Title	**Environmental Impact Assessment Report for the Proposed New Fish Market Project**
Location	**Northern Side of Male' (in front of existing fish market)**
Prepared for	**Male' Municipality**
Prepared by	**Energy Consultancy Pvt Ltd.**
Authors	**Zahid, Ahmed Inaan, Mohamed Abdul Latheef, Mohamed Ali**
Scope	**This Environmental Impact Assessment Report forms part of the process of planning and decision making for the proposed New Fish Market at Male'. Its purpose is to present the findings of the EIA process for review by stakeholders and Authorities. In particular, it will:** • **Identify any interactions between the proposed New Fish Market area and the environment;** • **Consider which of these aspects, if any, are likely to have a significant impact on the environment; and** • **Recommend measures that will enhance any positive impact and avoid any adverse negative impact, and if the latter cannot be avoided, to reduce its impact and ensure adequate protection during construction and operation of the proposed fish market.**
Date	**October, 2006**
Acknowledgement	**Yazeed Ahmed and Ali Shareef (Department of Meteorology)**

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2. Introduction

In year 2004, the existing Male' fish market harboured an estimate of 17,000 metric tones of fish and is expected to increase in coming years. The number of people who visit to the market is in increasing trend and it is one of the busiest areas in Male' (*see* ***Figure 1***). To overcome the crowdedness and to provide more space for selling fish, it is planned to develop a new fish market in front of existing market (*see* ***Figure 2***).

Figure 1: Existing Fish Market in Male'.

Since the proposed location is sea area, the project involves reclaiming and sheet piling the area. The operation of the fish market and other premises will comprise areas for fish offloading, fish cleaning area and plat forms to sell fish. The key objectives of the proposed fish market are:

- creation of large area for selling fish
- easy excess to the market by fishing vessels and people
- to minimize traffic congestion

Figure 2: Location of the planned reclamation area for New Fish Market.

The present study seeks key environmental issues related to reclamation, construction and operation of NFM and also provides the direction to solve the problems in terms of policy and operation sides as well as effective mitigation options to secure the environmental soundness of coastal reclamation for the project. This would facilitate to keep the existing aesthetic value of the area with its beauty, safety, and vigour and to direct sustainable development of the project.

The objectives of the assessment are as follows:

- to establish the ecological importance of the marine and land habitats affected by the construction operations;
- to identify marine and land fauna and flora affected by the project;
- to assess the scale of possible marine and land ecological impacts from the proposed NFM;
- to highlight any insurmountable impacts to marine and land ecological resources arising from the proposed Project;
- to identify any mitigation measures and residual impacts; and,
- to assess the need for a marine ecological monitoring and audit programme.

It is the objectives of this EIA report to give and disclosure of all relevant information that has been obtained during the consultations up to date. Furthermore, it is the objective of this report to inform briefly about the performed and planned activities to facilitate the public consultation process.

This Environmental Impact Assessment report was done by Energy Consultancy Pvt Ltd. The leading environmental consultant of the company is Mr. Zahid. Zahid is assisted by Mr. Mohamed Abdul Latheef, Mr. Mohamed Ali and Mr. Ahmed Inaan.

Mr. Zahid has obtained a masters degree in the field of Environmental Science from University of Wollongong, Australia and is presently working at the Department of Meteorology as a Senior Meteorological Forecaster. He obtained his first degree in Atmospheric Science (Climatology) from Macquarie University, Australia.

Mr. Zahid is one of the key figures in Department of Meteorology, especially in the field of climate change, environment and natural disasters. He has represented Government of Maldives in international seminars, workshops and conferences and presented papers on climate change and natural disasters. He is also actively involved in conducting training workshops locally to educate people on environment related issues. He is also the coordinator and the lecturer for the Meteorological Observer's course conducted by the Department of Meteorology. Mr. Zahid's special areas of expertise include Environmental Planning, Environmental Management, Costal Management, Environmental Impact Assessment and Solid Waste Management.

Mr. Mohamed has obtained a Bachelors degree in Electrical & Electronic Engineering from Islamic University of Technology, Bangladesh and is presently working at the Maldives Airports Company Ltd. as an Assistant Electrical Engineer. The responsibilities of Mohamed includes, but is not limited to; planning, development, implementation, operation and maintenance of electrical and mechanical equipments.

In addition to these, Mr. Mohamed provides technical direction to staff responsible for execution of projects and acts as focal point for technical and business liaison with other program/project engineers.

Mr. Mohamed Ali has a Bachelors Degree in Mechanical Engineering from Islamic University of Technology, Bangladesh and is presently working as an Assistant Engineer in the Maldives Energy Authority (MEA). His present responsibilities includes; evaluation of technical proposals, inspection of installed power systems, supervision of power supply approval process, keeping record of licensed power

suppliers, supervision of the power license approval process, research and be aware of new technologies related to power systems.

Mr. Ahmed Inaan has a Bachelors degree in Electrical and Electronic Engineering from Islamic University of Technology, Bangladesh and is presently working as an Assistant Engineer in the Department of Meteorology and is currently the Head of Technical and Information Technology Services Unit of National Meteorological Centre (NMC). His main responsibilities include but not limited to install, repair and the maintenance of all meteorological equipments.

He is currently fulfilling the role of Project Manager for the construction of new building at NMC and also acting as the senior consultant for establishing National Early Warning System in the Maldives. This project involves establishing a Doppler Weather Radar, six automatic weather stations and a seismometer. In addition to his professional career as an electrical engineer, he has worked in the Construction industry where he has obtained extensive experience in load calculations, drawing single line diagrams and site supervision of various construction projects. He is also working as lecture at College of Higher Education. *Curriculum Vitae of all the consultants are included in* **Annex 1**.

1. Executive Summary

The capital Male' is the centre of trade, commerce, business, health and education. More than one third of Maldives population (104,000) lives in Male' (land area of 1.8 square kilometers), which makes it the busiest and most populous island of the Republic. One of the busiest areas in Male' is, Male' Fish Market area located along the beach front of the west of Republic Square (Northern side of Male'). It is proposed to develop a New Fish Market (NFM) in front of existing market by reclaiming the Harbour area. The NFM will have a three story building, parking areas, two areas where fishing vessels can unload their catch, fish auction and cleaning area. Extensive and unplanned development in this location will result in a variety of environmental issues such as seawater pollution, loss of marine life habitat, the decrease of recreational fishing and accumulation of sand in some areas.

The following environmental impacts are found to be of special importance and therefore are duly considered in this Environmental Impact Assessment (EIA):

- Changes in water current
- Migration of fish species
- Seawater pollution
- Waste water
- Odour and noise pollution

Most of the mentioned environmental impacts can be minimized by modifying the current project engineering design. In the current design only one area is left for water movement. The project design should be modified in such a way that the water can have maximum flow. This will help to address above key areas of environmental impacts due to construction of NFM. Throughout the construction and operational phase, tests should be carried out to monitor seawater quality and survey should be carried out for fish species. After adjustments to the design, the NFM will have significantly low environmental impacts. Since the expected impacts are long term impacts, it is hard to quantify the impacts. It can be concluded that, if the project is to proceed with relatively minimal environmental impact with most economical method, the project design should be changed in such a way that the water can flow from different areas.

6. Project Description

In recent years, with the increase in population and vehicles in Male', has put enormous pressure on Male' Fish and Local Market area. Throughout the day, 'dhonis' and boats from all corners of the country unload fish, fresh fruits and vegetables from the atolls. On the other hand, this is also the area where most of the foodstuffs and construction materials are loaded in order to transport to the atolls.

The fact that fishing 'dhonis' come into the inner harbour of Male', right in front of the fish market and their catch are carried across the road into market makes the road so crowded and traffic congestions towards each evening (**figure 4**). Not only that, since the fish are carried across the road, fish blood make the road slippery and brings bad odour. Further more, the existing market is far too small to accommodate the fishing stock brought by the fishing vessels to Male'.

Figure 4: Often traffic congestion occurs near fish market area.

To overcome these issues (traffic, access to fish market by the fishing vessels and people), government of Maldives has proposed to reclaim the sea area in front of current market to build a new fish market. According to Male' Municipality the capacity of the planned fish market will not be required to expand during next 20-30 years or so.

The owner of the proposed new fish market location is government of Maldives. No initial project proposal document was prepared for the project. However, according to Male' Municipality, concerned stakeholders were consulted, including the Ministry of Environment, Energy and Water, Ministry of Construction and Public Infrastructure, Ministry of Planning and National Development, Ministry of Housing and Urban Development and Ministry of Fisheries and Agriculture; regarding the NFM project.

The location for the project was chosen by the Maldives Housing and Urban Development Board's planning committee. No other alternative location had been considered for the new fish market project. According to Male' Municipality, Ministry of Construction and Public Infrastructure, and Male' Municipality will have overall responsibility to operate, maintain and monitor the project during the construction phase. On the other hand, during operational phase, Male' Municipality will have overall responsibility to operate, maintain and monitor New Fish Market. According to Male' Municipality, as with the existing fish market, NFM will be leased for the operation after evaluating bid proposals.

During the designing stage, the engineering options considered were:

- Reclaim the area in such way it can have one channel
- Reclaim the area in such a way it can have two channels for water movement

According to the current design, new fish market project site will have only one channel for water movement.

New Fish Market project is divided into 2 phases. The phases are Reclamation and building a 3 story building for the fish market. It is estimated that, it will take about 100 days to reclaim the proposed site. It is planned to start the construction of the building on the site after leaving the reclaimed area for 6 months to settle the land. It is expected that the construction of the building would take another 18 months.

Annex 3 show the Scaled site and Architectural plan. The estimated cost for the proposed NFM is about MRF98,184,000.00. ***Table 1*** shows the estimated cost for different components of the project. Reclamation of the site is expected to begin once the outcome of the EIA report is made available.

Table 1: The costs involved for different components of the project.

Description of Components	Amount (MRF)
Reclamation and Coastal Engineering:	
Reclamation	7,200,000.00
Sheet pilling and coastal protection	12,720,000.00
Mobilizing and demobilizing	3,000,000.00
Building Costs:	
Ground Floor	21,600,000.00
First Floor	19,800,000.00
Second Floor	19,800,000.00
Special Roof	7,680,000.00
External works	2,400,000.00
Existing fish market:	
Ground floor	2,184,000.00
Parking	1,200,000.00
Demolition	600,000.00
Total Amount (MRF)	**98,184,000.00**

Source: Male' Municipality

The proposed new fish market would cover an area of about 2786m^2. It is estimated that the reclamation will require 24,000m^3 of debris (**figure 5**) to fill the area. The filling materials are from demolished buildings of Male' and which has been collected over years by the Municipality. Major raw materials which will be used for the construction of the fish market building include river sand, gravel, cement, iron bars, special roofing material, timber, and plywood.

Figure 5: Materials used for reclamation

The new fish market would facilitate the vessels to anchor on both sides of fish market. According to the current plan, the premises will have one way traffic flow

for land vehicles (i.e. the vehicles will enter from western side and will leave from eastern side).

The ground floor of the fish market has an open space and covers an area of about 1511 m^2 and the whole area is naturally ventilated. Ground floor also consists of deep fish area, reef fish area, fish stalls, fish cleaner's stalls, and frozen fish area. In order to minimize fish blood stains to permanently stick and to make cleaning simple and easy, the floor is made up of heavy duty polyurethane screed. Each fish stall can accommodate two sellers and salt water tap is attached for the use. This would help to keep day catch fresh for longer period.

In between stalls there are drainage systems and waste water will be directed to main drainage. This will keep market area clean and will reduce odour. Each fish cleaner's stall can accommodate two fish cleaners and a salt water tap is installed for each fish cleaner. This would help to keep cleaner's stall clean and ultimately it reduces smell. These stalls are designed in such a way that drain water flows to drainage system and fish wastes are collected to concrete rubbish bins. The floors of rubbish bins are inclined at an angle of one degree towards the drain. This will drain water and blood to drainage system and fish waste will be left in the bins. **Annex 4** shows water flow diagram including waste water, sea water and fresh water. The floor of these areas is inclined towards to the drain. This would minimize water stagnation on floor and would help self cleaning.

