Draft Social and Environmental Impact Assessment

January 2011

MLD: MALE INTERNATIONAL AIRPORT CONCESSION PROJECT

Prepared by AECOM in association with Water Solutions for GMR Male International Airport Private Limited

MALÉ INTERNATIONAL AIRPORT

GMR Malé International Airport Pvt. Ltd.

GMR

SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT



Expansion and Modernization of Malé International Airport

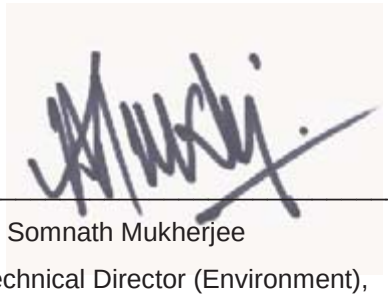
AECOM

in association with

WS

Prepared for:
GMR Malé International Airport Private Limited

SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT



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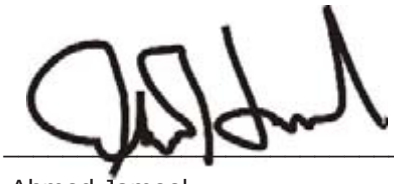

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Non Technical Summary

1.1 Introduction

The Government of Maldives (GoM) is implementing a long term Concession Agreement for operation, maintenance, expansion, rehabilitation and modernization of the Male' International Airport (MIA) with private developers under the aviation sector reform program and privatization plan. The proposed modernization project shall be beneficial for the Republic of Maldives since it involves installation of state-of-the-art infrastructure and facilities with the aim of upgrading the existing airport to an international level and cater to the future requirements.

GIAL has engaged AECOM in association with Water Solutions, Maldives for undertaking Social and Environmental Impact Assessment (SEIA) for the project and obtaining the Environmental Decision Statement (EDS) from the Ministry of Housing and Environment, Government of Maldives.

For determination of the final scope of the EIA study, a detailed scoping meeting was held with Environmental Protection Agency (EPA) of Maldives on 20 October 2010. Based on the meeting a Terms of Reference (ToR) has been approved by the EPA for the SEIA study.

The Malé International Airport is located on the Hulhulé Island which is formed on a large reef in the south eastern side of North Malé Atoll. The Hulhulé Island was reclaimed and constructed in year 1964 for creation of airport and now services the majority of visitors to Maldives. Hulhulé Island is located at about 6km North-East of Male'. Hulhumalé and Farukolhufushi islands are also located in the same reef system. Hulhulé Island is elongated along an approximate South-North axis and is about 3.5km long and 0.5km wide.

The traffic forecasts (Section 2.7) indicate that the total number of passengers at Malé International Airport is expected to increase from the current level of 2 million to 3 million by 2014 and 5.2 million by year 2035. It is apparent that the airport with current facilities will not be able to cater to the projected increase in the passenger traffic while providing quality service to its users. The expansion and modernization Project will increase both the number and efficiency of the aircraft gates, and increase and reallocate the terminal building to achieve higher effective capacity.

Project Description

The proposed expansion and modernization of Malé International Airport project involves six key components:

1. Work items for compliance with aerodrome licensing
   Critical repairs are to be carried out on certain segments of the runway and to develop the entire Airfield to meet ICAO specifications. At present the runway strip width is 75m on either side of runway centerline which will be widened to 150m on each side to be Code 4E compliant. This will necessitate reclamation and grading for a total strip width of 300m of around 330,534m^2
2. Terminal related work
   A New Passenger Terminal (PTB) will be constructed with an area of 45,000m^2 catering to passenger traffic of three million passengers per annum projected for year 2014, which is planned to be expanded to an area of 55,000m^2 to cater to passenger traffic of 5.2 million

passengers per annum projected for year 2035. The terminal will be located to the east of the runway. The design will explore the maximum use of natural light, innovative green technologies like geothermal / deep sea cooling, photovoltaic generation and rain water harvesting.

3. Air-side work

   Air-Side work will aim at improving the overall runway occupancy time and also reducing fuel burn due to decrease in taxiing distance after landing. These works will consist of provision of a partial parallel taxiway to Code E standards with separation of 182.5m east of the runway centerline. This taxiway will also be connected to the Runway 36 to improve runway capacity. An additional turnaround pad will also be constructed at a distance of approximately 1,800m from runway 36 threshold.

