assets created under PSIP.

[1] All procurement above MVR 1.5 million is referred to the MoFT tender committee

464. Budgeting and management accounting. The annual government budget formulation process commences in July each year, with MoFT issuing a Budget Circular requesting each Ministry/expenditure unit to submit estimates of expenditure for the following year. The government fiscal year is the calendar year.

465. The MoFT has an intensive period of work during August to November to consolidate the estimates provided by the various agencies and if necessary discuss and revise the original estimates sent in by each agency. The budget is then reviewed and cleared by a Budget Committee comprising of Ministers and a representative from the Maldives Monetary Authority (MMA) before submission to the President's Office for approval and presentation to the People's Majlis, which usually takes place in December. The budget is passed by the Majlis on a vote and the Speaker informs the President of its approval. The Speaker then informs the Minister in charge of the MoFT to implement the approved.

466. External audit. The AGO is the auditor of MoFT and the entire public sector. The AGO has last conducted a financial statement audit of MoFT for FY2012. The AGO has issued a disclaimer meaning that he cannot form a view on the financial statements. Many audit observations have been made and are summarized as follows; (i) consolidated financial statements not presented (ii) FY2011 comparative figures not presented (iii) incorrect classification of recurrent expenditure as capital (iv) lack of evidence for several transactions (v) instances of non compliance with the Law on Public Finances (vi) incomplete FAR (vii) non collection of dividends from state owned enterprises (viii) transfer between budget heads.

467. Internal audit. MoFT has an internal audit and investigation unit with a staff of 17. The intention is to function as an internal audit unit for not only MoFT but also the entire public sector. An internal audit manual has been prepared and a baseline assessment of systems has been conducted. The current director of the section was previously heading the Audit Committee, but on his appointment to the current position, the Audit Committee has ceased to function. The completed FMAQ for MoFT is presented in Appendix C1.

6.3.6 Financial Management Assessment of MHI

6.3.6.1 Brief Description of MHI

468. MHI is the IA for the proposed project. A financial management assessment was carried out with the aid of the ADB Financial Management Assessment Questionnaire (FMAQ). The assessment covers a broad range of issues ranging from its legal status and statutory reporting requirements, fund flow arrangements, staffing, accounting policies and procedures, budgeting, internal controls and internal audit. The FMAQ was administered primarily to the finance department of MHI.

469. MHI is one of the largest Ministries in both in terms of staffing (over 800) and the PSIP which at MVR 1.2 billion (FY2014) accounts for over 70% of PSIP. MHI's PSIP is estimated at well over 50% of the national PSIP for up to FY 2017. MHI

ranked after MoFT, Ministry of Health and Ministry of Education in terms of its recurrent budget MHI has evolved over the recent years from the Ministry of Housing and Environment and prior to that the Ministry of Housing, Transport and Environment. Transport and environment are now outside the purview of MHI. The infrastructure division was always within MHI.

470. The finance section at MHI is headed by a Finance Director with 9 staff. The SAP system is used as the General Ledger (GL), and also modules for accounts payable (AP) and materials management (MM). The organization of the finance section has been done in two sections (i) payments; and (ii) receipts. The payments sub-section is divided into AP & MM. AP relates to payments under the Public Sector Investment Program (PSIP) and projects funded by donor agencies. The infrastructure division at MHI approves supplier invoice/milestone payment based on the agreed schedule of payments, which is the source document to generate a Payment Voucher (PV) to be input into SAP against which MoFT makes the payment to the supplier under the TSA. The MM division prepares PVs against Purchase Orders (PO) prepared by the Procurement Division for materials required for internal consumption.

471. MHI collects income from parking charges, rent of government buildings, etc., and deposits such collections direct into the pubic bank account with the MMA using a Deposit Form. Deposits are generally banked daily, and where this is not possible kept in a safe until banked.

472. MHI is the IA for Phase II of the harbors development project funded by the Islamic Development Bank (IsDB). Under Phase II, 10 harbors will be constructed at a project cost of USD 20 million. Under Phase I, 7 harbors were constructed. The Phase II loan was effective in 2014 and the bid evaluation process has just been completed. MHI was the technical agency (responsible for contract supervision and approval of progress payments) for the ADB funded Domestic Maritime Transport Project, under the which the Malé North Harbor was constructed. The Ministry of Transport and Communication (MTC) was the IA and housed the PMU. Given that MHI has not been an IA for an ADB project in recent years, it is likely that it will need support for ADB related documentation and processes under the proposed project.

6.3.6.2 Findings of the Financial Management Assessment (FMA)

473. Financial reporting is monthly and annually to MoFT. Monthly reporting is in the form of actual and budgeted expenditure for the relevant month and cumulative up to the relevant month. The annual reporting is more detailed comprising of (i) a budget comparison statement, i.e., actual versus final budget (made up of approved budget, supplementary budget (if any) and budget control (for adjustments and transfers between budget items); (ii) income and expenditure statement; (iii) statement of financial position (balance sheet), and (iv) explanatory notes.

474. Financial reporting is based on a single Chart of Accounts (CoA) across the public sector. CoA is the critical to the functioning of the accounting system as it collects, classifies and collates transactions to produce the end product, financial reports. Although MHI operates a powerful accounting system, SAP, all reporting is

through MS Excel spreadsheets which is time consuming and prone to errors. This was the practice prior to implementation of SAP in 2010 and must be discontinued and all reporting must be through the SAP system. The last available financial statements are for FY2012, which are very outdated. The reason for FY2013 and FY2014 not been finalized is that adjustments due to an error resulting from certain items of expenditure which have been expensed in two fiscal years which are now corrected have not yet been approved by MoFT.

475. MHI reports only on its own assets such as furniture, mechanical equipment and IT hardware (total value of MVR 1.5 million) on its Balance Sheet. However, a major portion of the MHI capital budget is in building infrastructure assets for the country. Such assets are not recorded as work-in-progress whilst construction is on-going nor, for the most part, are they recorded by the beneficiaries such as islands and atolls. In FY 2012, MHI incurred MVR 248 million (total PSIP MVR 316 million) on works related to wharves, harbors and jetties, which are not recorded in its Balance Sheet or any other.

476. Double entry accounting is used although reporting is based on partial accrual accounting since depreciation is not recorded. In FY 2012, financial statements did not report on unpaid invoices (not accrued) as well although this is being done in FY2013 and FY2014.

477. Accounting Manual / Standard Operating Procedures. SAP was introduced in 2010 at MHI and is used by finance, procurement and payroll sections. Each new SAP user receives a short training at MoFT, which is wholly inadequate and can result in errors such as the one discussed above. Although there is "SAP support" from MoFT through a helpdesk, they are often referred to the SAP user manual which can be uploaded from the MoFT website. There is no screening of an employee to assess suitability of being a SAP user and once the employee starts using SAP, there is little formal support except from peers.

478. Accounting system. MHI operates is accounting system using SAP, which is an online, real-time, integrated, powerful tool used in many large organizations throughout the world. In order to effectively use SAP, staff must be properly trained and assisted when such assistance is required. The SAP system that the MHI operates is identical to other GoM ministries / departments where it is used. There are two modules which are in operation, (i) the AP module and (ii) MM module

479. AP relates to invoices which are paid without a PO. These mainly relate to contractor payments which are certified by the infrastructure division of MHI. For each vendor, a vendor master record is created and managed in a single database by the TPAD of MoFT. Therefore, all GoM entities will use the same assigned vendor number, bank details and payment methods and conditions for each vendor. If MHI wishes to create a new vendor it must be approved by TPAD/MoFT. All payments are centralized at MoFT which operates a Treasury Single Account (TSA). Payments can be made through TSA by cheque, local or international bank transfer, foreign bank draft or cash. Vendor invoices are entered into SAP by the Entering Officer and when entered the transaction is "parked". The Authorizing Officer will review the "parked" invoice, and approved or "post" for payment. SAP will only

"post" after checking for availability of funds through the budget. Therefore, SAP creates proper internal control through segregation between entering and approving transactions into the system. Furthermore, there are levels of authority also in place and any invoice above MVR 10,000 must be approved by two authorized signatories and the approval document needs to be scanned and uploaded

480. MM module of SAP is used for payments with a PO generated by the procurement division. Each invoice must originate from a Purchase Order (PO). PO is generated by SAP and the system ensures that there is sufficient budget before a PO is created. The procurement division is responsible for the creation of the PO confirmation of the subsequent goods receipt and will call for quotations from suppliers before creating a PO. Once the Entering Officer enters a PO from the vendor invoice, SAP with match the invoice, PO and goods receipt

481. Fixed assets purchased through the MM module can be only recorded on SAP once MHI requests MoFT to create an unique asset master number. The procurement division will lead the process from quotations to the creation of PO for an asset. MHI maintains a Fixed Asset Register (FAR) off –system, on MS Excel. The FAR is maintained in Dhivehi with the asset number, date of purchase, location within MHI and cost being recorded. Asset verification is done annually but no depreciation is reported in the financial statements. Donated assets remain unrecorded, as in the case of all assets created under PSIP.

482. Budgeting and management accounting. The annual government budget formulation process commences in July each year, with MoFT issuing a Budget Circular requesting each Ministry/expenditure unit to submit estimates of expenditure for the following year. The government fiscal year is the calendar year. The MoFT has an intensive period of work during August to November to consolidate the estimates provided by the various agencies and if necessary discuss and revise the original estimates sent in by each agency. The budget is then reviewed and cleared by a Budget Committee comprising of Ministers and a representative from the Maldives Monetary Authority (MMA) before submission to the President's Office for approval and presentation to the People's Majlis, which usually takes place in December. The budget is passed by the Majlis on a vote and the Speaker informs the President of its approval. The Speaker then informs the Minister in charge of the MoFT to implement the approved.

483. Payroll. The payroll section is separate to the finance section but is physically located on the same floor. Staff attendance data is captured using thumb imprints by the StomXpert system which is used exclusively for attendance information. A master payroll sheet is maintained on MS Excel for each employee with basic salary, allowances and deductions. Separate Excel sheets are extracted from this master sheet for each variable (allowance and deduction) and uploaded on the SAP system. The uploaded files are used by the SAP system for financial reporting purposes against the budget.

484. External audit. The Auditor General's Office (AGO) of the Maldives is the auditor of MHI and the entire public sector. The AGO conducted a compliance audit of MHI for FY2011 and issued an audit report. The audit report highlights instances where revenue due has not been collected (such as fines and penalties),

non compliance with the Finance Act in terms of advances to contractors, incomplete FAR and switching funds between projects in the PSIP, where projects which have been budgeted are not implemented. The auditor's opinion is not in the form of a qualified/unqualified opinion, rather it complies with all laws and regulations other than those highlighted.

485. Internal audit. MHI has an internal control section under the Executive Secretariat department. The section is supposed to be headed by an Assistant Director, an Internal Auditor and two assistants. The post of Assistant Director is vacant and the Internal Auditor post has been filled two months ago. There are no assistants. The internal auditor has no experience in internal auditing although he is currently studying for his professional examinations. Given these reasons, the level of internal audit work at MHI is virtually non-existent.

6.3.7 Recommendations of the Financial Management Assessment (FMA)

486. Delays of the magnitude found in finalizing financial statements are not acceptable, especially in a SAP environment. FY2013 and FY2014 financial statements need to be adjusted where necessary, finalized, audited and presented to Parliament as required by the law. MoFT and MHI need to work expeditiously to ensure that financial statements are ready on time and submitted for audit according to the law.

487. There are unacceptable delays in auditing. Financial statements must first be available for audit – FY2013 and FY2014 are not. There is a delay on the part of AGO as well since FY2012 audit report has not been issued. This is against the spirit and the letter of the Law on Public Finances. The issue here is the lack of communication and general lack of interest in getting accounts submitted and audited on time. AGO can invoke the provisions under the Finance Act and bring this to the notice of the Parliament, which has not been done.

488. The majority of PSIP assets remain unrecorded in the PAS. With time, details and values of such assets will be lost. This is not acceptable under a double entry accrual based PAS. The Consultant recommends the creation of a capital works-in-progress account in SAP to have a record of such assets in the future. On completion of works these can be transferred either direct to the beneficiary or to MoFT.

489. There is no depreciation provided on fixed assets despite the PAS being an accrual based system. MHI also has an Excel based FAR as a record of assets. The Consultant recommends that depreciation be calculated and reported. MoFT is planning to roll out the 'Business Intelligence' module of SAP in FY 2016 which will generate all required reports from the system itself, as it should. The completed FMAQ for MHI is presented in Appendix C2.

6.3.8 Financial Management Risk Assessment and Risk Management Planning

490. [The Guidelines] require that a Financial Management Internal Control and Risk Assessment (FMICRA) be carried out to identify risks. The FMICRA is based largely on the International Standard on Auditing 400 Risk Assessment and Internal Control was conducted on the existing structure, staffing, resources and procedures of MoFT and MHI. Both institutions are government ministries and have similar procedures (a common FMICRA) as set out in Table 61.

491. Inherent risks relate to the environment in which the project financial management systems operate, such as country rules and regulations and the entity's working environment. Control risk relate to internal controls to ensure that the project's funds are used economically and efficiently for the purpose intended.

Table 62: Financial Management Internal Control and Risk Assessment (FMICRA)

Risk Type	Risk	Risk Description	Mitigation Measures
A. Inherent Risk			
1. Country specific risks	M	Lack of skilled staff especially at managerial level	Contracting out key financial staff, consultants, training funded through the project.
	M	Weaknesses in public financial management is noted in most recent IMF report 2009.	Public financial management since improved. Specific support from ongoing World Bank funded Public Financial Management Strengthening Project
2. Entity specific risks	M	Significant changes to the public accounting system in a short time span from single entry to double entry, manual to automated, and introduction of TSA	Public sector has had World Bank and ADB assistance on this journey and World Bank assistance is still ongoing.
	M	Off system financial reporting used extensively	Roll out of module which will enable generation of financial reports from the system in FY 2016
	M	Recent audit reports not finalized	However project financial statements are audited on time and are unqualified
3. Project specific risks	N	A relatively straightforward project with one financier and a few contracts and a single IA	The EA and IA have had previous experience with ADB and well as other multilateral agencies
Overall Inherent Risk	**M**		
B. Control Risk			
Implementing Entity			
1. Fund Flow	N	TSA in operation	All government payments centralized through the TSA. Therefore, very little payments going through MoFT/MHI and therefore little risk.
	N	Imprest Account	Many of the project payments will be under direct payment procedures are being Imprest account will be quite small. .
2. Staffing	M	Difficulty in attracting and retaining qualified and experienced staff	The project will fund a full time qualified and experienced project accountant to ensure that project accounting is in order. A CDTA will provide knowledge transfer from experienced consultants to

Risk Type	Risk	Risk Description	Mitigation Measures
			government counterparts
3. Accounting policies and procedures	N	Project accounting will be separate from IA accounting and will be on a commercial basis	Experience with this commercial accounting for projects.
4. Internal Audit	M	Internal audit to be strengthened from purely investigation to strengthening internal controls systems	The World Bank funded project has already supported the MoFT in setting up the internal audit function. The objective is that this unit be the nodal unit for internal audit in the public sector.
5. External Audit	N	Project audit reports have been completed on time in the past and have been unqualified	
Overall Control Risk	**N**		

H=high, S=substantial, M=moderate, N=negligible or low

6.3.9 In-country Experience with ADB Loan Projects

492. ADB funded SME Project. A Project Management Unit (PMU) under the Ministry of Economic Affairs is implementing an ADB credit line to support small and medium scale industries. This project is quite complex since it is implemented in six regional offices and there is on-lending of funds from the banking sector to the various industries. The PMU has a full time staff member to prepare project accounts in accordance with ADB requirements, such as full accrual based accounting and according to International Financial Reporting Standards (IFRS). The staff member is responsible for preparation of ADB documentation such as Withdrawal Applications and supporting Statements of Expenditure (SoE).

493. ADB funded Outer Islands Electricity Project. This is a recently approved loan. PMU is in the process of being set up.

494. MoFT's Resource Mobilization and Debt Management Division. All ADB documentation is channeled through this division for approval and onward transmission. Well-experienced staff are available in the division who also carry out training of PMU staff.

495. Although recruiting and retaining staff for future PMU's could be a challenge, there is in-country experience with ADB project implementation from a financial management perspective. In addition, many other multilateral donors have similar procedures and there are several such projects in the country.

6.3.10 Financial Management for The Proposed Kulhudhuffushi Harbor

496. As part of the scope of this PPTA, a Capacity Development Technical Assistance (CDTA) will be developed to assist in the capacity building of the future harbor operations at Kulhudhuffushi. The Island Council already does basic maintenance work on the existing facilities in terms of providing lighting and cleaning of the

quay area. MHI has committed to undertake larger scale maintenance in terms of maintenance dredging.

497. The Councils are entitled to raise its own revenues and receive grants from the central government under the Constitution of Maldives. The Decentralization Act No. 7 of 2010 formalizes the roles and responsibilities of the Councils and requires that they be democratically elected. The Law 7/2010 also provided for the establishment of the Local Government Authority, to which the Councils are accountable. Despite the legal provisions, many of the smaller Councils face challenges in raising own revenue. Revenue is generally in the form of vehicle registration fees, vehicle license fees and land rents. Furthermore, under the Public Finance Act, Councils are required to deposit all collections in the public bank account, which contradicts the Law No. 7/2010 and further restricts decentralization.

498. During FY2013, MVR 846 million was spent on Councils, which accounted for 6% of total budgeted expenditure. The Council budget is MVR 967 million for FY2015 and accounts for 5% of the total. The Kulhudhuffushi Council accounted for MVR 8.7 million in FY2013 (FY2015: MVR 9.8 million) or about 10% of the budget allocated for Councils.

499. The Council has a finance section within its administration. Human resource management is centralized and officials are appointed centrally. TSA does not operate in Island Councils. Therefore, the Council operates a bank account with the Bank of Maldives.

500. The Council does not use the SAP public accounting system for accounting and reporting. There are instances where the Council is not aware of budget/commitment ceilings, which automatically appear on SAP. Therefore, some budget items are over-spent whilst others are under-spent. These operational issues, in addition to the shortage of skilled staff at Council level, have resulted in MoFT actively managing / instructing the Council on financial issues. This process is time consuming and defeats the objective of the Decentralization Act.

501. The Council will need capacity development in financial management in the event that it manages the port as a revenue generating entity in the future. Such measures should include;

- Identifying one or two officers (or recruiting) and creating a separate port financial operations cell within the Council's general finance function;
- Establishing office space within the administrative building at the port;
- Purchasing an off-the-shelf accounting software system that is very user-friendly and has support within the country;
- Purchasing hardware such computers and printers;
- Establishing a separate bank account, authorized signatories for port operations;

- Setting up a simple CoA for revenue and cost items;
- Establishing basic internal controls for collections and payments;
- Developing separate budgets for port operations and training staff in periodic reporting to Council;
- Integrating port financial results with Council financial results on a periodic basis, i.e. quarterly.

6.4 Recommendations on Capacity Development Technical Assistance

502. As part of this PPTA, the Consultant Team has identified several gaps and suggested recommendations for remedial action. To this end, four main capacity development technical assistance (CDTA) streams have been suggested as part of the ADB-funded technical assistance post this PPTA. The four CDTAs are:

- *Tariff Study for Kulhudhuffushi and other Local Harbors*
- *Port Institutional and Capacity Development for Kulhudhuffushi Council*
- *Update Design Reference Manual for Safe Port Shelters*
- *Harbor Development and Business Opportunities for Local Community*

503. A request from the Transport Authority and the MoED for a 5th CDTA on *port safety* was made in the last three weeks prior to submitting this Report. Because observed safety gaps in ports are nationwide across the Maldives and may include policy, regulatory, management, and operational dimensions, we only provide a brief insight on port safety rules, standards, and practices pending further input and clarification from the MoED and the Transport Authority.

6.4.1 Tariff Study for Kulhudhuffushi and Other Local Harbors

504. As mentioned previously in this Report, and except for ports operated by MPL, the past and current policy of the GoM has been to not charge any port dues, tariffs, or access charges in local ports. This denotes an underlying public policy that local island ports do not entail commercial activities which is often anecdotal and can be counter-productive as port users have no incentives or constraints put on them to operate efficiently and safely.

505. During this PPTA, and throughout the various meetings with both MHI and MoFT, there seems to be some recognition from both Ministries that a port tariff should be introduced at some point in the future. Following the recommendations of the Consultant, the scope and structure of port tariffs to be applied to Kulhudhuffushi, and potentially other local island ports, will be proposed as a CDTA component.

506. Port pricing and tariff charging is an area where several topics related to port capacity, investment, competition, strategy, policy and regulation are dealt with

simultaneously. Depending on the sources of port finance, the definition and structure of port costs, the elasticity and regulation of port demand, the nature and scope of port objectives and strategies, the methods of port pricing may vary widely. Furthermore, the pricing nomenclature in ports includes terms such as tariffs, dues, prices, taxes, and levies, each of which may be targeted at a single user or activity or at a combination of port users and services.

6.4.1.1 Categories of Port Charges

507. Port tariffs and charges can be categorized into 4 main categories: port dues, cargo handling charges, surcharges, and miscellaneous charges. The following descriptions are taken from Bichou (2009) and are widely quoted in the industry.

Port Dues

508. Port dues are divided into:

- *Ship dues* (also known as conservancy dues/ charges on ships): Those are charged to ship operators and levied on ships entering, leaving, or using the harbor, for the provision and maintenance of access channels, lighting and marking, pilotage, and regulation of maritime traffic between the open sea and the berth.
- *Harbor dues* (also known as berth dues at wharfage): Those are charged to ship operators and levied on ships using the berth for the provision and maintenance of the dock and surrounding water area and the regulation of maritime traffic in this area. Often, harbor & conservancy dues are combined into ship dues.
- *Cargo or goods dues* (also known as conservancy charges on cargo, dock rates): Those are charged to cargo owners (importers/exporters or their agents) for services related to goods brought into, taken out of or carried through the harbor by ship, but not related to services rendered or work performed in respect of those goods.
- *Passenger dues:* Those are charged to ship operators for services related to passenger, motorist, car or coach passing over the berth.

Cargo Handling Charges

509. Cargo handling charges are charged to cargo owners for services related to stevedoring, cargo loading/unloading, storage of cargo, and other cargo related services.

Surcharges

510. Those are charges levied to cover additional costs incurred due to changes or fluctuations in currency rate, energy prices, etc.; as well as the extra cost of regulatory compliance such as environmental and security surcharges.

Miscellaneous Charges

511. Those are charges levied for maintenance dredging, policing, fire fighting, medical and social services, etc. Miscellaneous charges also include charges for specific services such as bunkering and supply, equipment hire, container cleaning, etc.

6.4.1.2 Escalation and Discrimination in Port Charges

512. Port authorities and operators usually apply a tariff escalation through discriminating between different sizes and types of ships, cargoes, users, etc. The discrimination strategy can also be used as a trade policy, e.g. to encourage / discourage exports / imports; as an economic policy, e.g. to promote or subsidize a particular economic activity; and/or a regulatory policy, e.g. discouraging particular sizes or types of ships and cargo.

6.4.1.3 Port Pricing Methods

513. Port pricing is mainly a tool to achieve one or a combination of several objectives: cost recovery, profit maximization, economic and trade policy, efficient utilization of assets, economic/competitive efficiency, business strategy, social objectives, etc.

514. UNCTAD (1995) argues there are four main approaches to port pricing:

- *The economic approach* argues for marginal cost pricing, taking into consideration externalities, including costs to / benefits derived by non port users.
- *The financial approach* argues for prices to be set on the basis of accounting costs, to recover fixed and variable costs and to provide an adequate rate of return.
- *The public enterprise approach* argues for prices to be set in ways that foster national and/or local development and economic activities, potentially involving promotions and subsidies.
- *The strategic approach* argues for prices to be used as strategic tool to achieve strategic objectives such as boosting competition, increasing market share, improving performance, generating funding, etc.

515. A full discussion into the various models of port pricing and their applications is beyond the scope of this Report; however the Consultant would like to draw the attention to three pricing tools that can be particularly relevant to Kulhudhuffushi harbor and other local harbors in the Maldives:

- *Cost pricing* is a policy of setting port prices relative to port costs (total costs, average costs, marginal costs fixed costs, variable costs, etc.). In port and transport systems, it is based on having the selected port cost element divided by projected demand for port services and the facilities.
- *Congestion pricing* is a policy the port thereof (quay, berth, etc.) reaches full capacity working. It is used as a tool for increasing capacity by reducing demand.

- *Market pricing* is based on correlating port prices to market demand, elasticity, and competition.
- *Regulatory pricing* is a price filling tool to monitor for and prevent monopolistic and anti-competitive behavior. It is often achieved by setting price caps through X-efficiency and yardstick benchmarking methods.

6.4.1.4 Discussion

516. In the Maldives, local ports do not charge any dues or tariffs on their facilities and services. This is both un-economical and counter-productive, and often leads to inefficient allocation and utilization of port assets and resources.

517. Applying a port pricing and tariff structure to Kulhudhuffushi harbor, and other local harbors in the Maldives, would be a significant step towards encouraging efficient and safe utilization of port assets and services, generating an operating capital and a potential revenue stream to port and local authorities, and ensuring public and donor funds are fairly allocated in port development and expansion.

6.4.2 Port Institutional and Capacity Development for Kulhudhuffushi Council

518. As mentioned throughout various sections of this Report, current harbor operations and management in Kulhudhuffushi are being carried out with little or no supervision. If the expanded harbor is to operate properly, it would require a professional port management structure in charge.

519. The Consultant's understanding from various meetings with stakeholders is that the operations and management of the new and (existing) harbor would be principally carried out by the KC with occasional supervision from MHI, where applicable.

520. Institutionally, there is no reason why the Kulhudhuffushi harbor could not be managed by the local Council. Some of the World's most successful ports, e.g. Rotterdam, have been managed, supervised, and regulated by port authorities. It is possible to create an additional section/division within the Council solely in charge of port management and supervision; and this has been a preferred option of both the Council and MHI.

521. However, the basic skills set required for port management is missing under the current Council's structure. While MHI has a dedicated maritime engineer staff, the KC has no dedicated or trained staff in port operations and management, except for casual and contractual labor used for port cleaning and daily maintenance. However, assurances have been given that additional staff will be recruited, and the Consultant has already advised on the profile of staff and tasks required with reference to those made throughout this Report (see for instance the sections on employment benefits and on FMA).

522. To this end, a CDTA focusing on port institutional development and capacity building for KC is proposed by the Consultant. The range and components of the proposed institutional development and capacity building program are beyond the scope of this PPTA, but it is advisable that an international port institutional and capacity building expert be engaged to formulate and carry out such program, preferably in partnership with local training providers such as the MPL port training center in Malé.

523. As useful reference, industry associations as well as public authorities have developed a range of occupational standards and qualification frameworks for port and terminal workers at entry levels. For instance, the UK port skills and safety (PSSL) and its predecessor (the British ports industry training -BPIT-) have developed five national occupancy standards for the port industry; harbor masters, marine pilots, port operations, supervision of port operations, and vessel traffic system (VTS) operations. PSSL have also developed a range of port apprenticeships at national level qualifications (NVQ) 2 and 3. Unlike occupational standards, apprenticeships are formalized qualification programs leading to the award of a school degree which can be accepted as an entry qualification for undergraduate university education in the UK.

6.4.3 Update Design Reference Manual for Safe Port Shelters

524. Prior to the Consultant's engagement, there were no concept or prefeasibility design reports prepared for the TA-8829 MLD Kulhudhuffushi Harbor Expansion Project, meaning that a lot of research was required to establish design parameters for the Preliminary Design Report. It was revealed that although a lot of information exists, it isn't always readily available or reliable.

525. During the time of report preparation, wind records from Hanimaadhoo were unavailable. It is understood that for at least the last two years, wind data has been recorded at sufficiently frequent intervals to enable reliable wave hind-casting to be performed. This involves the use of standard graphs with fetch length and wind velocity/ duration as inputs.

526. The value of existing reports and studies focusing on the Maldives, would be considerably increased if useful information and findings were collated into a more coherent and comprehensive resource.

527. While the 'vessel safe shelters' by Oriental Consultants (2012) was prepared with this objective in mind; it has not been embraced as a design standard as was intended. It appears that there are some subjects requiring either clarification or additional information and that other subjects should be included.

6.4.3.1 Rubble Mound Breakwater Design

528. The design of breakwaters requires the selection of several parameters including:

- Return period of design event
- Still water level (SWL)

- Wave height for the given return period – usually H_{sig}
- The armor size
- Crest level of the breakwater.

529. In addition to these parameters, consideration of the toe protection detail and crest width are important to mitigate against the risk of localized failure.

6.4.3.2 Crest Width

530. The choice of crest width is often based on the practical consideration of plant access for construction and maintenance; however, there is a minimum width required for the structure to maintain its integrity during wave overtopping.

531. The cross section of a rubble mound breakwater is typically trapezoidal and the capital cost of construction is proportional to the cross sectional area i.e. the volume of rock that must be procured and placed. On the other hand, if the crest width is too small and the section fails, there is a maintenance cost to reinstate the failed regions of the breakwater at an unknown frequency of occurrence. In the worst case, the failure may be widespread and require a high proportion of the original capital cost to rebuild the breakwater. It is therefore recommended that physical model testing be conducted for a range of overtopping wave heights, to identify the safe minimum crest width, which is generally regarded as being 2 or 3 armor units.

6.4.3.3 Return Period

532. In Chapter 3 – Shore Protection Planning, section 3.1.1, p3-1 of the JICA 1992 Main Report for reconstruction of after the 2004 Tsunami, it was stated that the physical modelling was based on a "50-year probability wave and a storm wave in 1987, coupled with a high tidal level."

533. This work was undertaken by Goda and Lanka Hydraulics Institute (LHI), both having impeccable credentials in the field of research, analysis and modelling of coastal processes. While conducting research on this PPTA, it was discovered that this work formed the basis for the majority of other coastal protection works in the Maldives, although the basis for the adoption of the 50 y return period in the original modelling was not revealed. It would be of value to conduct an investigation into the water levels and wave heights for various return periods so that the consequences for existing and proposed breakwaters may be understood.

6.4.3.4 Still Water Level

534. The Still Water level (SWL) depends on the contributions from tide level, wave setup/ storm surge and sea level rise. Within reason, each of these contributors may be determined from the safe shelters design guide; however, storm surge is not considered.

535. The still water depth is calculated by deducting the sea bed level from the SWL and governs the maximum wave height incident to the breakwater.

536. As discussed in Chapter 4 of this report, there are some apparently alarmist claims made in various referenced documents, about the magnitude of storm surge to be expected in the Maldives and it would be of great benefit for the subject to be treated in some depth for inclusion in a design manual such as the Safe Shelters Design Guide.

6.4.3.5 Wave Height

537. The design of coastal structures generally considers two wave types: swell waves and wind waves. Wind wave are generated in the vicinity of the wind event, be it a storm or cyclone and swell waves are propagated from a far off location. Swell waves generally have a longer period or separation between each wave than wind waves and are therefore potentially more damaging due to their higher energy.

538. Where a breakwater location is protected from swell waves, the incident wave to be considered is a wind wave generated over a fetch length contained within the atoll. This analysis requires knowledge of wind velocity and duration for consideration with appropriate fetch lengths, to determine design waves for a given return period. Although it is understood that this wind data is available, it was not available to the Consultant Team, and the research undertaken as part of this PPTA mostly revealed that the Malé Seawall Project data was used as a starting point.

539. It would be beneficial if a wave hind-casting was performed using the available wind data, and included in the safe shelters design guide.

6.4.3.6 Review of Safe Shelters Design Guide (Subsection of Wave Height)

540. Chapter 2 - Natural Conditions of the Maldives, Section 2.2 Oceanography, on page 2-5 discusses the Sea wall construction project for Island, where it states: "According to the wave transformation analysis on the reef flat of Island, it was concluded that height of waves approaching to shoreline through the reef flat do not depend on height of offshore waves but depend mainly on the shallow reef topography.

541. A linear relationship was conducted between the inshore wave height on the reef and the water level on the reef flat with a high correlation coefficient (r2 = 0.94). The equation was given as follows.

HE = 0.37h* - 9.4, where HE = Inshore Wave height (meters), h* = Water depth (meters) above DL on the reef flat."

Where: DL is defined as datum level in the Abbreviations section of the report.

6.4.3.7 Discussion

542. Because datum level (DL) isn't defined (could be MSL or LAT for example), the resultant HE is dependent on the datum chosen, which is an obvious shortcoming of the equation as stated. Further, it is possible that h* is intended to mean water depth on the reef flat and the author has confused this intention with the reference to a

datum level. Assuming that the datum is MSL and the still water level (SWL) is RL1.0 m, this gives a water depth h* = 1 m above the DL on the reef flat. If the intention is that h* = water depth on the reef flat, with the reef generally at RL-1 m MSL, the water depth h* = 2 m.

543. In both cases a negative number is the outcome because 0.37h* is < 9.4. In fact, not until h*>25.4, is HE > 0.

544. Section 2.3.3 Reef Flat in front of harbor, states the following: 'The characteristic bathymetry surrounding the island harbor is Reef Flat in front of the harbor'. The actual beach profiles shown in *Figure 2.3.2 in the Safe Shelters Design Guide*; the source topographies are the beach profiles from the harbor project sites of Tsunami Reconstruction Project.