The ground floor also consists of closed areas and these areas are mechanically ventilated. Temperature controlled area of about 49m^2 is dedicated for waste removal. This area is expected to accommodate 7 tons of fish waste. The frozen fish area, compressor chamber and pump room would cover an area of about 24.2m^2, 9.2m^2, and 30.9m^2, respectively. The other close areas on ground floor are electricity control room, portable water sales area and toilets. Three staircases are located on ground level. Except toilets and stairs, finishing applied to all other areas are floor paint. Tiles will be used as a finishing material for toilets and stairs.

First floor of the NFM it is proposed to have a Museum (to display fish varieties), fish product area and an administrative area. The museum and fish product area would cover an area of about 1409m^2. The administrative area covers an area of about 47.9m^2 and would be air-conditioned. The museum and fish product area would be ventilated mechanically.

The second floor of the new fish market consists of a Terrace. The terrace might be developed as a café.

The new fish market will have fire alarm system certified by Fire Safety and Rescue Services of Maldives National Defence Force.

Water and electricity are not available from the site, therefore electricity for the construction will be from State Electric Company (STELCO) or own electricity by the contractor. Water from Male' Water and Sewerage Company Pvt. Ltd. (MWSC) will be used for construction. It is estimated that, for the construction a total 72,500 Litres and 36,400kWh of water and energy will be required respectively. During the operation of NFM, electricity will be provided by STELCO. The building has its own panel board. For the operation, electricity will be supplied by STELCO, electrical wiring and electrical system of the fish market premise will meet regulations of Maldives Energy Authority and STELCO. During operational phase, NFM would consume about 10,800kWh of energy per month and is expected to consume about 1.9 million Litres of water collected directly from open sea, every month. And also it is estimated the NFM will use about 250,000 Litres of fresh water per month and will be supplied by MWSC.

The project will generate waste during construction and in operational phase. These wastes should be managed effectively. Some of the solid wastes which maybe generated from construction are shown in ***Table 2.*** During construction phase, it is unlikely that the project will generate fish waste, sewage and odour. During construction noise will be generated from machineries and vehicles.

The wastes which are likely to generate from operation of the NFM are fish waste, sewage and garbage and their estimated quantities are shown in ***Table 3.*** The project is designed in such a way that the sewage and the wastewater from the NFM will not go to the ocean or sea directly. Instead, the main sewage from the NFM will go to Male' Sewerage System (MSS) and waste water will go to drainage system. The wastewater which will be generated from the toilets will be directed to MSS. The wastewater which will be generated from fish market will be accepted by Male' Sewerage system (see ***Annex 5*** - letter from Male' Water and Sewerage Company Ltd). Like existing fish market, it is expected that the NFM also will generate odour during operation. However, it is expected that odour condition in NFM will improve since there is a temperature controlled storage area where fish wastes will be stored for later collection and it is unlikely that the odour will be felt beyond 50m away from NFM. During operation of NFM, noise is likely be generated from vessels, vehicles and pump stations.

Table 2: Estimated waste generation during construction

Material	Quantity
Concrete	1 tons
Clean Wood Scrap	1-3 tons
Scrap Metal	2 tons
Empty cement and river sand bags	0.5 tons
All other wastes	2 tons

Table 3: Estimated Waste generation during operational phase of NFM

Material	Quantity / monthly
Fish waste	90 tons
Sewerage	12 tons
Garbage	5-8 tons

6.1. Waste Management Plan

Special considerations should be given to minimize generation of waste during construction and in operation. The waste which will be generated during construction and in operational phase should be managed effectively. An efficient system for collection and delivery of solid waste to designated disposal facilities should be arranged.

As a general rule, during the construction and operational phase the related procedures and guidelines of Male' Municipality, Ministry of Environment, Energy and Water, and Ministry of Construction and Public Infrastructure should be strictly followed.

6.1.1 Project Waste Handling

The following charts identify waste materials expected on this project and handling procedures.

Construction Phase

Material	Quantity	Handling Procedure
Concrete	1 tons	Break up any wastes or mistakes and put in appropriate bin and dispose in designated areas
Clean Wood Scrap	1-3 tons	Stack reusable pieces for reuse. Place unusable clean wood in wood recycling dumpster
Scrap Metal	2 tons	Deposit all metals in metal dumpster
Empty cement and river sand bags	0.5 tons	Collect and dispose into Male' waste management centre
All other wastes	2 tons	Dispose of in trash dumpster

Operational Phase

Material	Quantity / monthly	Handling Procedure
Fish waste	90 tons	Collect in clearly labeled bins and store in temperature controlled storage unit for collection by the contractor
Sewerage	12 tons	Should be directed to MSS
Garbage	5-8 tons	Collect in clearly labeled bins and should be disposed off the site

In no case should waste of any kind be discharged into the water without inspection and explicit permission from relevant authorities.

6.1.2 Communication Plan

- Waste prevention and recycling activities should be discussed at the beginning of each safety meeting.
- As each new subcontractor comes on-site, the project coordinator should present him/her with a copy of the Waste Management Plan and provide a tour of the waste collection and treatment areas.
- The subcontractor should be expected to make sure all their laborers comply with the Waste Management Plan.
- All containers should be clearly labeled.
- Lists of acceptable/unacceptable materials should be posted throughout the site.

6.2 Other Project Enhancement Features

The measures which were taken into consideration for the sustainable development during and implementation of the project include natural ventilation and lighting, thus minimizing the energy consumption by the facilities in the premises. One of the most noticeable Environment Management System adopted for the operation of the project is, temperature controlled area for disposal of waste generated from cleaning and cutting of fish. This area is mechanically ventilated in order to control the smell generated from the fish and fish waste (*see* ***Annex 3***).

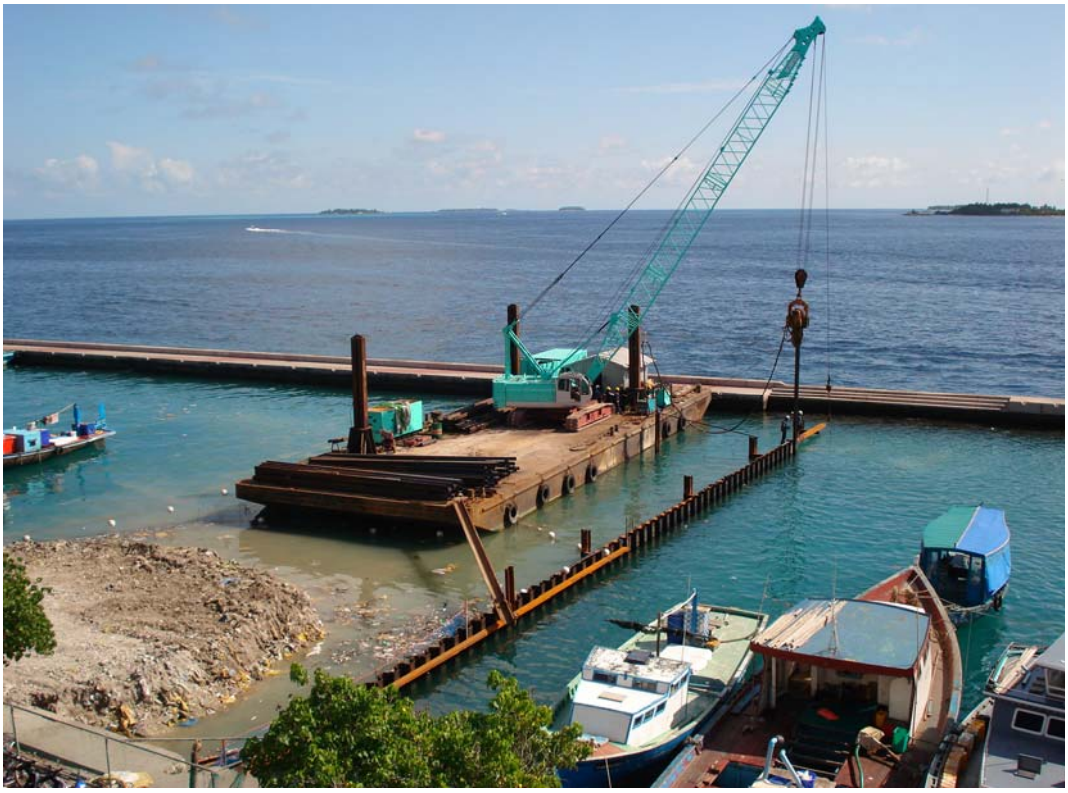
The work plan of the site preparation for the NFM project is designed in a way it will have least social impact. The proposed reclamation area is currently used by local fisherman to unload fish. Reclamation was begun after sheet piling from the eastern side of the project location and another location was allocated for fishing vessels to unload. In order to avoid land traffic in the area due to reclamation and

sheet piling work, a barge was anchored on the sea and as the work progress the barge will be relocated according to the work plan. ***Figure 6*** shows barge used for sheet pilling.

The contractor for sheet piling is Maldives Transport and Contracting Company (MTCC). So the work force and equipments will be supplied by MTCC. Important equipments include; barge and hammer. Trucks and Lorries will be used to carry debris to site for reclamation. It is expected that the project will provide employment opportunities for about 70 people during operational phase.

There are some enhancement works which are planned in conjunction with the new fish market project. It is planned to build a Harbour area around Maldives Ports Authority for unloading the goods brought from the atolls. In order to load goods, the boats will be anchored in southwest Harbour in Male'. The second enhancement work which is planned with the project is creating a road and parking plot in area where existing fish market is located.

Figure 6: Barge used for sheet piling for the proposed New Fish Market.



6.3. Climate

Climatology of Central parts of the Maldives indicates that the proposed area will experience about 215mm of rainfall on average from September to November. On the other hand, from December to April the location is expected to receive 113mm of rainfall on average. Further more, the same area is expected to receive 205mm of rainfall on average from May to August. The central parts of the Maldives indicate wind speed of 12 mile per hour (mph) from May to October, while other months indicate wind speed of 9mph, on average. Current in the channels around Male' have been recorded at 4.6mph or more. Inside the Atoll, water current is more settled. During the seasonal transition months of April and November, when the wind direction and oceanic currents are less predictable, current is more likely to be influenced by the tides and similarly flow both in and out of the channels. Since the second phase of the project is expected to last for about 18 months, *heavy rainfall and high wind speed might delay the construction process*.

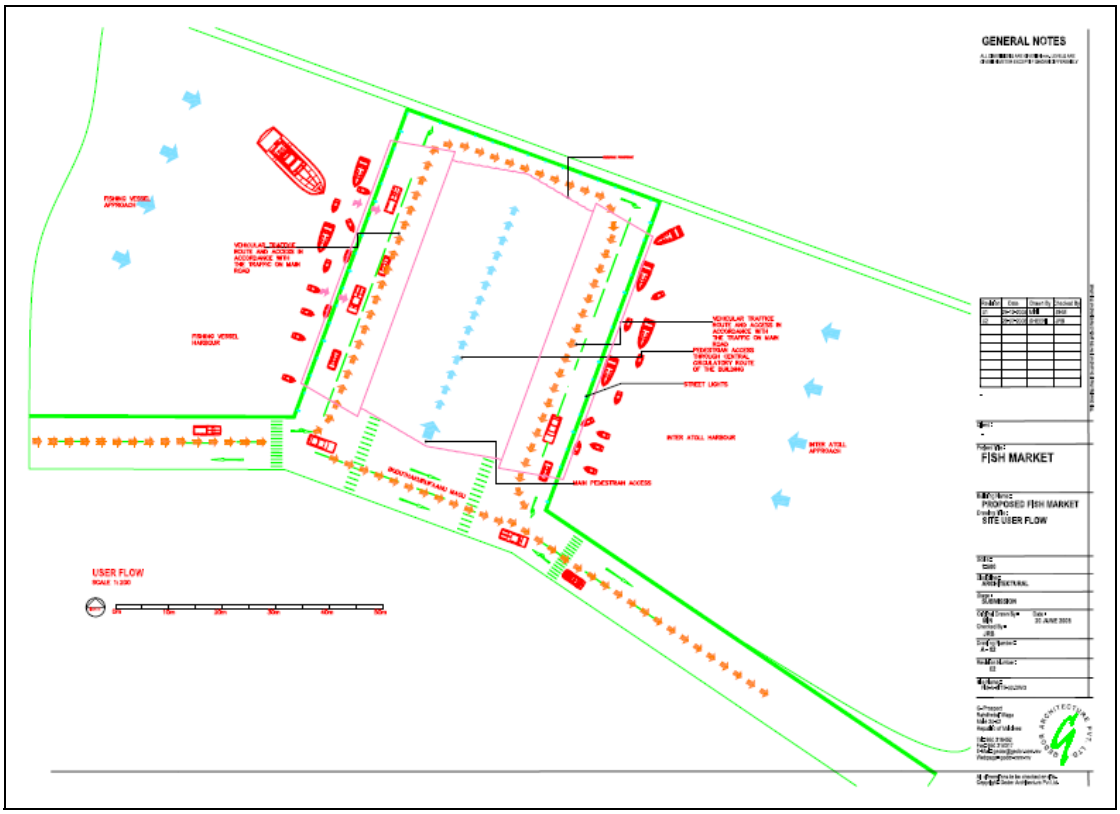
4. Project Setting

The proposed new fish market project is a multi-million dollar project. This project involves reclaiming sea area, sheet piling, building three story building and demolishing existing fish market. Undoubtedly, unplanned development in this area will have negative impacts on the environment, particularly seawater pollution and loss of marine life habitat. Environmental Impact Assessment (EIA) is one of the main types of environmental appraisal work required by the Government of Maldives.