4. Land Reclamation

   The construction activities will require total reclamation of about 787,899m^2 of land and 2,500,000m^3 of total soil quantity

5. Support Facilities

   These support facilities consist of the following:

   - The existing aviation fuel farm will be relocated and expanded to meet the future storage requirements. The new fuel farm for an initial storage capacity of 24,000 KL will be set up with on land which is already partially reclaimed north of the existing location.
   - A new storage facility will be constructed in the area vacated by the fuel farm in an area of atleast 650m^2.
   - A new ground handling base will be provided for the storage and maintenance of Ground Support Equipments. An airport maintenance workshop of 200m^2 will also be constructed near ground handling base.
   - The various components of utility services systems are detailed below:

     Air Conditioning System

     The system will be designed to provide air-conditioning in area of 33,650m^2. The anticipated cooling load requirement for terminal building is 1,500 tonnes.

     Power Requirement

     It has also been estimated that preliminary load requirement for passenger terminal building will be in the range of 2700kW to 3000kW. The additional power requirement after proposed up-gradation of airport will be met through existing diesel generator facilities.

     Water Requirement

     After proposed up-gradation and modernization of airport, the water demand will increase to 630kld from existing 380kld.The required water will be sourced from the existing desalination plants. However, if required capacity augmentation will be done to supplement existing capacity.

     Sewage Treatment Plant

     A completely automatic Sequential Batch Reactor (SBR) of capacity 850 KLD will be installed in an area of about 2 acres. The effluent water will be used for irrigation purposes and flushing after post-disinfection treatment by dosing with hypochlorite or peracetic acid.

     Fire Fighting Facilities and Alarm System

     A new fire station complex will be constructed in an area of about 2,800m^2 in area vacated by the old fuel farm. The terminal building and its surroundings will be provided with fire hydrant posts which will be supplied water from existing fire pump house.

     Storm Water Drainage

     Storm water will be drained into the sea through a series of connected drains. The rain water from terraces and other open spaces will be collected through rain water down-take pipes and passed to channels in external area for rainwater harvesting.

     Aircraft Stand Drainage

Aircraft Stand Drainage system will be designed as per NFPA 415 requirements. It will be ensured that fuel or its vapour does not enter the drainage system of the building or streets. Fuel will not be allowed to collect on the aircraft-refueling areas where it may pose fire threat.

6. Land-side Development

   Landside development for airport includes the construction of a new terminal forecourt, parking and seaplane and boat facilities. These construction activities are discussed below in brief:

   - A 240m terminal forecourt will be developed along the full length of terminal frontage.
   - Parking for cars will be constructed in an area of approximately 3,500m^2 next to the forecourt.
   - A new ferry pier with a hotel hospitality center will be developed to the north of new passenger terminal.
   - A new boat jetty facility will be developed on the east of the runway for accommodating speed boats plying to and from airport resorts. Also a parking for 200 speed boats will be constructed.

Seaplane operations in Malé international Airport is expected to increase to 160,000 by year 2035. Up-gradation of seaplane facilities including length, number and operation of runways on lagoon for seaplanes will be done. However, passenger terminal facilities will continue to be provided by the existing two seaplane operators

During Construction Phase, it is anticipated that the completion of proposed expansion and modernization of Malé International Airport will take approximately 42 months. The mobilization will begin after the EIA is approved. During construction phase the projected demand of workers will be between 200and 1000 persons. Accommodation ensuring approximately 25ft^2 area per worker will be provided within the Airport Island. A common kitchen facility and one toilet per 10 workers will be provided. The power required for the construction phase will be in the range of 500kVA to 1.2mVA. It will be procured from main power source (Diesel generators sets) and an additional transformer of 630kVA will be installed near terminal site. An additional 200 to 300 KLD of water will be required for the construction phase. This water demand will be met through the existing water desalination plants. Additional desalination plants will be installed in the airport if required. However, groundwater will not be used for construction purposes.

It is expected that 20,000 metric ton of construction and demolition waste will be generated from the proposed up-gradation of airport during the construction phase. The solid waste and hazardous waste will be collected daily and sent to Thilafushi island for further treatment. The waste water and sewage will also be treated to the required international standards and discharged.