545. The typical beach profile was assumed to have a reef flat topography of 400 to 500 meters wide and continues to a reef slope of 1/30 – 1/50 in gradient. The elevation at the sea bottom is around MSL-1.0 m on the reef flat. This beach profile is taken into consideration for the calculation of the wave transformation on the reef flat. Height of waves approaching to shoreline through the reef flat does not depend on the height of offshore waves but controlled mainly by the shallow reef topography.

546. An empirical formula to calculate the wave height on the reef topography was derived by Takayama et al., with reference made to Section 3.3.3: Wave Height on Reef Flat. This section provides mathematical formulae culminating in a graph showing the exponential decay of Wave Height (m) from the incident wave height at the edge of the reef, to a constant value of wave height at approximately 100 m from the edge of the reef as shown in Figure 32 (*Fig. 3.3.5 in the Safe Shelters Guide)*:

Figure 32: Wave Height Formula Applied to the Dhiyamigili Beach

The following **Figure 3.3.5** presents the wave height profile calculated by the formula on the beach of Th. Dhiyamigili.

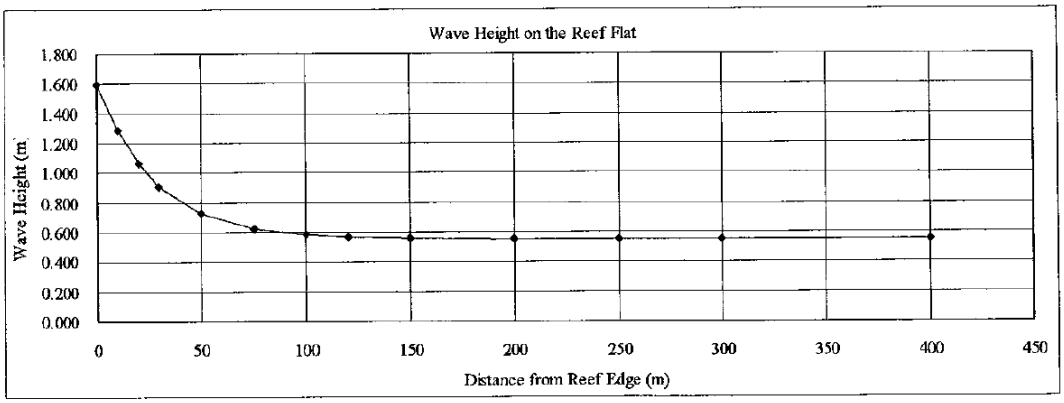


Figure 3.3.5 Wave Height Profile on Reef Flat
(Source: Th. Dhiyamigili, Tsunami Reconstruction Project, JICA)

547. Clearly, the magnitude of wave height has a non-linear relationship with the distance from the edge of the reef. With this in mind, the formula for HE above, is only useful if the distance from the edge of the reef is known.

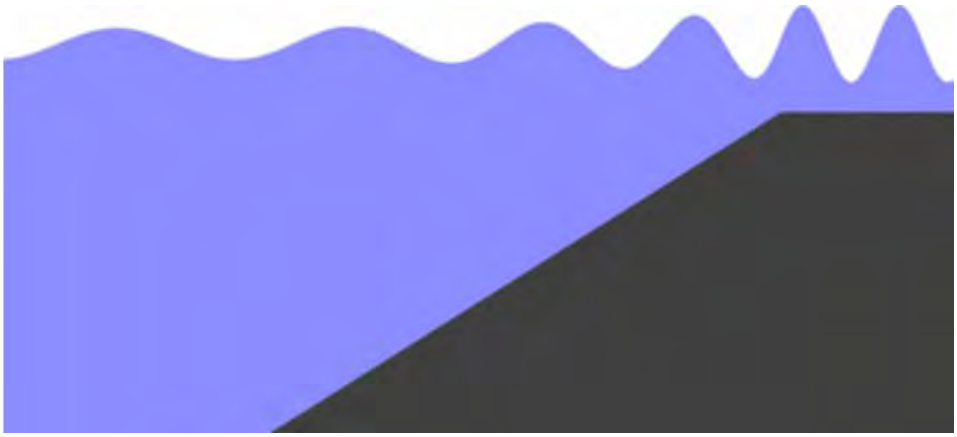
548. Unfortunately, the magnitude of the incident wave that shoals at the reef's edge isn't defined; however, the Detailed Design Report – Harbor Projects……. shown below, indicates that the incident wave height is 1.39 m, which shoals to a height of 1.6 m. It also shows that the design water depth on the reef is 1.37 m.

549. What this methodology does not seem to address, is the wave height incident to the edge of the reef which shoals but does not break. The maximum wave height for which this can occur is the depth limited wave height on the reef, reduced by the shoaling factor of approximately 15%.

550. On a flat reef, the maximum wave height at the onset of breaking is 0.78 x water depth = 1.07 m, yet the wave height considered in the example below is approximately 0.55 m, around half that which is possible. It is understandable that there would be less wave energy (wave height) after an incident wave broke and reformed than if the incident wave did not break; however, it appears that this possibility has not been considered and clarification is required.

551. Figure 33 below shows a pictorial representation of shoaling, where the wave height increases as the wave moves from deep water to relatively shallow water on a reef.

Figure 33: Wave Shoaling



6.4.3.8 Crest Level

552. Oriental Consultants in association with Yachiyo Engineering Co Ltd, 2011, Maldives Tsunamis Reconstruction Project (JBIC L/A No. MV-P1) Detailed Design Report – Additional Works for Ukulhas Harbor Breakwater Projects, states on page 4-2 in section 4.2.1 Crest Height: "Crest height of Breakwater is designed considering the Design Wave Height ($H_{1/3}$) above Design High Water Level (DHWL) considering mean monthly highest water level (MHWS or HWOST) and

the rise of mean water level (η) in the surf zone. The Crest Elevation is estimated as follows:

$$HWOST + \eta + 1.0\ H_{1/3}$$

η = the rise of mean water level in the surf zone

553. The Overseas Coastal Area Development Institute of Japan (OCDI), 2002 Technical Standards and Commentaries for Port and Harbor Facilities in Japan, in Part VII Protective Facilities for Harbors, states the following for determining the appropriate crest height of a breakwater, irrespective of the type: "2.5.1 Upright Breakwater (Notification Article 46, Clause 1)

554. The crest elevation of a breakwater shall be appropriately determined at 0.6 times the design significant wave height or greater above the mean monthly-highest water level. In this case, the appropriate height shall be established with consideration given to the factors such as the calmness of a basin and the protection of port and harbor facilities behind the breakwater.

6.4.3.9 Commentary

555. For ports and harbors where the influence of storm surges should be considered, the datum sea level for determining the crest elevation of the breakwaters should preferably be taken at the tidal level obtained by adding an appropriate deviation of storm tide based on the past records to the mean monthly-highest water level.

556. For determination of the crest elevation of a breakwater with an added amenity purpose that will be used by the general public, a separate investigation of splash or overtopping rate is required from the standpoint of public usage and safety.

6.4.3.10 Technical Notes

557. The crest elevation of a breakwater should be not less than 0.6 times the design significant wave height above the mean monthly-highest water level (HWL).

558. In most of existing breakwaters, the crest elevations have been determined as in the following:

(a) In a harbor of large ships' calling, where the water area behind the breakwater is so wide that wave overtopping is allowed to some extent, the crest elevation is set at $0.6H_{1/3}$ above the mean monthly-highest water level in situations where it is not necessary to consider the influence of storm surge.

(b) In a harbor where the water area behind the breakwater is small and is used for small ships, overtopping waves should be prevented as much as possible. Hence the crest elevation is set at $1.25H_{1/3}$ above the mean monthly highest water level.

559. In the region where large storm waves close to the design waves attack frequently with long duration, even the activity of a harbor of large ships' calling with a wide water area behind the breakwaters may be limited by the influence of waves

overtopping the breakwaters, even if the breakwater has the crest elevation of 0.6H 1/3 above the mean monthly highest water level. Accordingly, in such a harbor, the crest elevation is preferably set higher than 0.6H 1/3 above the mean monthly-highest water level."

560. It would be of value to include physical modelling results for various breakwater crest levels and wave height combinations, to establish associated wave heights in the lee of the breakwater (within the harbor) and quay wall elevation necessary to minimize land inundation.

6.4.3.11 Remediation for Existing Quay walls as Sea Level Rises

561. Given that there are over 150 harbors in the Maldives, in the event of sea level rising, bringing with it higher still water levels and wave heights, a solution will be required to mitigate the consequential sea water inundation due to harbor quay walls being overtopped. It would be valuable to have summary data for a typical harbor, for incremental still water level rises of 250 mm, up to a meter, to understand what may be required.

562. Scope of additional contributions to the Safe Shelters Design Guide:

- Using wind records from Hanimaadhoo determine H_{sig} and wave setup at a typical coral reef for various return periods (25 y, 50 y, 100y) for non-cyclonic events
- Determine H_{sig} and storm surge for various return periods (25 y, 50 y and 100 y) cyclonic events affecting a typical coral reef
- Calibrate wave height and period information against data from previous reports
- Conduct physical model testing of breakwaters with varying rock armor sizing, crest height and widths, to determine overtopping, damage, wave heights in the lee of the structure and quay wall level required to mitigate/eliminate overtopping
- Provide risk analysis based on the above testing, for the level of damage (repair cost) for the quantity of rock installed (capital cost) for each scenario
- Provide risk analysis based on the above testing, for days of unacceptable harbor conditions for each scenario.

6.4.4 Business Opportunities and Harbor Development for Local Community

563. The 4th proposed CDTA component emphasizes the crucial role of skills and knowledge in generating new economic, business, and employment opportunities for Kulhudhuffushi and the region as a direct and indirect impact of the Kulhudhuffushi harbor expansion. It is based on the identification of employment and income-generating opportunities derived from the expanded harbor, support

and equip local communities with the appropriate skills and business knowledge to contribute to and benefit from the opportunities generated by the expanded harbor.

564. To achieve this, the proposed CDTA will address three levels of intervention:

- At the macro level, a wider enabling environment is required for community-based development initiatives.
- At the meso level, designing and delivering appropriate training programs through training centers or other training providers including the Kulhudhuffushi Business Centers and the University/College campuses.
- At the micro level, matching skills training to harbor related economic and trade demand.

6.4.4.1 Targeted Mainstreams

Local Economic Development

565. Since the activities are mainly community-based, participation in community development, empowering individuals and groups to effect change in their own communities through capacity building, direct action, institutionalization and support to local policy reforms are important processes for sustained local economic and social development.

Gender

566. Gender issues cannot be overlooked if women as well as men are to be active micro-entrepreneurs or wage workers and apply the technical and business skills they have learned. For this to happen, there is a need for an enabling gender-responsive environment, from the level of partner institutions and the community, down to curricula, training materials, training of trainers, training venue and facilities, training delivery and post-training support. The mainstreaming of gender concerns from the very beginning and throughout the implementation of CDTA is critical.

Disabled Persons and Other Socially Excluded Groups

567. The disabled and other socially excluded groups are a part of every community and where possible they should benefit from the same business and economic opportunities as the rest of the population.

6.4.4.2 Methodology and Tools for Implementation

568. The following is a proposed methodology for guiding the identification and implementation of income generation opportunities and their articulation to local development initiatives. Starting with institutional organization and planning, these processes aim at systematically identifying employment and income-generation opportunities at the local level; designing and delivering appropriate training programs and post-training support; gender mainstreaming to launch and sustain wage-and self-employment; and micro-enterprises.

Institutional Organization and Planning

569. This process consists of assessing the scope of the program, including the selection of target groups and geographical areas, establishing an appropriate local and national governance system that is able to effectively implement programs and strategies, and mobilizing and empowering local partners.

Identification of Economic Opportunities and Training Needs Assessment

570. Working closely with the local partners, this process involves preparing community profiles and baseline information, identifying employment and income earning opportunities and development needs and constraints, providing innovative ideas for new business and employment opportunities, undertaking feasibility studies concerning potential economic activities and undertaking corresponding training needs assessments.

Training Design, Organization and Delivery

571. This process involves designing training programs suited to the needs of men and women in a target group, selection and training of instructors, including gender, disability and diversity sensitization, preparation of training plans, selecting trainees, developing and providing the required training materials, supplies, tools and equipment, identification of the training venue, delivery of the training, evaluation of trainees and training monitoring. Training programs could also include entrepreneurial development and core work-skills training.

Post-training Support for Micro-Enterprise Development and Employment

572. This process involves designing and installing appropriate support mechanisms to help the target group in their employment and self-employment endeavors. This is done through linkages with employers to facilitate employment, linking to service infrastructure of the locality, (micro-) finance institutions, technology centers, providers of business development services, counselling and support.

6.4.4.3 Monitoring, Evaluation and Documentation

573. Monitoring, evaluation and documentation are key elements of CDTA. Monitoring is important to track project progress, identify problems, improve implementation and provide feedback to policy-makers and other stakeholders on an on-going basis. Evaluation is necessary to assess the impact of training and post-training support. As for documenting the CDTA experience, it is essential for shared learning and to ensure the institutional memory of the process that is being pilot tested.

6.4.5 Port Safety

574. As mentioned above, this CDTA was requested by the MoED and has not been originally proposed by the Consultant since numerous safety gaps have observed across local and regional ports in the Maldives. Pending clarifications from the MoED and the Transport Authority on the nature of their request, the Consultant provide here some insight as to port safety standards and practices.

575. Regulators and international agencies have been aware of the safety and training challenges imposed by a rapidly changing port environment. Enhanced national

safety and health occupancy regulations were introduced in several countries (see for instance the port marine safety act in the UK). Other countries have embodied international instruments in force for occupational safety and health in dock-work and cargo handling in ports in national certification standards for safety and occupational health. Among international instruments developed in the field of port safety and working practices, worth noting a number of conventions and codes of practices developed by UN organizations (ILO, IMO, WHO, etc.) as well as by the International Organization for Standardization (ISO), as outlined below.

- ILO Dock Work Convention (No. 137), 1973: Convention concerning the Social Repercussions of New Methods of Cargo Handling in Docks.
- ILO Occupational Safety and Health (Dock Work) Convention (No. 152), 1979
- ILO Code of Practice on Safety and Health in Ports (2005)
- ILO/IMO Code of Practice on Security in Ports (2004)
- ILO Port Safety and Health Audit Manual (2005)
- A number of ISO standards for containers, container seals, etc.

576. Even though, no global regulatory standards or internationally-certified best-practices on ship and cargo handling operations in ports exist as yet.

7. SOCIAL SAFEGUARDS

7.1 Scope and Objectives

577. This project aims at increasing inter-island connectivity and improving access to jobs, health, education and commercial services in the Northern region of Maldives. The Northern Region consists of three administrative Atolls: Haa Alifu Atoll, Haa Dhaalu Atoll and Shaviyani Atoll. Among these, the most developed and populated atoll is Haa Dhaalu Atoll, owing to one of the largest in the country in terms of population, Kulhudhuffushi.

578. Kulhudhuffushi is considered as the regional trade and transport hub due to the number of passenger and cargo vessels between the island and Malé, and inter region islands. The existing local harbor in Kulhudhuffushi is a multi-purpose harbor, and is used for handling passengers, fishing, and trade and agricultural commodities. The harbor is operated by the Kulhudhuffushi Council, with funding support for operation and maintenance from the GoM.

579. At present, there are around 150 vessels operating out of the harbor daily. It is estimated that additional capacity catering for 100 vessel operations per day would be required to support the urban center development. The GoM plans to increase the harbor capacity by developing a new passenger harbor with a capability to cater for larger vessels. The new passenger harbor will also serve the long distance passenger services from the central and Southern regions as recommended in the Maldives' Maritime Transport Master Plan.

580. This harbor expansion project will bring about inclusive socio-economic benefits to the inhabitants in the Northern region. As such the project corridor of the project

would be the whole of Northern Region (Haa Alifu, Haa Dhaalu & Shaviyani Atoll).

581. The TOR for this PPTA states that the *Social and Poverty Assessment* (PSA*)* is to 'Assess impact on poverty and social impacts, including involuntary resettlement, indigenous peoples, HIV/AIDS, human trafficking, gender, participation and empowerment, labor, and other relevant issues for the project; to Conduct assessment and prepare required documentation in accordance with the requirements of the ADB and the GoM, and to produce the social safeguard documents.'

582. During this PPTA, the Consultant has carried out work related to both the PSA and the Social Due Diligence Report (SDDR). The above components as reported in this Chapter include a revised and upgraded version of the draft chapter submitted on 20 January 2016 as part of the DFR.

7.2 Resettlement Impact

583. This project would not include any physical resettlement, as the project area does not have any households or any privately owned land. Resettling option could be a very sensitive issue considering current social and political situation. If such resettlement is imposed, a resistance might be built between the project proponent and the community obstructing the project.

584. During the social survey, it was found that the project is to be implemented in the already existing harbor area of the island or the industrial zone of the island. The community uses these areas for recreational activities and as congregating areas. However, the areas contain some trees and shrubs which are not privately owned. Any farming or coconut plantations privately owned by people would need to give compensation, if privately owned trees are needed to be uprooted, as per the Regulation on Uprooting of Trees. During the project implementation stages (physical implementation), alternatives and compensation need to be discussed if there are any privately owned trees.

585. In the year 2010, when shark fishery was banned, the shark fishermen in Kulhudhuffushi opted for different fisheries and a settlement was given for these fishermen and their gear. Such economic settlement could be used though both cases are different. The basic concept is finding an alternative option to facilitate the conservation of the surrounding environment. It is a win-win situation where the tree owners are resettled and compensated economically meanwhile the project is implemented where in-turn the community gets direct and indirect benefit.

7.3 Poverty and Social Assessment (PSA)

586. The aim of this PSA is to research the social and community benefits of the Kulhudhuffushi harbor expansion project in accordance with ADB's guidelines and Government policies. In recognition with this, the report also includes aspects

related to social inclusion, gender assessment, labor impacts, and health and safety. The specific objectives of the PSA are to:

- Identify the stakeholders of the project
- investigate the impacts to the stakeholders from the implementation of the project;
- understand the socio-economic and poverty conditions of the island

587. The PSA is to present a socio-economic profile of the project area with particular reference to local community, communicable diseases especially HIV/AIDS, human trafficking, poverty level, gender issues, local economy like agriculture, industry, health and educational status in accordance with ADB Guidelines. The findings presented in this report draw on existing studies and reports and interviews with a wide range of key informants.

7.3.1 Methodology

588. Keeping in view of the objective of the PSA the study was carried out with a participatory approach that aimed at putting the community at the center and involved a collective process of reflection, discussion and consultation with all major stakeholders in the Project. As part of the preparatory work, a detailed stakeholder identification exercise was carried out and primary and secondary stakeholders were identified. The primary stakeholders, such as women and youth groups, farmers, shopkeepers, school teachers, and Non-Government Organizations (NGOs) were consulted individually in homogenous sub-groups and also as mixed groups to understand the local needs and responses to the proposed subprojects and also to ascertain the impact of the proposed Project on the communities, the area and the overall region.

7.3.1.1 Information Sources

589. This study relies on information from a wide range of documents and interviews, site visits, analysis of statistical data from various sources. The information sources include:

- Documents on the project and inception report (the documents referenced are listed as references)
- Initial stakeholder's assessments with Ministry of Housing and Infrastructure, etc.
- Statistical information from the population Census 2014
- Interviews with key informants including elected local council members, community groups and members of general public through consultative meetings and interviews
- Field visit to the site of proposed development, Kulhudhuffushi
- Detailed public Consultation in Kulhudhuffushi which is explained in detailed in this report

- Review of existing data and related project reports in Kulhudhuffushi and Northern Region

7.3.1.2 An Evidence-Based Approach

590. Projects involving considerable public related services and facilities ought to be subject to careful and robust analysis of social and economic benefits to ensure that the investment is not only in the public interest but justifies the expenditure. The PSA analysis by this study encourages an evidence-based approach to reporting social benefits. This means providing references and sources for assertions made, and for all estimates of benefits - quantitative or qualitative.

7.3.1.3 An Assessment of Benefits Only

591. This report assesses social and community benefits from the harbor development project. It therefore only gives part of the picture: it does not identify or assess social and community costs due to the project, such as increased demand for housing plots, increase in rents or increased demand on social and health services due to in-migration of locals from the region.

7.3.1.4 Identifying the Stakeholders

592. An initial stakeholder analysis was carried out to identify the primary and secondary stakeholders of this project, to be consulted during the course of this study. The stakeholders identified were consulted to identify their issues and needs. The field visits and investigations to the site helped in providing a foundation for the poverty analysis. Baseline assessment of the social conditions of the island were assessed based on random individual interviews in the islands, rural appraisal techniques and focus group discussions, literature review of past reports and using statistical data from census 2014.

7.3.1.5 Stakeholder Categories

593. For the purpose of this study, ADB definitions of Primary and Secondary Stakeholder are used:

- "Primary Stakeholder: People, groups or institutions affected positively (beneficiaries) or negatively (e.g., involuntarily resettled).
- "Secondary Stakeholder: People, groups or institutions that are important intermediaries in the project delivery processes (e.g., ADB, government agencies, NGOs) (ADB Handbook on Poverty and Social Analysis, Appendix 4.1, p. 2, Dec 2001).

594. The key stakeholder categories and analysis are provided in Table 63.

7.3.1.6 Focus Group Discussions

595. Focus group discussions were organized in separate sessions with groups including, but not limited to: youth, elders, business owners, operators, women and other vulnerable people who were available during survey period on specific topics, such as: perceived benefits, present constraints of the current harbor, etc. These discussions were held during two field trips to Kulhudhuffushi during November and December 2015.

7.3.1.7 Key Informant Interviews

596. Key Informants Interviews (KII) was another qualitative data collection method in this survey. KII were conducted with council members to gain the local level political views regarding harbor expansion related issues in their elected area. This method was used to gather information from key individuals under conditions where a formal questionnaire was not appropriate. Key informant interviews sought out data from individuals having special knowledge on a topic of interest.

Table 63: Key Stakeholders and Analysis

Stakeholder	Level of Interest	Key Stakeholder Interests
General Public		
Community (general)	Primary	Improving the island's connectivity to regional and national markets and promoting local and visiting populations' accessibility to key services such as health, education, businesses, income generation, etc.
Women/ Women Development Committees	Primary	Improving access and as there a lot of fee headed households in islands, improving access means better quality of life with an easy transportation system (specially for women needing specialist treatment during pregnancy and childbirth)
Agriculturalists	Primary	There is a Sunday Market in Kulhudhuffushi to sell locally grown vegetables and fruits by local farmers from nearby islands and having a passenger harbor would increase the reliability and would also limit the increase in costs so that products would still be affordable when costs passed on to customers
Local Transport Providers	Primary	At present, Kulhudhuffushi acts as a major passenger and cargo hub in the Northern region of the country. There are regular scheduled boats/ferries both carrying cargo and passengers. An improved accessibility through the passenger harbor project would widen the already existing local sea transport system.
Visitors seeking health services	Primary	There is a regional hospital in Kulhudhuffushi, which provides all the specialist facilities of health care including laboratory services and brings in visitors seeking health care services from nearby islands on a daily basis. Need for regular and reliable transport services that would ensure the visitors to return to their island on the same day.
Fish Processors	Primary	As above and require sufficient cargo capacity to be able to ship processed goods to Malé and then overseas. Need regularity so that they are therefore able to accept supplies of fish for processing as and when available from fishermen.
Fishermen	Primary	As above. Fishermen require adequate harbors for protection of vessels, and depend on the fish processors having access to sufficient cargo capacity to be able to ship processed fish and therefore purchase from fishermen.
Retailers/ Small Businesses	Primary	To ensure reliable, adequate and timely supply of retail goods at a rate that enables adequate margin for profitability.
Construction Groups	Primary	To ensure reliable and timely supply of construction materials and ability to travel to meet contract requirements of time and location.
Students from nearby islands seeking education	Primary	Kulhudhuffushi has campuses of both Maldives National University and Villa College, which brings in students from the Northern region to the island. Need for regular and reliable services to enable home family visits during holidays, or visits by family during term time, at an affordable rate and ensuring the ability to return to school/university on time.
Local and Central Government		
Atoll and Island Councils	Primary	Elected atoll and local councils are responsible for working and lobbying with central government towards the needs of community such as accessing development resources, managing island affairs to maximize social and economic benefit, which is directly affected by transport capacity and reliability. An effective transport system positively

		impacts on the achievement of this role.
Ministry of Housing and Infrastructure	Primary	MHI is mandated with physical development planning policy and regulations, land-use planning in islands and improving accessibility infrastructure of inhabited islands.
Ministry of Environment and Energy	Primary	MEE is mandated with overall environmental policy and regulatory framework. All the developmental projects, including harbor development projects are initiated after conducting an Environmental Impact Assessment.
Ministry of Home Affairs/Local Government Authority	Primary	Local Government Authority is mandated with developing island management plans and overseeing the works of the elected atoll and island councils. Improved accessibility would improve the implementation of island development plans
Ministry of Economic Development	Secondary	Responsible for company registration, setting of freight rates for domestic staple items, regulating fair competition freights, regulating shop opening hours
Ministry of Tourism	Secondary	Now responsible for civil aviation which is sometimes integrated with and at times in competition with maritime transport.
Ministry of Defense/Maldives National Defense Force	Secondary	Responsible for policing and patrolling the waters of the economic zone of the nation. They are also responsible for passenger and freight movements and safety within the Port Areas.
Kulhudhuffushi Ports Authority	Secondary	Mandated with managing the Regional Ports Facility
Ministry of Education	Secondary	Responsible for the overall education policy and increasing educational opportunities for the people of Maldives. Reliable and affordable transportation is a necessary prerequisite for the ministry's commitments to make primary and secondary education accessible to all children.
Ministry of Health	Secondary	Responsible for the management of health services in the country – equitable access to health services is significantly affected by transportation services.
Ministry of Fisheries and Agriculture	Secondary	Responsible for development of the necessary infrastructure for the growth of the fisheries and agriculture sector

7.3.2 Socioeconomic Profile of Project State and Project Locations

7.3.2.1 Project Locations

597. The island of Kulhudhuffushi, one of the biggest and most populated islands in North of Maldives, is the capital of Haa Dhaalu Atoll administrative division. Kulhudhuffushi is located at 73° 04' 10"E and 6° 37' 24" N and geographically part of Thiladhummathi Atoll in the north of the Maldives. Kulhudhuffushi is known as the Heart of North and is 19 km from the nearest airport, Hanimaadhoo. It's nearest inhabited islands are Nolhivaramu (4 km), and Kumundhoo (6 km). Kulhudhuffushi is amongst a group of 8 large islands, totaling 18km2, located along the north eastern rim of Thiladhunmathi, making the area one of the dense concentrations of land in Maldives. The island's location in the northern exposes it to NE monsoon generated winds and waves, and occasional storm activities originating from the cyclone belt of Indian Ocean (UNDP, 2005).

598. The island is 195.5 Ha (1.95 km^2) and the reef system has a surface area of 366 Ha (3.66 km2) and the island occupies 54% of the system. The island is supporting a population of nearly 8,244 local residents living in four wards (Census, 2014).

599. Kulhudhuffushi supports a diverse range of habitats including tropical woodlands (mainly coconut palms and mangrove trees for income, building, fuel, food, rope weaving), and inland lake, reef, ground water, back yard fruit and vegetable trees, land, beach and strong coastal vegetation.

7.3.2.2 Population and Migration

600. According to the 2014 census, the population of Kulhudhuffushi is 8,224 of which 3712 males and 4299 females (excluding expat immigrants). It is increasing at a rate of 1.68% which is average compared to some other atolls in Maldives. Kulhudhuffushi population contributed to 2.4% of the total population of Maldives during this period. Population data of Kulhudhuffushi from 2006 to 2014 is shown in Table 64 below. The population of Kulhudhuffushi highly depends on the migration of people from islands of Haa Dhaalu and the neighboring atolls of Haa Alif and Shaviyani.

Table 64: Population data of Kulhudhuffushi (source: Census 2014)

Population	Maldives census 2014	
	2006	2014
Total	6998	8224
Malé (local)	3299	3712
Fe (local)	3699	4299
Malé (foreign)	145	168
Fe (foreign)	35	45

7.3.3 Socio Economic Profile of the Project Influence Area

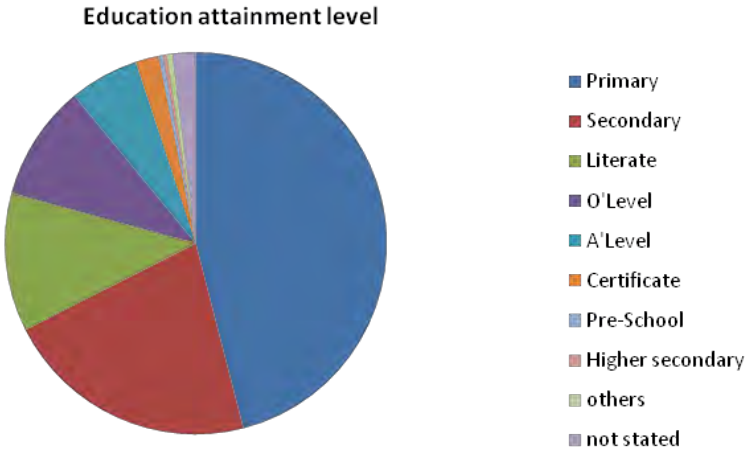
7.3.3.1 Access to Social Services and Civic Amenities

Education

601. Kulhudhuffushi is one of the few islands where higher secondary and tertiary education is offered in Maldives. As of November 2015, according to island council, there are 2808 students and 245 teachers in the island. Jalaaludhin School, the only secondary and higher secondary school serving in the island is also the largest education center in the Atoll. Inaugurated on February 15, 1998, it currently serves more than 1000 students. The two primary schools of Kulhudhuffushi include Fuvahmulaku Affeudheen School and H.Dh Atoll Education Center. There are also 2 preschools in the island managed by the government as well as private parties. From 2012 onwards Maldives National University campus in Kulhudhuffushi is offering degree courses in the island which gave opportunities for many students who complete their secondary and higher secondary in the island, to pursue higher education.

602. According to 2014 census, the majority of the people who have attained education over the age of 6 has obtained primary education (47%). However, there is a huge decrease in the number of persons attending secondary education and even more for primary education. The percent of population who have received secondary education is 12% with 10% completing GCE Level examinations. Added to this, 6% completed certificate level education, only 0.3% of this population completed GCE A 'Level examinations. 0.5% of the population have attained Diploma level, Degree and Masters Level.

Figure 34: Levels of Education Attained by Kulhudhuffushi Population over the Age of 6.



Electricity

603. Electricity is provided to the island by Fenaka Corporation Pvt. Ltd. Electricity is provided for 24 hours and according to the 85% of the respondents of the survey, the quality of the service provided by them is good. However, the engines used to provide electricity are old and as a consequence, the service providers face difficulties in maintaining and managing the engines.

Waste Management

604. Other services provided to the community include waste management service provided by the Island Council through an island waste management center. With the increasing population and the developments coming to the island, managing waste has become one of the biggest challenges faced by the island community as per the majority of the respondents of the survey. Although, a waste management center is established on the island, there is no proper equipment in the center to manage waste. Also, the community is not aware about the importance of waste management which makes it even more challenging.

Water Supply and Sewerage Services

605. Kulhudhuffushi is one of the few islands in the country that enjoys utility services such as water supply and sewerage services with household connections. Before these services, the residents were using ground water and rain water for drinking and septic tank system. The desalinated water supply and sewerage system is operated by Malé Water and Sewerage Company.

Communication

606. Telecommunication services to the island are provided by Dhiraagu and Ooredhoo. Landline telephone communication service to the island, provided by Dhiraagu, is the only landline telephone communication service provider in the island. "Ooredhoo" along with Dhiraagu provides mobile communication services. Almost all people of the working population have a mobile phone. Meanwhile, internet services are provided by Dhiraagu and Infocom Private Limited.

607. Establishment of communication services on the island has led to further development of the island. It has brought many employment opportunities and has connected the island to the rest of the country.

Transport

608. Modes of transport used on the island include bicycles, motor cycles, cars, lorries and pick-ups. Earlier there were many bicycles on the island and many have used it as an ideal form of transportation. However, with the construction of the Harbor on the island, there has been a sudden boost in the number of vehicles - notably motor cycles. Now it is the main and preferred mode of transportation in the island. According to the island council, currently there are 2256 vehicles registered on the island.

609. Kulhudhuffushi also acts as a key regional maritime connection and cargo interchange point for the Haa Dhaalu atoll and other Northern atolls in general. At present, Kulhudhuffushi also acts as a major passenger and cargo hub in the Northern region of the country. There are regular scheduled boats/ferries carrying both cargo and passengers. Improved accessibility through the passenger harbor project would widen the already existing local sea transport system.

Health Services

610. The first Health Center of Kulhudhuffushi officially started its services on May 12, 1973. Since its establishment, many developments have taken place in the health sector of the island. New infrastructure has been built and a variety of services are offered. Because of the geographical isolation of the island and rapid increasing population, the government upgraded the health center to a 50 bed regional hospital on June 11, 2001.The hospital operates daily 24 hours with 2 general practitioners, 4 specialists, 1 radiographer and 36 nurses. Medical tests like blood tests and urine tests can be done in the hospital.