7. Description of the Natural and Human Environment

The description of the Natural and Human environmental baseline conditions are based on field observation from surrounding area (Northern side of Male'). ***Figure 7*** shows the site plan drawn to scale. The width and length of the proposed site is about 46m and 59m, respectively. The depth of water column is about 3.5m around the site. Site Plan drawn to scale and bathymetry of proposed site is attached in **Annex 6.**

Figure 7: Site Plan drawn to scale.



The terrestrial environment at fish market area is characterized by a landscape of paved road and the road is crowded with vehicles and people. The area is noisy because of vehicles and people. The surrounding area consists of many shops and acts as a Harbour for many local boats. Since the whole area is paved, very few or no vegetations and soil exist in the area.

In addition to the shops in the surrounding, the existing fish market is located in the study area. Field visits indicate that odour exists in the surrounding area. The most noticeable sources of odour in the surrounding air might have arisen from

the existing fish market, especially from the fish cleaning area and the part of the road area where fish is carried to the market. And also, the odour might have arisen from fishing vessels approaching or leaving the market area and emissions from vehicles and 'masmaarukate hota'. The sensitive receivers of odour include customers, visitors, shop workers, fisherman and workers in the fish market. However, field visits at different times and days suggests that the nuisance from odour is only limited to approximately 50m radius.

There are no outstanding biological resources in the area. The marine environment of the project area is characterized by low productivity of fish and phytoplankton. The marine environment is some what disturbed by the reclamation of the sea area (***figure 5***). Life forms in the coastal waters of the project area are mainly abiotics: nonliving ecosystem components such as rock and sand. There are no coral reefs, seagrass beds, or algal beds. However, some fish were observed during field observation (*refer* **Annex 8**). No endangered species or cultural heritage areas are observed on the territory of the proposed new fish market construction site. ***Figure 8*** shows the aerial photographs of the proposed site.

Figure 8: Aerial view of proposed new fish market site.

Figure 9a *and* ***9b*** shows close view of channel for water movement and material used for reclamation. Although hardly any water movement can be observed

close to the road on two sides of the reclaimed area, high water current is observed at the channel which was designed for water movement, compared to other adjacent areas of the site. In addition to that, high wave action can be seen outside the sea wall. Since the wave and current action is low in some areas, some floating rubbish was observed close to road on either side of reclaimed area. It is clear from the field visits that the proposed site has some value in terms of recreational fishing (***figure 10***).

Figure 9a: Shows channel for water movement.

Figure 9b: The 2 lines shown in bottom figure indicate high(pink line) and mean(yellow line) water mark.

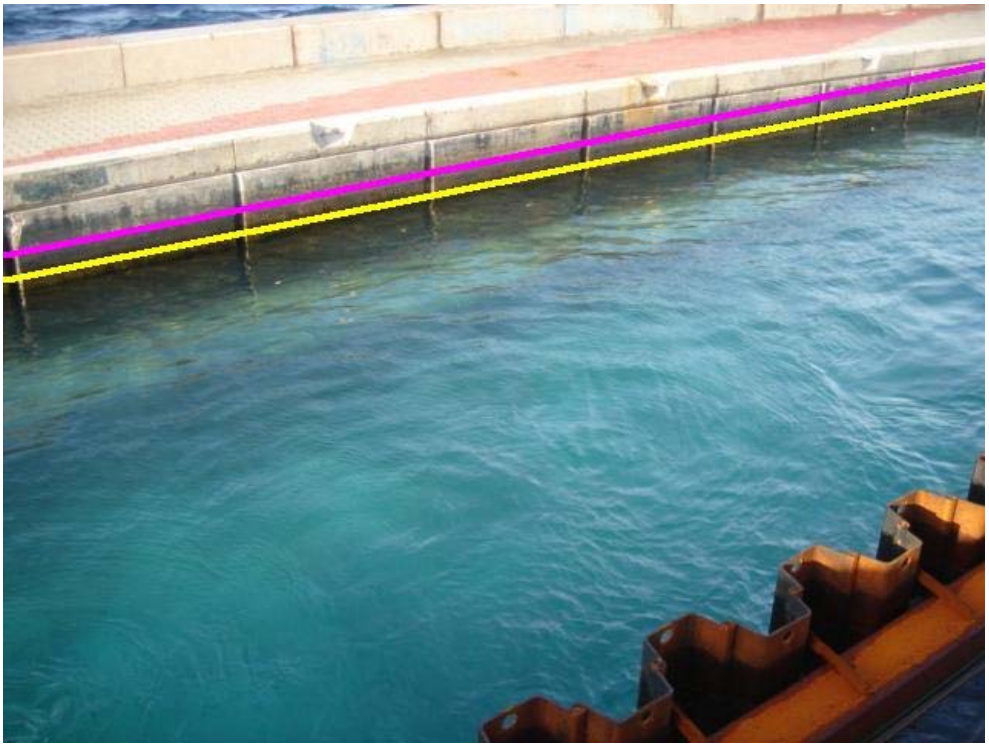


Figure 10: Proposed site has some value in terms of recreational fishing

10. Assessment of Direct and Indirect Environmental Impacts

The current design of the new fish market project will have both direct and indirect negative environmental impacts in short and long term, mostly on the marine environment. Among three principal methods for identifying environmental impacts which have been identified by *Sorensen and Moss (1973)* and *Warner and Preston (1973)*, matrices method as shown in ***Table 5*** *and* ***6*** are used. The assessment of risks to marine ecology due to the proposed activity indicated 12 negative impacts. Mostly positive environmental impacts have been identified for land based activities; noise, smell and land traffic. These positive impacts are of high to medium significance, hence no enhancement procedures are recommended. Land and marine based impacts will be dealt here separately.

Table 5: Impacts on marine environment (negative)

Indicator	Nature (+, -, direct, indirect, cumulative)	Magnitude (Minor, moderate, major)	Geographical Extent	Phase when impact occur	Duration	Significant (low, medium & high)
Water current	Direct (-)	major	Local	During construction, operation	Short to long term	High
Loss of fish species	Direct (-)	Moderate	Local	During construction	Short	High
Water pollution	Direct (-)	Moderate	Local	Construction and operation	Short to long	Medium
Accumulation of sand	Indirect (-)	Minor	Local	operation	Long term	Low to medium
Changes in temperature	Indirect (-)	Minor	Local	Construction and operation	Short and long term	Low to medium
Oil	Indirect (-)	Minor to moderate	Local	operation	Short to long term	Low to medium
Changes in salinity	Indirect (-)	moderate	Local	Construction and operation	Long term	Low to medium
Changes in pH	Indirect (-)	Moderate	Local	Construction and operation	Long term	Low to medium
Changes in BOD	Indirect (-)	moderate	Local	Construction and operation	Long term	Low to medium
Changes in DO	Indirect (-)	moderate	Local	Construction and operation	Long term	Low to medium
Fish Migration	Indirect (-)	minor	Local	Construction and operation	Short and long	Low to medium
Dying of fish	Indirect (-)	Minor	Local	Construction and operation	Short to long term	Low

10.1. Impact on Marine Ecology

Impacts on marine ecological resources may arise during the reclamation. They may be derived from direct disturbance to the habitat and indirect disturbances through changes to key water quality parameters. Reclamation of the site will have impacts on water current in the local area. Without sufficient water currents, the sea water would stagnate. Currents circulate food, nutrients and oxygen and play a major role in the reproductive success of many fish. Maturing adults

migrate into the current to their spawning grounds. Eggs and larvae are then carried by the current to their nursery grounds. Fish and other marine organism can adjust slowly changing environment, but not the suddenly changed environment. Since part of the area is now reclaimed, it is clear that the water current in some areas are lower compared to the channel. This will impact ocean parameters in short and long term which in turn affect the marine ecology.

The other direct negative impact from the reclamation is changes that will occur to fish species. Dumping of debris for reclamation of the site will kill some fish and others will be displaced. In the course of dumping, the suspended materials will disturb the water, thus making the fishes to shy away. Most fishes favour clear water. When they shy away from the polluted waters, their swimming route is changed, which is called "dispersion activity" in the fishing filed. This activity will inevitably bring two consequences: firstly in the breeding season the fish group that generates eggs here will leave on different route; secondly the distribution and swimming regulations of fish living here will be disturbed. With increasing vessels, the fishing resources and the species and density of marine organism in the water area nearby will be affected directly or indirectly. Associated with the expected changes in water current, it is likely that there will be negative impacts on turbidity, suspended solids, BOD, DO, pH and salinity. The water current measurements indicate very low water flow in some areas. This may result in water temperature getting higher in these areas, impacting parameters such as salinity, pH, BOD and DO. Furthermore, in the long run, some chemicals might be discharged from the materials used for reclamation.

The NFM could potentially result in an increase in marine traffic and underwater noise. Studies have shown that because of the efficient transfer of sound in water, some species can detect noises associated with vessels at distances up to approximately 5 km. Noise disturbance interferes with communication and echolocation pulses which are used for navigation and feeding; leading to behavioural changes. There is evidence suggesting that some marine species will minimize their use of areas affected by underwater noise. In addition, increase in marine traffics may disturb fish movement patterns through potential collision with vessels, increased turbidity generated by submerged equipment. However, these impacts are expected to be transient and low magnitude and therefore acceptable as marine species will resume their activities in the area once the reclamation is complete.

Increase in number of users of the fish market and the surrounding area might increase garbage in the area. Furthermore, with the increase in number of fishing vessel cleaning in the area might make the adjacent sea water dirty which would

bring bad smell. In addition to this, increase in marine transport might lead to pollution due to oils. This would decrease dissolved oxygen and light which penetrates into water.

Field observations and available information around the area indicates that no rare species are likely to be occurring in the areas near NFM. Some localized corals have been recorded in the area. However, their diversity and abundance was very low and they are considered to be common species around Male' area.

Of the 12 negative impacts (*refer* ***Table 5***), three impacts are considered to be of direct and eight impacts are believed to be indirect. ***Table 5*** summarizes the impacts on the marine environment. Most of these impacts can be reduce to low significance when the recommended mitigation measures are implemented effectively.

10.2. Impacts on Land Environment

There are both positive and negative impacts on the land environment. The human health impacts can be both positive and negative. The positive health impacts come from reduced traffic congestion in the area. This will reduce the amount of inhaled toxic gases emitted from the vehicles and hence it will reduce the respiratory diseases. In the long term, if the chemicals (zinc, mercury and lead) leaks to the surrounding area, the chemicals will accumulate in fish found in the area. These chemicals will be passed to human through food chain. This may cause some health problems in the long term. Furthermore, at present many fishing vessel crews use sea water from the area for bathing. Since sea water has been polluted over the years and some faecal matter are present in sea water, the situation might get worse in the future and health problems may arise in future.

The existing fish market also cause nuisance due to odour. It is expected; even with the new fish market during the operational phase odour can be regarded as unavoidable for certain extent. Odour from the market operations (fish cleaning and cleaning of fish cutting area), from fishing vessels approaching or leaving the market and would cause nuisance to the sensitive receivers to some extent.