1.2 Environmental and Social Baseline Status

At Malé International Airport, no topographical point is more than about 1.7 m above highest water level. The height point of the runway is 1.2 m above mean sea level and thus has only about 0.5m clearance at highest high water level. The islands are low-lying and began forming between 3,000 and 5,500 years ago. They represent the most recent deposition along a submarine plateau that is underlain by approximately 2,100 m of mostly shallow-water carbonates resting on a slowly-subsiding volcanic foundation.

Maldives is located at the equator and experiences monsoonal climate. Maldives has two distinct seasons; dry season (northeast monsoon) and wet season (southwest monsoon). In these two seasons the temperature remains more or less the same. Northeast monsoon extends from January to March. The mean daily maximum temperature for Central parts (Hulhule) of the Maldives is 30.5 degrees Celsius and minimum temperature is 25.7 degrees Celsius. The predominant wind direction throughout the year is from North and North-East. The calm periods are low at less than

2% throughout the year. The maximum average wind speed has been observed in the month of January and lowest in March.

The maximum tidal range recorded at this Malé International Airport tide station is 1.20m. The highest astronomical tide level is +0.64m (MSL) and the lowest astronomical tide level is -0.56m (MSL).

Malé International Airport is found on a large reef which is located south eastern side of North Malé Atoll. The total area which the reef encloses is estimated to be 1,310.6 hectares. The total length of the reef is estimated to be 17,830 km. A proper lagoon exists on the north eastern side of Hulhule Island. This lagoon is presently used as a water runway by the sea planes. A rapid bathymetric calculation based on the analysis of the satellite photo indicates a significant area of the lagoon on western side and north eastern side of the island has been excavated. In addition, there are also areas on the south eastern side that has been excavated for various purposes. The preliminary assessment also indicates that most of the proposed fill area on the south-east side has been dredged.

Quantitative marine surveys were carried out at two sites which are expected to be impacted, but will not be transformed, by the proposed project. At depth of 8 and 15meters abundant coral family wer Acroporidae were Poritidae and Pocilloporidae. Other coral species were less abundant and belonged to the Faviidae and Merulinidae family. No bleached corals were found during the survey, and “recently dead” corals were seen rarely.

The most abundant fish families observed were the Cardinal fish Scaridae, Butterflyfish, the Collared and Racoon Butterflyfish. However, large fish interesting for the food industry are lacking in the observed location. Their stocks reported to be dwindling due to their commercial exploitation.During the time of our survey,three turtles and an eagle ray were also spotted. The fish life at both sites are considered “to be good.

Baseline marine water quality data around Hulhule’ island,which is connected to the open ocean through five pipes, have higher pH values and higher salinity than the surrounding seawater.

Vegetation in Hulhule island is insignificant as there are no significant vegetation clusters in the island that can be considered ecologically important. In Hulhule, neither natural vegetation nor outstanding biological resources exists. This includes both the inland and coastal vegetation. It can be said that more than 95% of the vegetation is human induced and have been planted as part of landscaping. Trees have been planted at different areas, mostly on the western side of the runway as part of landscaping. The floral profile of Hulhule indicates a relatively higher frequency of Coconut palms and hence Coconut palms (Cocos nucifera) are the most abundant type of trees recorded in the island. Among the protected species, Banyan trees have been recorded to exist, scattered in the island.

The island of Hulhulé is not known to contain any specific fauna species but many bird species inhabit the island and is therefore considered the most significant fauna for this project. There are no special or rare species found in the Hulhulé. Available baseline information from the above mentioned study indicate at least six species of birds in Hulhulé, most of them Waders. Reef Herons, are the largest resident bird found in Maldives were found in large numbers in the immediate vicinity of the runway. It was also found that herons and cattle egrets collide with airplanes more frequently than any other species found in Hulhulé.

Air quality monitoring were conducted at four locations for a period of two weeks. The ambient air quality results obtained from the monitoring undertaken indicate that all parameters were within the WHO guidelines for ambient air quality.

Ground water samples were collected from the existing wells of the areas and analyzed both in situ and at the National Health laboratory. A total number of eight samples were collected. The minimum true groundwater conductivity recorded in Hulhulé was 575 µS/cm. Only one sample tested positive for Coliforms. More than sixty two percent (62.5%) percent of the wells in Hulhulé island can be considered fresh (taking EC levels below 2500 µS/cm). The electrical conductivity (EC) of these samples are also below 1500 µS/cm which is the threshold limit for drinking water. Only one sample tested positive for bacteriological contamination.