611. Although, the hospital has been upgraded and it provides a better service compared to the many other islands in Maldives, it still lacks many facilities and services. Many people travel to Malé to receive better services. Apart from the hospital there are two private clinics, a branch of eye care, one STO pharmacy, 3 private pharmacies and one drug rehabilitation and detoxification center on the island.

612. The health condition of people in Kulhudhuffushi is generally good compared to other atolls in Maldives. Most commonly reported diseases are acute respiratory infections, viral fever and diarrhea. Other diseases rarely reported on the island include dengue fever, typhoid and scrub typhus. The table below shows the total number of reported cases by selected disease in Kulhudhuffushi in 2012.

Table 65: Number of Reported Cases by Selected Diseases in Kulhudhuffushi in 2012

Acute respiratory infection		Viral fever		Diarrhoea		Scrub Typhus		Dengue fever		Typhoid	
Under 5years	Above 5years	Under 5years	Above 5years	Under 5years	Above 5years	Under 5years	Above 5years	Under 5years	Above 5years	Under 5years	Above 5years
1863	2960	331	653	236	299	-	4	1	12	-	1

Source: Statistical year book, 2013, Department of National Planning

613. Kulhudhuffushi does not have specific health issues that are unique to the island; only general health issues common in a developing community in a developing country. Since the late 1980s, all children have been vaccinated as per WHO guidelines, and diseases such as Tuberculosis and Polio have been completely eradicated.

7.3.3.2 Status of Women

614. Kulhudhuffushi is one of the few islands in the Maldives where higher secondary and tertiary education is available. These opportunities are equally available for males and females in the island. All the children on the island have access to primary and secondary education. According to island records, in total there are 2808 students studying in different schools around the island, out of which 1431 are females and 1377 are males.

615. Despite this, gender differences can be seen in the employment sector. There is no recent official data available to compare the percentage of females and males in the labor force or to compare the percentage of unemployed males and females. However, the vulnerability and poverty assessment conducted in 2004 shows that there is disparity between males and females when it comes to employment. The percentage of employed males (89%) is more than that of employed females (71%). Similarly, the percentage of unemployed females (29%) is more than unemployed males (11%). Census 2014 shows that in Haa Dhaal Atoll more women (693) are employed in civil service than men (655).

616. In addition to this, gender differences are clearly visible in the sectors for which each gender have been traditionally employed. As mentioned above, there is no official data available, but according to the island records more women engage in agricultural practices such as growing vegetables and more men engage in fishing sector and transportation industry. However, according to the 2014 census, more men are employed in construction, Transport Storage and Communication and Fishing while more women are employed in manufacturing and education sector.

7.3.3.3 Participation of People in Government Development schemes

617. Public participation in developmental projects is important to make sure that government addresses the real needs of communities in the most appropriate way. Participation also helps to build an informed and responsible citizenry with a sense of ownership of government developments and projects.

618. In the Maldives, there are laws and regulations that make it compulsory for Government to consult the community or local councils. One such example is the Environmental Impact Assessment (EIA) Regulation. Before any EIA regarding developmental projects are submitted to the responsible government agency, a public consultation meeting is required to be carried out and a copy of the EIA report is also required to be submitted to the responsible local island council authority. In the case of EIA process, opinions expressed during public consultations are rarely taken into consideration, since by then major components of the developmental project such as budget and engineering designing would have already been finalized.

619. Public participation and communication are very often treated as add-ons and dealt with only by consultants and outside agencies, instead of the responsible Government agency. However, consultation with the public will help the Government make more appropriate decisions based on the real needs of people, and the more informed people are, the better they will understand what the government is trying to do and what the budget and resource limitations are. For a communication and participation strategy to be effective, problems, concerns and suggestions raised by the target communities must be properly processed and addressed during the planning stages of developmental projects.

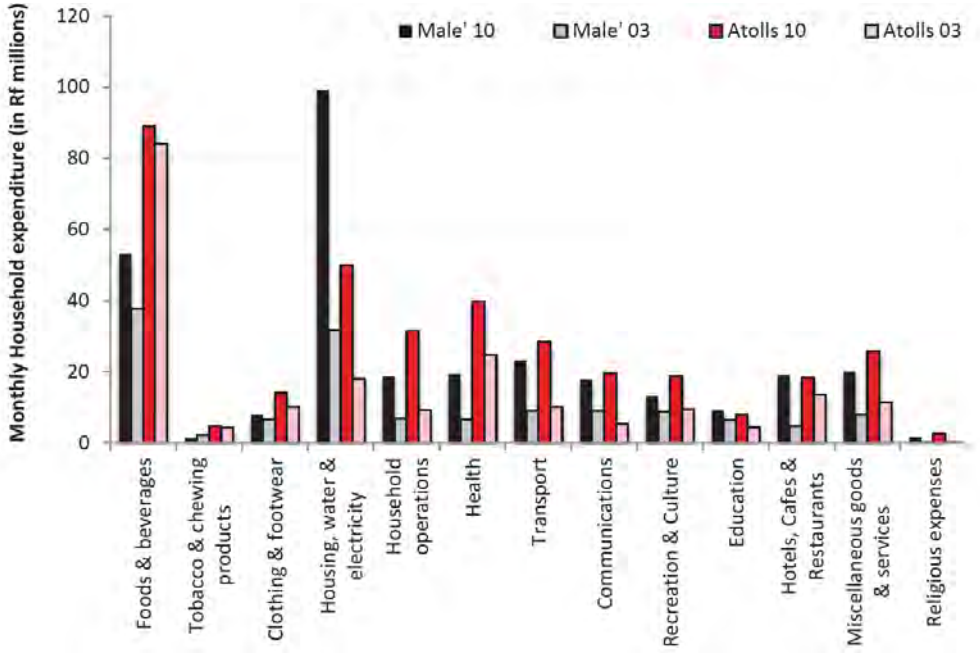
7.3.3.4 Income and Expenditure Pattern

620. The most recent nationwide household income and expenditure survey was conducted by the Department of National Planning in 2010. The report of HIES

was published in 2012. The report presented income and expenditure of households in Malé and the Atolls to assess the economic wellbeing of the population.

621. For the purpose of this report, the HIE data in HIES 2012 for Atolls is used to represent the Income and Expenditure data for Kulhudhuffushi. As per the report, the average monthly expenditure per household in the Atoll is MRV 10,417. The daily expenditure per person in the Atolls is MRV 59. The average monthly income per earner is 4824 rufiyaa in the Atolls. On average, there are two members earning in every household in Kulhudhuffushi. The main household expenditure is spent on foods and beverages, followed by expenditure spent on housing, water and electricity and health.

Figure 35: Household expenditure by expenditure groups for Malé and Atolls



7.3.3.5 Assets and Durables Possessed

622. The community of Kulhudhuffushi are in possession of the following durable assets such as:

- natural capital that includes natural resource assets (island, land plots, beach, sand and soil, ground and rainwater, air and sea);
- reproducible capital (mainly consumer durables from household electric appliances to transport and communication equipment to audio-visual equipment);
- human capital (the productive potential of human beings such as the employed population in the community); and
- Social capital (norms and institutions that influence the interactions among community such as harbor, port, hospital, schools, etc.).

623. These four major components of durable assets empower the community of Kulhudhuffushi to be self-sufficient even in times of hardship, as they possess the materials necessary for ensuring their livelihood regardless of the larger economic climate. Unlike other countries in South Asia, the Maldives lack livestock on land; however, fishing and resources from the sea compensate for this.

624. There is also a movement of development driven by the creation of funds for establishment of small businesses by Business Development Service Center (BDSC) in Kulhudhuffushi. Through such programs, people collectively save in order to acquire loans or assets to acquire the tools to initiate income generating activities. One such small business developed in Kulhudhuffushi through BDSC is a photography studio called Photo Magic. The studio owner must possess the necessary audio-visual equipment to pursue his/her business and this highlights a useful view on how to facilitate the inherent creativity of people for pursuing livelihoods for themselves and their families.

7.3.4 Project Awareness

625. The island communities are very conscious about any change in their community or the surrounding environment. The public perception of the project may vary resulting in any misconception about the project and its major outcomes. The community may voice out against any improperly implemented project which might result in discontinuation of the project. The potentially affected groups, who live nearby, who might experience noise and visual impacts from the project works, will have an opinion on vital aspects of the project.

626. The decision taken on a policy level in regards to the project would need to be shared with the public early on in the project cycle. If such decisions are enforced rather than discussed and agreed, it will affect the social wellbeing of the community.

627. During the field visit to the island, focus group discussions were held regarding the project, and the majority of the community were already aware of the project. This may be due to the level of media coverage of the project as the promise of the development of the passenger harbor has been part of the election campaign of the current Government.

628. The dynamic political situation will have significant impacts on the project which might have a negative or positive effect on the community. Political unrest and economic recession will directly affect the community and the project implementation.

7.3.5 Gender Issues

7.3.5.1 Gender Development and Gender Empowerment Indexes

629. The 2014 gender development index (GDI) puts the Maldives in 104th place out of the 188 countries ranked (UNDP HDR 2015). The GDI measures differences

between and female achievements in three basic dimensions of human development: health, measured by female and life expectancy at birth; education, measured by female and expected years of schooling for children and female and mean years of schooling for adults ages 25 and older; and equitable command over economic resources, measured by female and estimated earned income. The Maldives has particularly strong performance on female educational attainment.

630. The Gender Empowerment Measure (GEM) is an index designed to measure of gender equality for which Maldives falls in 95th place out of the 135 countries ranked (ahead of India at 105, but behind Sri Lanka at 39). It was introduced at the same time as the Gender-related Development Index (GDI), but measures other benchmarks such as empowerment that are not covered by that index.

631. The Government's policy to provide education to all children, and exclude no one is one of the most accomplished policies of the administration. As a result, equal opportunities in education for female children are available from primary to secondary education. As education is the most vital instrument for women's empowerment, this paves the way for more opportunities for women in high-paying positions with economic power and greater decision-making.

632. Kulhudhuffushi is one of the few islands in Maldives where higher secondary and tertiary education is available. These opportunities are equally available for male and female in the island. As a result, family members do not have to be separated for education reasons, and the overall social impact to women is very positive. This reduces the workload on women in maintaining the home and increases family cohesion.

633. Similar to education, there is universal and equal health care services provided equally to male and female through the Regional Hospital in Kulhudhuffushi. The state provides medical insurance to both genders. The island also has a pharmacy that is covered under the national medical insurance scheme "Aasandha". Pregnant women are provided pre-natal care, and births are attended by skilled health care professionals; as a result, maternal deaths rarely occur on the island.

634. Gender differences can be seen in the employment sector. There is no recent official data available to compare the percentage of female and male in the labor force or to compare the percentage of unemployed male and female. The most recent data from census 2015 is not available at present other than demographic data for inhabited islands. Census 2015 shows that in Haa Dhal Atoll more women (693) are employed in civil service than men (655).

635. The vulnerability and poverty assessment conducted in 2004 shows that there is disparity between male and female when it comes to employment. The percentages of employed male (89%) are more than that of employed female (71%). Similarly, the percentages of unemployed female (29%) are more than unemployed male (11%).

636. In addition to this, gender differences are clearly visible in the sectors men and women are traditionally employed. In Kulhudhuffushi, no women are elected to the

local island council, mainly due the fact that no woman had run in the election. As mentioned above, there is no official data available but according to the island records more women engage in agricultural practices such as growing vegetables and household level small-scale catering services such as preparation of "short eats", which they sell to their immediate communities. As a result, women directly benefit from increased income generation opportunities and, in most cases, from control of what they earn. More men engage in fishing sector, transportation industry and construction industry. With the implementation of the harbor extension project, more women in Kulhudhuffushi will be able to venture directly and indirectly into the transport industry with the increase in employment opportunities.

7.3.5.2 Need of a Gender Action Plan (GAP)

637. Due to the religious and cultural system of stereotyping women to be homemakers and limited opportunities for women to work outside from home for long hours due to the responsibility for child-rearing and domestic work, the number of women working in the transport industry is very few. Since Kulhudhuffushi is a major transportation hub of the North region, many women from Kulhudhuffushi are indirectly working in the transport industry in aspects that they could manage from their home. Many women cater to the crew and passengers (in transit and visiting) by selling homemade Maldivian delicacies such as short-eats and Haalu folhi (a traditional dried snack made from rice flour only made in Kulhudhuffushi).

638. There is also the issue of a high number of students who complete secondary schooling but not opt for high secondary education due to the fact it is not state sponsored. Thus, there is a competition for jobs and employers hire female for a low salary mainly because females are more committed and reliable. This issue was raised during focus group meetings held with Women's Development Committee.

639. However, the need for a Gender Action Plan (GAP) is not required as per the findings of the field visits and interviews. However, the implementation of the harbor development would have important implications for women and children's health as shortages of supply of food, particularly fresh fruit and vegetables has been linked to malnutrition in children and dietary deficiencies. The development of passenger harbor facility would also improve maternal health risks induced by unreliability in transport system. Recently, there was a reported case of a woman from Haa Dhaalu Atoll giving birth on the ferry on the way to Kulhudhuffushi Regional Hospital.

640. Although there is not a need for GAP, through this project, ADB will ensure mainstreaming gender equality considerations to enhance women's access to services and economic opportunities.

7.3.6 Other Social Issues

7.3.6.1 Prevalence of HIV/AIDS in Kulhudhuffushi

641. The health conditions of people in Kulhudhuffushi are generally well compared to other islands in the region. Most commonly reported diseases are acute respiratory infections, viral fever and diarrhea. Other diseases more rarely reported in the island include dengue fever, typhoid, and scrub typhus. Although there are only few reported cases of HIV/AIDS in Maldives, there is no reported case from Kulhudhuffushi.

642. During the household visits and focus group discussions held, it was apparent that there was high level of HIV/AIDS awareness among the youth, married and unmarried members on the community. Almost all of the respondents were aware of the ways of HIV transmission and methods of prevention. This would be due to the high number of targeted awareness campaigns regarding HIV/AIDS that had been previously conducted in Kulhudhuffushi. As per the respondents, there was a recent awareness campaign program organized by Women's Development Committee with a national level NGO which included forming of an alliance, educating and building the capacity of parent stake holder groups, developing the youth as peer educators for drugs and HIV prevention in the island, including a massive door to door outreach information disseminating program and a dynamic youth camp. The activities focused for Kulhudhuffushi was tailor made, while accounting to the risk factors and the preventive factors associated with drug use and HIV prevention in the island. But due to the number of drug abusing members of the youth, the community of Kulhudhuffushi is vulnerable to the risk of an HIV/AIDS epidemic.

7.3.6.2 Human Trafficking

643. Human Trafficking is an offence in the Maldives and the main objective of the Anti-Human Trafficking Act which was ratified in late 2013 to prevent trafficking of persons through and across the Maldives and to offer protection and assistance to victims of human trafficking and prescribe punishment to traffickers. However, the Maldives has been placed back on the US State Department's tier 2 watch list for human trafficking over lack of progress in the government's anti-trafficking efforts after being removed from the watch list in 2014.

644. The Government has formulated a coordination committee to address the issues of human trafficking and has also adopted a national action plan for 2015-2019 to develop procedures for victim identification, protection, and referral. Currently there is a state-run shelter for female trafficking victims that opened in January 2014.

645. Preliminary results of Census 2014 show that there are 63,637 foreigners in the country and among these 213 foreigners are employed in Kulhudhuffushi. However, there are reports of over 100,000 foreign workers in Maldives, of which many have an irregular status (IOM Maldives, 2014). The majority of the migrant workers are believed to be Bangladeshi; however, there are also large numbers of

migrants from India, Sri Lanka, Nepal, Philippines and other South Asian countries, amongst others.

646. Most of the foreign nationals work in the construction and transport industry in Kulhudhuffushi. However, a large number of teachers and health care professionals in the island are also foreigners. During the field survey, Council members from Kulhudhuffushi Island Council stated that there are foreign laborers without proper work permits in Kulhudhuffushi.

7.3.6.3 Child Labor

647. The Employment Act of the Maldives prohibits the employment of a minor under the age of sixteen except for the purpose of training in relation to such minor's education and requires parental consent for employing minors (HRMC, 2009). The Act makes an exception for children participating, with their consent, in work undertaken by their families. The Employment Act also prohibits the employment of a child (below 18 years of age) in any work or employment that may have a detrimental effect on a child's health, education, safety or morals due to the work or job undertaken or the conditions of work. Those who employ minors are required to maintain a register of minors employed containing their names, addresses and dates of birth. The Act also requires a medical fitness test prior to employing minors on vessels and further such tests for continued employment on vessels.

648. In 2013, the United Nations Children's Fund (UNICEF) reported that the number of children involved in economic productive labor is increasing in the Maldives. The report on the situation of children in the Maldives showed that the proportion of children aged between 5-14 years working in the Maldives increased from 26.2 percent to 34.2 percent in 2009 (UNICEF, 2013).

649. During the field surveys and interviews in Kulhudhuffushi, respondents highlighted issues of household poverty due to broken family circumstances and drug abuse inside the family, forcing children to seek employment in the construction industry and in passenger ferries and in some local shops. Concerns were raised by the respondents that these children might be subjected to exploitation. To address this issue, in 2015, the Government has opened a shelter called "Safe Home" in Kulhudhuffushi to house women and children suffering from domestic abuse but the community is unconvinced that this would bring in any improvement to the less privileged people in the community.

7.3.6.4 Indigenous People

650. The population of Maldives is ethnically homogenous with no recognized sub-categories. It can therefore be stated with confidence that there are no "indigenous minority" groups which need to be separately considered for the purposes of this study. In view of this, it is clear that there is no need to evaluate any impact on indigenous people.

7.3.7 Impacts of Development of Harbor on People's Livelihood

7.3.7.1 Approach to Tackle Key Poverty Issues

651. The 2nd vulnerability and poverty assessment conducted in 2004 estimated that population with per capita income less than MVR 10 falls under the poverty line (UNDB & WB, 2005) According to the assessment, 36% of the population has an income less than MVR 15 per day while 23% has an income less than MVR 10 per day. The percentage of people earning less than MVR 15 per day is higher than the national average of 21% as well as the atoll average of 28% (UNDB & WB, 2005). However, this study was conducted in 2004 and the island has gone through a number of changes in terms of land use and population numbers over the past 12 years.

652. In comparison to other islands of Haa Dhaalu atoll, the people of Kulhudhuffushi are relatively well-off. Although there may be a small fraction of the population under the poverty line, the economic condition of the island has improved significantly with more economic activities being carried out in the island.

653. Poverty as in absolute poverty is not present in the island, but there are underprivileged people such as single mothers and handicapped people who are not benefitted directly or indirectly from the current available resources as they have competition in using the resources. With the proposed project of harbor extension, the economic condition of the island and the living standard of the local community as well as the underprivileged group of people will progress significantly as more opportunities for economic activities become developed.

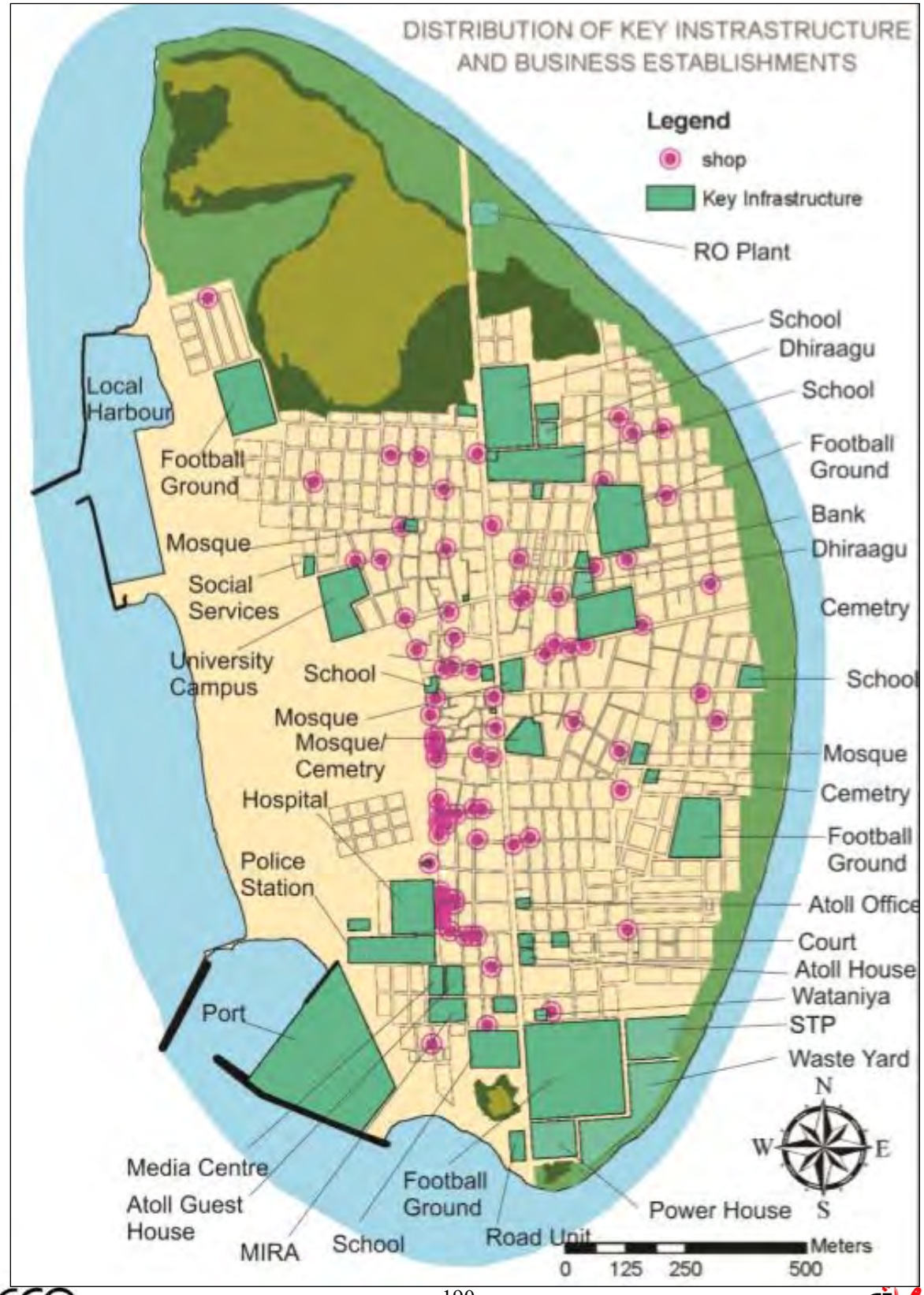
7.3.7.2 Land Acquisition, Rehabilitation and Resettlement

654. Kulhudhuffushi can be considered as a highly urbanized island with a population density of 41 persons/hectare. The settlement foot print of the island covers 43% of the total habitable land area. Within this settlement foot print the population density is 88 persons/hectare. Since 2008, major changes have been brought to the island structure through physical developments such as development of the harbor area, development of port, land reclamation of the west coast followed by more warehouses and business establishments near the port. All the infrastructures are at a close proximity to each other. Land was also reclaimed from the north and south wetlands to address the issue of land shortage with the increase in population. However, even with the increase in landmass, the island is still experiencing scarcity of land for housing and other urban services.

655. According to the land use plan of Kulhudhuffushi, the issue of land shortage is addressed by allocating more land for residential housing of different types, including public and commercial housing. Separate areas are allocated for industrial and commercial uses, separating it from the residential areas. As most of the businesses are established near the harbor, the development of the passenger harbor will increase the economic benefits to the local businesses (Figure 36).

656. In Kulhudhuffushi the land use plan for the waterfront area allows sufficient space for the development of the passenger harbor. In view of the above, it is clear that there is no need for a resettlement plan for this project.

Figure 36: Distribution of key infrastructure and businesses in Kulhudhuffushi



7.3.7.3 Market Access

657. In Kulhudhuffushi, the key economic infrastructure includes the local harbor, communication infrastructures (DHIRAAGU and Ooredoo site), regional port, power house, roads and Bank of Maldives. In addition, the public facilities and amenities, and institutions can also be considered as contributors to the economy. In Kulhudhuffushi, there is a high concentration of business activities along the old western shoreline, which now is the central part of the island. This area was previously the harbor area making it an ideal location to provide wholesale and retail activities especially for the visitors from other islands. However, with the new reclaimed land, these areas are now shifted inwards. In the near future, it is highly likely that more establishments will be located near the existing harbor to cater to the visitors as proposed in the land use plan. There is also a high concentration of business activities on the main roads. This is mainly due to good accessibility to the roads making it easy for the customers and also for loading and unloading. While larger retail shops are located on the main roads, the small retail shops and personal service sectors such as workshops are randomly distributed across the island.

658. As most of the businesses are established near the harbor, the development of the passenger harbor will increase the economic benefits to the local businesses. Similarly, the businesses being near to the harbor makes easier access for the visitors from the other islands.

659. Moreover, due to passenger harbor increase in marine traffic volume would offer opportunities to increase in marine transport business, easiness in island to island passenger ferry network and transportation of cargo leading to overall economic development of the region.

660. The passenger harbor will act as a linkage to all the people participating in the Sunday Market. The reliability of supply of agricultural products from other local islands in the region to the Sunday Market in Kulhudhuffushi would be increased while providing opportunities for buyers from nearby resorts and other islands to visit to Kulhudhuffushi on Sundays. This would increase the value of the produce and bring in a steady income to the local farmers.

661. Re-development of the harbor would increase the fishing sector and would bring in more fishing vessels as there would be space for more vessels at the new harbor. This would improve the fishing industry and socio-economic condition of the region.

662. Lastly, the new passenger harbor would also ease access to Banking and or credit facilities is for the locals where they can have access to save their earnings and also get credit for fisheries and agricultural needs or for beginning new business, etc.

7.3.7.4 Employment Opportunities

663. With the largest population in the northern region of Maldives, Kulhudhuffushi also has the largest economy among the islands in the north of Maldives. Being the

capital of the atoll and the regional hub, the island is well equipped with all necessary facilities and infrastructures including the regional hospital, schools, power house, water and sewerage system, harbor etc. The economy of the island is mainly based on three basic sectors: wholesale and retail trade, manufacturing and fishing. Previously, fishing was the main economic activity, though this has now changed with the ban on shark fisheries and decreasing fish catch. With the changes and opportunities from operations of regional (International) port wholesale and retail business, transport sector (passenger and cargo) and employment in government, there has been a significant increase in the number of public and private businesses.

664. Government (civil service) and public enterprises are the major employers on the island. Employment in whole sale and retail sector and transport sector shows a significant increase while there is a decrease in employment in fishing and related activities. As per the focus group discussions held with Fishermen and Fish Processors, with the new harbor, the frequency of fishing vessels from nearby islands visiting Kulhudhuffushi would increase.

665. The development of the new passenger harbor would be beneficial to the local people as it would provide more job opportunities in the transport sector. Furthermore, more wholesale and retail business would be developed to cater for the influx of visitors, which would sequentially increase the number of employment opportunities in the wholesale and retail trade. In addition to this, during the construction of the harbor, it is expected that local population gets the opportunity to apply for work thus increasing the employment generation for construction related activities in the project region. This opportunity would also be available during the operational phase of the harbor. This factor will also contribute towards increasing average household income in these areas.

7.3.7.5 Lower Transportation Cost

666. People from the region visit Kulhudhuffushi for many reasons such as healthcare, education, to buy goods etc. Development of the passenger harbor would increase the number of vessels travelling to and from Kulhudhuffushi enhancing the transportation sector. Increase in the number of vessels travelling within the region would increase in supply for the demand which would reduce the cost of transportation. Additionally, change in passenger fares would indicate low operation cost of vehicles due to regular services and more number of ferries and hence, would decrease in families' expenditure on travel. Furthermore, change in cargo freight rates help small retailers in the island to sell their goods at an affordable rate to the locals. Therefore, changes in marine vehicle operating costs would have a direct impact on bearing capacity.

7.3.7.6 Reduced Travel Time

667. The key transport infrastructures in the island are the regional port and the local harbor. The port is to cater to large container vessels from overseas. The local harbor was completed in 2010 with limited space for more vessels. The passenger harbor will provide space for more vessels. Thus, will reduce delays in waiting for

entrance at low tide and for space on the current limited harbor. It would also reduce turn-around time. Moreover, the harbor would have significant benefit in protection of vessels within harbor, and minimization of losses due to weather damage.

7.3.7.7 Access to Education

668. Kulhudhuffushi provides all levels of education. These include preschools, primary, secondary higher secondary and tertiary education. In addition, they have a vocational training center and campus of Maldives National University which offers short courses for skill development to Bachelor's Degree Courses. Students from nearby island migrate to Kulhudhuffushi in search of better education facilities.

669. With the new passenger harbor project proposed, accessibility to education for students migrating to the island would become easier. Similarly, it would also provide more opportunities to get more students come onto the island for education which would consecutively increase the number of educated people in the region.

7.3.7.8 Access to Health

670. The health care delivery system of Maldives is organized into a four-tier referral system with the island level health facilities referring patients to higher level health facilities in the atolls, regions and to central level depending upon the need and service availability. The government is committed to improving the health services in the country and improving the accessibility of services at the very peripheral levels, which due to the dispersed nature of the population in very small islands exerts diseconomies of scale. Due to this, island level facilities lacks doctors, nurses and equipment, decreasing the quality of services available to the local people. Therefore, for better quality health services, most of the people goes to the capital city Malé which is expensive and time consuming.

671. The regional hospital for the upper northern region is located in Kulhudhuffushi. A hospital with better services than other islands in the region is another reason for people to visit/migrate to the island. The passenger harbor would enhance the accessibility for the people from other islands to a better health care system which is a less expensive healthcare alternative for these people.

7.3.7.9 Mobility and Improved Participation

672. The transport sector is well-established in Kulhudhuffushi. Direct imports of goods from overseas to the island (regional port) have increased the demand for transport services. Kulhudhuffushi is the hub for distribution of goods to islands in Haa Alifu, Haa Dhaalu and Shaviyani Atoll. While the cargo plus passenger boats travel to and from Malé, the speed boats cater for inter-island transport, particularly to and from the airport and for emergency medical transfers.

673. With regular passenger cargo and ferry services, the number of local farmers and buyers visiting to Kulhudhuffushi on Sunday for Sunday Agricultural Market

would increase. The development of the passenger harbor would enhance the transport sector increasing mobility within the region. This would increase people visiting the island which would enrich socializing of people from other islands with the local island community.

7.4 Major Findings of Stakeholder Consultations

7.4.1 Public Consultation in the Project

674. Public Consultations regarding the project were held both in Kulhudhuffushi and in Malé. Stakeholder consultations were held in Malé with MHI to brief about the field visit to the island and to acquire the necessary travel permits and with EPA to set the scope for the EIA for the project.

675. As part of the public consultation in Kulhudhuffushi, a mixed-method approach was used which consists of both quantitative and qualitative data collection techniques, depending on the requirements of the information. The public consultation process was held from 20-22 November 2015 and the second consultation was held from 23-26 December 2015 in Kulhudhuffushi. The first consultations were held with fishermen and fish processors in Kulhudhuffushi. The second consultation was held for members of the community from youth groups to women's groups, NGOs, Women's Development Committee, School administration and teachers, Bank officials, entrepreneurs, business owners and members from Kulhudhuffushi Island Council were consulted. All efforts were taken to select most suitable, impartial and knowledgeable members from each group that were chosen for the consultation process.

676. The consultative process focused mainly on collecting information on the following areas:

- General introduction of the work carried out by the organization or introduction/say about the island by the group,
- Discussions on the pros and cons of the new extended harbor development projects,
- Challenges faced by the current harbor which needs to be addressed in new harbor development/designing,
- Gender and poverty issues – keeping focus on employment and other opportunities for females in the implementations and future developments of harbor. This also covered the areas of training and development that are lacking in the island and need more focus in near future,
- The discussion of minimum ancillary facilities that should be available from the harbor was also an area that was explored,

- Lastly, additional comments or feedback – this area covered how much people will be willing to pay for land and building rent out. And other additional feedback for the design and implementation phases from the community groups.

677. The detailed findings from the consultation are referred to in various sections of the Report.

7.4.2 Methods of Public Consultation

678. A mixed-method approach was used which consists of both quantitative and qualitative data collection techniques, depending on the requirements of the information. The following table summarizes the key methods and the instruments that were undertaken to collect information for the purpose of identifying social impacts that might arise from this project.

Table 66: Methods and Techniques for Data Collection

Type of Data	Methods	Techniques/Instruments
Qualitative/ Quantitative	Desk studies	Literature review Secondary data collection
Quantitative	Community Consultation	Interviews and group discussion
Qualitative	Observation	Site visits Attendance of meetings Case studies
	Participatory Rural Appraisal (PRA)	Focus Group Discussion Key Informant Interviews

7.4.3 Scope of Consultation and Issues

7.4.3.1 Participatory Rural Appraisal

679. The participatory rural appraisal (PRA) is one of the major qualitative data collection methods in social assessment. The goal was to enable island people to analyses their own situation, to share their knowledge and teach us, to do the analysis, to plan and own the outcome. The specific objectives of the PRA were to assess the biophysical and socioeconomic conditions of the islands; identify opportunities and constraints confronting the people; and determine appropriate implementation strategies.