An assessment of worst case scenarios for odour from market operations during the peak hours (from 2:30pm to 6:30pm) is considered in the analysis. Major worst case scenario envisaged is the case where the days fish catch would not sell for some reason and the fish stock start to rot inside the market. If this happens coupled with blocking of drainage system would cause unbearable odour

for the sensitive receiver in vicinity. However, considering the fact that the demand for fresh fish always exceeds the supply and the Male' population have the refrigerators in their homes to store excess fish, the worst case scenario ever occurring is very unlikely.

The odour associated with off-peak daytime operations (from 7.00am and 2.30pm), are from unloading fish from vessels and direct transfer to parked Lorries. But the odour generated from these activities may be negligible and are unavoidable and can be considered as common character of any fish market operation. In view of the fact that the throughput is considerably less than that during peak operations, it is considered that the odour emissions will at the most be 50% of peak levels.

The proposed location and design of the proposed new market will improve odour condition in the surrounding area. First, the proposed location of the market will eliminate fish carried across the road to the market and hence will minimise fish blood spills and stains on the road. Temperature is the single most important factor which controls the decomposition of fish and fish waste. The rate of bacterial growth, and therefore the speed at which fish waste decomposition, depends on temperature. The lower the temperature, the slower the process occurs. It is not possible to completely stop bacterial growth by chilling fish waste, but the rate of growth and decomposition can be significantly reduced by keeping waste at a temperatures as close to freezing as possible. These measures have been incorporated in the designing of the market. The proposed new fish market is equipped with a temperature controlled storage area (with a capacity of 7 tons at any given time), where waste from the fish cleaning will be stored for later dispatch. This low temperature controlled storage facility will minimise the rotting of fish waste. Male' Municipality has made a contract with a private party to sell the fish waste. The private party will be using the fish waste for making fertilizers.

There have been different types of detergents or cleaning compounds designed for cleaning fish market area. Most common types include chlorine, iodine and phenols. In the existing fish market in Male', chlorine is used for cleaning. Chlorine is a very effective detergent if used properly and have limited impacts. The most common misuse of chlorine occurs when solutions are improperly diluted. Chlorine is very effective in solutions with a low pH (eight or below), but the effect of the chlorine diminishes as the pH rises. Chlorinated alkaline detergents are most effective for the removal of proteins which accumulate as a result of fish gurry. Solutions of 25 to 100 parts per million (.0025 to .01 percent) are most effective when using hypochlorite. The old adage "If a little is good,

more is better," is not true when using hypochlorite solutions because as the solution becomes more concentrated, its pH rises, lowering the effectiveness of the chlorine. To avoid this problem chlorine should be used in accordance with labelled instructions. Design of the proposed new fish market has incorporated a feature which would reduce the amount of chlorine used for cleaning the market. That is, the fish cutting platforms will be covered with special type of material (polyurethane screed) so that the blood will not stain and would facilitate easy cleaning of the area. And the cleaning water will be directed to Male' sewage system. This will have very minimal impact on the marine environment and hydrodynamics of the already impacted environment. All in all, the proposed new fish market will have positive impact on odour condition, compared to the existing fish market.

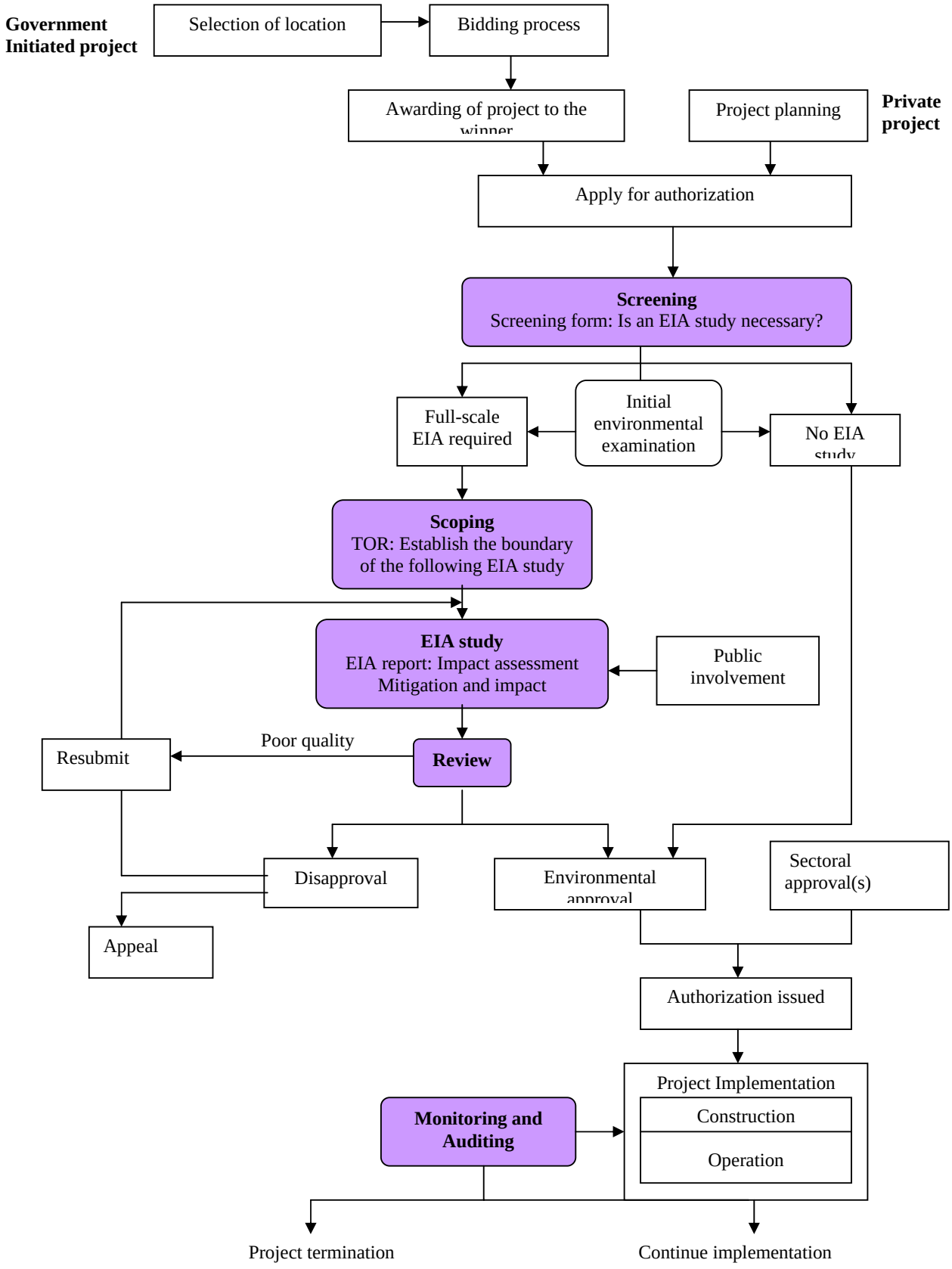
Even though there will be indirect impacts on traffic during construction phase due to heavy duty vehicles used for reclamation and construction, the proposed project will have positive impact on traffic, since it is expected that the traffic congestion and delay will be reduced significantly. This will reduce the amount of greenhouses gases emitted by the vehicles; thus helping to implement Kyoto Protocol.

The proposed construction of the new fish marked will generally have low indirect impact on noise. The transportation of debris to the construction site during the day may cause some disturbances. An alternative route, which would pass through fewer residential areas with fewer intersections, would eliminate the issues of start-stop related noise during construction. In general, it is believed that the noise from vehicles will be significantly reduced, since it is expected that the traffic congestion will be minimal during operation stage of the fish market. ***Table 6****:* Summarizes impacts on land environment.

Table 6: Positive and negative impacts on land environment

Indicator	**Nature (+, -, direct, indirect, cumulative)**	**Magnitude (Minor, moderate, major)**	**Geographical Extent**	**Phase when impact occur**	**Duration**	**Significant (low, medium & high)**
Human Health	Indirect (-, +)	Minor	Local	operation	Long term	Low
Smell	Indirect (+)	Moderate	Local	Operation	Short to long	Medium
Traffic	Indirect (+)	Moderate	Local	operation	Long term	High
Traffic	Indirect (-)	low		construction	Short term	Medium
Noise	Indirect (+)	Moderate	Local	operation	Short to long term	Medium
Noise	Direct (-)	low	Local	Construction	-Short	Medium

5. Environmental Impact Assessment Process in Maldives



The Environmental Impact Assessment System in the Maldives was established through the Environmental Protection and Preservation Act of Maldives (4/93), which came into effect in April, 1993. The legislation provides the basic framework for the EIA process in the country and the EIA procedures are laid out in the form of guidelines. Article 5(a) of the Act states that, an impact assessment study shall be submitted to the Ministry of Environment, Energy and Water before implementing any activity that may have an impact on the environment. However, this project was started (reclamation of sea area) without carrying out Environmental Impact Assessment (EIA). **Figure 3** shows part of reclaimed area for the proposed NFM.

Figure 3: Part of reclaimed area for the proposed new fish market.

11. Evaluation of Alternatives

For the proposed project, no alternative location has been considered by respective government authorities. If a new fish market were to be constructed in Male', it has to be proxy to harbour area. Costal areas of Male' is under pressure due to extensive development. The proposed new fish market location was regarded as the most appropriate site to build the market with least disruption to other facilities. For the proposed project, four engineering options can be regarded as four alternatives. Engineering options are (detail drawings in **Annex 11**):

Option 1: Build concrete pillars in sea and lay a concrete slab on pillars

Option 2: Reclaim the area in such way it can have one channel (as proposed now)

Option 3: Reclaim the area in such a way it can have two channels for water movement (One near inner harbour sea wall and the other close to the outer sea wall)

Option 4: Reclaim with one water channel (as proposed now) and two pipes or tubes (to allow significant water flow) for water movement from one side to the other in two different locations (one pipe about 2m away from inner harbour sea wall and the other in the middle)

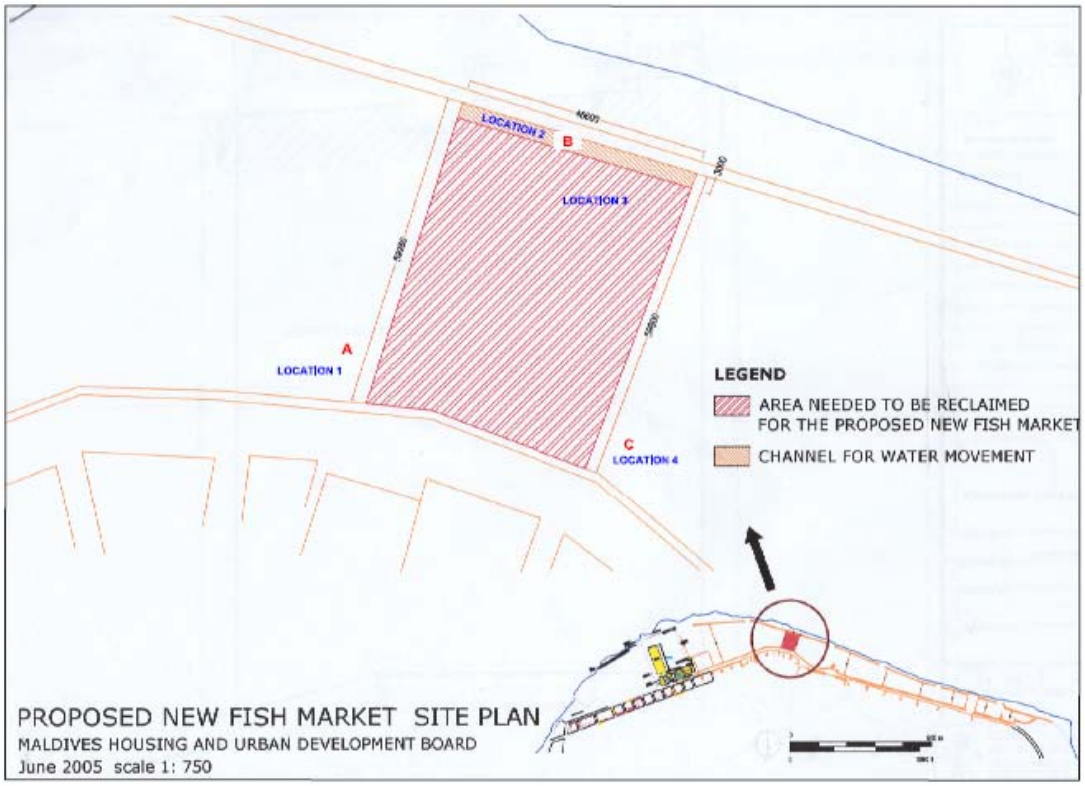
These options will be discussed in detail in the "selection of preferred alternative" section.

8. Methodology

Several visits were made to the project site for observation and to collect data. In this regard, sea water samples were collected from different locations of the site. ***Figure 11*** shows the locations where samples were taken. Tests were carried out for the following:

a. Turbidity
b. Sedimentation
c. Biological Oxygen Demand (BOD)
d. Dissolved Oxygen(DO)
e. Suspended Solids (SS)
f. pH
g. Dissolved chemicals (Lead, Zinc and Mercury)
h. Salinity and,
i. Oil

Figure 11: Showing sample locations



Points A,B & C marks the points of temperature measurements
Locations 1,2,3 & 4 shows the sample points for water parameters

There are gaps in baseline data due to the fact that the proposed site has been disturbed by the sheet piling and reclamation. Because of low water current and pollution caused by the reclamation process, some fish species might have

migrated. Not only that, it will not be possible to get true results of Turbidity, BOD, DO, SS, pH, Dissolved chemicals, Salinity and Oil which was present in the water before reclamation began. Furthermore, to get more corrective measures of the parameters, samples should be collected for longer time. Since the water column is 3.5m deep, it was assumed that the water column is homogeneous. The results of the tests are presented in ***Table 4*** and in **Annex 7.**

Table 4: Sea water sample test results

	Test Results			
Parameters	**Location 1**	**Location 2**	**Location 3**	**Location 4**
Turbidity	0 NTU	0 NTU	0 NTU	0 NTU
Suspended Solids	0.00 mg/L	0.00 mg/L	0.00 mg/L	0.00 mg/L
pH	8.1	8.0	8.0	7.9
DO	4.7 mg/L	3.8 mg/L	4.8 mg/L	4.8 mg/L
BOD	7.2 mg/L	11.1 mg/L	10.0 mg/L	7.1 mg/L
Salinity	30700 mg/L	30900 mg/L	31200 mg/L	30900 mg/L
Lead	0.008 mg/L	0.004 mg/L	0.004 mg/L	0.007 mg/L
Mercury	0.000 mg/L	0.000 mg/L	0.000 mg/L	0.000 mg/L
Zinc	0.00 mg/L	0.00 mg/L	0.00 mg/L	0.00 mg/L
Oil	0.000 mg/L	0.000 mg/L	0.000 mg/L	0.000 mg/L

Data were collected from two locations to get the water current in the area. The result shows that the water flow is negligible at point C (***figure 11***). On the other hand, in the channel water current is 4.6mph on average. **Annex 8** shows the results of water current in the channel. To get true picture of measurements of water current, data should be collected for a longer period and from more locations. Data from tide station at Hulhule indicates tidal range of about 1m. Sea surface temperature was obtained from 3 points (***figure 11***: points A, B and C). Temperature from points A and C was found to be 31 degrees Celsius. On the other hand, point B indicates temperature of 29.5 degrees Celsius.

In order to get the existing fish species in the proposed site, Ministry of Fisheries and Agriculture and Marine Resource Centre were contacted. The fact that the ministry and centre were not able to provide information of species found in the area, a survey was undertaken (questions were asked from recreational fisherman in the area) to get the fish species found in the area. List of fish species found in the area is attached at the **Annex 9.**

8.1. Turbidity and Suspended Solids

Turbidity is the result of suspended sediments and is a relative measure of the clarity of water: the greater the turbidity, the murkier the water. When levels is less than 5 units are considered safe (*Water Quality Research Council Water Review, 1990*). On the other hand, when the Suspended Solids (SS) is less than 20mg/L is considered as normal. This indicates that the potential impacts of turbidity and suspended solids to the marine environment in the vicinity of the project site are anticipated to be minimal (*refer* ***Table 4***). However, during reclamation and construction, these parameters might change. Increased SS in the water column combines with a number of other factors reduce Dissolved Oxygen (DO) concentrations in water. Elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis of phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. This has a particularly adverse effect on the eggs and larvae of fish, as at these stages of development high levels of oxygen in the water are required for growth due to high metabolic rate.

8.2. pH

Measuring the pH level in water bodies is an important factor for determining aquatic life. A normal reading for salt water is between 7.5 and 8.5. When pH is high, it can limit the ability of gills to transport ions essential to the fish, which can lead to osmoregulatory failure or death (Murdock et al 2001). From the results in (***Table 4***), it is clear that the pH is in the normal level for sea water. Ocean water has an excellent buffering system with the interaction of carbon dioxide and water so that it is generally always at a pH range of 7.5 to 8.5. It is unlikely that there will be any negative impact due to changes in pH in the area.

8.3. Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD)

One of the key water quality parameter that is intimately linked with the health of marine biota is Dissolved Oxygen (DO). This is the amount of oxygen available to the fish in the water. The oxygen dissolved in water is as vital for most aquatic organisms as oxygen in air for terrestrial animals. A safe level of dissolved oxygen in sea water is 7 - 9 mg/L (*Murdoch et al 2001*). The saturation point of DO in water is dependent on the temperature (*Kegley and Andrews 1998*). At all of the 4 locations (***Table 4*** *and* ***Figure 9***), Dissolved Oxygen levels were not within a healthy range. Low DO concentration levels can have adverse effects of fish health including respiratory stress, tissue hypoxia and eventually death. In

most cases, if dissolved oxygen concentrations drop below 5mg/L (5 ppm), fish will be unable to live for very long.

The level of DO decreases as the temperature and salinity of the water increase. Biological Oxygen Demand (BOD) is the measure of demand for DO in the water. BOD can increase due to introduction of nutrients from boats and run-off from the land and this would quickly deplete DO needed by organisms. The increase in BOD in the water from boating or other human activity often coincides with warmer temperatures, exacerbating the depletion of DO. DO and BOD levels measured across the area indicated unacceptable value for most of the aquatic species. Areas with a high BOD and low DO will not support much life.

8.4. Salinity

The salinity of seawater is usually 35,000mg/L or ppm (parts per million) in most marine areas. This salinity measurement is a total of all the salts that are dissolved in the water. Although 35,000ppm is not very concentrated, variations occur in ocean salinity due to several factors. The most common factor is the relative amount of evaporation or precipitation in an area. If there is more evaporation than precipitation then the salinity increases (since salt is not evaporated into the atmosphere). If there is more precipitation (rain) than evaporation then the salinity decreases. Many marine organisms are highly affected by changes in salinity. This is because of a process called osmosis which is the ability of water to move in and out of living cells, in response to a concentration of a dissolved material, until equilibrium is reached. ***Table 4*** shows that the salinity is lower than the normal levels. This might be due the fact that heavy rain was experienced in that areas on the day samples were taken.

8.5. Dissolved Chemicals (Lead, Mercury and Zinc)

Lead is a natural element that is persistent in water and soil. Most of the lead in environmental media is of anthropogenic sources. The mean concentration is 0.00005 mg/L in sea water. The evidence shows that lead is a multitargeted toxicant, causing effects in the gastrointestinal tract, haematopoietic system, cardiovascular system, central and peripheral nervous systems, kidneys, immune system, and reproductive system. Overt symptoms of subencephalopathic Central Nervous System (CNS) effects and peripheral nerve damage occur at blood lead levels of 0.4-0.6 mg/L, and symptoms, such as peripheral nerve dysfunction, occur at levels of 0.3-0.5 mg/L in adults. The causes of death most often associated with exposure are cardiovascular disease, renal disease, and cancer (*Cooper, 1988; Agency for Toxic Substances and Disease Registry, 1997*). The test results (***Table 4***) shows that the lead concentration for the four locations

were higher than normal level (0.004 to 0.008mg/L). However, it is not clear that these lead has emerged due to reclamation or was initially present. Hence special measures should be taken not to use materials for reclamation which are contaminated with chemicals such as lead, zinc and mercury. There is no evidence to show that the site contains zinc and mercury.

8.6. Oil

The fact that the result shows 0.000 mg/L oil indicates that the sea water was not polluted by oils. However, site observations shows that oil presents on the sea surface. The difference between test results and the site observation could be due to the time and the day when samples were collected.

8.7. Seawater temperature

Water temperature has profound physiological effects on organisms, and if the water temperature goes too far above the tolerance range of an organism, the organisms ability to survive will be compromised. As temperature increases, the amount of dissolved oxygen decreases. Corals are particularly vulnerable to increased seawater temperature as they live within a relatively narrow temperature range, and positive or negative temperature anomalies of only a few degrees can induce bleaching. The most extensive and intensive coral bleaching events on record occurred in 1998 and 2002. In 1998 event, about 90% of corals in Maldives experienced coral bleaching. Sea temperature found to be between 29.5 and 31 degree Celsius in the project area. However, if sea water gets stagnant in some areas as predicted (especially location 1 and 4) the temperature might increase in these areas. Not only that, it is expected that global sea surface temperature will increase due climate change in future (*IPCC, 2001*). This might have many ecological implications in the area.

13. Mitigation Measures

Considering current situation of the site and the costs involved for the project, it appears that it is almost inevitable that the proposed new fish market will go ahead without reclamation of marine area. Reclamation will disturb the surrounding marine area. To minimize the impacts to both land and marine area, special mitigation measures should be taken.

First, the current design should be modified in such a way that the water can flow from different locations (refer Option 4 and **Annex 11**). To allow water to flow all the time, the pipes or tubes should be installed at a level in such a way that the water can flow at low tides and the pipes should not be touching at the bottom, to minimize sand being carried through pipes to the other side. This will have very minimal impact on water current and hence water parameters. Periodic dredging should be done depending on how fast the sand deposits on two sides.

The second mitigation measure which should be taken is that the required plot should be sheet piled before reclamation proceeds any further, to minimize turbidity, sedimentation and total suspended material. The materials (debris or sand) that will be used for reclamation must not be contaminated with chemicals (like batteries, lead, mercury and zinc) to prevent such chemicals leaking into the water.

13.1. Mitigation plan for water pollution

The measures to minimize the impact to the marine water quality by the project should be estimated in planning stage. The following can be considered in the planning stage:

- Installation of water exchange facilities
- Installation of facilities for processing polluted and waste water
- Establishment of mitigation measures for the polluting material of the fish market development

The increased facilities in the proposed new fish market will create greater demands for water. Because of the limited water supply in Male', ground water is used for cleaning the fish auction floor. It may not be feasible in the short term to expand the municipal water system or tap groundwater to provide for the water needs of the fish market. Therefore, engineering design should consider the use of seawater for the market washwater requirements. This will involve pumping of seawater from an offshore intake point. For other normal uses, clean water

supply systems from MWSC should be considered and the use of sea water from the area for bathing should be discouraged. With the increase in the number of fishing vessels and the users, the cleaning of the vessels will discharge fish blood water to the surrounding area and could bring bad smell to the surrounding area. Awareness should be raised among fishing vessel crews so that less cleaning water will be discharged to the surrounding sea and sea water will not be used for bathing purpose and sign boards should be displayed indicating such practices. Deposited garbage's on water should be collected regularly and disposed.

13.2. Other measures

13.2.1 Odour

As a result of prevailing wind direction and strength there is a low risk that a few receivers may experience a minor and temporary odour impact. Mitigation measures proposed to cope with the cases like this comprise of the following:

- No on street parking for loading fish to Lorries by providing adequate parking within the premise. (Loading and unloading area is incorporated in the building design)
- Provision of a mechanical ventilation system to extract odour from inside the premises and discharge from the seaside
- Implementation of a management plan to ensure and monitor good handling and cleansing practices at the market, including suitable containment and daily removal of all organic waste and regular maintenance of equipment.
- Good design with easy clean detailing and use of impervious materials to avoid build up of odour from organic material carried in washing water.
- Frequent cleaning during peak hours
- Cleaning brushes and mops should be kept in a clean and sound condition and should be disinfected after each use (dipping it 50ppm chlorine solution is recommended) and when not used should be stored in a dry state. This would reduce the odour and would minimize proliferation of micro-organisms.
- Deodorizing systems should be incorporated in the designs of the NFM

The above measures will ensure that there is minimal risk of unacceptable residual odour impact at any of the identified receivers as a result of market operations.