7.4.3.2 Focus Group Discussions

680. Focus groups were selected from different categories of people who have direct and indirect stake in the project. The main emphasis was eliciting information through systematically conducted discussions with carefully selected groups. The groups identified for FGDs include, but not limited to: Island / Atoll / Provincial Officers; Members of Women Development Committee; Members of Island

Development Committee; School teachers; Student groups; Business people; Members of CBOs; and community members representing different age groups, social and economic status.

681. A checklist including the themes was prepared for the FGD. The list of questions identified in the FGD covered the following, but were not limited to:

- Importance of passenger harbor to the island
- Uniqueness of the island
- Investments/projects of the island
- Social and economic descriptions of the island
- Risk if any envisaged from the harbor development

7.4.3.3 Key Informant Interviews

682. Key Informants Interviews (KII) was another qualitative data collection method in this survey. This method was used to gather information from key individuals under conditions where a formal questionnaire was not appropriate. Key informant interviews sought out data from individuals having special knowledge on a topic of interest.

683. Key Informants was selected from the beneficiaries of the target community. In selecting members for KIIs due recognition was given gender and educational and other social differences of each of the above users. All effort was given to select most suitable, impartial and knowledgeable of possible members chosen for the KII's. A total of 5 Key Informants was identified for KIIs. Among other issues, KII helped to understand historical event and community perceptions on the following:

- Perceptions of community on expansion of harbor;
- Risks and challenges faced due to existing harbor;
- Potential benefits of having a passenger harbor;
- Qualitative feedback on available options; and
- Willingness of community to contribute to the development of the island.

7.4.4 Findings of Public Consultation

684. In general, there was a consensus among all the participants of the consultations that the development and expansion of the harbor would bring in economic prospective to the island and region. As other islands depend on Kulhudhuffushi as a business hub, the scale of business will increase when people gain confidence on the investments and a reliable transport system between inter-islands in the region is the key to this confidence. There were also concerns that Kulhudhuffushi Ports Limited is not being operated to its full capacity. The detailed findings from the public consultation with various groups is attached in annex D of this report.

7.4.4.1 Project Awareness

685. In all stakeholder consultations the participants stated that they were aware of the harbor expansion and redevelopment project by the Ministry of Housing and Infrastructure. There was a huge media coverage of the project since the promise of the harbor expansion was a promise made during an election campaign of the current Government according to the locals.

686. At the beginning of each consultative meeting, an overall brief of the project was provided to various groups. Impacts, both negative and positive, that are common with any infrastructure development program acquiring land were discussed with the stakeholders. People interacted with interest to learn about the project and shared their views as well.

7.4.4.2 Plan for Further Consultation in the Project

687. Several additional rounds of public consultations will be carried out during the Environmental Impact Assessment report development stages of the project. During the bi-annual and annual monitoring and evaluation, consultations will be carried out. The engineering details of the harbor will also be shared with the Council and community, and regular progress of the project development will be shared. Consultation and focus group discussions should be conducted with the vulnerable groups like women, youth groups and nearby islands to ensure that the vulnerable groups understand the process and their needs are specifically taken into consideration.

7.4.5 Performance Indicators and Monitoring System

688. Monitoring and evaluation (M&E) is vital to ensure that the project implementation is run in the expected manner. The main purpose of the M&E is to ensure the proposed activities of the project are carried out with caution and appropriate measures are taken for the social safeguards of the beneficiaries and integrity of the proposed site and areas in proximity to the site. The following M&E mechanism is proposed to help assess the progress of project implementation over an implementation schedule with target times for completion of target activities in order to achieve the objectives of the project.

7.4.5.1 Performance Indicators Monitoring

689. Monitoring and evaluation for the development of the passenger harbor would be carried out for assessing progress of both physical and financial targets of the project. This would be done on a regular basis as per the monitoring mechanism and schedule proposed for the Environmental Impact Assessment report and the Social and Poverty Impact Assessment Report. For the purpose of this report, the set of monitoring indicators proposed below are to monitor the social safeguards and poverty improvement of the project corridor.

7.4.5.2 Economic Growth

690. Increase in marine traffic volume offer opportunities to increase in marine transport business and ease in island to island passenger ferry network and transporting of cargo leading to overall economic development of the region.

691. Change in traffic pattern to a reliable and safe routinized scheduled reflects peoples' attitude towards social harmony and a development towards such a direction is an important indication of prosperity.

692. Increase in the reliable supply of the agricultural products from local islands in the region to Sunday Market in Kulhudhuffushi would provide opportunities for buyers from nearby resorts and other islands to visit to Kulhudhuffushi on Sundays. This would increase the value of the produce and bring in a steady income to the local farmers. This would be an important monitoring indicator of accomplishment of one of the developmental purpose of the passenger harbor in Kulhudhuffushi and that is to increase the economic activity of the area.

693. Re-development of the harbor would increase the fishing sector and would bring in more fishing vessels. This would improve the fishing industry and socio-economic condition of the region.

694. Access to Banking and or credit facilities is another factor which indirectly indicates the increased economic activity where people have access to save their earnings and also access credit including for business needs.

Table 67: Performance Indicators for the Project

Project Impact	Performance Indicator	Frequency
1. Economic Growth	Marine traffic volumes by vehicle type (passenger ferries, cargo ships, safaris, fishing vessels, etc.) Change in traffic patterns by vehicle type Increase in the produce/value/demand of the agriculture product Increase in fishing and value-added fishery products Access to banking/ credit facilities Access to education and health facilities	Bi-annually
2. Reduction of transport costs	Change in passenger fares Change in cargo freight rates Changes in average travel time (min) Changes in marine vessel operating costs	Annually
3. Improved access to social service	Number of visitors to Kulhudhuffushi on Sunday Market day Number of visitors to Regional Hospital Number of off-island students residing in Kulhudhuffushi Increase in migration to Kulhudhuffushi	Annually
4. Lower poverty in the region	Change in the percentage of families below the poverty line Change in average household income	Annually

6. Local employment generation through passenger harbor project	Employment generation through construction phase and operational phase	Bi-annually
7. Gender status	Health conditions/ Safe delivery Violence against women reduced GDI & GEM Values	Annually

7.4.5.3 Transport Cost

695. Change in passenger fares would indicate low operation cost of vehicles due to regular services and more number of ferries would decrease in families' expenditure on travel.

696. Change in cargo freight rates help small retailers in the island to sell their goods at an affordable rate to the locals.

697. Changes in average travel time (due to the increased number of vessels with bigger vessels) is an important indicator for taking up extra income generation activities and livelihood options.

698. Changes in marine vehicle operating costs would have a direct impact on bearing capacity.

7.4.5.4 Access to Public and Social Services

699. With regular passenger cargo and ferry services, the number of local farmers and buyers visiting to Kulhudhuffushi for Sunday Agricultural Market would increase.

700. A regular ferry network would also bring in more visitor seeking much specialized medical attention than offered in their respective islands to visit Kulhudhuffushi Regional Hospital. This would improve general health and well-being of the region.

701. A regular ferry network would also bring in more students to seek higher secondary education in Kulhudhuffushi, which is otherwise not offered in their island.

702. With improved social services and higher education opportunities, increase in migration from small islands to Kulhudhuffushi would occur and there would arise the need to increase school capacity and also demand for housing will also increase.

7.4.5.5 Poverty Line in the Region

703. Minimizing the poverty in the project area by providing people from near-by islands, the much needed connectivity and access to various regional facilities and social services available in Kulhudhuffushi that would be achieving a major goal of this project especially owing to the fact that half of population of the project corridor are located in remote islands with few services. In order to evaluate poverty in the project area two performance indicators (i) Change in the % of families below the poverty line and (ii) Change in average house hold income have been selected.

7.4.5.6 Local Employment Generation during construction and operational phase

704. During construction of the harbor, it is expected that local population gets the opportunity to apply for work thus increasing the employment generation for construction related activities in the project region. This opportunity would also be available during the operational phase of the harbor. This factor will also contribute towards increasing average household income in these areas.

7.4.5.7 Gender Status

705. The improvement in the status of gender related issues is also an important factor that needs attention as it will reflect the condition of women in the study area. The improvement in status of women will also results in the overall growth of the region. Hence to quantify the improvement in gender conditions, three indicators have been selected: health conditions/ safe delivery, decrease in violence against women and GDI and GEM improved.

7.4.5.8 Evaluation System

706. Regular and timely evaluation would help in assessing whether the project implementation is being done along the right track and would have a check and balance system that ensures the expected targets are being achieved. The process of evaluation would be carried out twice a year for some indicators while once a year for the remaining indicators.

707. With concept of evaluating major social and environmental impacts of the Kulhudhuffushi harbor development project, the above social impact assessment indicators have been picked out. These performance indicators have to be carefully evaluated in order to get maximum idea about the influence of the development of the harbor project on the livelihood of people living in the project influence area.

7.5 Social Due Diligence Report (SDDR)

7.5.1 Background and Objectives of the SDDR

708. The GoM plans to develop Kulhudhuffushi as an urban center in the development plans and a new harbor with the above facilities would help in achieving the government objective of developing urban centers to a standard that would cater for a target population of 50,000. The construction of a new passenger harbor will be an added advantage to the accessibility of services such as housing, education, health, ease of access to fishing grounds and contribute to small and medium enterprise development.

709. The allocated area for Kulhudhuffushi new passenger harbor area and harbor associated facilities are attached in the figure below. The landuse plan is shown in Figure 1 in this Report.

710. The objective of the Social Due Diligence Report (SDDR) is to confirm that the project does not trigger ADB's Safeguard Policy Statement (2009)'s Safeguard Requirements 2 regarding involuntary resettlement or Safeguard Requirement 3 regarding indigenous peoples. In addition, that the respective stakeholders to allow the issuance of "no objection" for the award of civil works contract for the construction of project components in Kulhudhuffushi.

711. Specifically, the SDDR will (i) determine whether the development of harbor project is free of any involuntary resettlement impacts, e.g., land acquisition, displacement, and (ii) ascertain if there would be any adverse impacts on income and livelihood of indigenous people.

712. The SDDR also details the consultation process where the Grievance Redress Process was discussed with people living along the project corridor. The field visit was undertaken by the Project Preparatory Technical Assistance (PPTA) team's safeguard specialist on 26-29 December 2015.

7.5.2 Methodology of Social Due Diligence

713. Special public consultations were arranged in Kulhudhuffushi with members of the community from youth groups to women's groups, NGOs, Women's Development Committee, School administration and teachers, bank officials, entrepreneurs, business owners and members from Kulhudhuffushi Island Council. As part of the consultation primary and secondary stakeholders of the project were identified. A list of these stakeholders are presented in Annex D.

714. The consultations focused on impacts on community buildings and lands as well temporary disruption of livelihood if any from the proposed harbor development.

715. During public consultations, information of project was explained by the representatives of MHI. Grievance Redress Mechanism was explained in local language (Dhivehi) along with list (names, address and contact numbers) of key persons at MHI to be contacted in case of a grievance.

7.5.3 The Proposed Work

716. The proposed project includes two main components: (i) a Passenger/Cargo Harbor Component (ii) a Waterfront Small Craft Zone component and Harbor separation wall, and (iii) reclamations of Area 1 and Area 2 as described in Chapter 3 of this Report.

717. The areas where the Passenger/Cargo harbor and waterfront craft zone are to be developed in already allocated for expansion of the existing harbor in the land-use plan of Kulhudhuffushi. There is currently no agricultural activity or housing on this area, except as a recreational area by community for hang-outs.

7.5.4 Potential Safeguard Issues

7.5.4.1 Land Acquisition and Resettlement

718. As the island has a land-use plan and the area for the harbor area has been already allocated for that purpose, it is concluded that no resettlement issues have been identified or are expected. The details are presented as below:

- Separate areas are allocated for industrial and commercial uses in Kulhudhuffushi, separating it from the residential areas.
- In Kulhudhuffushi the land use plan for the waterfront area allows sufficient space for the development of the passenger harbor. The project area does not have any households or any privately owned land. In view of the above, it is clear that there is no need for a resettlement plan for this project.

7.5.4.2 Indigenous Peoples

719. The population of Maldives is ethnically homogenous (Mayall, 2010) and there are no "indigenous minority" groups in Kulhudhuffushi, who would be affected by the project. In view of this, it is clear that there is no need to evaluate any impact on indigenous people or any grievance would arise from indigenous people.

7.5.5 Grievance Redress Mechanism

720. To establish Grievance Redress Machanism (GRM) within project, a temporary "Grievance Redress Committees" made up of key officials from the project implementation unit of MHI have been established and their names and contact numbers have been provided to the Kulhudhuffushi Island Council and community members. The Consultant suggests this committee would be merged with the Environmental proposed GRM so that a single committee can address both social and environmental girvances.

7.6 CONCLUSIONS

721. The proposed project of developing a passenger harbor in Kulhudhuffushi is aimed improving the connectivity in the Northern Region of the Maldives. The overall objective of the proposed passenger harbor is to bring about inclusive socio-economic benefits to the inhabitants of Kulhudhuffushi and the Northern region as a whole through improving the island's connectivity to regional and national markets and promoting local and visiting populations' accessibility to key services.

722. With its main objective of relating transport sector development and poverty reduction with a reflection on ADB approach to poverty reduction in the region, a PSA study was carried out through intensive survey of the project area and various

consultations with different stakeholders. The findings of the study justify the importance of the development of the passenger harbor in Kulhudhuffushi.

723. Transportation is the lifeline of the people of the project area. Due to the fragmented nature of the islands in Maldives, connectivity within the regions needs to be enhanced for the betterment of life of the people living within the region so that they could have better accessibility to basic social services. This study has revealed that transportation and mobility in the region is very much linked with the well-being of the locals and also economic development of the region. Based on our observation, study and public consultations following recommendations are made:

- The development of the passenger harbor should be treated as the tool for social as well as overall development of the surrounding region.
- The passenger harbor project should be designed considering engineering aspects in general and social engineering aspects in particular.
- Not only physical infrastructure but also social infrastructure should be developed along the passenger harbor project. Meaning that along with development of the passenger harbor, skill development & social development programs should be carried out.
- Prior to construction, all the islands within the project corridor should be notified of construction schedule and completion time to instill ownership feeling in them.
- A holistic and integrated approach should be adopted and passenger harbor development should be an integral part of that overall development plan of the particular region or area. It means that in addition to harbor development, other development like improvements of water facilities, sanitation facilities, traveler shed and other social development facilities should be developed.
- People's participation in the passenger harbor construction work at various levels need to be institutionalized.
- In order to link poverty with the project it is necessary that at the construction stage the work relating to petty contracts and unskilled labor should be given to the local population specially the weaker and vulnerable groups so that it makes a dent of the poverty problem and social and economic status of local populace.
- Local labor residing in nearby islands should be encouraged to work in the construction work.
- Contract for petty works like supply of food, water etc. should be given to the local population.
- It is better that if a project of income generation and skill development of women including women headed household is prepared under GAP and implemented to mainstreaming them and addressing the gender issues in particular.

724. The results of the SDDR concludes that, there should be no issues of land acquisition and payment of compensation related to this project. There will be no temporary disruption of livelihood of any group of community in Kulhudhuffushi during construction period. In case any claims or complaints are submitted during the project implementation period, an effective and efficient Grievance Redress Mechanism, being already in place, will enhance provision of timely and sensible hearings and facilitate solutions.

8. ENVIRONMENTAL SAFEGUARDS

The following is a copy of the main report of the EIA submitted to the EPA and ADB separately. The attachments and appendices accompanying this EIA are not included in this Final Report.

8.1 Project Description

725. The project proponent is Government of Maldives. The Ministry of Housing and Infrastructure (MHI) is the Implementing Agency (IA), and the Ministry of Finance and Treasury (MoFT) is the Executing Agency (EA). The project beneficiary is Kulhudhuffushi Council.

726. The proposed project consists of three infrastructure components: Reclamation, Passenger/Cargo harbor, and a Waterfront Small Craft Zone including a separation wall. In addition, there are a number of superstructure and ancillary facilities planned in this project. These structure and facilities are located in an artificially created shoreline and shallow lagoon between Kulhudhuffushi port (South end) and existing harbor (North end).

727. A full description of the project's components is provided in Chapter 3 of this Report along with design drawings in Appendix B.

8.2 Scope and Objectives

728. A major milestone of this PPTA is to ensure environmental safeguards policy of ADB is inherent to project preparatory works, construction and operation works. In addressing the project's environmental and social impact, the methodology and process of assessment was carried out in accordance to ADB environmental guidelines and ADB Safeguard Policy Statement (SPS) and GoM's policies on environment and social safeguards.

729. In accordance to ADBs environmental safeguard Policy and relevant guidelines, this project has been classified as Category A project. Hence, the project environmental impacts have been screened through a Rapid Environmental Assessment (REA) screening available from ADB; which the affirmed the requirement for a category A EIA.

730. In addition, ADB's safeguards requiring a *Category A* EIA, the regulations of Maldives also require projects similar to this one to prepare an EIA report and environmental decision made through a Decision Note (DN) issued by the Environmental Protection Agency (EPA). Developers of such projects are required to carry out EIA studies under the Environmental Act of Maldives. The developer is required to obtain approval of EPA prior to the implementation of any development activities related to this project.

731. A Scoping Application to EIA with a draft terms of reference were prepared by the Consultant with support from ADB's environmental Safeguards officer assigned to this project. The final ToR for the project was issues by the EPA on 27th December 2015. A copy of the ToR is given in Appendix F.

8.3 Project Setting

8.3.1 National Policies and Guidelines

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

732. Environmental protection Act came has a framework law to managing all environmental issues soon after ratification of Convention of Biological Diversity in 1993. Under this Law the most significance component is preparation of environmental impact assessment for all development projects that could have a significant impact on natural environment. Clause 5a states that an impact assessment study shall be submitted to the Ministry of Environment, Energy and Water before implementing any development project that may have a potentially detrimental impact on the environment. Therefore, Clause 5 is of specific relevance to this EIA. The EIA Regulations, which came into force in May 2012 has been developed by the powers vested by the above umbrella law. This EIA has also been prepared as per this regulation.

8.3.1.2 The National Solid Waste Management Policy

733. The National Solid Waste Management Policy (NSWMP) was developed in 2008 in order to address solid waste management issues in the Maldives and thereby create a healthier environment. This policy was developed through participatory consultations with island communities and extensive research that led to a set of strategic and governance principles that reflected the universally accepted practices. This includes establish a governance structure for solid waste management which will distribute and establish clearly delineated roles and responsibilities for solid waste management at island, regional and national levels. This imposes all waste producers have a duty to manage the waste they produce. Waste will be managed and disposed as close as possible to the place of their generation.

734. Development of a waste management system to accommodate the specific requirements of special wastes based on verifiable facts and known effective

strategies that are financially viable is also part of the strategy. Financial incentives and disincentives will be pursued to support goo d waste management practices. Goods that are harmful to the environment or cause public nuisances and unacceptable waste activities will be discouraged. The community participation and awareness about good waste management practices will maximized through this policy. In order to achieve this a Solid waste management regulation was developed and became effective in 2010.

8.3.1.3 Solid Waste Management Regulation

735. The Solid Waste Management Regulation which is pertinent to the proposed project, was drafted by the Ministry of Housing and Environment in 2010 with the aim of implementing the National Solid Waste Management Policy formulated in 2008. The administrating authority for the regulation has been identified as the Environmental Protection Agency at the national level and island/city councils at the provincial level. Implementation of the Solid Waste Management Regulation will aid to protect the environment through:

- Minimizing the impact of waste on the environment including, in particular the impact of waste so far as it directly affects human health;
- Establishing an integrated framework for minimizing and managing waste in a sustainable manner; and
- Put in place uniform measures to seek to reduce the amount of waste that is generated, and where waste is generated, to ensure that waste is reused, recycled and recovered in an environmentally sound manner before being safely treated and disposed.

736. Parts II, III, IV and V of the Regulation provide detailed clauses on the following in the respective order:

- Part II – Waste management measures: this part highlights detailed clauses on waste management standards and plans, declaration of priority wastes, extended producer responsibility, prohibition of unauthorized disposal of waste, littering, collection containers in public places, waste collection at sea and waste collection facilities at ports, reduction, reuse, recycling and recovery of waste, waste management activities list and restrictions on provision of waste management services.
- Part III – Waste Management Licenses: this part gives detailed clauses on waste management licenses, license periods and licensing requirements, standards to be observed by licensees, bundling of services and transferring or surrender of license, waste management license fees and how to charge the relevant fees, financial securities and the license register.
- Part IV – Transportation of waste: this part gives detailed clauses on duties of persons transporting waste and duties of receivers of waste, export and trans-boundary transportation of hazardous waste, transportation of waste from one island to another and accidents at sea.
- Part V – Monitoring, Inspection, Auditing and Enforcement: this part gives detailed clauses on duty to furnish information and duty to report, notice from

the Administrating Authority requiring a review of activities carried out under a license, revocation of a license, defrayal of Administrating Authority costs, register of fines and administrative actions, Inspectors, establishment of a national waste information system and National waste management status reports.

737. The regulation was gazette in August 2013 and became effective in January 2014 under authority of the Environmental Protection Agency.

8.3.1.4 Solid Waste Management Regulation

738. The guideline suggests specific values of the maximum concentration that can be tolerated for each parameter potentially present in the wastewater. The values must not be exceeded when treated wastewater is released into surface water, ground water or into deep sea. According to this guideline, these values should be used in line with Environmental Impact Assessments and Clean Production Protocols to finalize the license for the discharge of specific wastewater.

739. The guideline covers combined domestic and industrial water requirements for deep sea discharge. According to this, no trade effluents will be accepted for discharge into deep-sea outfall unless:

- The industry has proven to government that it is following best international Clean Production practice
- An Environmental Impact Assessment has been submitted, and
- The trade effluent complies with the following conditions:
- The effluents should have a pH in the range 5 - 9.5;
- Temperature no more than 44 Degree Celsius;
- Total Suspended Solids up to 150 mg/l.

740. Frequent monitoring of the receiving body is required on a regular basis to ensure the parameters above mentioned are within acceptable levels.

741. The project developer and contractor shall follow this guideline in the handling and disposal of effluents from the operation of batching plants and other sources of wastewater from construction and operation of the project.

8.3.1.5 Third National Environment Action Plans (2009 – 2013)

742. The proposed project is expected to provide a learning experience in terms of effectiveness of the use of EIA as a planning instrument and appropriate monitoring for which specific focus is laid in Objective 24.1 of NEAP 3 (Ministry of Housing, Transport and Environment, 2009).

8.3.1.6 National Biodiversity Strategy and Action Plan (NBSAP)

743. In implementing the proposed project activities, due care has to be taken to ensure that the national biodiversity strategies are adhered to. To adhere, surveys were undertaken as part of the EIA to find out if biological resources of value and protected nature are affected by implementing any component of the project.

8.3.1.7 Guidelines for Land-use Planning

744. This guideline outlines the relevant elements of land allocation and how it should be allocated in inhabited islands. The entire regulation is referenced.

8.3.1.8 Dredging and Reclamation Regulation

745. Dredging and permit can be given. Clause 7 discusses the types of situations in which dredging and reclamation can be undertaken.

746. Clause 11 outlines the criteria's to be utilized during dredging and reclamation.

747. Clause 13 outlines the details conditions to be met in a borrow area. This includes, minimum buffer zone between the reef line, shore lines and also buffer zones around reef. Clause 14 outlines the dredge spoil disposal methods and its use.

748. Clause 15 outlines the maximum area for dredging. Clause 16 outlines the maximum area for reclamation.

8.3.2 ADB's Safeguard Policies

749. The operational policies of ADB includes 3 safeguard policies: the involuntary Resettlement policy (1995), the policy on indigenous people (1998) and the environment policy (2002). Safeguard policies are generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. All 3 safeguard policies involve a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle. The safeguard policies require that (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse impacts are developed and implemented; and (iii) affected people are informed and consulted during project preparation and implementation. The policies apply to all ADB-financed projects and to all project components.

750. Due to the nature and extent of this project and applying safeguard standards the project has been classified as category A project. Category A refers to proposed projects if it is likely to have a significant adverse environmental impact that are irreversible, diverse or unprecedented. These impacts may affect an area larger than the site for facilities subjected to physical work. In this case an environmental impact assessment is required.

8.3.3 International Conventions and Agreements

751. The Maldives has signed and ratified several international conventions that is relevant to protection and preservation of the environment. This include protection of biodiversity, climate change mitigation and adaptation and environmental pollution. Table 68 provide a list of relevant environmental governance oriented international conventions. The GoM has ratified UNFCCC and associated protocols, and convention concerning protection of the world cultural and natural heritage, the convention on biological diversity and the convention of Law of the sea. In addition, the Maldives is also party to IMO Marine Pollution (MARPOL) convention and other maritime regulations (see also Table 61). The GoM has certain obligation under ratification of these convention and local legal and regulatory instruments has to incorporate relevant components of these conventions into national environmental management. Several regulations have already been formulated to address these.

Table 68: International Conventions relevant to this project signed and ratified by the GoM

Convention/Agreement	**Date of Ratification/ Accession (a) Acceptance (A)**
Vienna Convention for the Protection of the Ozone Layer Vienna, 22 March 1985.	26 Apr 1988 (a)
Montreal Protocol on Substances that Deplete the Ozone Layer *Montreal, 16 September 1987*	16 May 1989
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *London, 29 June 1990.*	31 Jul 1993 (a)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *Copenhagen, 25 November 1992.*	27 Sep 2001 (A)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer adopted by the Ninth Meeting of the Parties *Montreal, 17 September 1997.*	27 Sep 2001 (A)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *Beijing, 3 December 1999.*	3 Sep 2002 (a)
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal *Basel, 22 March 1989.*	28 Apr 1992 (a)
United Nations Framework Convention on Climate Change *New York, 9 May 1992.*	9 Nov 1992
Kyoto Protocol to the United Nations Framework Convention on Climate Change *Kyoto, 11 December 1997.*	28 Mar 2002
Convention on biological diversity *Rio de Janeiro, 5 June 1992.*	9 Nov 1992
Cartagena Protocol on Biosafety to the Convention on Biological Diversity *Montreal, 29 January 2000.*	3 Sep 2002 (a)
Convention Concerning the Protection of the World Cultural and Natural Heritage, *23 November 1972*	22 May 1986
Stockholm Convention on Persistent Organic Pollutants *Stockholm, 22 May 2001*	17 Oct 2006 (a)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam 10 Sep 1998	17 Oct 2006 (a)
United Nations Framework Convention on Law of the Sea	7 Sep 2000

8.4 Methodology

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

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

753. Information on existing environment was collected during the field visit to the project site from 12 till 15 January 2015. Additional information for the project was collected during various filed visits to the site by the consultants' team. General information on the existing environment was based on available secondary data, such as climatic data from Hanimaadhoo Meteorological Centre (nearest meteorological information center to Kulhudhuffushi. Oceanographic data and information used to determine the current patterns around the island were also based on monsoonal wind patterns, wind generated waves, tidal flushing, geographic setting, the topography of the lagoon and shape of the shoreline. Wave and tide data collected from the project site during January 2016 site visit.

8.4.1 Physical Surveys

8.4.1.1 Shoreline Survey

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

8.4.1.2 Beach Profiles

755. A total of 7 beach profiles were taken in the area proposed for development using an electronic level instrument. Locations where beach profiles were taken is shown in Table 69 and Appendix 13. The starting points of the profiles were fixed using Topcon HiperII GPS system (±10 millimeter accuracy). These data were compared with previous beach profiles taken on the same locations in order to have an understanding of the impact of beach sediment movement in the area for proposed development. This area is not part of the natural shoreline (reclaimed shoreline in 2010) and therefore should not be taken as natural shoreline changes. This location where beach profiles were taken will be entirely modified. Adjacent areas of the shoreline are heavily modified through various coastal structure;

hence no profiles were taken on either side of the harbor as the project works will not have impact on the shoreline on either side.

Table 69: Location (GPS referenced) of beach profiles

Beach Profiles	Bench mark position (GPS coodinates)
Profile 1	6°37'22.0"N; 73°03'51.5"E
Profile 2	6°37'19.3"N; 73°03'52.4"E
Profile 3	6°37'15.7"N; 73°03'52.9"E
Profile 4	6°37'12.3"N; 73°03'53.2"E
Profile 5	6°37'09.2"N; 73°03'53.8"E
Profile 6	6°37'06.0"N; 73°03'55.0"E
Profile 7	6°37'02.9"N 73°03'56.3"E

8.4.1.3 Wave and Tide

756. Wave and tide data were used for the purpose of understanding general wave and tide condition at from available secondary data that can be applied. This include national tide monitoring data available from National Meteorological Centre. Other relevant data on tides and waves were used where applicable.

8.4.1.4 Surface Currents

757. Current data at reef was collected using drogue method. A precision GPS was attached to a drogue and line feature data was collected at point intervals of 30 seconds. The current speed (surface current) was calculated as a function of distance travelled by drogue per unit time (m/s). The speed measurement was made as meters per second. The final output of drogue data is made using MatLab routine. Drogue data was collected from the West side reef slope and reef flat in the general area for proposed development.

8.4.1.5 Shoreline Changes

758. The island morphology or historical changes were analyzed using images obtained from the Google Earth image archives (images from 2006, 2010 and 2014). shoreline on all the images were traced. The image for the year 2006 was used as a base year image. The movement or the changes of the shoreline line was determined with respect to this baseline. Change in the area enclosed by the vegetation line was used to determine the net change in the area of the island enclosed by the vegetation.

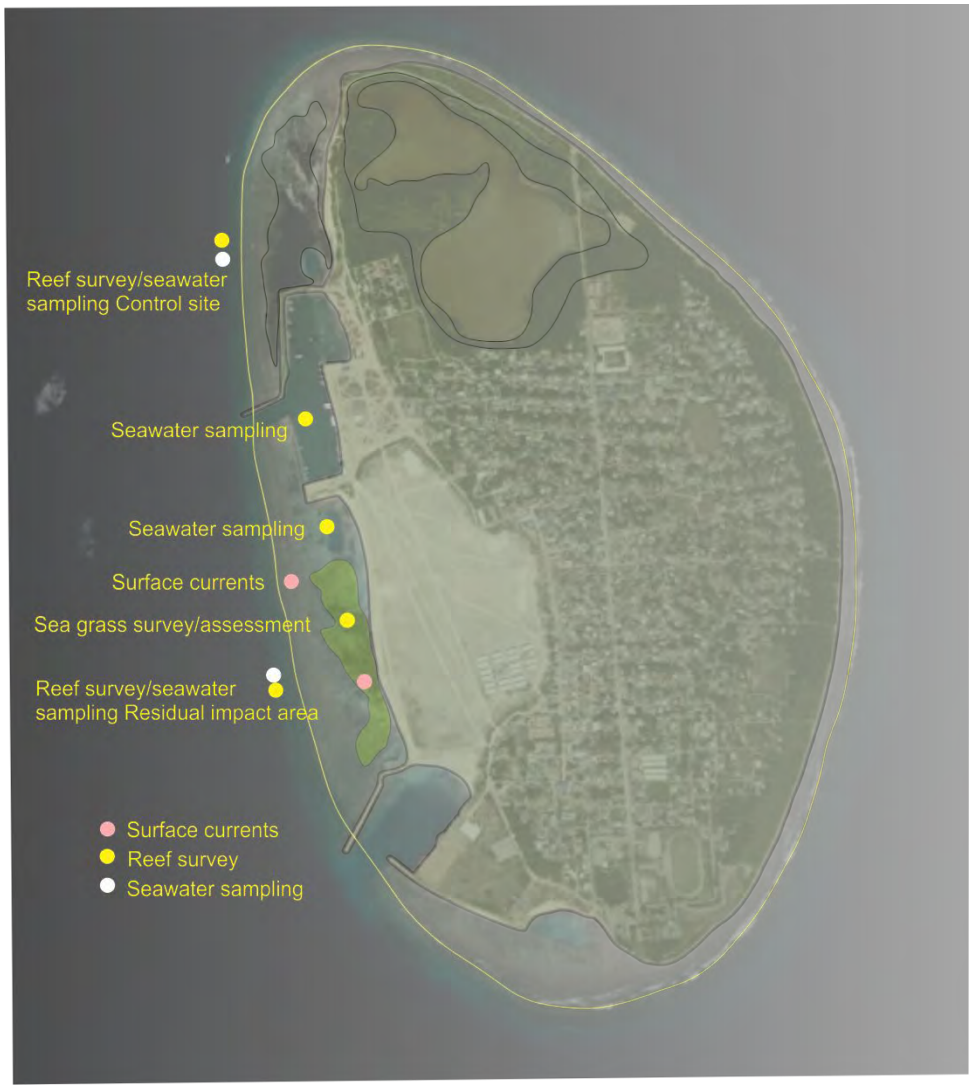
8.4.1.6 Sediment Characteristics

759. Sediment characteristics of the impact area was assessed by sampling upper surface of the sea bottom from the proposed area for development. 12 sediment samples from three transects perpendicular to the beach from beach to 150 m off shore location were taken and analyzed for gain size. The location of sediment samples is given in Figure 37.