In summary, the construction and operation of the complex should not lead to unacceptable odour nuisance to sensitive receivers provided that the recommended mitigation measures are adopted effectively.

13.2.2 Noise

The construction of the proposed NFM complex is anticipated to last for 27 months (including 3 months piling). Field assessment demonstrates that there can be construction noise impact on the nearby sensitive receivers during the foundation and superstructure phases. The assessment demonstrates that with appropriate mitigation measures, such as using low noise mechanical equipment, the construction noise levels at the nearby sensitive receivers can be minimized.

The transportation of debris to the construction site during the day, with the stop-start operation of the trucks at intersections in residential areas, may cause disturbances. An alternative route, which would pass through fewer residential areas with fewer intersections, would eliminate the issues of start-stop related noise during construction.

Practical noise mitigation measures such as scheduling of works, use of movable noise screens and good site management practices are recommended to further alleviate the potential construction noise impact. The assessment has identified fixed noise from market operations, traffic noise from additional Lorries using the area and marine traffic noise from fishing vessels approaching or leaving the market as potential sources of operational noise impact. Sources of fixed noise arising from the market operations and building services plant including that from vessels berthed at the waterfront and lorries loading or waiting to load fish will not cause unacceptable noise impact on any identified sensitive receivers after the recommended mitigation measures are implemented.

Mitigation measures to minimize the noise impacts from the operation of the NFM have to be integrated in the building. These measures include

- full enclosure to lorry parking and NFM operations facing nearby sensitive receivers,
- acoustic louvers and silencers for mechanical ventilation system and other building services plant,
- provision of sufficient parking spaces inside the premises to avoid traffic congestion on-street and in premises and to reduce queuing of lorries
- implementation of a management plan to ensure and monitor good
- Practices for vessel management and schedule regular maintenance of equipment.

Traffic noise from Lorries using the market is not expected to cause unacceptable impact on nearby sensitive receivers in view of the limited additional traffic involved. Nevertheless, to minimize the potential off-site traffic noise nuisance

that may be caused to nearby sensitive receivers, the NFM access junction will be designed to allow only entrance to or exit from the NFM complex. Marine traffic noise from the engines of vessels approaching or leaving the market is not expected to cause potential nuisance to any of the sensitive receivers close to the market irrespective of the route they take and it is unlikely that the associated marine traffic noise impact will be greater than at present.

Good management practices should be adopted throughout the operation of the NFM in order to further minimize the potential noise nuisance:

- Assistance should be sought from NFM users and vessel operators to prohibit the use of loudhailer and reduce horn tooting along the seafront
- Vessel operators should be requested to avoid horning except in emergency and to use other means such as phones to notify their presence
- Vessel operators should be encouraged to use silencers at fishing vessels' exhaust
- Practical and safe movement within the harbour should be monitored and maintained, and where possible minimize noise impact to nearby sensitive receivers.

In summary, the construction and operation of the NFM complex will not lead to unacceptable noise impact at any of the identified noise sensitive receivers provided that the recommended mitigation measures are adopted.

During the reclamation and construction, measures should be taken to prevent the soils from leaking in the course of transportation especially in poor weather. When the wind is of Class 6 or above, dumping should be stopped. Reinforce measures to prevent accidents and safety measures should be taken in advance. In order to ensure the safety operation, clear signage around the selected dumping area should be placed. It can help the vehicles going in and out the dumping area.

During operation of the facilities, operational best practice must be encouraged to minimize energy and water usage. Awareness should be raised among different users to minimize the energy and water consumption. Low energy and water appliances should be installed in the premises.

14. Monitoring Plan

Management actions and requirements for operational best practice must be incorporated into the Environmental Management Plan (EMP) for the design of the proposed structure, its construction, and mitigation measures proposed for addressing possible pollution. The EMP should be designed so that it will monitor the effectiveness of management actions. It will include regular auditing and reporting, and the monitoring programmes will promote continuous improvement and identify any negative trends that need to be managed effectively.

14.1. Institutional Monitoring Arrangements

The Project Executing Agency (Male' Municipality), will have overall responsibility for both operational monitoring and environmental monitoring of the Project. The cost of both environmental and operational monitoring must be covered under the project budget.

14.2. Environmental Monitoring Program

To monitor environmental impacts during construction phase, site-based Project Implementing Unit (PIU) to be established at the new fish market proposed site. The PIU should be headed by Site Managers and staffed by personnel from Male' Municipality and assisted by Project Consultants. The PIU should have adequate and qualified technical staff. The PIU should carry out the day-to-day environmental monitoring work for all the project components within their areas of coverage. With inputs from PIU, Male' Municipality should be responsible for preparing consolidated environmental monitoring reports as part of the regular project monitoring and they should prepare monitoring and assessment reports for submission to the Ministry of Environment, Energy and Water. Reporting should be done annually and summary reports should be prepared every two months.

The monitoring program should be a continuing program of data gathering and analysis to ensure the effectiveness of the mitigation measures for potentially adverse environmental impacts arising from construction and operation of new fish market project facilities. The following should be monitored:

1. possible changes in coastal deposition resulting from disruption of natural sediment transport (once every year)
2. water quality during reclamation particularly for key parameters including suspended solids, biological oxygen demand (BOD), dissolved oxygen (DO), pH, salinity, turbidity and oil (once every month)

3. wastewater discharges during market operation, particularly washwater from the fish auction hall, sanitary water from toilets, and bilge water from boats;
4. water quality in the harbour basin and surrounding coastal water during NFM operation, particularly for key parameters including suspended solids, biological oxygen demand (BOD), dissolved oxygen (DO), pH, salinity and oil (once every 3 months)
5. test for chemicals (lead, zinc, mercury) during operation (once every 6 months)
6. fish species found during operation (once year)
7. regular odour patrols should be carried out to monitor and verify if the operation of the NFM would cause any odour nuisance to the nearby sensitive receivers (every 3 months).

The samples should be collected from at least 3 locations (from the channel and from 2 sides). The Male' Municipality should pay particular attention to the specified mitigation measures for odour reduction and to any complaints that arise from nearby receivers. During the initial 12 months of operations regular odour patrols should be carried out to monitor and verify if the operation of the NFM would cause any odour nuisance to the nearby sensitive receivers.

In the event that such monitoring show a distinct incidence of unpleasant odour at any receiver that is confirmed to be attributable to the operations of the NFM there is provision in the building design to incorporate a scrubber system into the ventilation system to remove odour.

The most important role of monitoring in operation stage is to validate the impact predicted in environmental impact assessment (EIA). If the monitoring reveals higher impact compared to the prediction in EIA, the additional mitigation measures should be established. Conversely, the mitigation measures established in the EIA process could be lightened when the monitoring shows lower impact relative to the prediction. Also the monitoring result can be used for feedback to other similar marine reclamation project, which results in more accurate prediction. Thus the monitoring of construction and operation stage should be planned to meet this objective.

14.3. Operational Monitoring Program

During operational phase, Male' Municipality should monitor fish market facilities to meet the Standard Operational Standards (SPS). A staff should be designated for operational monitoring of the premises. The monitoring program should be

continuous to ensure the effectiveness of the mitigation measures for potentially adverse impacts arising from operation of new fish market facilities. The following should be monitored regularly:

- water consumption, requirements and water supply during operation (every 6 months)
- Energy consumption, requirements and supply during operation (every 6 months)
- Fire Alarm Systems (every 2 months)
- Fire exits (every 6 months)-should not blockage fire exits
- Check for tripping of MCB and Circuit Breaker for any damages and electrical shortage (Monthly)
- Ventilation systems (every 6 months)
- Check drainage system for blockages (Monthly)

Male' Municipality should take necessary actions if the monitoring reveals the operation of fish market and premises are below Standard Operational Standards. Special considerations should be given to minimize fire, oil spills and labour accidents and loss of life and property during operational phase. During an emergency, following contingency plans should be implemented effectively.

14.4. Contingency Plan for Fire hazards

14.4.1 General Operational Procedures

- Proper housekeeping including the prompt removal of wastes and keeping the NFM of unnecessary combustible materials will help to prevent or reduce the severity of fires.
- Limited quantities of flammable liquids may be stored in the premise.
- Storage of combustible materials such as cardboard boxes, etc. should be kept to a minimum.
- Electrical wiring should be maintained in good condition.
- The emergency numbers should be posted on the walls in each level.
- Fire alarms and extinguishers should be maintained in good condition at all times.
- Exits should be labelled and maintained.

14.4.2. Fire Emergency Response

If the fire alarm gets activated or a fire is discovered:

- Alert other people in the area in order to evacuate
- Activate the nearest fire alarm
- Call fire and rescue at 118
- Do not re-enter the premises unless all clear indication is given.

If trained member of staff are available at the scene:

Small fires can be extinguished without evacuation.

- Alert people in the area.
- Activate the fire alarm.
- Smother the fire or use the correct fire extinguisher.
- Maintain an accessible exit.
- Avoid smoke and fumes.
- Remain available to answer questions from fire and rescue.

14.4.3. Emergency Response for Marine Fire

In the event of a fire on a vessel near the NFM and the vessel's crew is unable to contain the fire, Coast Guard and Fire and Rescue should be contacted immediately. Upon arriving at the scene, an officer from Fire and Rescue team should assume charge of all aspects of the fire fighting operation.

14.5. Contingency Plan-Hydrocarbon spills

14.5.1. General Guidelines and procedures

First priority in the event of a spill is protecting human health and safety. It is imperative that the safety of rescuers is ensured before attempting to rescue any victims. Therefore it is important that nearby personnel are alerted of the situation before action is taken.

In order to respond rapidly and successfully to Hydrocarbon spill, personnel responsible for containing and cleaning up the spill must know the steps that need to be followed during and after the spill. When used properly by trained personnel, a well-designed contingency plan enables oil spill response efforts to proceed smoothly and effectively, minimizes danger to cleanup personnel, reduces the overall costs of cleanup by avoiding unnecessary effort, and ensures that sensitive habitats are protected.

14.5.2. Response Techniques

A number of advanced response mechanisms are available for controlling oil spills and minimizing their impacts on human health and the environment. The key to effectively combating spills is careful selection and proper use of the equipment and materials best suited to the type of oil and the conditions at the spill site. Most spill response equipment and materials are greatly affected by such factors as conditions at sea, water currents, and wind. Damage to spill-contaminated shorelines and dangers to other threatened areas can be reduced by timely and proper use of containment and recovery equipment.

Mechanical containment or recovery is the primary line of defence against oil spills. Mechanical containment is used to capture and store the spilled oil until it can be disposed of properly.

Chemical and biological methods can be used in conjunction with mechanical means for containing and cleaning up spills. Dispersants and gelling agents are most useful in helping to keep spill from reaching shorelines and other sensitive habitats. Biological agents have the potential to assist recovery in sensitive areas such as shorelines.

Physical methods are used to clean up shorelines. Natural processes such as evaporation, oxidation, and biodegradation can start the cleanup process, but are generally too slow to provide adequate environmental recovery. Physical methods, such as wiping with sorbent materials, pressure washing, and raking and bulldozing can be used to assist these natural processes.

Where there is threat to birds and animals, scare tactics can be used to protect birds and animals by keeping them away from oil spill areas. Devices such as propane scare-cans, floating dummies, and helium-filled balloons are often used, particularly to keep away birds. Scare tactics is not necessary for NFM area, since no birds and animals can be found in the area.

14.5.3. Spill Control and Cleanup Procedure

Small spills of non-ignitable, low toxicity liquids should be handled by trained staff. High hazard spills will be handled by an outside, licensed hazardous spill response contractor.

14.5.4. Spill Response Actions

In the event of a spill, take the following actions:

1. Render first aid, if necessary.
2. Make emergency notifications using the emergency telephone numbers

    - Fire (118) and Police (119)
    - Other numbers, such as hospitals, large-spill environmental contractors, etc.

3. Make initial assessments regarding spill. Has hydrocarbons spilled into or near a watercourse or drainage? Has the spill created a traffic hazard? Are there immediate dangers to human health, such as inhalation of asbestos or toxic ash due to windy conditions or likelihood of fire due to spill?