8.4.1.7 Marine Survey

760. A 200-meter long and 5-meter belt transect area was chosen at each survey site. An underwater camera with housing was used to take a series of photographs for assessing reef benthic community at 2 sites, 2 depths (5 m and 10 m depths). Several photo quadrats (1m by 1m) were taken along 200 by 5 m belt transect at each site at these two depths 40 randomly selected photo quadrats were used to assess reef benthic community by determining percentage of various benthic substrate (categories) using standard benthic categories for coral reef benthic substrate sampling as described by English et. al., 1997. As a subset of benthic community, corals were grouped into their taxonomic level as general. Where identification enabled coral were also identified to species level, with specific reference to Endangered Species as classified by IUCN Red list.

Figure 37. Reef survey (R- quantitative, Q- qualitative), seawater sampling (SW) and sediment sampling locations



761. The ecological setting of sites R1, R2 and will act as a baseline for future reef monitoring (Figure 37 and Table 70 for location and GPS coordinates of survey

sites). Coral Point Count with excel extension (CPCe) was used to assess the benthic cover.

Table 70: GPS coordinates of the survey, water sampling locations

Survey locations	GPS coordinates
Reef 2/seawater (control)	6°37'44.4"N; 73°03'41.0"E
Reef 1/seawater (Residual impact area)	6°37'10.2"N; 73°03'45.5"E
Seawater (exisitng harbour basin)	6°37'29.6"N; 73°03'47.2"E
Seawater (nearshorel lagoon)	6°37'18.2"N; 73°03'48.7"E
Sea grass (impact area)	6°37'10.2"N; 73°03'50.6"E

762. The assessment selected fish community was also carried out at the same sites and transects which would also be considered as the reef benthic baseline assessment sites for future monitoring of the impact of the project. Fish abundance surveys were based on visual fish census techniques described in English et. al. (1997).

763. The 200 by 5 m long belt transect area was used to estimate the diversity and abundance of coral reef fish an significant invertebrates that are commonly associated with the reef environment of Maldives. Special reference was given to estimating the numbers of lobsters, giant clams and sea cucumbers as they are of various level of protection for conservation and management locally. In addition to this selected mega fauna such as sharks, napoleon wrasse, sea turtle were also the focus of the assessment. All surveys were carried out by SCUBA.

764. In addition, qualitative assessment of the shallow lagoon (predominantly a sea grass meadow) was also carried out to document the extent and nature of the sea grass community. Major categories of sea grass were identified to their species level. Presence of sea grass associated benthic fauna especially invertebrates were assessed. It is expected that this area will be effected as result of proposed coastal modification through dredging and reclamation. Locations of various surveys including reef survey sites are shown in Figure 37.

8.4.1.8 Water Quality Analysis

765. In order to assess the sea water quality, seawater samples taken from 4 locations (Figure 37 and Table 70 sample location). The samples were also tested for their physical parameters using a multi probe water instrument (Hanna Instrument, HI9828). The samples were analyzed for specific parameters given in TOR.

8.4.2 Socioeconomic Condition

766. The socio economic profile of the project area was assessed and presented through available secondary data on population and major economic activities with particular emphasis on local and regional maritime transport.

8.4.3 Existing Environment

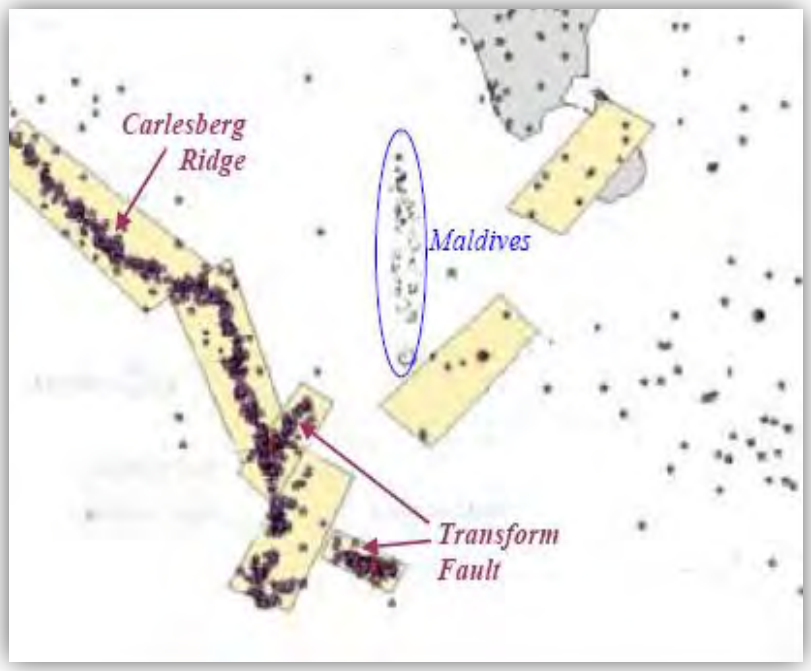
8.4.3.1 General setting

767. The Maldives archipelago is a long double chain of coral atolls formed over the Lacadives-Chagos ridge that runs 1 deg North to 9 deg south along the longitude 73 deg. Maldives is among the only four independent states that comprises entirely of low lying small islands. The 26 geographic atolls that form the country cover an area of 21,373 km^2 over 100,000 km^2 with some 1,200 islands (Naseer and Hatcher, 2004). The land area of all the islands sum up to approximately 300 km^2 with a total coastline length of 644 km. The Maldivian atolls are quite diverse in their shape and size, ranging from circular to elliptical to oval with areas ranging from of 5.4 km^2 to 4219.48 km^2. Channels which run from east to west separate these atolls.

768. Similar to the atolls, the characteristics of the Maldivian islands also greatly vary from the North to the South of the archipelago. While the fringing reefs in the northern atolls are more distinct and discontinuous with smaller islands and numerous patch reefs in the shallower lagoon, the atolls in the south host a large number of continuous reefs of considerable length along its perimeter, with several reefs hosting large islands. The lagoons of the southern atolls are deeper and host fewer patch reefs. The shapes of the islands are also influenced by the climate. Maldives is governed by the Indian Ocean Monsoon climate. As a result, the Maldives experiences a wet season (the southwest monsoon) and a dry season (the northeast monsoon) annually. The strong reversals in the wind regime as a result of monsoon change bring about short term changes in island shorelines by transferring the sand along the shorelines of the islands.

769. Although Maldives is not in a seismically active zone, the Carlsberg Ridge which is a seismically active zone runs along 800 km west of Maldives. This ridge is a slow spreading divergent boundary between the African and the Indian plates. The zig-zag pattern observed at the boundary is associated with the transform faults where the plates are moving horizontally past each other. The earthquake of magnitude 7.5 at the Carlsberg Ridge, in 2003 was experienced by the Maldives. Figure 38 below shows the location of the ridge and the associated transform faults.

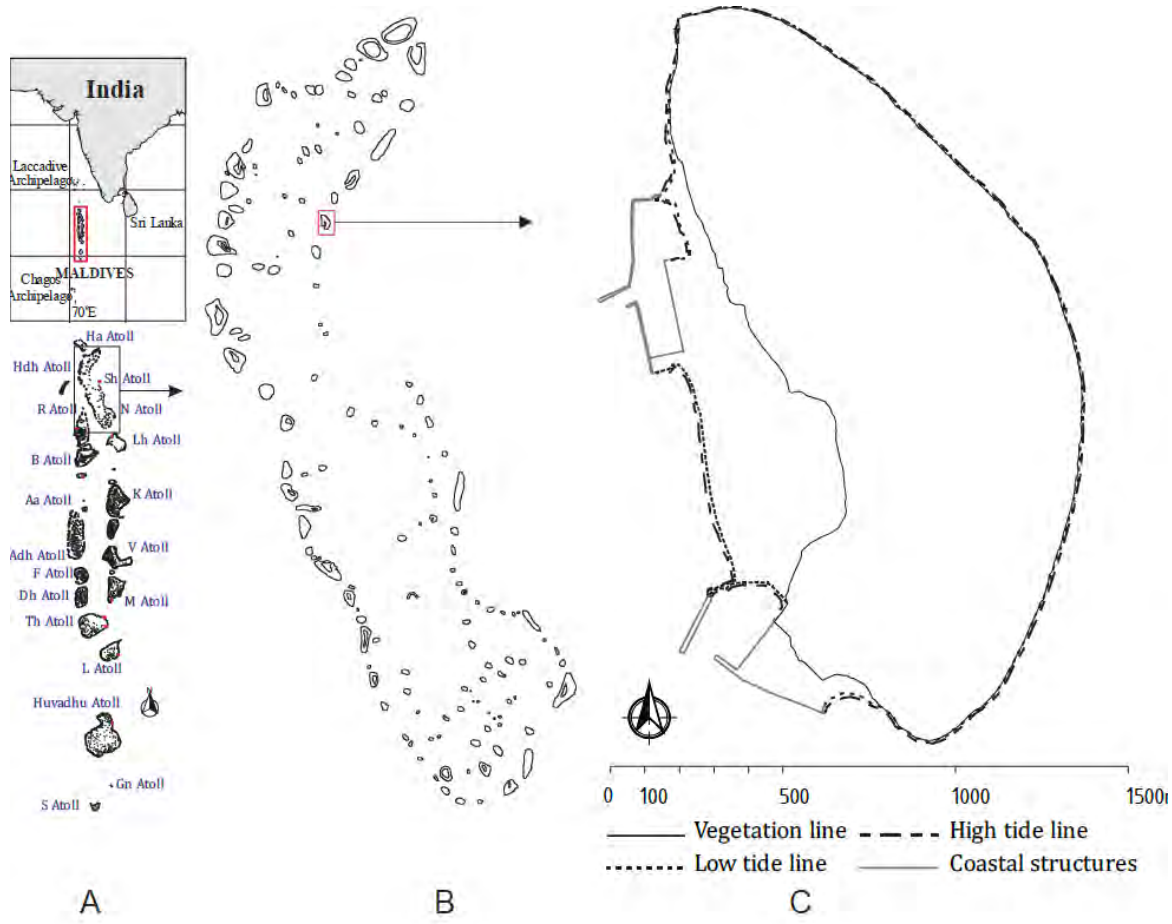
Figure 38 Location of Carlsberg ridge near the Maldives



8.4.3.2 Geographic location and general setting of Kulhudhuffushi

770. Kulhudhuffushi is located on the Eastern side peripheral reef of Thiladhummathi Atoll, at geographic coordinates of N6° 37' 24" and E73° 04' 10" (Official Alas of Maldives, MPND), (Figure 39). For administrative purpose the atoll is also refrerred as Haa Dhaal atoll, the second northern most atoll of Maldives. At is the administrative focal island of Haa dhall atoll. This distance between Kulhudhdhuffushi and Male (capital of Maldives is approximately 275km. It has an area of approximately 235 hectares with an addition of 35 hectares from reclamation of the shallow lagoon on the western side shoreline in 2010. Neibouring inhabited islands on separate peripheral reefs are Nolhivaram and Kumundhoo on the north and south respectively.

Figure 39 Location of Haa Alif Atoll in Maldives (A), location of Kulhudhuffushi within Ha Alif Atoll (B) and an enlarged image of Kulhudhuffushi showing significant shoreline features (C) (Sources: A and B – Thakuru Publishers, C – LaMer and Riyan survey group)



771. As typical of many islands in the North of Maldives, the reef exclusive to the island. The Reef is almost oval in shape, maximum length and width (visible extend) are 2.87 km and 1.78 km respectively. Length and width of island are 2.53 km and 0.9 km. It also has significantly large wetlands (mangrove fringed) on north and south end with a combined area of 33.46 hectares. The island at its geographic setting is exposed to the north east monsoon from the ocean side (east) with strong winds, waves and occasional storms (tropical storm scale) originating from Indian Ocean cyclone belt (UNDP, 2006)

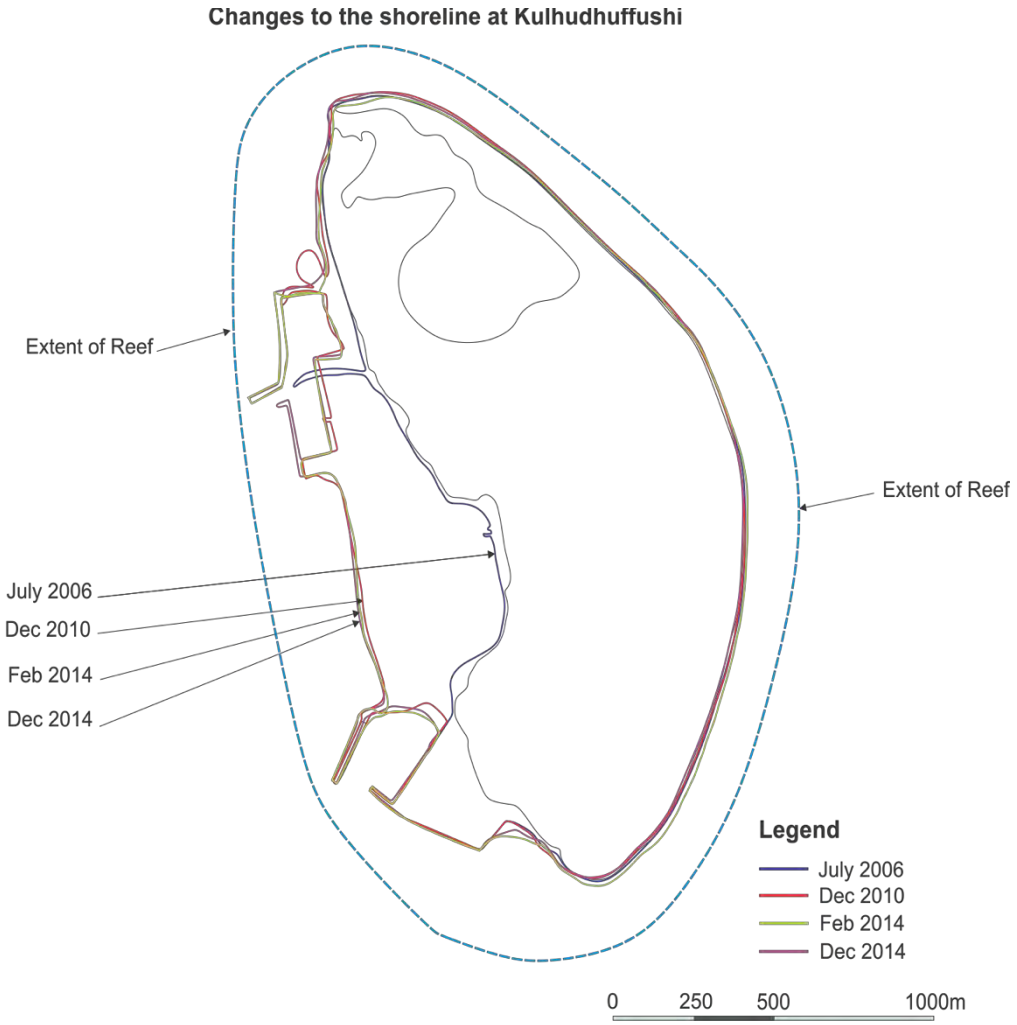
8.4.4 Shoreline Survey

772. A proper physical shoreline survey of the island has not been carried out to have an understanding of changes to shoreline. Satellite and aerial images of the island from 1969 to 2011 showed significant changes to the shoreline on the north end, but minimal change to the south (MEE 2013). This change is somewhat altered doe to construction of port and its coastal structures completed in 2005. The most significant changes to the shoreline came from the excavation works and subsequent surplus dredge spoil associated with local harbor in 2009 and due to large reclamation project that added approximately 28 hectares to the western shoreline.

773. Changes to the shoreline using Google based imagery from 2006 to 2014 are shown in Figure 40. The added land and its artificial shoreline remain exposed to

wave energy and sediment movement. Stabilization of the reclaimed shoreline since 2010 has led to changes and this change has been surveyed in 2013. Subjected portion of the shoreline that will be almost entirely modified has been surveyed as part EIA which include shoreline profiles. Comparison of these profiles to 2013 survey including profiles are shown in Figures 46-52.

Figure 40 Results of shoreline survey compared (EIA based)



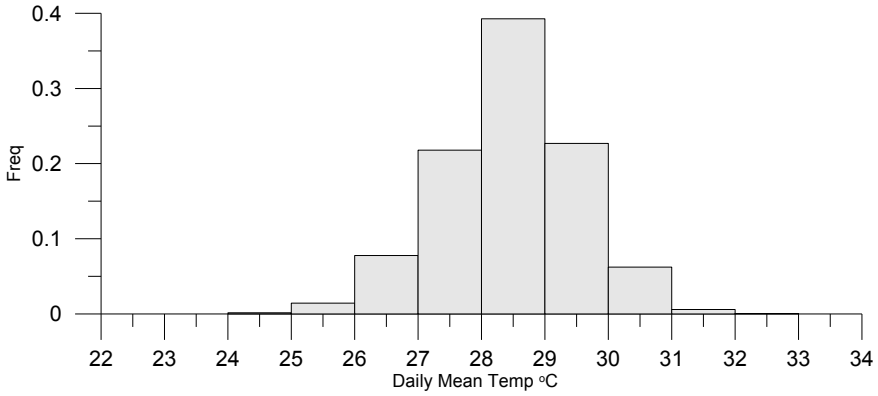
8.4.5 Climatology and oceanography

8.4.5.1 Temperature

774. The Meteorological station at HDh. Hanimaadhoo records temperature on an hourly basis. Data on mean daily temperature was obtained from the station for the period of May 2008 to December 2012. The whole data set was analyzed to obtain a frequency distribution of daily mean temperature for the given period. Results of this analysis are shown in Figure 41, which shows that temperature in the region was most commonly at temperatures between 28C and 29C. The lowest

recorded temperature was at 24.2C while the highest recorded temperature was at 32.5 C.

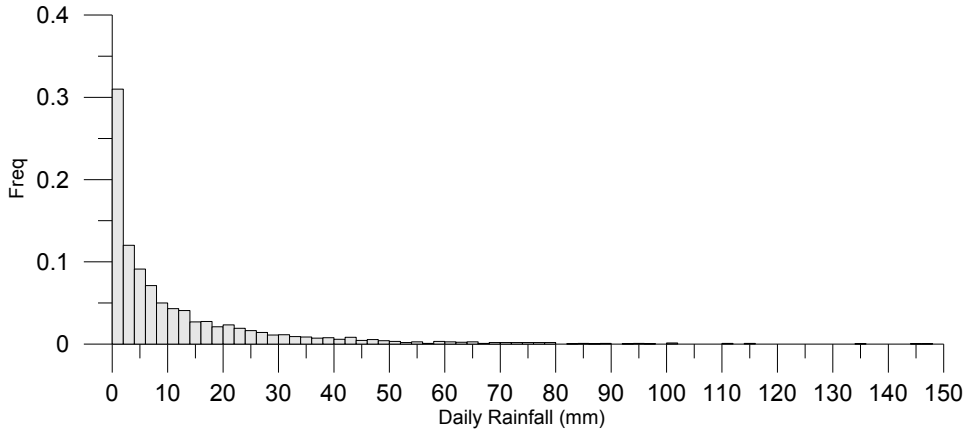
Figure 41. Frequency Distribution of Daily Mean Temperature Recorded at HDh. Hanimaadhoo Station (May 2008 – December 2012)



8.4.5.2 Rainfall Characteristics

775. No site specific rainfall data are available, hence rainfall data for the analysis of the existing environment at Kulhudhuffushi was used as proxy from the Meteorological station at Hanimaadhoo. Figure 42 shows a frequency distribution plot of daily rainfall measurements recorded for the region, for the period between May 2008 and December 2012.

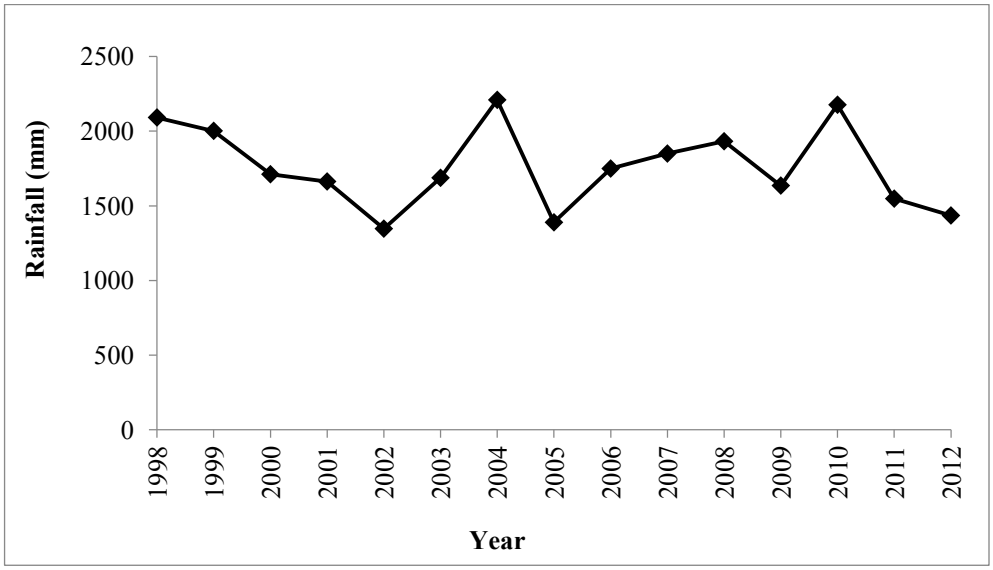
Figure 42. Frequency Distribution of Daily Mean Rainfall Recorded at HDh. Hanimaadhoo Station (May 2008 – December 2012)



776. Daily rainfall exceeding 50 mm can be classified as heavy rain, and as evident from the above figure, this is a rare instance for the region. Most commonly recorded rainfall for the region is between 0 to 2 mm daily, which is seen to occur for about 30% of the year.

777. Figure 43 shows a plot of average annual rainfall for the region, between the years of 1998 and 2012. The average annual rainfall was obtained from the daily rainfall recorded for the region. The highest average annual rainfall was recorded for 2004 at 2209.3mm, while the lowest was recorded at 2002 at 1346.5mm.

Figure 43 Average Annual Rainfall for the 15-year Period between 1998 and 2012



8.4.5.3 Wind Climate

778. Wind climate in the Maldives is dominated by the Indian Ocean monsoon climate, with the SW and North East monsoons. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia (Overpeck et, al., 1996). The monsoon climate is driven by the atmospheric pressure differences that arise as a result of rapid warming or cooling of the Tibetan Plateau relative to the Indian Ocean.

779. During the summer of Northern hemisphere, the Tibetan Plateau warms rapidly relative to the Indian Ocean which results in an atmospheric pressure gradient (Low pressure over Asia and high pressure over the Indian Ocean) between the Asian landmass and the Indian ocean, which drives the prevailing wind from south to westerly directions. The period during which prevailing winds are from south to westerly direction is known as the SW monsoon.

780. In the winter of Northern hemisphere, the continent cools relative to the ocean. This reverses the pressure gradient (low pressure over the Indian Ocean high pressure over the Asian landmass) and the prevailing winds become northeasterly. The period during which prevailing winds are from northeasterly directions is known as NE monsoon. The transitions from NE to SW monsoon and vice versa are distinctly different from SW or NE monsoon. During these transition periods the wind becomes more variable.

781. The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the Hulhangu Halha, while the transition period from SW monsoon to NE monsoon is known as Iruvai Halha. Iruvai halha lasts from October to November (Table 71). The SW monsoon is generally rough and wetter than the NE monsoon. Storms and

gales are infrequent in this part of the world and cyclones do not reach as far south as the Maldivian archipelago (Ministry of Construction and Public Works, 1999).

Table 71: The Four Seasons Experienced in the Maldives

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

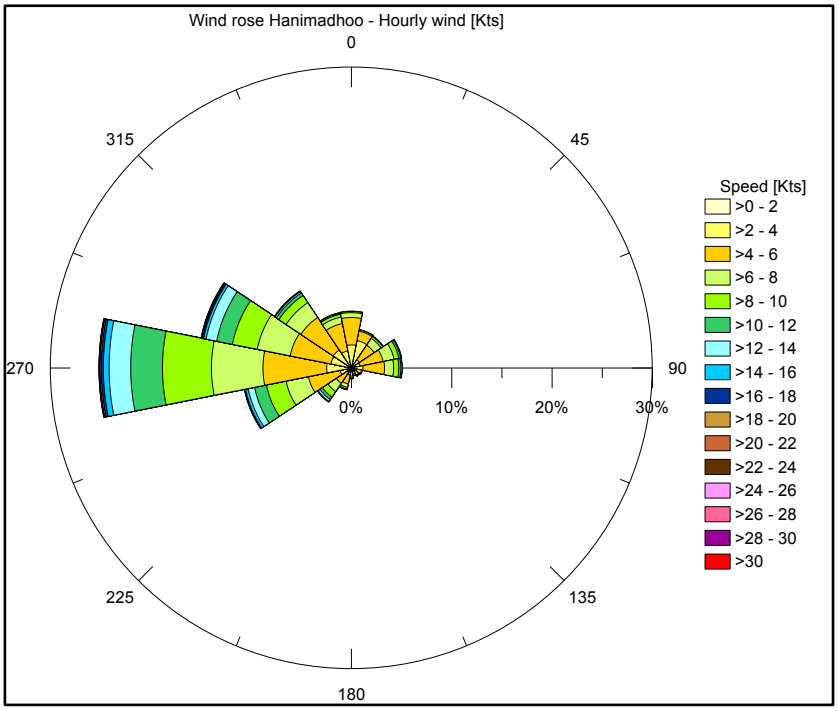
782. Since there were no site specific wind data, wind regime around the island was assumed to be similar to that at the closest meteorological station, which is at HDh. Hanimaadhoo, approximately 30 km north of Kulhudhuffushi. An analysis of the wind climate was done using hourly wind data between the period of May 2008 to December 2012 from Hanimaadhoo meteorological station. In this analysis, wind rose diagram based on wind speed and direction and the frequency of speeds and direction was produced.

783. Wind rose plot (Figure 44) shows that winds from the western quadrant are dominant reaching speeds as high as 30 knots. Winds from the northern and eastern quadrant are less prevalent and with comparatively low speeds. Wind speeds above 18 knots were found to be a rare occurrence, and the instances when it does occur, wind direction was from the western quadrant (Table 72), thus indicating that this was during the SW monsoon, when winds are generally stronger.

Table 72: Hourly Wind Data from Hanimaadhoo Meteorological Station

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

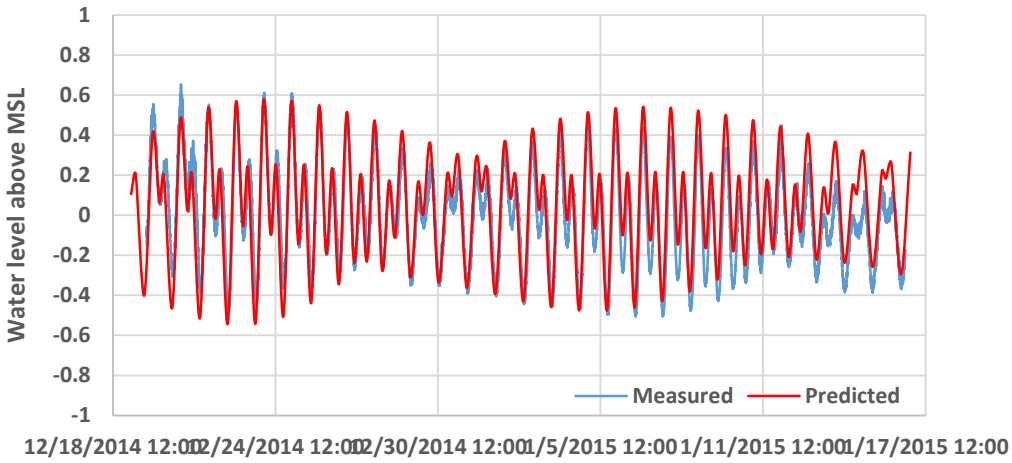
Figure 44 Wind Rose Plot for Hanimaadhoo Meteorological Station, Based on Hourly Wind Data for the Period of May 2008 to December 2012



8.4.5.4 Tide

784. Tides in the Maldives are usually characterized as a mixed tide. It contains two main cycles (diurnal and semi-diurnal tides) per day. Harmonic analysis of the tides represents the period of oscillation of the celestial forcing that gives rise to the respective harmonic (Figure 45).

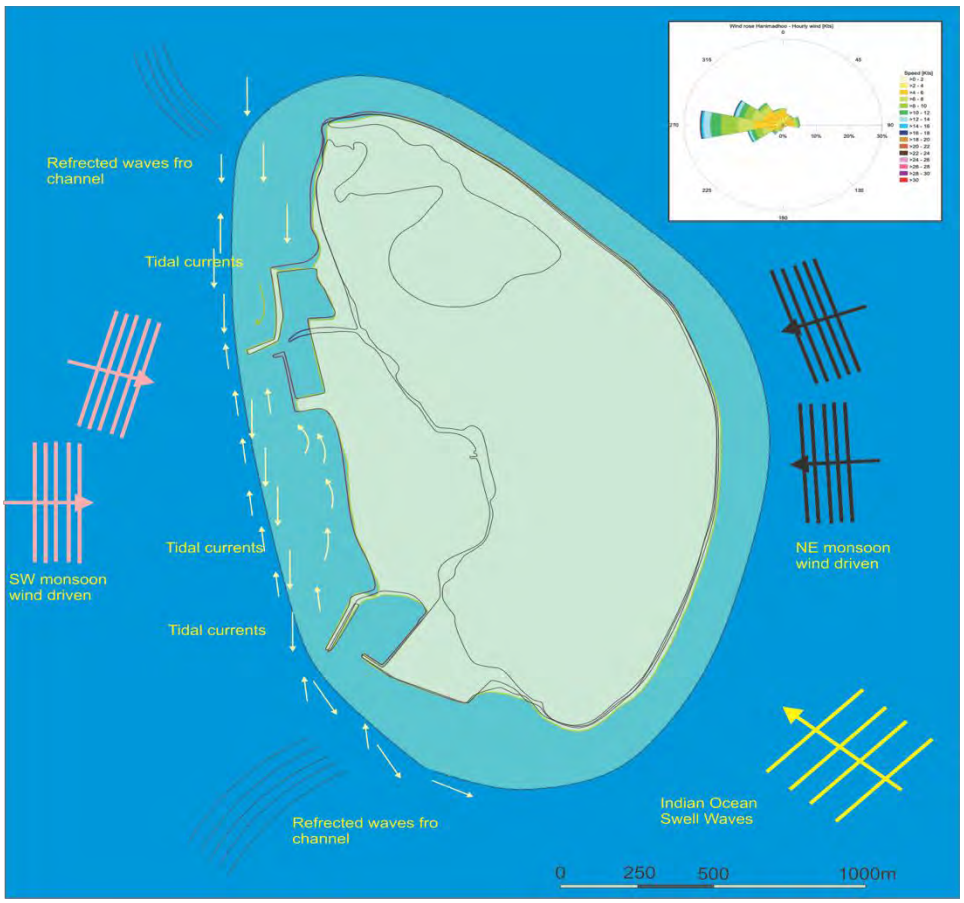
Figure 45: Observed Tide at Nearby Location to Kulhudhuffushi and Predicted Tide for Hanimaadhoo Station



8.4.5.5 Wave

785. The dynamics of wave is an important factor to consider in construction of any offshore structures such as water bungalows, harbors, jetties etc. Waves play a significant role in the modification of the beach environment and the surrounding.

Figure 46: Refraction and Shoaling of Waves from the Atoll Channel Openings Dominating the Waves on the Eastern Side



8.4.5.6 Current

786. Currents play an important role in the movement of the sediment dynamics. The current regimes around the island are mostly governed by the wind, swell and tide. Since there is no local data about the current regime at the location, a GPS tracked drogue was tracked to determine the current regime at the time of field visit. Recorded drogue tracks at western side reef slope and near shore lagoon during the field survey indicated that the currents slow. Currents are mainly along the reef and along the shoreline with average speed of 0.2 m/s and 0.09 m/s respectively both flowing from north to south. The current governed by the wind waves and refracted swells waves from relatively wide channels on either end of the reef. Tidal and wave induced current often increase to speed of 0.3-05 m/s during ebb (receding tide) and flow (incoming tide) especially in channels. However, the magnitude of the current is weak during the time of survey.