4. If the spill is major and can not be safely or effectively cleaned up by crew or workers in the area, contact fire and rescue immediately
5. Document the date, time of incident, and persons on scene, summary of clean up actions taken, departure time, and any other information.

14.6. Contingency Plan- Labour Accidents

14.6.1. General Guidelines and Procedures

An accident is an unplanned event. Sometimes it injures people or damages property, sometimes not. By recognizing and eliminating the cause, it is possible to avoid repeat performance of an accident. Accidents and illnesses on the job result in a no win situation. Employees suffer from injury at workplace. It is for this reason, it is important to prevent accidents whenever possible. However, when an accident occurs, a contingency plan should be in place to follow. The following contingency plan outlines emergency procedures for work related accidents.

All accidents, no matter how minor, shall be reported promptly to the immediate supervisor for evaluation and investigation. Since every accident includes a sequence of contributing causes, it is possible to avoid a repeat performance of the first event by recognizing and eliminating the contributing causes. The removal of just a single cause can prevent a recurrence.

During the supervisor's evaluation and investigation, he/she must determine the possible consequences that could take place if the situation is not correct. Supervisors must take appropriate action based upon their findings; e.g., initiate corrective action, additional training, possible counselling and follow-up.

14.6.2. Medical Emergency Procedure

14.6.2.1. Major Injury or Illness

An ambulance should be called (Phone: 102) in the case of serious injury and when an employee needs immediate medical attention.

14.6.2.2. Minor Injury or Illness

If the severity of the injury does not warrant an emergency response of an ambulance, the injured employee could be transported to the hospital in a private vehicle (if the vehicle permits).

14.6.2.3. Near Misses: (Likelihood of personal injury or property damage)

A near-miss accident is defined as an unplanned event where damage resulted to equipment but there was no personal injury to employees, OR where damage did not result but the likelihood of personal injury to the employee was great.

If the conditions which permitted the near-miss or "close call" to exist are not eliminated, they will continue to be available to cause additional accidents which could eventually result in personal injury to an employee.

To the greatest extent possible, "near-miss" accidents shall be investigated by the employee's supervisor and reported to the appropriate authorities. Documentation should be made on the Accident Report form.

14.6.3.4. Accident Investigation

A careful and complete accident investigation should reveal the entire major contributing causes in the sequence of events. An attitude of fact-finding, not fault finding, should prevail.

14.6.3.5. Accident Reporting

If a work related injury is sustained, the following steps are to be followed:

- Report the injury immediately to supervisor, whether or not medical attention is required.
- The accident is logged on to an accident report.

9. Public Consultation

This project has a very strong beneficiary orientation for the general public. Therefore it is assumed that the relevant authorities have carried out the necessary stakeholder consultations throughout the design stage.

Furthermore a survey was conducted to explore how well informed the stakeholders are with regarding the existing and new fish market and to check if the people involved are aware of the envisaged benefits resulting from this new development.

9.1. Participants of the Survey

The interviewers asked selected questions to gauge a general perception of the major users of the existing fish market and the proposed new fish market. Considerable time and effort were spent in seeking their views and listening to their concerns.

A total of 31 people participated in the survey. A questioner was prepared (see **Annex 10** for the structure of the questionnaire) and survey was carried targeting fishermen, businessmen, boat crew and tour guides. These target groups were selected as they are assumed to have a good understanding of the fish market and the locality.

9.2. Methodology

Interviews were carried out by the EIA project team member Mr. Mohamed Ali and Mr. Ahmed Inaan. The questionnaire was designed to engage more fishermen as they are the people most affected by this NFM development. In general the questions can be group into two broad categories.

Group 1: Questions regarding the access to the fish market: For example access to the fish market, loading and unloading of goods, harboring of vessels.

Group 2: Questions regarding the fish market facilities, space and other services within the fish market

Both group of questions were designed to understand the whether the new fish market would improve the access and facilities available in the fish market. The outcome of the analysis is depicted in ***Figure 12a*** and ***Figure 12b*** which

represent the general perception regarding access and facilities in the existing fish market and the proposed new fish market respectively.

Additionally some general questions regarding their overall knowledge of the project was asked

This would help to understand their satisfaction level with these two broad areas in the existing and the proposed new fish market.

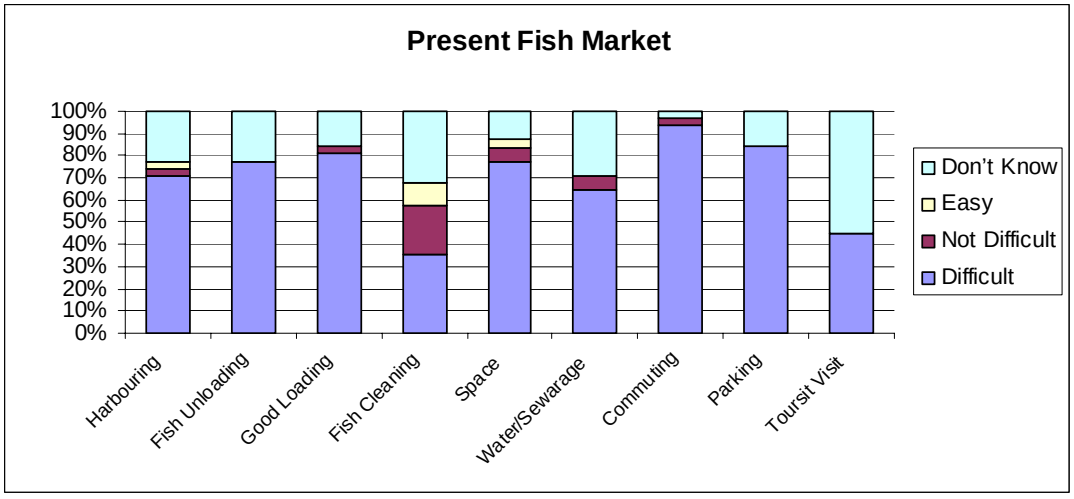
The following table gives a brief description of the variables used in the survey.

Label used in the graph	**Description of the Label**
Harboring	Difficulty in boat harboring
Fish Unloading	Difficulty in fish unloading
Goods Loading	Difficulty in goods loading
Fish Cleaning	Difficulty in fish processing
Space	Spatial constraints
Water and Sewerage	Quality of water and sewerage system
Commuting	Difficulty in commuting in the area
Parking	Difficulty in parking
Tourist Visit	Fish market as a tourist attraction

9.3. Results

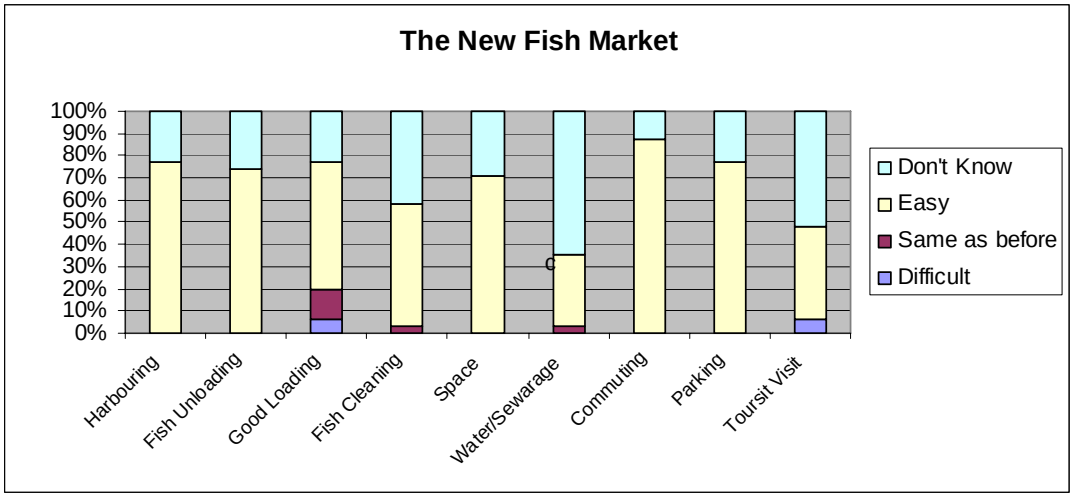
For the existing fish market as depicted in the ***Figure 12a*** it was found in general, in terms of access to the market and the facilities inside the fish market all participants agree that they are facing difficulties in both categories.

Figure 12a: Analysis of participant's response to the existing fish market



In contrast the overwhelming negative comments regarding the existing market, it is encouraging to find out the all participants in general agree that the new fish market would help to alleviate the existing problems and would in fact provide better access and facilities for the users of the market (*refer* ***Figure 12b***).

Figure 12b: Analysis of participant's response to new fish market development



With regarding the general questions asked 62% people of the sample population agrees that they have acceptable level of awareness regarding this project (*See* ***Figure 12c***). An overwhelming 94% agree that this new project is important to provide better access and facilities (*see* ***Figure 12d***). Furthermore, 77% people sample population agrees with the proposed location for the new fish market.

Figure 12c: General public awareness of the new fish market project

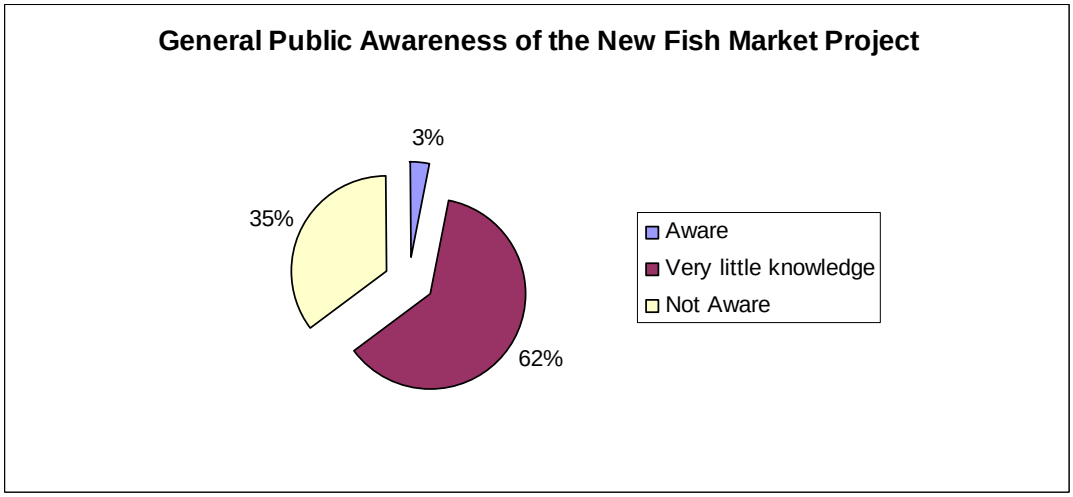
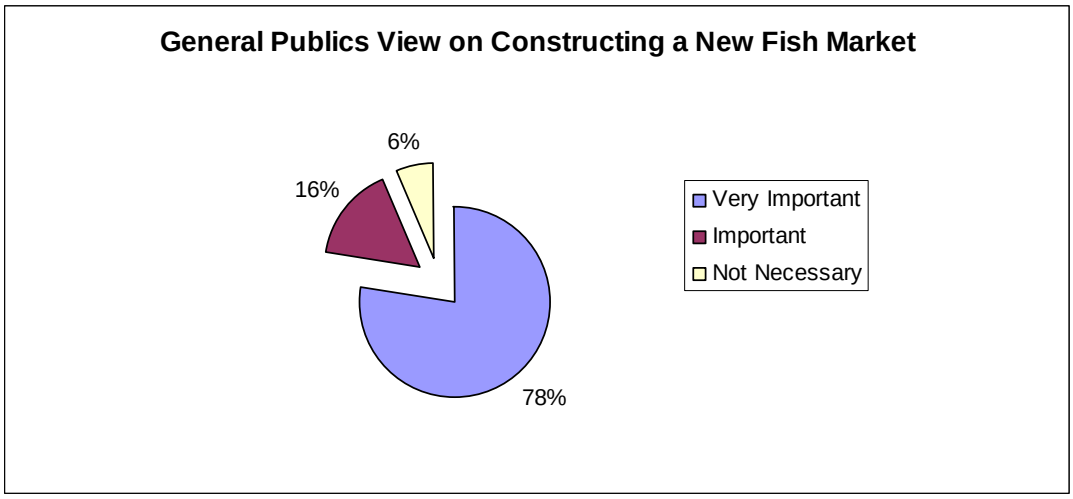


Figure 12d: General public views on constructing a new fish market

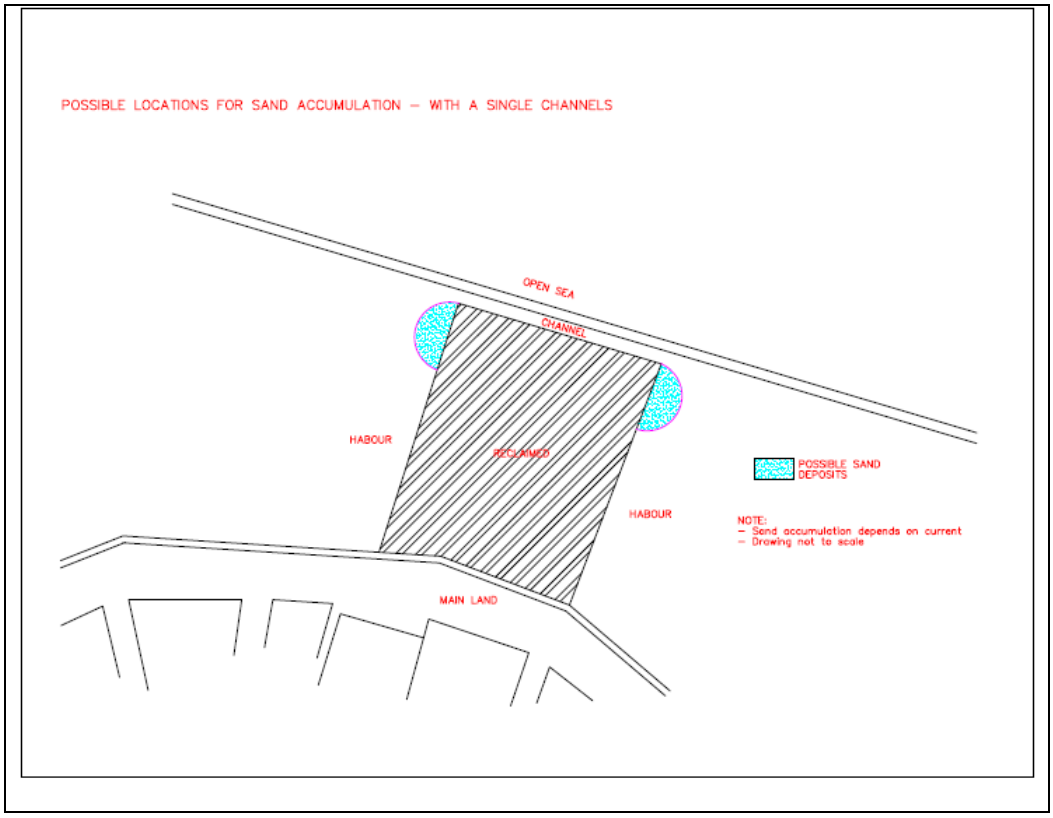


As an additional comment many respondents pointed out that they expect better availability of drinking water in new fish market facility.

12. Selection of the Preferred Alternative

Even though, the first engineering option mentioned above (Build concrete pillars in sea and lay a concrete slab on pillars) will have very minimal impact on both the land and marine environment among four alternatives, economically it might not be viable for the NFM. Hence, this option can be regarded as no development option. This leaves the option of reclamation of the site. Since this project is of national benefit and interest, reclamation of this marine area is almost inevitable. The second, third and forth options will have equal impact on the land environment. The second option mentioned above will have direct major impact on water current in the local area. Associate with changes in water current, there will be indirect marine impacts (***Table 5***). Furthermore, the current is noticeably high at the channel compared to other locations, there is high probability that the sand from the water channel will be carried away and will be deposited on either sides of the reclamation area as shown (see ***Figure 13a***). This will result in the channel getting deeper and in long term sand might be eroded from the reclaim area.

Figure 13a: Locations showing where sand might be deposited in future.



The third engineering option will have less impact compared to first and second option. However, if two channels were made from two ends, it is likely that the sands from two channels will deposit on two sides of reclamation area (***Figure 13b***). This will result in the channels getting deeper and in the long run sand might be eroded from the reclaimed area and under the inner harbour Sea Wall sheet pile (as experienced during the 26th December 2004 tsunami). Taking account of the current situation of the site (part of proposed location has been reclaimed), the fourth option (reclaim the area with one water channel (as proposed now) and two pipes or tubes (approximately 0.5m in diameter or more) for water movement from one side to the other in two different locations (one pipe about 2m away from inner harbour sea wall and the other in the middle) is more financially feasible and will have the least impacts on the marine environment and land environment. ***Table 7*** shows the expected impacts on marine environment after changing the current design of the project (as recommended in option 4) and appropriate mitigation measures (described below) are taken.

Figure 13b: Locations showing where sand might be deposited in future.

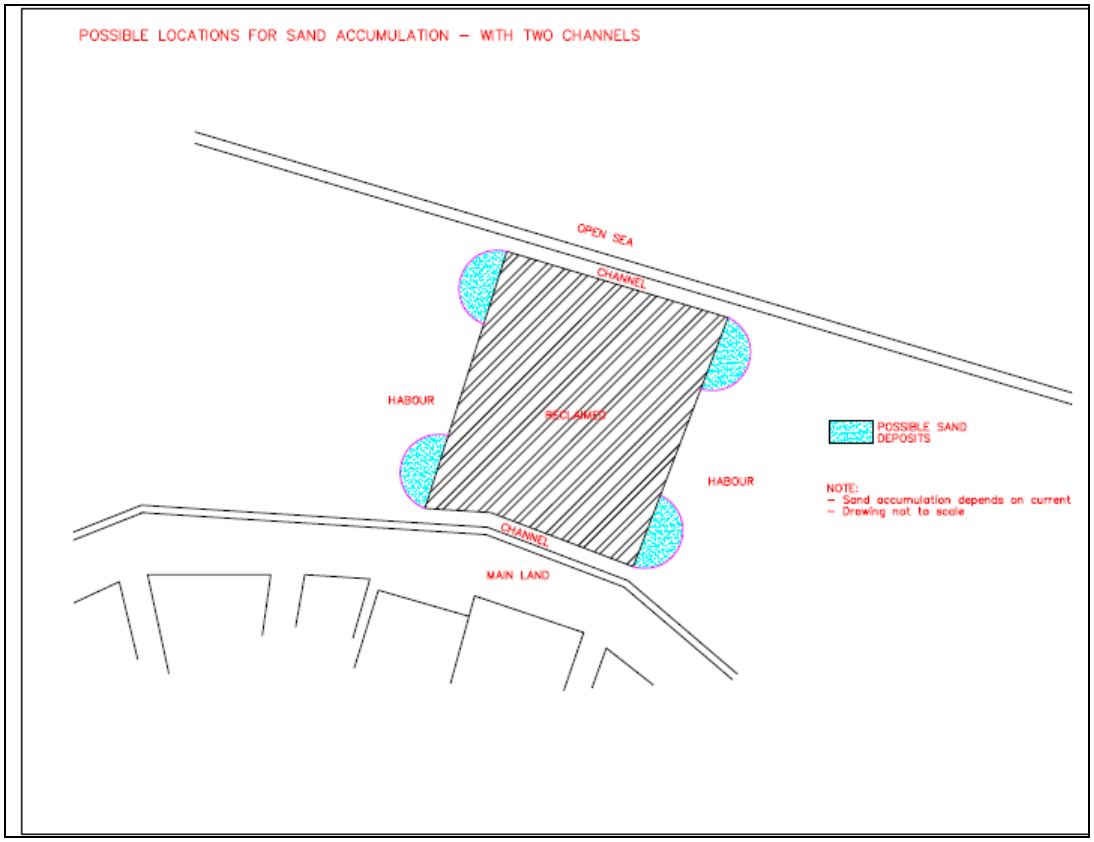


Table 7: Impacts on marine environment (negative)

Indicator	Nature (+, -, direct, indirect, cumulative)	Magnitude (Minor, moderate, major)	Geographical Extent	Phase when impact occur	Duration	Significant (low, medium & high)
Water current	Direct (-)	Low	Local	During construction, operation	Short to long term	Low
Loss of fish species	Direct (-)	moderate	Local	During construction	Short	Low
Water pollution	Direct (-)	Low	Local	Construction and operation	Long	Low
Accumulation of sand	Indirect (-)	Low	Local	operation	Long term	Low
Changes in temperature	Indirect (-)	Low	Local	operation	long term	Low
Oil	Indirect (-)	Low	Local	operation	Short to long term	Low
Changes in salinity	Indirect (-)	Low	Local	operation	Long term	Low
Changes in pH	Indirect (-)	Low	Local	operation	Long term	Low
Changes in BOD	Indirect (-)	Low	Local	operation	Long term	Low
Changes in DO	Indirect (-)	Low	Local	operation	Long term	Low
Fish Migration	Indirect (-)	Low	Local	operation	long term	Low
Dying of fish	Indirect (-)	Low	Local	operation	long term	Low

3. Terms of Reference

The agreed terms of reference for the Environmental Impact Assessment for the project are included in **Annex 2**.

15. Conclusion

Due to increasing population in Male', increase in traffic congestion in Harbour area and the lack of space in existing fish market for auction, a solution is urgently required. The government of Maldives has proposed to build a new fish market in front of existing market by reclaiming harbour sea area.

Based on environmental, social and technical analysis the proposed location for the construction of NFM is most suitable for the land scarce Male'.

The proposed project is highly unlikely to have major negative environmental impacts on global, national and regional scale. The proposed design of the project is expected to have local environmental impacts confined to that area only. However, if the mitigation measures are taken (most importantly the mentioned engineering option 4 is considered and implemented effectively), it is quite certain that the project will have very minimal environmental impact on the local environment.

Male' Municipality should monitor the local environment and tests should be carried out on water parameters during both construction and operational phase. If the monitoring reveals adverse impact compared to the prediction in EIA, additional mitigation measures should be established. On the other hand, if the monitoring reveals that there are no significant impacts, the monitoring established in the EIA process could be lightened.

16. Appendices

16.1. Tables and Figures

List of Figures

List of Tables

16.2. Reference

- Agency for Toxic Substances and Disease Registry, 1997. *Toxicological Profile for Lead*, Atlanta, GA: Department of Health and Human Services.
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16.3. Definitions

1. **Current:** water moving continuously in a certain direction.

2. **pH:** is simply a measurement of dissolved hydrogen ions in the water (the symbol stands for the logarithm of the reciprocal of the hydrogen ion concentration)

3. **Salinity:** Salinity is the salt content of the ocean. Salinity (S) may be defined as "the total amount of solid materials in grams contained in one kilogram of seawater when all the carbonate has been converted to oxide, the bromide and iodide replaced by chlorine and all organic matter completely oxidized."

4. **Dissolved Oxygen:** Dissolved oxygen measures the quantity of oxygen available for respiration in a water body.

5. **Biological Oxygen Demand:** Biochemical Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa.

6. **ppm:** parts per million

7. **mg/L:** milligram per litre

8. **Kyoto Protocol:** The Kyoto Protocol is an international treaty designed to limit global greenhouse gas emissions.

16.4. Abbreviations

BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
SS	Suspended Solids
NFM	New Fish Market
EIA	Environmental Impact Assessment
PIU	Project Implementing Unit
EMP	Environmental Management Plan
MTCC	Maldives Transport and Contracting Company
MSS	Male' Sewerage System
STELCO	State Electric Company
CNS	Central Nervous System
MWSC	Male' Water Supply Company Ltd
SPS	Standard Operational Standards

16.5. Annex

Annex 1:

Consultants Curriculum Vita

Annex 2:

Terms of Reference

Annex 3:

Scaled Site Plan and Architectural plan

Annex 4:

Water flow diagram including waste water, sea water and fresh water

Annex 5:

MWSC letter

Annex 6:

Site Plan drawn to scale and Bathymetry of proposed site

Annex 7:

Test results

Annex 8:

Results of water current in the area

Annex 9:

List of fish species found in the area

Annex 10:

Questioner

Annex 11:

Engineering options