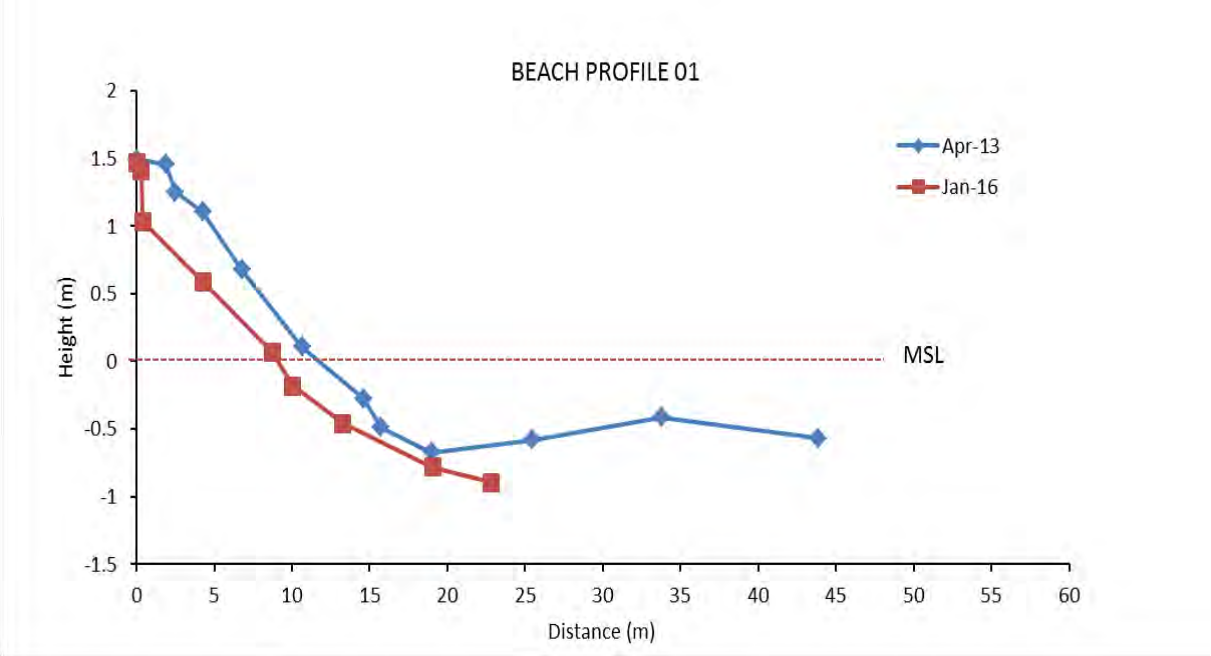
8.4.5.7 Beach environment

787. Beach profiles from 7 locations were taken along the shoreline (artificially created) where the developments are proposed.

788. The existing beach is shaped after a large reclamation works that filled majority of shallow lagoon between regional harbor (KPL) and existing passenger/cargo and fishing harbor. Significant change to the shoreline has been observed when compared with 2013 survey (3 years after reclamation) and that of 2016 (EIA report survey). With groyne effect between two harbors, shoreline appear to be changing with wind generated wave action. Beach profiles compared between 2013 and 2016 for the 7 locations are shown in Figure 47 to Figure 53. The northern end of beach based on the profiles shown a significant decrease in level of beach with respect to MSL (Figure 47). Same profile also indicate that this part of beach has eroded significantly. This may be a seasonal pattern as beach movement is influenced by monsoonal wind and associated near-shore hydrodynamic influence.

789. Similar pattern is observed in the entire northern part of the beach. The central part of the beach appears to accrete due to sediment movement (profile 04 and 05). Similar to northern end of beach the southern end of beach also has eroded compared to 2013. It is however, noted that this change will be stopped to development of proposed structure on the entire stretch of this artificially created beach. With this change the entire shoreline on the western side (almost 2 km) will be modified with terminal groynes, revetments and breakwater constructed. It is therefore not anticipated that natural shoreline on either side of the harbor will change due to changes from proposed activities associated with this project.

Figure 47: Beach Profiles Compared 2013 and 2016 (EIA Field Survey) on the North End of the Beach



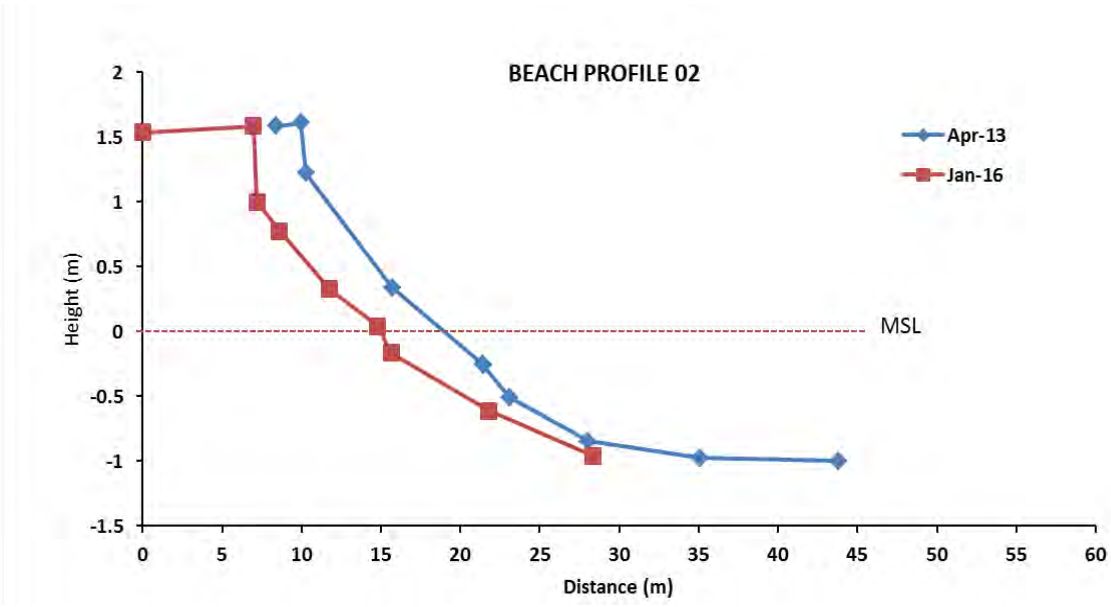


Figure 48 Beach Profiles Compared 2013 and 2016 (EIA Field Survey) on the North Extent of Beach

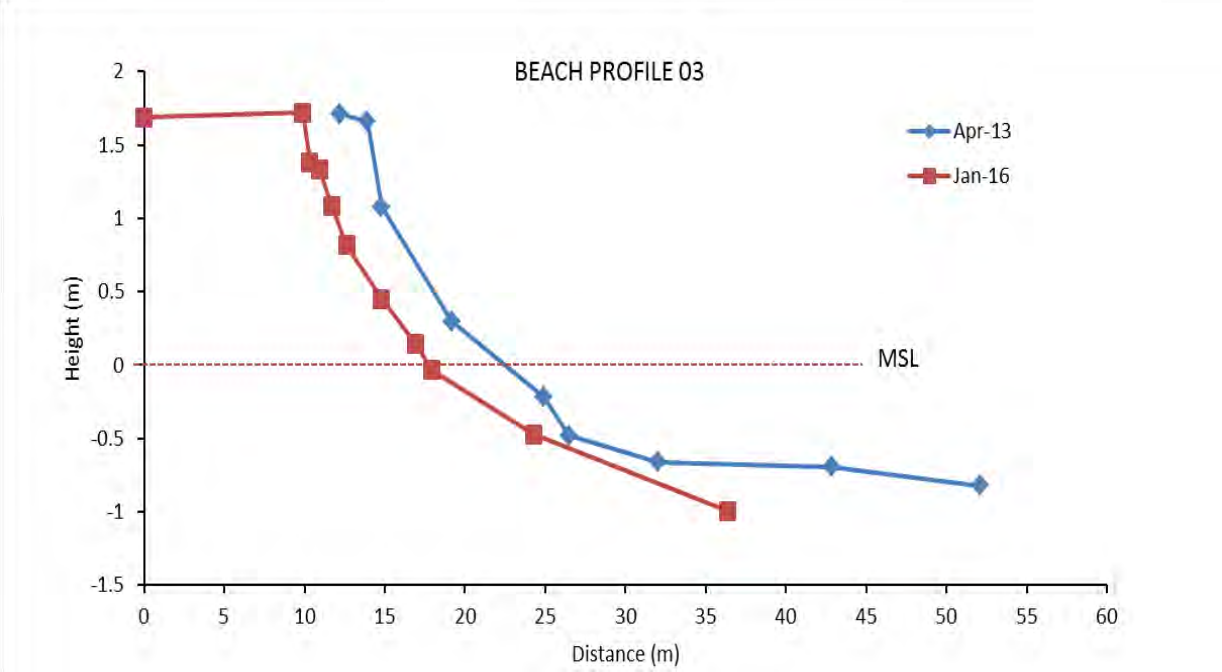


Figure 49 Beach Profiles Compared 2013 and 2016 (EIA field survey) on Central Part of Beach

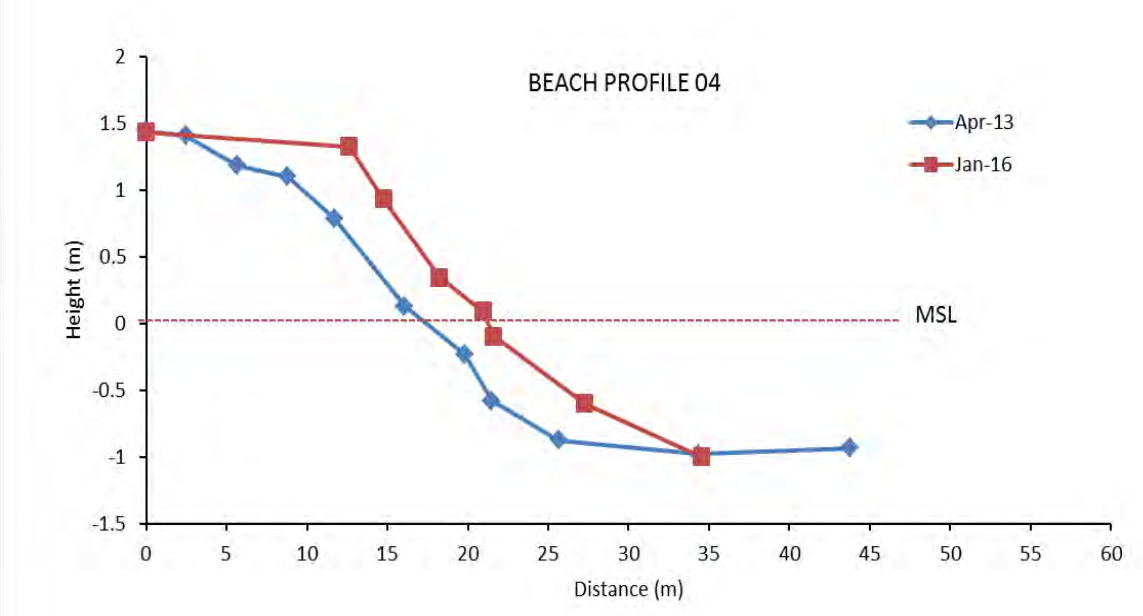


Figure 50 Beach Profiles compared 2013 and 2016 on South-Central Part of Beach

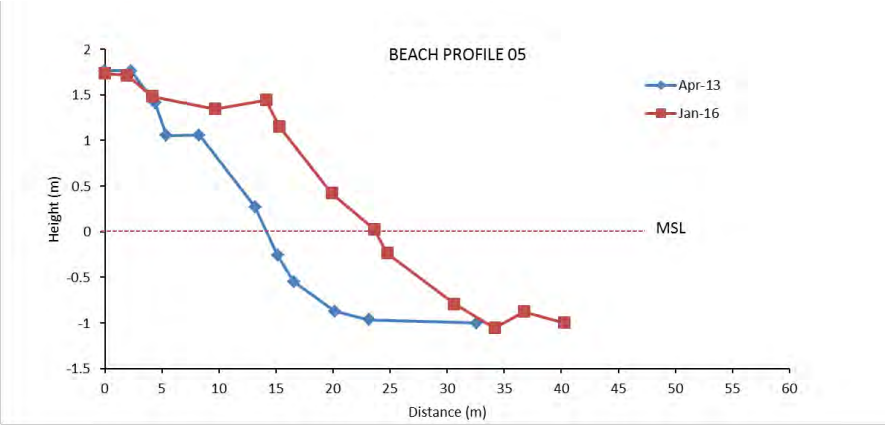


Figure 51 Beach profiles compared 2013 and 2016 on South of Beach

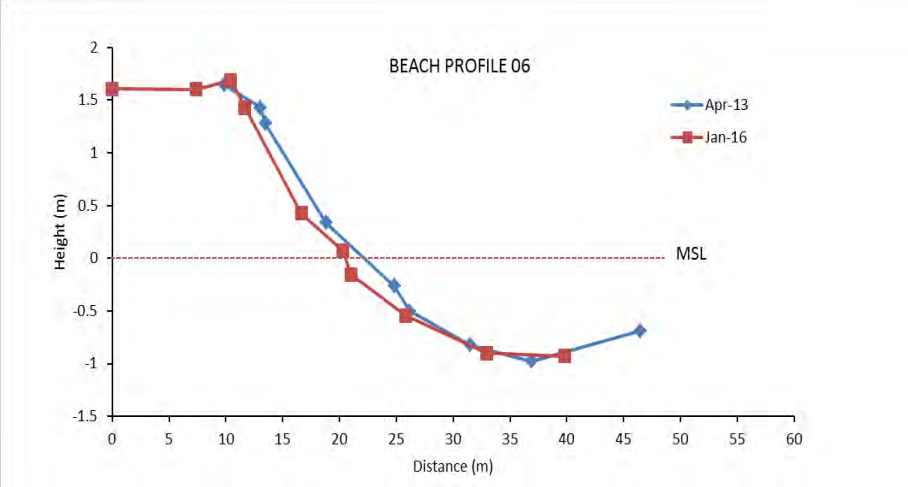
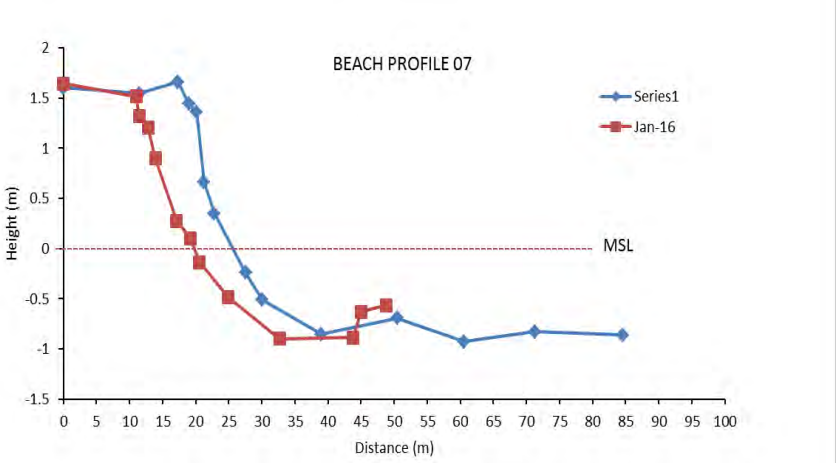


Figure 52 Beach Profiles Compared 2013 and 2016 on South Extent of Beach



8.4.5.8 Sediment Characteristics

790. Natural sediments of Maldives are entirely marine based and calcareous origin since the atolls of Maldives are developed on a oceanic ridge toped with calcium carbonate accreted over several thousand years. Shoreline sediments are this driven from the reef through physical (wave action) and biological (grazing and erosion) breakdown of calcium carbonate based or organisms. Sediments are often characterized by their exposure to environmental forcing, habitat types. Fine sediments where they are present are often settled in and trapped in calm enclosed habitats. According to United States Geological Survey (USGS) sediments are characterized as shown in Table 73.

791. Understanding characteristics of sediments at the proposed project area is important since majority of the civil works associated with the project involves dredging and reclamation. This is particularly important with regard to impact of sediments on adjacent and nearby habitat which may be impacted due to sedimentation and turbidity. Sine sediments especially silt and clay may impact benthic habitats such as coral reefs and sea grass beds.

792. Sediment samples taken from 3 transects across the shore area proposed for dredging. Each transect consists of samples from beach, near-shore, mid-shore and fore-shore within a distance of 150 m from beach to fore-shore sample. Core samples were taken from surface to a depth of 20 cm using an improvised corer fabricated from a PVC pipe. Sieve analysis of samples indicated that over 80% of the samples consist of sand classified as 0.0626 to 2 mm size. Silt and clay (<0.625 mm) was 3% and gravel (> 2 mm) was 13%. Beach sediments at all 3 transects were predominantly sand (> 99%). Silt and clay was highest in near shore samples which ranged between 5-10%. A descriptive summary of characteristic of sediments samples are given in Table 74. Graphical description of the samples from sieve analysis is given in Appendix (sieve analysis data).

793. Sediments were not sampled or their organic contents, presence of heavy metals as it is not specifically required by TOR. Natural sediments are of entirely coral reef calcium carbonate based and hence natural background level of heavy metals would be virtually nil.

Table 73: Sediment classification table (Source: USGS)

Sediment Sizes		
Descrption	**Classification**	**Size (mm)**
Gravel	Boulders	>256
	Cobbles	64-256
	Pebbles	2-64
Sand	Sand	0.0625-2
Silt	Silt	0.002-0.0625
Clay	Clay	<0.002

Table 74: General description of various sediment types with respect sampling zones

Sample position	North shoreline (transect 1)	Mid shoreline (transect 2)	South shoreline (Transect 3)
Beach	Moderately well sorted medium size sand that is skewed towards coarser grain size	Moderately well sorted medium size sand that is skewed towards coarse grain size	Moderately well sorted medium sand skewed towards fine size
Nearshore	Poorly sorted medium size sand that is skewed towards finer grain size	Poorly sorted medium size sand that is skewed towards finer grain size	Well sorted fine sand that has a near symetrical distribution
Mid shore	Poorly sorted granule that is very much skewed towards coaser grain size	Poorly sorted coarse sand that is strongly skewed towards finer grain size	Poorly sorted very coarse sand that is skewed towards coarser size
Foreshore	Poorly sorted pebble that is very much skewed towards coaser grain size	Very poorly sorted granule that is skewed towards coase grain size	Poorly sorted coarse sand that is skewed towards finer grain size

8.4.6 Coastal Characteristics of the Project

794. Coastal features at the project site was assessed along the three transect from where sediment samples were analyzed, starting from reclaimed land across the lagoon to the extent of reef slope. General morphological and benthic substrate features. The extent of sea bottom from beach toe to lower extent of reef slope (30 m) below mean sea level is approximately 330 m long. Shallow sandy lagoon width ranges from roughly 120 to 140 m with an approximate depth of 1m below MSL. The southern part of the shallow lagoon from near shore towards reef crest is covered by sea grass which extends to 90 m from low tide extent of beach.

795. This area is predominantly sandy with very little amount of fine sand (silt and clay sizes) as shown in section 6.6. Width of reef crest is approximately 60 m which is highly consolidated due cementing of this area through wave breaking continuously in this portion of reef. Wave energy during filed visit in January was minimal due to reduced wave action as a result of NE monsoon where wind direction is from east and north east making this area as leeward side of wind. However, wave energy during SW monsoon will be more intense as predominant wind blows from west especially when the wind is strong during stormy weather. Reef crest has minimal coral community.

796. Beyond reef crest the upper reef slope and lower reef slope plunges to the atoll basin to a depth of 30-40 m. The width of upper and loser slope combined is approximately 80 meters. Coral community (biotic substrate as approximately 20%) with other non biotic substrate such as rock, rubble and sand characterize reef bottom. This portion of the reef is also well consolidated. Beyond the reef slope the sea bottom is sandy.

Figure 53 Three transects showing general characteristic of the sea bottom showing all major and significant features

8.4.6.1 Fauna

797. Assessment of fauna focuses on marine environment as the project impact is anticipated on nearby reef and associated habitats. Reef surveys were carried out at 2 sites of the reef western reef. The site R1 is located at the southern end of west side reef, while R2 are located at the northern end of the west side reef R1 represents as aside that may have residual impact due to excavation and

reclamation works while R2 represents reef site some 500m from residual impact area at is also referred as control site. Qualitative assessment of adjacent lagoon which is dominated by sea grass was also carried out.

8.4.6.2 Reef Survey

Baseline Survey location R1

798. This site chosen as a representative site for reef health (coral cover and abundance of fish) was chosen to establish baseline environmental status as an area that would have indirect (residual) impact from the proposed civil works, i.e. dredging and reclamation works associated with the project. Surveys were carried out at two depth 5 m and 10m following standard protocols. At 5 m coral cover as indicator of reef health that maybe affected due to sedimentation was approximately 20% (Figure 54). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae (does not include macro algae) was approximately 10%.

799. Total number of coral general in the Maldives is estimated as 62. At 5 m depth at survey location R1 only 7 coral general was encountered which is less than 11% of the total generic diversity of corals (Figure 54). Massive growth form attaining coral groups (slow growing corals) such as porites and favites are more dominant (over 60% of live coral composition) compared with branching (fast growing corals) corals groups such as acropora and pocillopora (less than 20%)

Figure 54 Reef benthic community structure at the upper reef slope (5m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean

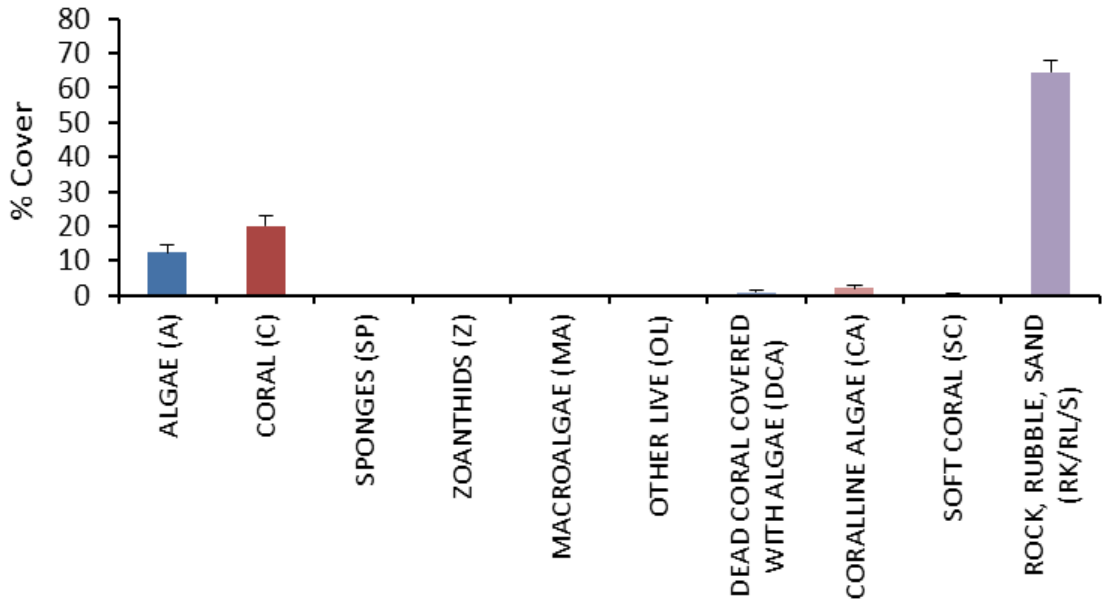
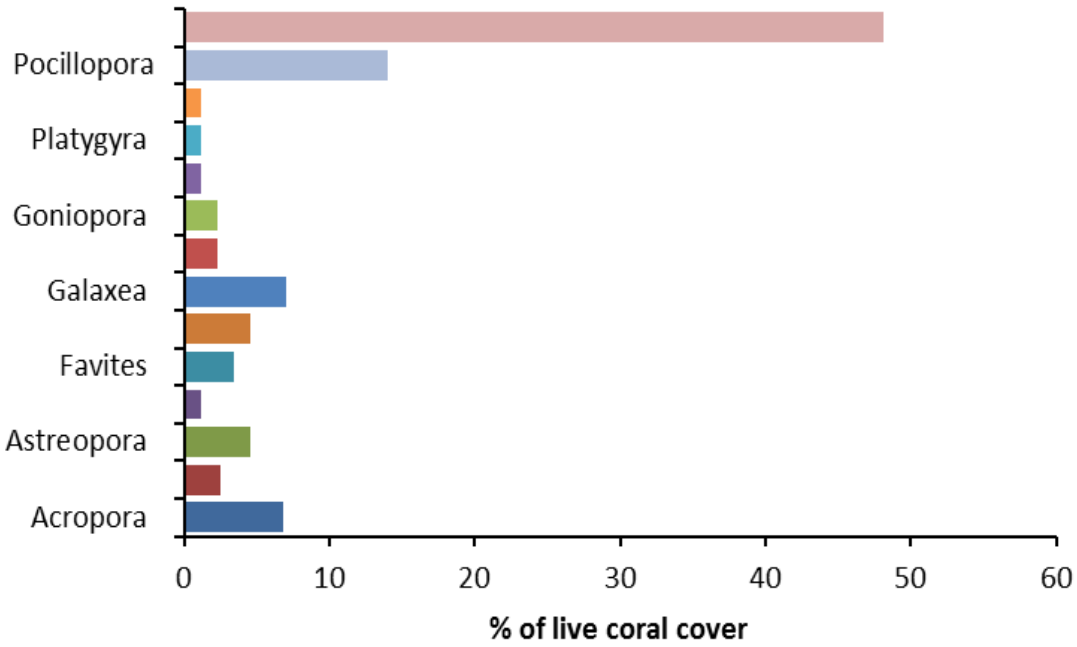


Figure 55 Coral genera (diversity) at R1 5m



800. At 10 m coral cover was also approximately 20% (Figure 56). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae (does not include macro algae) was approximately 10%. There was no significant difference in reef substrate between two depth surveyed including coral cover.

801. At 10 m depth 12 coral general was encountered which is less than 20% of the total generic diversity of corals (Figure 56). Acropora was the dominant coral general accounting for over 50% oc live coral cover followed by porites.

Figure 56 Reef benthic community structure at the reef slope (10m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean

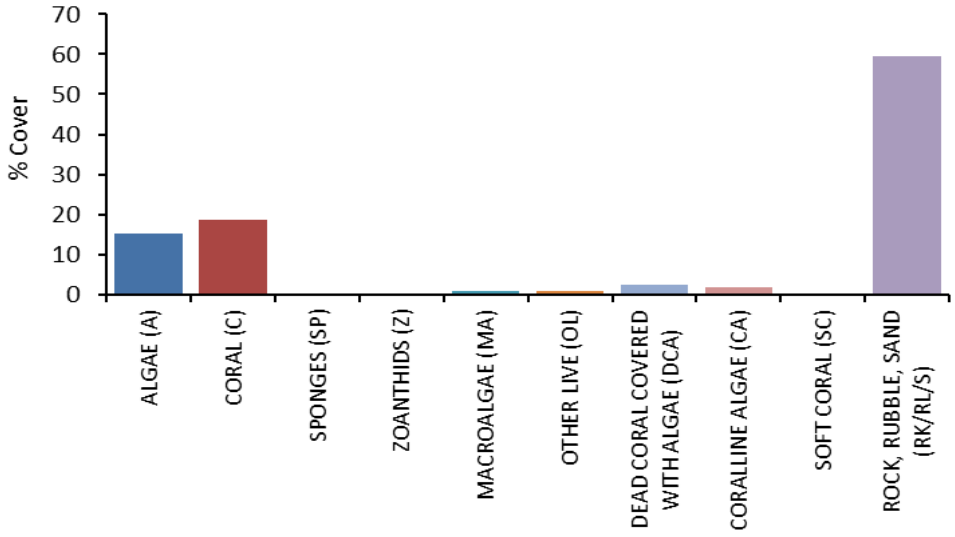
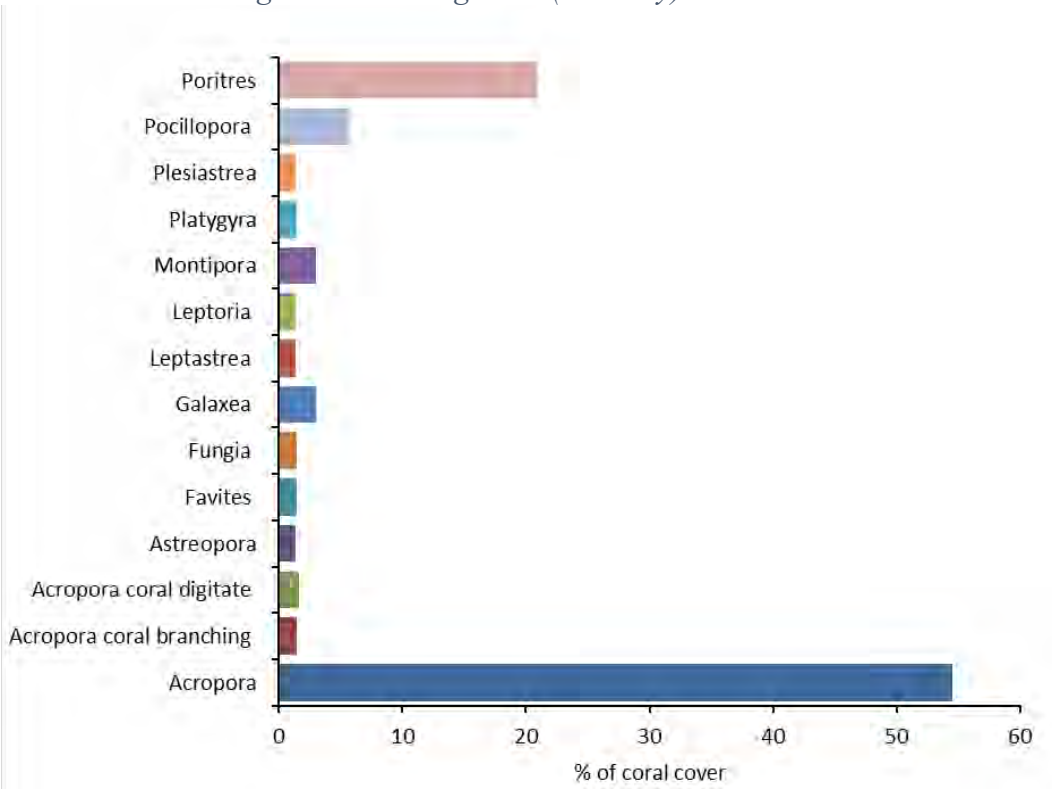


Figure 57 Coral genera (diversity) at R1 10m



Baseline Survey location R2

802. This site was chosen a control site to compare with potential residual impact from dredging activities that may effect benthic coral community. At 5 m coral cover 15% (Figure 58). Abiotic benthic substrate that include rock, rubble and sand was over 40%. Composition of algae (does not include macro algae) was approximately 15%. Coralline algae as important reef cementing biotic organism was significantly high (over 25%) which is also a good substrate and indicator for coral settlement.

803. 12 coral general was encountered which is less than 20% of the total generic diversity of corals (Figure 58). Massive growth form attaining coral porites are most dominant (over 35% of live coral composition) followed by branching (fast growing corals) corals groups such as acropora and pocillopora (over 35%). Among acroporids, table shape acroporid (Acopora hyacinthus) accounted for 15% of live coral cover.

Figure 58 Reef benthic community structure at the upper reef slope (5m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

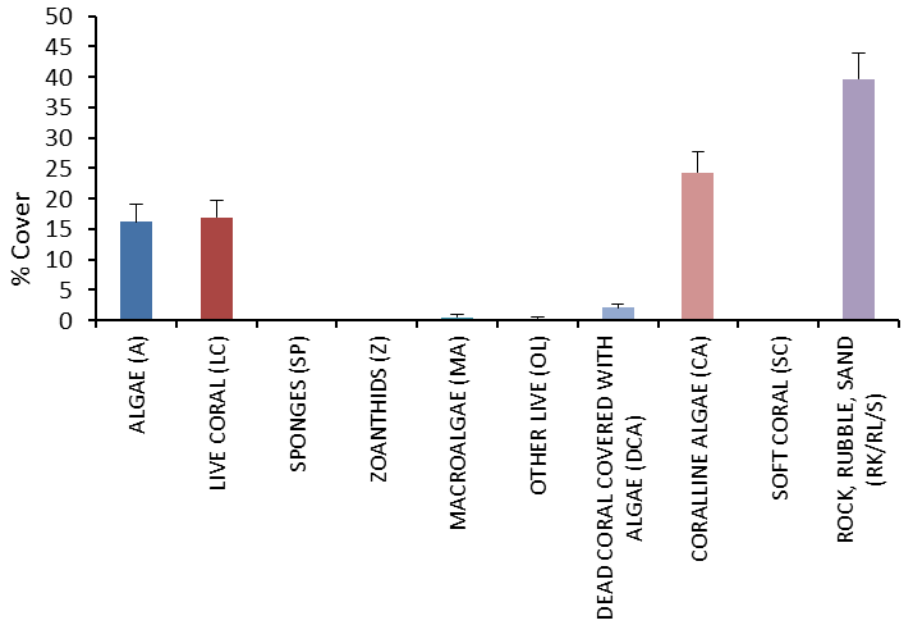
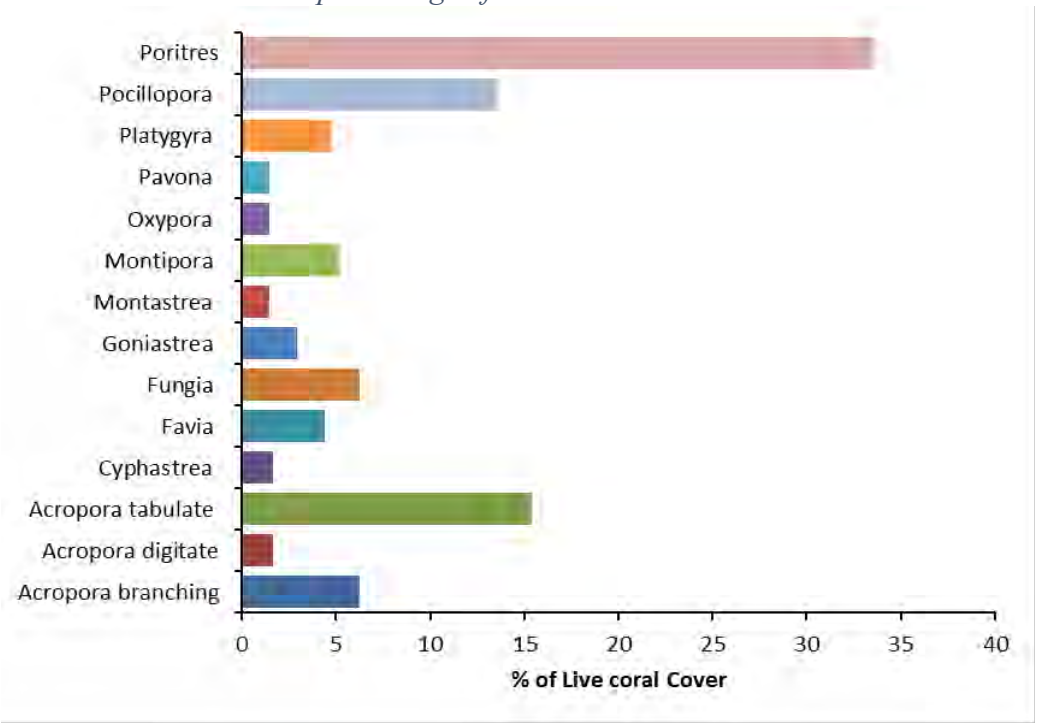


Figure 59 Coral genera encountered at 5m depth at baseline survey location R2, as percentage of total coral cover



804. At 10 m coral cover was also approximately 15% (Figure 60). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae was low (less than 5%). There was no significant difference in reef substrate between two depth surveyed including coral cover.

805. At 10 m depth at survey location R2 only 9 coral general was encountered which is 14% of the total generic diversity of corals. (Figure 61). similar to other reef surveyed locations, acropora and porites were most dominant coral general accounting for over 70% of live coral cover. Solitary coral (free living genera (fungids) were significantly high accounting for over 15% of live coral community.

Figure 60 Reef benthic community structure at the reef slope (10m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

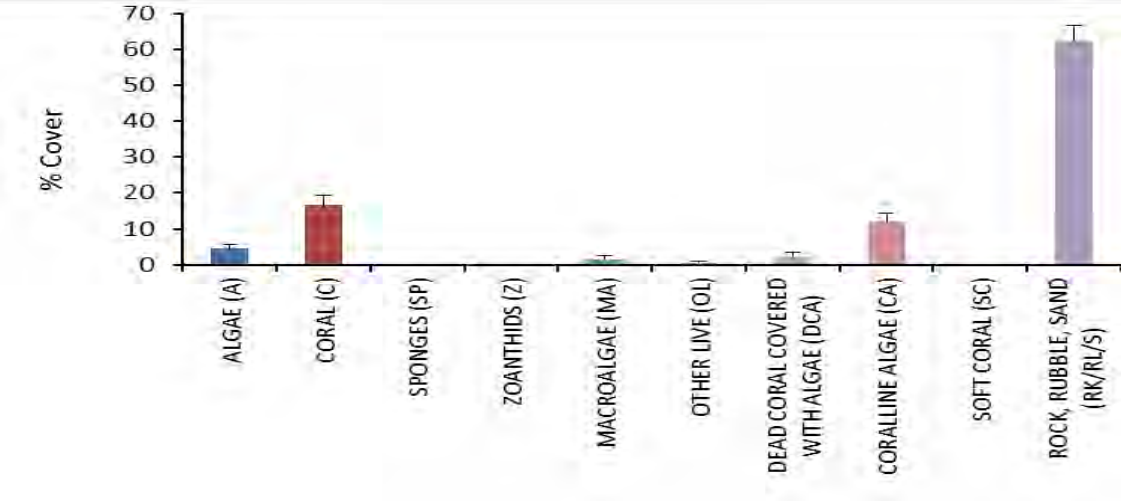
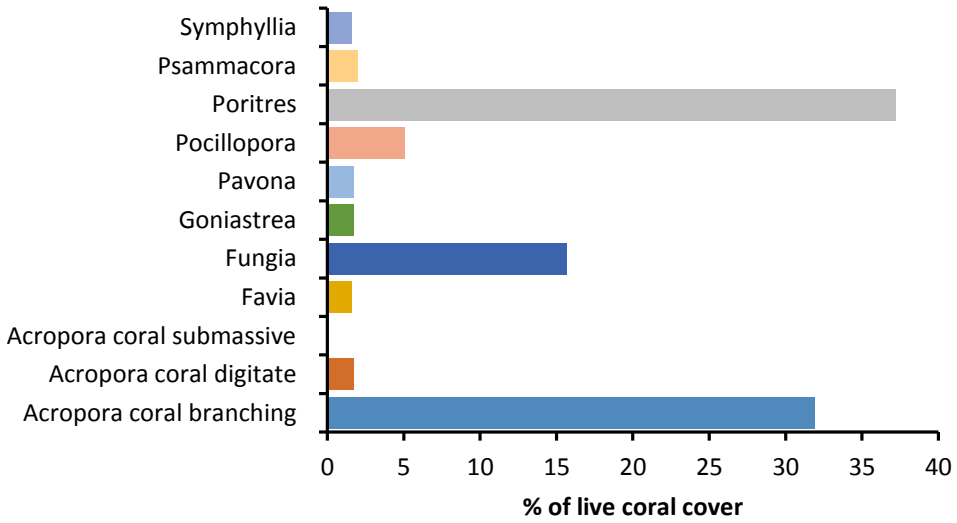


Figure 61 Coral genera encountered at 10m depth at baseline survey location R2, as percentage of total coral cover



806. Based on this data it can be concluded that the reef benthic community (coral community) is not highly diverse. Only 20% (maximum) of the coral general diversity for recorded. The number of coral species recorded in the Maldives is 230 (Picheon and Benzoni, 2007). It is estimated that number of coral species at the reef sites would be less than 30.

8.4.6.3 Reef Fish Community

807. Assessment on species and abundance of common fish were carried out at the two reef sampling locations where coral and other benthic community characteristics were assessed. This to establish baseline data on fish community for the required environmental monitoring of these sites during construction and operation phase. Commercially important food fishes present at both sites include, Aphareous viridiscence Lutjanus gibbus Lutjanus bohar Lutjanus kashmera Lutjanus monostigma.

Table 75: Abundance of fish and their trophic levels at two reef community sampling locations. L1 is impact/residual impact site, L2 is control site

Family	Species	Functional group	Abundance	Presence
Herbivores				
Acanthuridae	*Naso brevirostris*	Browsers	C	L1, L2
	Acanthurus leucosternon	Grazers/detrivores	C	L1, L2
	Acanthurus lineatus	Grazers/ detrivores	A	L1, L2
	Acanthurus dussumieri	Grazers/ detrivores	C	L1, L2
	Naso lituratus	Browsers	C	L1, L2
	Naso hexacanthus	Browsers	C	L1, L2
	Zebrasoma scopas	Grazers/ detrivores	R	L1, L2
Pomacentridae	*Chromis viridis*	Grazers	A	L1, L2
	C. atripectoralis	Grazers	C	L1, L2
	C. ternatensis	Grazers	C	L1, L2
	Dascyllus aruanus		C	L1, L2
Pomacanthidae	*Centropyge multispinis*	Grazers/ detrivores	R	L1, L2
	P. xanthometopon	Grazers/ detrivores	R	L1, L2
	Pygoplites diacanthus	Grazers/ detrivores	C	L1, L2
	Aolemichthys xanthurus	Grazers/ detrivores	R	L1, L2
Chaetodontidae	*Chaetodon collare*	Browsers	C	S1
	Chaetodon trifascialis	Browsers	R	L1, L2
	Chaetodon melannotus	Browsers	C	L1, L2
	Chaetodon guttatissimus	Browsers	C	L1, L2
	Chaetodon kleinii	Browsers	C	L1, L2
	Forcipiger longirostris	Browsers	C	L1, L2
Labridae	*Cetoscarus bicolor*	Browsers	C	L1, L2
	Hipposcarus hairid	Browsers	C	L1
	Scarus festivus	Scrapers/excavator	C	L1
Balistidae				
	Odonus niger	Grazers/ detrivores	C	L1, L2
	Melichthys indicus	Grazers/ detrivores	C	L1, L2
Carnivores				
Lutjanidae	*Aphareous viridiscence*	Predator	(O)	
	Lutjanus gibbus	Predator	(C)	L1, L2
	Lutjanus bohar	Predator	(O)	L1, L2
	Lutjanus kashmera	Predator	(A)	L1, L2
	Lutjanus monostigma	Predator	C	L1, L2
Lethrinidae	*Gnathodentex aurolineatus*	Predator	(A)	L1, L2
	Monotaxis grandoculis	Predator	C	L1, L2
Bait species				
Bpadhi				
Caesionidae	*Caesio sp*		A	L1, L2
	Sprateloides delicatlus		A	L1, L2

808. The following table provides marine protected species that are often associated with reef areas and open ocean.

Table 76 List of marine protected species in the Maldives. Table also indicates their threatened status according to IUCN Red list

Species	Locally protected	IUCN Red List category
Napoleon wrasse	yes	E
Turtles (five species)	yes	E and CE
Whale shark	yes	E
Giant Clam (2 species)	yes	LC
Whale and dolphins (all species)	yes	NA
Lobsters (5 species)	yes	NA
Sharks	yes	NA
Triton shell	yes	V

8.4.6.4 Sea grass community

809. Four out of 5 species that have been reported to occur in the Maldives were present at the small meadow (approximately 2 hectares). These include Thallasia hemprichii (abundant), Holdule uninervis (common) Cymodocea rotundata (common) and Syringodium isoetifolium (occation) in their establishment. Photographic representation of sea grass meadow is given in Appendix 5.

810. Other associated fauna present are Black sea cucmber (Actinopyga miliaris), Impatient sea cucumber (Holothuria impatiens), few numbers of giant clam (Tridacna maxima).

8.4.6.5 Significant fauna

811. Significant fish fauna such as sharks, manta rays, Napoleon wrasse were not encountered during the baseline environmental data collection at field. , Of the 5 species of sea turtles that are reported to occur in the Maldives only a hawksbill turtle was seen during the entire survey. Sea turtles are the most common and locally abundant species of turtles. Only one individual spiny lobster (Penulirus versicolor) was present in the vicinity of the belth transect at 10 meter depth of survey site referred as control site. Few numbers (< 30) of Tridacna maxima) and 9 of Tridacna scuamosa were recorded at both sites and depth combined.

8.4.6.6 Seawater Quality

812. The condition or quality of coastal water is important for ecological functioning of the organisms living in the habitat, for health and safety reasons and also for visual and aesthetic impacts. The water quality is generally determined by the level of nutrients. There are several sources that can lead to increased nutrients in coastal waters, e.g. sedimentation from dredging and reclamation works.

Sediment stir-up can also lead to release of nutrients within the sediments especially when there is excavation and dredging involved.

813. The most important nutrients of concern in coastal waters are nitrates and phosphates. In excessive quantities these can cause rapid growth of phytoplankton and result in algal blooms. Visual quality of the water is also important; a beach environment is much more attractive when the water is clean and one can see the sea bottom. However, even clear waters may sometimes be polluted. Dredging and excavation often carry heavy load of sediments, increasing sediment load in the water column causing discoloration of the of the impact area for a prolonged period.

814. It is worthwhile to note here that there is no direct input source of nutrients in the coastal waters as a result of the proposed activities but rather a potential release of nutrients associated with dredging or excavation (harbor entrance channel dredging, harbor basin dredging, reclamation sites). Therefore, the purpose of the assessment of water quality is to establish a baseline for the seawater quality, taken as a standard to compare with any future water quality assessments. A list of parameters tested and their values for the 4 locations are given in Table 11 (test results from MWSC) and Tables 76 and (in-situ water testing done using Hanna HI9828 probe).

Table 77: Water test results from MWSC Laboratory

Parameters	Harbor out side (residual impact area)	Harbor inside	Reef control	Beach/near shore
Salinity (ppt)	34.31	34.31	32.46	33.44
Biological Oxygen demand (mg/L)	1	1	1	1
Total Dissolved solids (mg/L)	26100	25100	24800	25500
Total Suspended solids (mg/L)	<5	<5	<5	7
Turbidity(NTU)	0.105	1.53	0.315	1.78
Total coliforms (CFU/100ml)	>201	>201	>201	>201
Fecal coliforms (CFU/100ml)	35	66	0	18

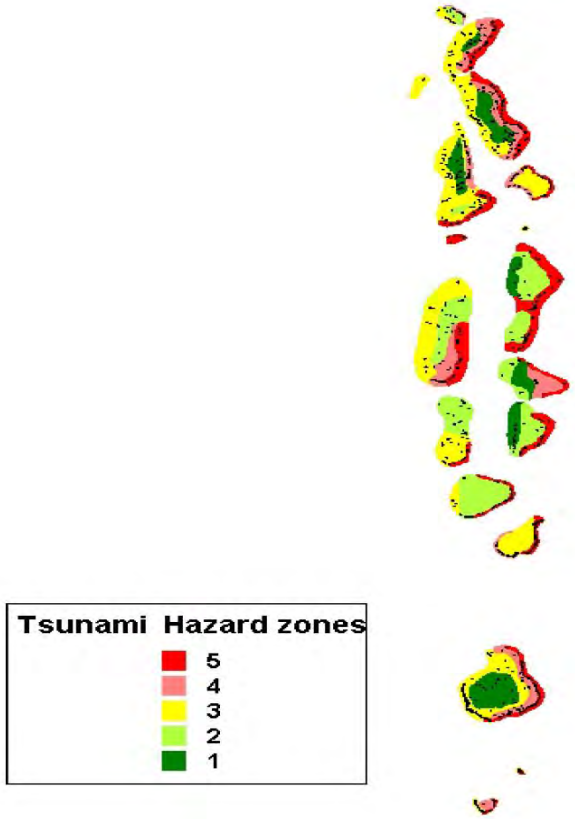
Table 78: Sea water quality parameters tested and their results (Hanna HI9828 water test brobe)

Parameters	Nearshore lagoon		Fishery /commercial harbour		Reeef Survey location R1		Reef Survey locationR 2(control)	
	Mean	STDV	Mean	STDV	Mean	STDV	Mean	STDV
Temperature (¡C)	29.88	0	28.82	0.02	28.45	0.08	28.54	0.04
pH	8.17	0	8.28	0.11	8.32	0.12	8.31	0.11
Dissolved Oxygen (mg/l)	3.58	0.01	3.75	0.24	4.36	0.12	4.82	0.08
Conductivity (µS/cm)	51282	19.32	51614.17	108.58	51259.29	90.25	51308	118.4
Total Dissolved Solids (g/l)	25.64	0.01	25.81	0.05	25.63	0.05	25.66	0.06
Salinity (ppt)	33.53	0.01	33.81	0.08	33.56	0.07	33.59	0.09

8.4.6.7 Hazard Vulnerability, Area Vulnerable to Flooding and Storm Surge

815. Hazard vulnerability of kulhudhuffushi is assessed based on the literature available and field data collection. The report prepared by UNDP on disaster risk assessment of Maldives states that the region which hosts Kulhuduffushi falls in to highest risk category (category 5) in terms of tsunami risk (Figure 61).

Figure 62 Tsunami hazard zones; category 5 is the highest risk zone while 1 is the lowest (figure derived from UNDP report on Disaster risk profile for Maldives, November 2006)

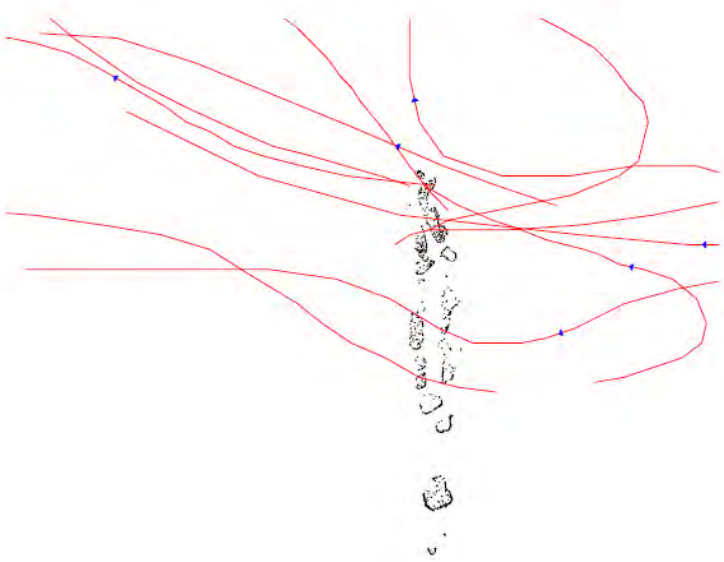


816. Hazardous weather systems, other than general monsoons (heavy rain and strong winds) that affect Maldives are tropical storms (tropical cyclone) and severe local storms (thunder storms/thunder squalls). Tropical cyclones are extreme weather events with positive and negative consequences. At times, these are very destructive due to associated strong winds (often exceeding 150 km/h), heavy rainfall (often exceeding 30 to 40 cm in 24 hours) and storm tides (often exceeding 4 to 5 meters). Strong winds can damage structures, houses, communication systems, roads, bridges and vegetation. Heavy rainfall can cause serious flooding. Storm surge is a sudden rise of sea level elevation along the coast caused by cyclonic winds. Sea level also rises twice daily due to astronomical reasons. The combined effect of surge and tide is known as storm tide. Storm tides can cause catastrophic results in low lying areas, flat coast and island territories such as Maldives.

817. Islands of Maldives are also affected by severe local storms (thunder storms/thunder squalls). Hazards associated with thunderstorms are strong winds (often exceeding 100kmph), heavy rainfall, lightning and hail. They give birth to

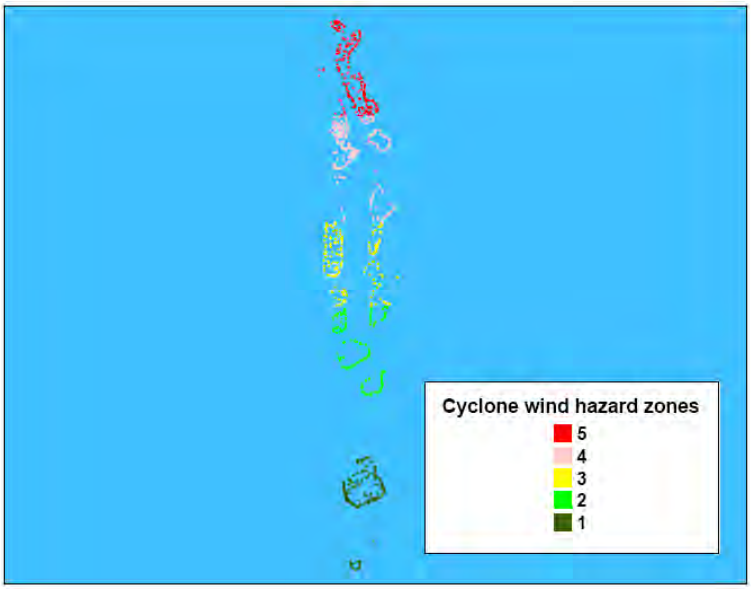
tornadoes in some regions (other than equatorial regions). In general thunderstorms are more frequent in equatorial regions compared to other areas. Land areas get more thunder storms compared to open ocean areas. However, thunderstorms close to the equator are less violent compared to those of other parts of tropics and extra-tropics. Maldives being close to the equator; thunderstorms are quite frequent here but are less violent. Strong winds generated by severe local storms consequently generate larger wind driven waves, which are hazardous to the Maldives.

Figure 63 Track of severe storms affecting the Maldives during 1877-2004



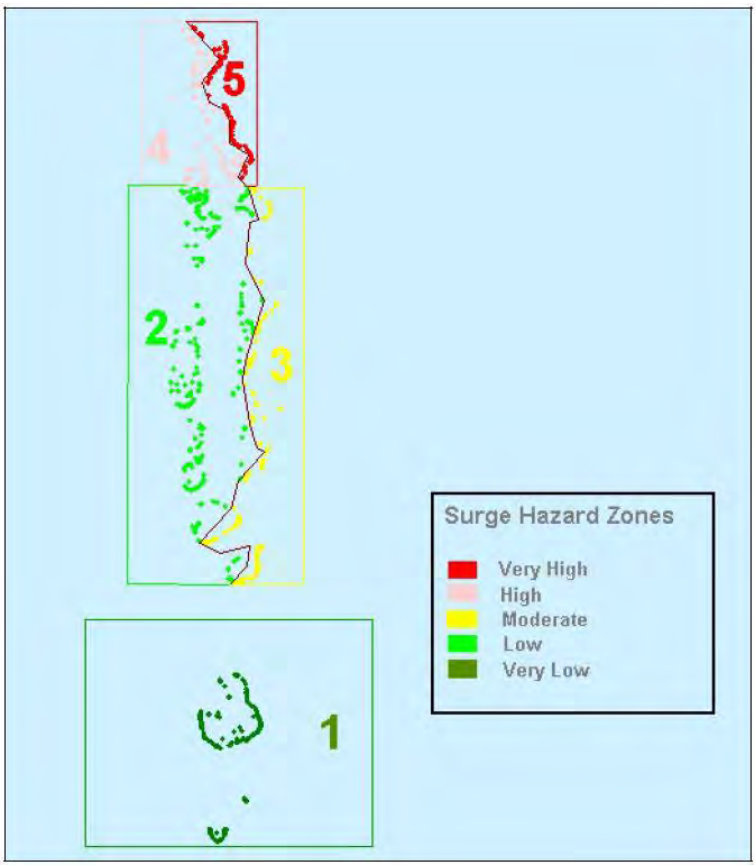
818. Major zones affected are the mid and northern parts of the Maldives. Based on Figure 62, Kulhudhuffushi falls in to category 5, which is the second highest scale given in the risk assessment of cyclones or storms (Figure 63). However, it should be noted that the island is at the boundary between the highest and second highest risk scale.

Figure 64 Cyclone Hazard Zones (figure derived from UNDP Report on Disaster Risk Profile for Maldives, November 2006)



819. Bathymetry around Maldives shows that the ocean slope close to east coast is steep compared to the same on the west coast. This led us to conclude that eastern islands of Maldives are vulnerable to higher surge hazard compared to western islands. Kulhudhuffushi region falls in to zone 5 (very high risk zone) of the surge hazard zoning categories (Figure 64).

Figure 65 Surge Hazard Zones (Figure Derived from UNDP Report on Disaster Risk Profile for Maldives, November 2006)



820. Based on these findings, Kulhudhuffushi has high probability of impact due to tsunami, storm surges and flooding and cyclones. Therefore, appropriate mitigation measure should be in place (disaster management program) which should enable the island to sustain in the event of unpredictable environmental and climate risks. Consideration should be given to design of coastal structure so that they are in line with climate prediction and return period for extreme event such as sea level rise where the islands are very low lying with respect to MSL.

8.4.7 Social Economic environment

8.4.7.1 Demography

821. Population of Kulhudhuffushi is 8,224 of which3712 males and 4299 females (excluding expatriate immigrants). It is increasing at a rate of 1.68% which is average compared to some other atolls in Maldives. Kulhudhuffushi population contributed to 2.4% of the total population of Maldives during this period. Population data of Kulhudhuffushi from 2006 to 2014 (Census 2014).

822. The population of Kulhudhuffushi highly depends on the migration of people from islands of Haa Dhaalu and the neighboring atolls of Haa Alif and Shaviyani.

8.4.7.2 Access to social services and Amenities

823. Education: Kulhudhuffushi is one of the few islands where higher secondary and tertiary education is offered in Maldives. As of November 2015, according to island council, there are 2808 students and 245 teachers in the island. Jalaaludhin School, the only secondary and higher secondary school serving in the island is also the largest education center in the Atoll. Started in 1998, it currently serves more than 1000 students. The two primary schools of Kulhudhuffushi include Affeudheen School and H.Dh Atoll Education Center. There are also 2 preschools in the island managed by the government as well as private parties. From 2012 onwards Maldives National University campus in Kulhudhuffushi is offering degree courses in the island which gave opportunities for many students who complete their secondary and higher secondary in the island, to pursue higher education.

824. According to 2014 census, the majority of the people who have attained education over the age of 6 has obtained primary education (47%). However, there is a huge decrease in the number of persons attending secondary education and even more for primary education. The percent of population who have received secondary education is 12% with 10% completing GCE Level examinations. Added to this, 6% completed certificate level education, only 0.3% of this population completed GCE A 'Level examinations. 0.5% of the population have attained Diploma level, Degree and Masters Level.

825. Electricity: Electricity is provided to the island by Fenaka Corporation Pvt. Ltd. Electricity is provided for 24 hours and according to the 85% of the respondents of the survey, the quality of the service provided by them is good. However, the engines used to provide electricity are old and as a consequence, the service providers face difficulties in maintaining and managing the engines.

826. Waste management: waste management service is provided by the Island Council through an island waste management center. With the increasing population and the developments coming to the island, managing waste has become one of the biggest challenges faced by the island community as per the majority of the respondents of the survey. Although, a waste management center is established on the island, there is no proper equipment in the center to manage waste. Also, the community is not aware about the importance of waste management which makes it even more challenging.

827. Water supply and sewerage: Kulhudhuffushi is one of the few islands in the country that enjoys utility services such as water supply and sewerage services with household connections. Before these services, the residents were using ground water and rain water for drinking and septic tank system. The desalinated water supply and sewerage system is operated by Malé Water and Sewerage Company.

828. Communication: Telecommunication services to the island are provided by Dhiraagu and Ooredhoo. Landline telephone communication service to the island, provided by Dhiraagu, is the only landline telephone communication service provider in the island. "Ooredhoo" along with Dhiraagu provides mobile communication services. Almost all people of the working population have a mobile phone. Meanwhile, internet services are provided by Dhiraagu and Infocom Private Limited.

829. Transport: Modes of transport used on the island include bicycles, motor cycles, cars, lorries and pick-ups. Earlier there were many bicycles on the island and many have used it as an ideal form of transportation. However, with the construction of the Harbor on the island, there has been a sudden boost in the number of vehicles - notably motor cycles. Now it is the main and preferred mode of transportation in the island. According to the island council, currently there are 2256 vehicles registered on the island.

830. Kulhudhuffushi also acts as a key regional maritime connection and cargo interchange point for the Haa Dhaalu atoll and other Northern atolls in general. At present, Kulhudhuffushi also acts as a major passenger and cargo hub in the Northern region of the country. There are regular scheduled boats/ferries carrying both cargo and passengers. Improved accessibility through the passenger harbor project would widen the already existing local sea transport system.

831. Health services: The first Health Center of Kulhudhuffushi officially started its services on May 12, 1973. Since its establishment, many developments have taken place in the health sector of the island. New infrastructure has been built and a variety of services are offered. Because of the geographical isolation of the island and rapid increasing population, the government upgraded the health center to a 50 bed regional hospital on June 11, 2001.The hospital operates daily 24 hours with 2 general practitioners, 4 specialists, 1 radiographer and 36 nurses. Medical tests like blood tests and urine tests can be done in the hospital.

832. Although, the hospital has been upgraded and it provides a better service compared to the many other islands in Maldives, it still lacks many facilities and services. Many people travel to Malé to receive better services. Apart from the hospital there are two private clinics, a branch of eye care, one STO pharmacy, 3 private pharmacies and one drug rehabilitation and detoxification center on the island.

833. The health condition of people in Kulhudhuffushi is generally good compared to other atolls in Maldives. Most commonly reported diseases are acute respiratory infections, viral fever and diarrhea. Other diseases rarely reported on the island include dengue fever, typhoid and scrub typhus. The table below shows the total number of reported cases by selected disease in Kulhudhuffushi in 2012.

8.4.8 Stakeholder Consultation

8.4.8.1 EIA Scoping

834. As an important part of the EIA formulation, under EIA regulation of Maldives a scoping application for developing a TOR based on project brief (scoping application form) was submitted to EPA on 20th of December 2015. A draft Terms of Reference for preparation of EIA was submitted to EPA along with the scoping application form.

835. EIA scoping meeting was held on 27th of December with representatives of various stakeholder of the project. This included representatives of EPA, representatives from MHI, representatives from Kulhudhuffushi Council and representative from project design consultants. During the scoping meeting, information with regard to project was briefed by MHI and representative from design consultants. Based on this discussion, issues raised by various stakeholder, scope of EIA was finalized based on draft ToR submitted to EIA. ToR for the EIA report was issued by EPA on 27th December 2015.

8.4.8.2 Meeting with MHI and concept design team

836. EIA consultant was member of the concept design team. Hence through our the concept design at various stages of design related consultations and discussion EIA consultant has been involved. In this regard consultant met with relevant stakeholders of the project both at meeting and was engaged in discussion to understand the components that are likely to have impacts on the environment in assisting various components of this report

8.4.8.3 Meetings with local stakeholder

837. As part of socio economic assessment exercise for this project the socio economic consulting team with various stakeholders of the project. The public consultation process was held from 20-22 November 2015 and the second consultation was held from 23-26 December 2015 in Kulhudhuffushi. The first consultations were held with fishermen and fish processors in Kulhudhuffushi. The second consultation was held for members of the community from youth groups to women's groups, NGOs, Women's Development Committee, School

administration and teachers, Bank officials, entrepreneurs, business owners and members from Kulhudhuffushi Island Council were consulted. All efforts were taken to select most suitable, impartial and knowledgeable members from each group that were chosen for the consultation process.

8.4.8.4 Meetings with Public (Kulhuduffushi)

838. EIA consultant's made a field visit to independently meet local public. Island Council facilitated to invite general public (or interested/concerned stakeholder of the island) through a PA system used by the council to make announcements to the Public. Meeting with interested parties were held on 13th of January 2016. Only 28 representatives or individuals who showed interest in hearing about the project, raise concern or issues with regard to the project attended the meeting. No women attended the meeting.

839. EIA consultant gave an introduction; the following is a brief of the introduction followed by some of the relevant points of discussion between PADECO/Riyan team and the island community, especially relevant stakeholders.

840. Work is based on the port extension, and to secure the loan from ADB, certain studies have to be made and reports submitted. Riyan team is there to do a survey of the port area and prepare an EIA report. As part of EIA, the consultant informed that community concern, social needs and requirements have to be incorporated within the reports. In this regard, they have been informed that a separate socio-economic assessment is already ongoing and shall be part of overall socioeconomic assessment for the EIA report. Consultant is therefore seeking their views and concerns on various aspects of the project. Consultant also affirmed that their concern will be informed to the project implementing agency (MHI) and feedback on their concerns will be reflected in final EIA report.

841. Based on the project component brief on preliminary design, some people who attended the meeting seemed dissatisfied with previous engagements, and a lot of comments and questions were based on those engagements. The following are some of the questions and statements which were more relevant to the discussion:

- Proper means of water flow in and out of the harbor will be needed; have they been incorporated into the design? They were concerned that enough means of circulation to clear the harbor may not be given.
- During stormy weather, they already experience difficulties during entry and exit to the harbor. How has the design been implemented to cater for that?
- Some questions to find the lengths, areas and depths of the designed harbor. Also how high the harbor walls will be above high tide. In addition, there were questions based on the slope, width of the wall at the top and base. Generally, the people present were better able to understand when measurements were based on linear dimensions rather than slopes and angles. (It may be more appropriate to include these dimensions when presenting to the public, in future.)

- Some commented that outer wall side of harbor wall (currently a revetment is never used; can future extensions include means to utilize the space?
- Some commented that the designed depth of 4m is too low.
- Some felt that the entry is very narrow, and that the current design will bring in swells during the stormy weather.
- Some commented that whatever the design, there were certain parties who influence how the project gets built. Will there be proper quality control to ensure that what is designed is what gets built.
- Some were concerned that waves may get bigger in future.
- Comments about the current design, some feel that the harbor access channel walls and basin adjoining points are too sharply defined corners. This need to be revised to avoid difficulty in manoeuvering larger sized boats.
- Issues with regard to orientation of harbor entrance channels were also raised. It was suggested that it should be more inclined to the existing orientation that what the current design shows.
- Questioned whether harbor entrance breakwater wall will be extended right to the edge of the reef.
- Some commented that rather than having recreational spaces, why not make the port bigger.
- Will there be any repair or upgrading work done to the existing harbor while new development is taking place
- Can vessels utilize the outer harbor wall after new development?
- Should have better means of loading and unloading cargo.
- Some comments about the entry of the current design being completely wrong.
- Some of those present wants to have the drawings so they can study them later.

8.4.8.5 Finding of stakeholder consultations

842. In general, there was a consensus among all the participants of the consultations that the development and expansion of the harbor would bring in economic prospective to the island and region. As other islands depend on Kulhudhuffushi as a business hub, the scale of business will increase when people gain confidence on the investments and a reliable transport system between inter-islands in the region isthe key to this confidence. There were also concerns that Kulhudhuffushi Ports Limited is not being operated to its full capacity.

843. In all stakeholder consultations the participants stated that they were aware of the harbor expansion and redevelopment project by the Ministry of Housing and Infrastructure. There was a huge media coverage of the project since the promise of the harbor expansion was a promise made during an election campaign of the current Government according to the locals.

844. At the beginning of each consultative meeting, an overall brief of the project was provided to various groups. Impacts, both negative and positive, that are common with any infrastructure development program acquiring land were discussed with the stakeholders. People interacted with interest to learn about the project and shared their views as well.

845. Additional public consultations will be carried out as part of environmental monitoring and management aspect of the project as part of continued involvement of the relevant stakeholders. This particularly important during project detailed design stages to ensure that their concerns particularly direct users of the harbor to ensure their concerns and recommendations identified. Detailed design and engineering aspects of the harbor will also be shared with the Council in addition to the community, and regular progress of the project development will be shared.

8.5 Environmental Impacts

8.5.1 Impact Identification

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

847. Possible impacts arising from the construction and operation works are categorized into reversible and permanent (irreversible) impacts. The impacts identified are also described according to their location, extent (magnitude) and characteristics. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken.

Table 79: Impact Prediction Categorized

Impact category	Description	Reversible/ irreversible	Cumulative impacts
Negligible	The impact has no significant risk to environment either short term or long term	Reversible	No
Minor	The impact is short term and cause very limited risk to the environment	Reversible	No
Moderate	Impacts give rise to some concern, may cause long term environmental problems	Reversible	May or may not

Impact category	Description	Reversible/ irreversible	Cumulative impacts
	but are likely short term and acceptable		
Major	Impact is long term, large scale environmental risk	Reversible and Irreversible	Yes, mitigation measures has to be addressed

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

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

850. Each action which is significant is evaluated in terms of magnitude of effects on the environmental condition and importance of this impact. Value in upper left hand corner of the block indicates magnitude of interaction and that in the bottom right hand corner of the block indicates importance. All significant actions, their magnitude of impact and importance of impact (which specifies whether the impact is short term or long term) are further described in the text.

851. The proposed project involves the construction of coastal structures that are likely to have impact on near-shore, marine environment especially direct impact areas. The severity of impacts is predicted by reviewing the design plans and construction methodologies. Mitigation measures are formulated in light of the information revealed by the project engineers with respect to construction methodologies.

8.5.2 Limitation or Uncertainty of Impact Prediction

852. Uncertainty of impact prediction are mainly due to the lack of long term data (shoreline, local currents and wave climate), inherent complexity of ecosystem (reef environment, habitat and terrestrial environment although to a lesser extent) and lack of coordinated monitoring programs with consistent methodologies which can be used to predict outcomes or reliability of predictions of previous projects.

853. The impacts are predicted by reviewing the survey data collected during the field visits and information revealed by the designers and engineers. The data

collected during the field visit is limited in terms of number of days to a week or few more, which limits the overall understanding of even the short term environmental conditions (wave condition, currents, and littoral movement).

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

8.5.3 Constructional Impacts

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

- Changes to hydrodynamic pattern;
- Direct loss of habitat and disturbance to the lagoon bottom and reef flat area by dredging works;
- Indirect impact on reef environment due to sedimentation
- Impacts due to noise and vibration

1.1.1.1 Changes in Hydrodynamic Pattern

856. The construction of harbor facility at the northern side of the island will change the existing hydrodynamic pattern at the northern side of the island. The strong swell wave induced currents will be reduced by the coastal protection structures and the harbor facility, possibly creating accretion at the western side of the harbor. During SW monsoon the littoral movement will be from west to east, hence western side of the harbor is envisaged to widen. Western side of the harbor will be sheltered from NE monsoonal wind waves which will probably cause accretion at this area.

857. The stilling effect at the northern side may cause some level of erosion at the western shoreline, but since littoral movement is effected by refracted swell waves entering the deep lagoon from the southern side, this effect is thought to be minor to moderate. Since extent of erosion issue is uncertain proper monitoring is required to check changes to shoreline during the operational phase.

1.1.1.2 Direct Loss of Habitat and Disturbance to the Lagoon Bottom and Reef Flat Area due to Dredging Works

858. Live coral cover at the reef flat area near the harbor front reef site was 20% with mostly massive and branching forms dominating the coral composition. Impact of habitat loss is irreversible at the basin and entrance location and unavoidable. Hence construction of the facility at the site and associated dredging is anticipated to have, significant impacts on the marine environment of the area, with high amount of habitat loss and associated impacts on the marine fauna. The live coral cover at the harbor basin area is less than 1%; however, predominantly covered

with sea grass meadow. Therefore, the impact on corals at this area is thought to be minor where as impact on sea that will be removed by dredging and smothered by reclamation will be significant and cannot be avoided.

1.1.1.3 Indirect Impacts due to Sedimentation

859. The sediment plume due to the dredging works in expected to spread along the western reef, into atoll basin. The currents along the reef are expected to transport the sediments into atoll into atoll basin, depending on the direction of tidal current at the time of dredging. Hence impact on seawater quality is anticipated to be moderate to major. The sediments which are transported to the west of the island are expected to impact the deeper lagoon area. However, this impact is anticipated to be minor and insignificant. Live coral cover at the northern side of the harbor facility is approximately 20%, and therefore impact on live coral cover in the area due to sedimentation is also envisaged to be moderate.

1.1.1.4 Impacts of Noise, Vibration and other Disturbances

860. The residential area on the northern side of the island is 240 m from the project area (newly built residential houses. Thick vegetation belt separates the project area and residential area. Hence impacts due to noise and air pollution are expected to be minor. Agricultural land is approximately 100 m away from the project site and is also separated by thick vegetation.

1.1.1.5 Protection Against Hazards

861. The northern side of the island experiences severe erosion. Hence the construction of the harbor facility on the northern side of the island at the proposed location, would address the issue of erosion felt at the area, thus giving a level of protection to the island.

862. The reclaimed land (dredged material disposal area) will be sloped towards the lagoon to allow natural drainage of storm water. The natural elevation of the island at the northern side is just over 1 m MSL. The harbor front area (road) will be provided with drainage mechanism. Hence these mechanisms will provide better protection against storms and associated flooding.

1.1.1.6 Increased Demands on Natural Resources and Services

863. No impacts are anticipated on the demand for natural resources and services.

1.1.2 Impact Analysis

864. An analysis of the impacts due to the project was done using the Leopold matrix (Table 78). Magnitude and importance of an impact is given a numerical value from 1-10, 1 being the lowest and 10 highest. Importance of impact is judged based on existing environment data, methods used and past experience with similar project.

865. The matrix showed that impacts on marine habitat are anticipated to be major and significant, while impacts on seawater quality due to excavation and disposal of excavated material are anticipated to be minor to moderate due to the low cover of live coral in the area and currents within the area.

866. Positive impacts due to the project are expected to be a safer docking area for vessels and easier unloading of fish by the fishing vessels. Furthermore, development of the harbor front area would open up the area for business facilities and income opportunities. What's more, the construction of the harbor facility on the northern side of the island also provides protection to that side of the island from further erosion issues currently being felt in the area.

Table 80: Leopold Matrix for Harbor Development and Expansion Works

				Constructional Activities					Operational Activities				Total
				Dredging	Sedimentation	Operation of heavy machinery	Fuel / hazardous material spillage	Solid waste generation	Safer docking and easier unloading	Increased land area	Income opportunities	Prevention of erosion on northern side of island	
Environmental /Social Condition	**Physical**	Water	Seawater	7	7		1	1					16
				5	5		1	1					12
			Coastal Zone									+8	+8
												+10	+10
		Air	Air Quality			6							6
						4							4
			Odours										
			Noise	7		10							17
				4		3							7
	Biological	Ecosystems	Quality	10	4			1					15
				10	2			1					13
	Social	Social	Employment								+6		+6
											+10		+10
			Hazards/ safety/wellbeing				3		+8	+10		+18	+33
							3		+10	+10		+10	+27
			Total	24	11	16	4	2	+8	+10	+6	+10	
				19	7	7	4	2	+10	+10	+10	+20	

1.2 Environmental Management Plan

867. There are a number of actions that can be taken to minimize or avoid impacts altogether. Those that are explored below emerged out of the discussions and consultations during this EIA and from the past experience of the consultant. Mitigation measures are selected to reduce or eliminate the severity of any predicted adverse environmental effects and improve the overall environmental performance and acceptability of the project.

868. Mitigation measures are discussed for the construction and operational stage of the project. During the construction stage it is important to take measures to minimize generation of construction waste; impacts due to disposal of construction waste may have significant degradation of terrestrial habitat or groundwater quality or reef health. Method of construction also has to be taken in to account for minimize impact. A construction method that has the least impact on terrestrial or marine environment has to be utilized.

869. Table 79 below outlines the potential environmental impacts and mitigation measures for Kulhudhuffushi Harbor's expansion and operations.

1.2.1.1 Monitoring Program

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

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

Table 81: Possible environmental Impacts and Mitigation Measures for Harbor Development Works

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
CONSTRUCTION PHASE (Temporary impacts)	Littering on terrestrial and marine environment	Littering, accidental disposal and spillage of any construction wastes should be avoided by pre-planning ways of their transportation and unloading at site. Careful planning of the work activities can also reduce the amount of waste generated.	Lagoon	During construction	Minor to moderate, short term impact	Contractor, MHI	N/A (no additional cost)
		During piling works at the over water structures, all construction related waste will be collected and sent to the waste management site. Burnable waste will be incinerated rest sent to local disposal site	Lagoon	During construction/ operational phases	Minor	Contractor, MHI	Included in the initial cost of project
		Development of a waste disposal management plan which will be implemented during construction	Land/ Lagoon/ Reef	During construction	Moderate	Contractor, MHI	Included in the initial cost of project
	Damage to reef by unloading works	Awareness raising of project managers on environmentally friendly practices to minimize negative impacts at the temporary access jetty area	Temporary access area and land	During construction	Minor, short term impact	Contractor, MHI	N/A
		Remaining material and machinery sent after completion of dredging works	On land	During construction	Minor	Contractor, MHI	N/A (may cost more for the material unloading process)

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
	Sedimentation and siltation on the reef and lagoon	Operation of heavy machinery only in the low tide (dredging and piling works) Setting up of silt curtain at the reef area where entrance channel and harbor dredging works will be carried out	Lagoon	During construction	Major to moderate, short term impact	Contractor, MHI	Cost of heavy machinery increase of 20% Silt curtain cost unit rate is $46.00, total length required is 680m therefore cost is $31,280.00
	Physical damage to marine flora and fauna	Avoid operation of heavy machinery out of construction area or boundary Outfall pipe laying area inspected before laying pipe. Adjust location so that live coral colonies are avoided Relocation or transplantation of live coral (movable colonies) to northern side of the reef near back reef margin at western side (refer to Figure 94) Once the STP is installed septic tank system dismantled and all toilet and kitchens connected to new STP	Lagoon / reef	During construction	Minor to moderate	Contractor, MHI	N/A Eco centre staff will be involved in coral transplantation work
	Sea water contamination	Oil /chemical handling and management procedures will be made known to all relevant staff, mismanagement will be fined.	Reef flat area/ lagoon	Construction/ operational phase	Positive impact	Contractor, MHI	N/A (included in the initial project cost)
	Air pollution	Heavy machinery used dredging and reclamation works operated only during mid to low tide. Minimise use of excavators.	Air	Construction phase	Minor/short termed	Contractor, MHI.	N/A (may increase labor cost)

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
	Noise pollution	Avoid use of heavy machinery during night hours	On land	Construction phase	Minor/short term	Contractor	N/A (same as above)
OPERATIONAL PHASE (permanent impacts)	Solid waste generated at the complex	Glass crusher and compactor installed at the waste management building in the initial phase of construction period. Start operation of Eco Centre during initial phase of construction so as to achieve the zero waste policy Solid waste sorted at service outlets and sorted at the waste processing area Reuse and recycle waste where possible Conduct awareness programs for staff and guest, on the need for waste reduction, through brochures which area available in both guest rooms and staff areas	On land	Operational phase	Minor if proper waste management lanes are in place, long term throughout the operation of the complex	MHI, KC, Harbor Management	N/A (included in the initial project cost) USD 200-300 (printing of brochures and leaflets)
	Sewage disposal	Sewage treatment plant installation (biological wastewater treatment & STP) Waste water from kitchen, toilets (flushing) and laundry treated and reused Remaining grey water, mixed with brine and discharged to the ocean at a depth no less than 15m	Reef	Operational phase	Minor/long term	MHI, KC, Harbor Management	N/A (included in the main project plan) N/A Included in the construction cost

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
	Damage to the reef by recreational activity	Marked areas (sign boards put on the reef) to access outer reef slope, thereby reducing trampling in other areas To promote awareness, all guest rooms will have multi-lingual explanatory pamphlets advising on environmentally friendly practices Collection of corals, shells and other species will be prohibited at all times	Lagoon, reef	Operational phase	Minor/long term	MHI, KC, Harbor Management	USD 100-150 (cost of making sign boards) N/A (included in the staff training program) N/A (included in the information pamphlets at each room)
	Air pollution from power generation	Measures will be taken to minimize power consumption by installing energy saving lights and other electrical devices. Detailed in Section 5.6.2.3. (Power generation) When purchasing air conditioning units and freezers, ozone friendly brands will be purchased Conduct awareness among staff, place brochures advising guest on switching off electrical appliances and air-conditioning	Air	Operational phase	Minor if properly managed, long term	Resort management	N/A (included in the original project plan) N/A provided in information pamphlets at each room)

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
	Oil spills and fire related accidents	Lay out fire control protocols, train staff in firefighting and prevention Provision of emergency and fire prevention information in guest and staff rooms The use of fire retardant construction materials for guest and staff accommodation Installing fire safety equipment service facilities and public areas Bund wall constructed around the fuel tanks. Fuel handling and generator area floors sealed materials	On land	Operational phase	Minor if properly managed, long term	Resort management	N/A (included in the staff training program) Included in the guest information pamphlets N/A Included in the initial costs Included in the initial costs

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

872. Monitoring works during the construction and operational phase will be carried out according to the Tables 80 and 81. Cost for the monitoring (data collection) activities will be covered by operating cost (commitment to carrying out and financing the mitigation and monitoring work is given in the Proponent's declaration at the beginning of the report).

873. The EIA monitoring report structure provided in the EIA Regulations 2012 (2012/R-27) shall be used for the monitoring report preparation. Preliminary reports shall be submitted once every two months to EPA for the duration of construction phase. Final monitoring report submitted after completion of the project and follow up monitoring report submitted one year after completion of the project.

Table 82: Monitoring Program for Construction Phase of the Project

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring
Reef benthos (coral and other benthic cover)	Photo quadrate method	Every 4 months	Rate per field survey USD 500.00
Reef fish community, diversity and abundance	Fish visual Census	Every 4 months	Rate per field survey USD 500.00
Sea water (sea water tested for contaminants or increased in nutrients due to outfall),	Water samples sent to Food and Drug Authority for analysis. Following parameters are to be tested; • Salinity • pH • Electrical conductivity • Dissolved oxygen • Biological Oxygen Demand • Chemical Oxygen Demand • Nitrite • Nitrate • Phosphate • Sulphates	Every 2 months	Rate per test set USD 600.00
Beach environment	Shoreline mapping using precision GPS (high tide and beach toe)	Once every 2 months	USD 1,000.00 per trip

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring
Sedimentation rates	Set up sediment traps on western side reef (2 locations south an northern side of proposed development site	Every 2 weeks for the entire construction period	USD 1500 per cycle

Table 83: Monitoring Program for Operational Phase of the Project

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring
Reef benthos (coral and other benthic cover)	Photo quadrate method	1) After completion of construction, 2)After one year	1) USD 500.00 2) USD 500.00
Reef fish community, diversity and abundance	Fish visual Census	1) After completion of construction, 2)After one year	1) USD 500.00 2) USD 500.00
Sea water (sea water tested for contaminants or increased in nutrients due to outfall), ground water quality (tested due to use treated water for irrigation)	Water samples sent to Food and drug authority for analysis. Following parameters are to be tested; • Salinity • pH • Electrical conductivity • Dissolved oxygen • Biological Oxygen Demand • Chemical Oxygen Demand • Nitrite • Nitrate • Phosphate • Sulphates	1) After completion of construction, 2) Bi-annual after one year	1) Rate per field survey USD 600.00 2) USD 600.00
Beach littoral dynamics	Use of precision GPS to map the beach area. High tide line, beach toe line and erosion scarp lines will be mapped	Every four months (this would give a clear picture of shoreline changes over long term and seasonal shifts)	Beach profile and mapping surveys; USD 1000.00 per survey trip

1.2.1.2 Environment Management Plan (EMP) Structure and Responsibilities

874. For an EMP to be effective, an organizational structure within the resort management has to be established and the individual roles and responsibilities of every person within this organisation must clearly be defined as they relate to the achievement of environmental Objectives and Targets, and the overall operation of the EMP.

875. Key personnel involved in the implementation of the EMP would include the following:

- Environmental Manager

- Environmental Officer
- Chief Engineer
- External Consultant

876. The administrative structure showing the people whose duties including active participation in EMP training, monitoring, consultation, reporting, review and/or decision-taking shall be identified (an example of the administrative structure for a typical resort is shown in Figure 95). This figure summarises the key management and supervisor personnel who will be most closely associated with the day-to-day operation of the EMP and their main responsibilities.

877. In addition to this the Environmental Manager, who is accountable for the establishment, implementation and maintenance of the EMP and reporting the EMP performance to the resort manager, has to be appointed. It is also essential that the Environmental Manager has en equal representation at the business management as that of other departmental managers.

878. The PMU shall identify its training needs. It shall require that all personnel, whose work may create a significant impact on the environment, have received appropriate training. It shall establish and maintain procedures to make its employees or members at each relevant function and level aware of:

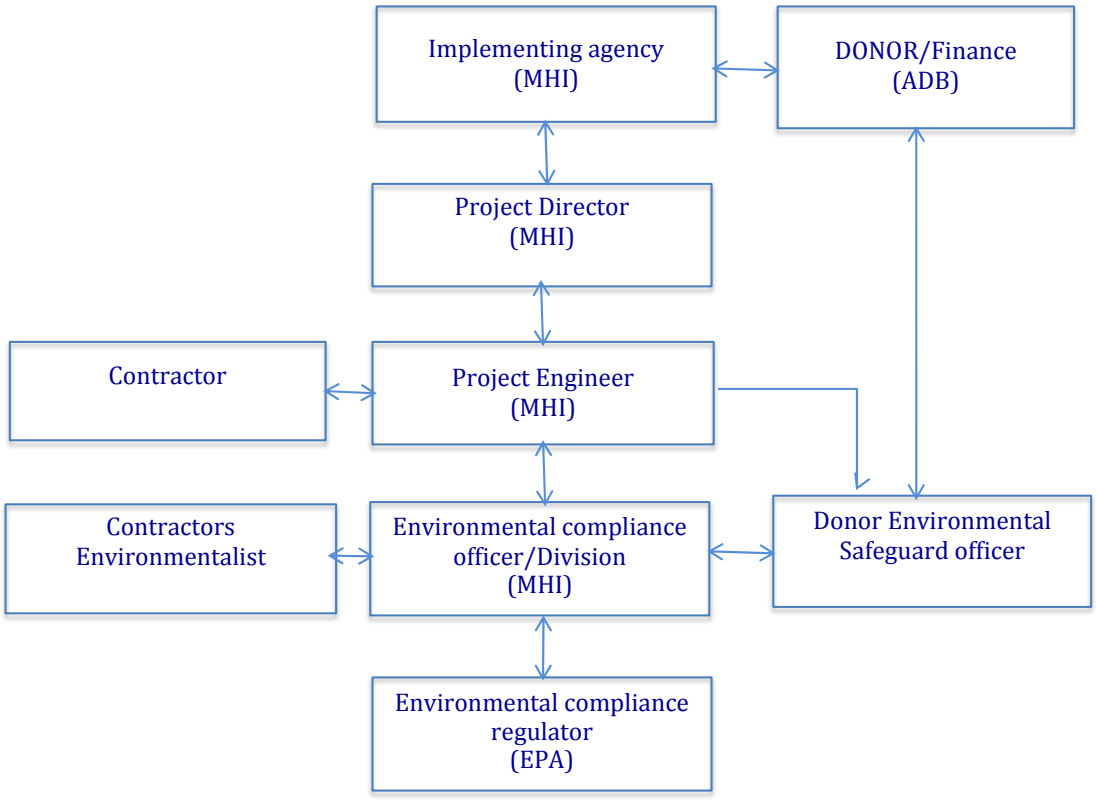
- the importance of conformance with the environmental policy and procedures and with the requirements of the environmental management system;
- the significant environmental impacts, actual or potential, of their work activities and the environmental benefits of improved personal performance;
- their roles and responsibilities in achieving conformance with the environmental policy and procedures and with the requirements of the environmental management system;
- the potential consequences of departure from specific operating procedures.

879. The personnel performing the tasks which can cause significant environmental impacts shall be competent on the basis of appropriate education, training and/or experience.

1.2.1.3 Institutional arrangements for implementing EMP

880. Figure 65 suggests and institutional setup flow diagram for EMP.

Figure 66: Suggested Institutional Arrangement for EMP



1.2.1.4 Grievance Redress Mechanism (GRM)

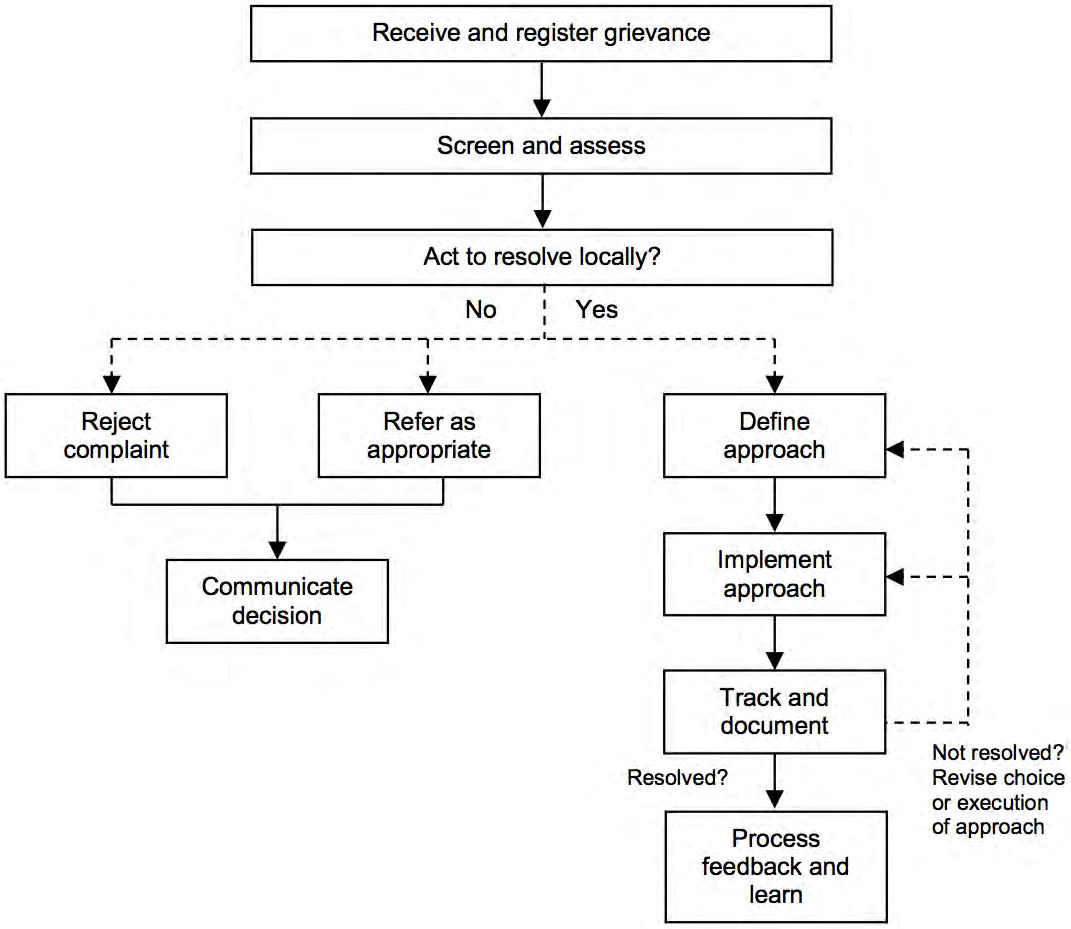
881. The most successful Grievance Redress Mechanisms (GRM) involve representatives from the affected community in the design of the GRM. The implementing agency and contractors are advised to engage community representatives in identifying the key factors that will make the GRM successful (e.g. the kinds of disputes that could arise, how affected people want to raise concerns, the effectiveness of existing procedures for resolving complaints, and the availability of local resources to resolve conflicts), as well as in designing and improving the GRM based on community feedback.

882. The Consultant's suggestion is to form a grievance redress committee which should include the followings:

- Representatives from MHI
- Representatives from Contractor
- Representatives from Kulhudhuffushi Council
- Representatives from local social NGOs

883. The following diagram in Figure 66 is a suggested mechanism to implement the GRM.

Figure 67: Suggested Mechanism to Implement GRM



2. Summary and Conclusions

2.1 Project Description

884. The Project Preparatory Technical Assistance (PPTA) on the Kulhudhuffushi Harbor Expansion consists of six main components: (i) Technical Feasibility including Preliminary Design and Cost Estimate; (ii) Economic and Financial Feasibility, (iii) Governance and Institutional Assessment including Financial Management Assessment and recommendations on Capacity Development Technical Assistance (CDTA) ; (iv) Social Safeguards including Poverty and Social Assessment and Social Due Diligence; (v) Environmental Safeguards including Environmental Impact Assessment; and (vi) Technical Advisory and Project Management Support to ADB and EA/IA including on the procurement and costing of the Project Management Consultant (PMC).

885. The PPTA Consultant fully carried out all the above tasks, provided technical advisory and supported ADB, EA, and IA throughout the duration of the project, proposed and outlined relevant CDTAs for development and implementation, and suggested recommendations for appropriate mitigation actions during the implementation phase. All activities were undertaken in coordination and consultation with the EA/IA, ADB, and other public and private stakeholders including the Kulhudhuffushi Council, the Environmental Protection Agency, the Transport Authority, the Ministry of Economy and Development, the Maldives Port Limited, the Kulhudhuffushi Harbor's users and operators, the business and social community, local NGOs and community groups, and the wider Kulhudhuffushi's and Islands' populations.

886. The work undertaken along various feasibility reports showed that all project components are technically, economically, and financially feasible. Any adverse environmental and social impacts will not be significant if appropriate mitigation and management measures are applied.

887. The following is a summary of the main findings and the key issues identified during this PPTA.

2.2 Preliminary Design and Cost Estimate

888. The Consultant proposed several design options with the preferred/retained option being the one that meets the needs of the IA and is the least costly for immediate expansion and future redevelopment.

889. The scope of the proposed civil works for the Kuhudhuffushi harbor expansion includes the following components: Area 1 Reclamation, Waterfront Small Craft Zone, Harbor-Separation Wall, Passenger/Cargo Harbor, and Area 2 Reclamation. In addition, operational infrastructure facilities (navigation lights, timber jetty, pavement, drainage, apron lights) and superstructure and ancillary facilities

(passenger terminal, harbor market, buildings for commerce and business activities) were proposed. Once the new expansion is constructed and becomes operational; passenger, cargo and small craft operations and services will move to the new facilities while the existing harbor will be entirely dedicated to fishing activities.

890. Cost estimates were calculated based on market rates of two Contractors' tender rates and the quantities on similar projects in the Maldives, then approximated to the three quarters of the difference between them to produce a market cost estimate representing the upper quartile of the two estimates. To this, a contingency of 10% was added along with an estimate of PMC and ancillary costs to produce a grand total cost of USD 8,941,674.

891. Prior to the Consultant's engagement, there were no concept or prefeasibility design reports prepared for this project; thus requiring a lot of research to establish design parameters for the Preliminary Design. With this in mind, the Consultant recommends a comprehensive review and update of the reference manual for safe port shelters to be used as a design standard for harbor projects in the Maldives. This recommendation has been suggested as one of the CDTA components.

2.3 Economic and Financial Feasibility

892. The economic analysis evaluated a number of benefits that arise from the construction and operations of the new harbor, its operational infrastructure, superstructure, and ancillary facilities. Three scenarios were evaluated: (i) the Base Scenario which includes the dredging and reclamation works, the harbor breakwater and separation walls, and the Passenger/Cargo harbor, (ii) Scenario 2 which includes the Base Scenario and the Waterfront Small Craft Zone, and (iii) Scenario 3 which includes Scenario 2 and the import base benefits.

893. All the project's scenarios and components were supported with sensitivity analysis showing an EIRR greater than 12% on costs increased by 10% and benefits decreased by 10% and a delay of one year in construction. Anticipated economic returns would be further enhanced if direct imports to the Kulhudhuffushi Regional Harbor (KPL) and more frequent connectivity and maritime services to-from Kulhudhuffushi are considered.

894. The financial feasibility and evaluation has been carried out with respect to two analyses. The 1st analysis is for the harbor as a non-revenue generating activity and for which the analysis focused on the methods of financing through the ADB grant and the financing of harbor operations and maintenance costs. The 2nd analysis is for potential income generating activities within the harbor (rental of shops, market and retail space) which shows an FIRR of 19%, thus providing a financially attractive investment for the project owner (Kulhudhuffushi Council) and a main source of revenue to cover regular operations and maintenance costs of the harbor.

895. Both the economic and financial feasibilities are based on (i) the the GoM's policy not to levy port dues and tariffs on domestic harbors in the Maldives, including the expanded Kulhudhuffushi harbor, and (ii) that all infrastructure and regular maintenance costs and expenditures will be borne by the GoM. Both MHI and KC have committed to incorporating the expanded Kulhudhuffushi harbor into their maintenance programs, and where needed to increasing maintenance expenditures commensurate with the size and needs of the proposed harbor's expansion.

896. Due to the lack and/or absence of updated and reliable data, the economic feasibility and evaluation relied on a mix of field surveys, focus-group interviews, simulation modeling, and at times practical assumptions based on the Consultant's site and expert knowledge and rational reasoning, and where relevant using international benchmarks and industry best practice. In this respect, the Consultant recommends the establishment of a port's and maritime data warehouse that collects regular and reliable port and maritime statistics in Kulhudhuffushi and elsewhere, including on port and passenger traffic, ship calls, and relevant operational, safety, and environmental statistics.

2.4 Institutional and Governance Assessment

897. The Financial Management Assessment found that both the IA and the EA have sufficient experience implementing harbor infrastructure projects including for ADB and other international development agencies. However, in terms of harbor's operations and management which will be largely conducted by the Kulhudhuffushi Council, institutional and capacity building on port financial management and budgeting will be required.

898. Throughout this project, and as part of the tasks of the Consultant, several gaps have been identified at institutional and governance levels. The Consultant suggests several recommendations for remedial actions including on the creation of a port's data warehouse for collecting and processing port and maritime statistics, the delineation of institutional, operational, and regulatory port functions between various public authorities, the necessity for a port's institutional and capacity development for the Kulhudhuffushi Council, a major overhaul of port and maritime safety systems and practices in Kulhudhuffushi and other harbors, the use and full implementation of harmonized SAP public accounting systems across harbor's operating agencies, and the consideration for tariff introduction and implementation across local harbors.

2.5 Social and Environmental Safeguards

899. The results of the Poverty and Social Assessment and Social Due Diligence reports found that there should be no issues of land acquisition, resettlement, or payment of compensation related to this project. Furthermore, there will be no

temporary disruption of livelihood of any group of community in Kulhudhuffushi during the construction period. Further stakeholder' consultation found that the project would engender significant socio-economic benefits including for social and business communities in Kulhudhuffushi and the Islands. To this end, a specific CDTA component was proposed by the Consultant and emphasizes the crucial role of skills and knowledge in generating new economic, business, and employment opportunities for Kulhudhuffushi and the region as a direct and indirect impact of the harbor expansion.

900. The results of the Draft Environmental Impact Assessment show that the impacts of the harbor expansion on marine habitat are anticipated to be major and significant, while the impacts on seawater quality due to excavation and disposal of excavated material are anticipated to be minor to moderate due to the low cover of live coral in the area and currents within the area. On the other hand, the project will have positive impacts protecting against erosion, providing for safer mooring and docking for fishing, cargo, and passenger vessels and small crafts, and generating wider environmental and social benefits.

901. To mitigate against project risks, the Consultant proposed a detailed Environmental Management Plan and Monitoring Program for both the construction and operational stages of the project. Furthermore, a Grievance Redress Mechanism (GRM) has been proposed including through the establishment of a joint grievance redress committee to address both social and environmental grievances that may arise during all project phases.

2.6 Capacity Development Technical Assistance

902. As part of this PPTA, the Consultant has identified several gaps and suggested recommendations for remedial action. To this end, four main CDTA streams have been suggested and outlined for development and implementation:

- Tariff Study for Kulhudhuffushi and other Local Harbors
- Port Institutional and Capacity Development for Kulhudhuffushi Council
- Update Design Reference Manual for Safe Port Shelters
- Harbor Development and Business Opportunities for Local Community

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