Noise was monitored at 25 locations continuously for 24 hours. The ambient noise levels were moderate to high considering the international standards. The higher background noise can be attributed to the roar from the sea, windy conditions and closely packed residential areas and movement of boats. The highest day time equivalent noise Leq day was observed at Wataniya gallery while the highest night time noise Leq night was observed at STELCO power.

The total population of Male' stands at 103693 by 2006 and the land area being 192.07 hectares the population density is 540 people per hectare. With continuing migration from the islands the growth rate of Male' is estimated at 5.59 per annum compared the country's growth rate of 1.69 per annum. More than a third (34.7%) of the country's total population of 298,968 resides in the capital city of Malé. Nearly one-half (46.3%) of the population is very young (under 20 years). The sex ratio is 103.7 and population is growing annually at 1.69 percent.

The vulnerability and poverty of 2004 is compared with the VPA of the 1997 to understand the vulnerability and poverty situation of Male'. Three different poverty lines: a) the median income of the atoll population in 1997, MRF 15.00 per person per day; b) half the median income, Mrf 7.50 per person per day; and c) an in-between line of Mrf 10.00 per person per day are compared. For all three poverty lines, the headcount ratio has declined, in the atolls and especially in Male' where by 2004 income poverty had virtually disappeared. Housing in the Maldives is very expensive with prices in Malé exceeding 12 times the average annual income. This is partly due to the shortage of land as well as the high cost of construction given the reliance on imported building materials. Tourism is the key economic sector, contributing 28% of GDP and with 48.4 percent in revenue in 2010. Since the first resort was established in 1972, more than 97 islands have been developed, with a total capacity of 24650 beds by 2009.

Fishing sector employs about 11% of the labor force. The fish catch has recorded an unusually sharp decline over the past few years to about 100,000 metric tons in 2009. With the decline in the production contribution of fisheries to GDP has declined to about 3%.

Poor soil and scarce arable land have historically limited agriculture to a few subsistence crops, such as coconut, banana, breadfruit, papayas, mangoes, taro, betel, chilies, sweet potatoes, and onions. Almost all food, including staples, has to be imported. Agriculture provides about 2% of GDP.

According to the VPA II of 2004, about 40 percent of the young women and over 20 percent of the young men are unemployed, not only because they lack the skills required in the labour market but also because of limited job opportunities.

1.3 Potential Impacts and Mitigation Measures

The marine components involved in the proposed reclamation area of the project will be directly affected and and could be completely lost during the construction period, whereas habitats in the proximity will be adversely impacted by reclamation works due to increased sedimentation and possible nutrient influx. During dredging and reclamation works and related coastal development activities, a significant amount of siltation and sedimentation of the lagoon waters and reef slope is anticipated. Areas such as the south-western side of the runway, the reclamation areas which are

expected to be influenced from the reclamation works and those on the north-western side of the runway which could be influenced during the extension works at the runway will be prone to elevated sedimentation during the dredging works in the seaplane area.

Solid waste is expected to be a significant residue from the development in construction phase. Waste will principally come from the building sites. A considerable amount of solid waste will be generated during the construction of buildings and the extension of the runway. Any mishandling of solid (non-biodegradable) waste, hazardous waste like oil spills or other toxic substances, will contaminate the marine environment.

Mitigation measures to protect the marine environment around must focus on the reclamation works to avoid coastal erosion, as well as sedimentation/siltation, which have detrimental effects on the health of corals. The mitigation measures shall include

- Deployment of silt screens between the eastern reclamation area (future passenger terminal) and the coral reef slope, wherever possible.
- Construction of bund walls to fully enclose the reclamation area and to minimize the loss of suspended sediments from the reclamation area,.
- Separation and storage of construction wastes, including packaging, in the waste management area and later be taken to Thilafushi for disposal.
- Oil, solid waste and hazardous waste have to be handled carefully and transported in sealed containers in properly bunded vehicles/vessels.
- Storm water generated has to be collected in holdings tanks to ensure that suspended solids are removed before water is diverted into the sea.
- An Sequential Bio Reactor plant is proposed for installation. The SBR is a biological, suspended colonies type activated sludge purifier combining oxidation and sedimentation in the same tank that follow each other in sequence.

The project components which likely to have an environmental impact on coastal environment will be dredging, reclamation, levelling, development of new sea plan runways, development of new jetties and development of the mooring area for the speed boats. The project proposes to borrow sand from Hulhle lagoon for the reclamation component of the project.

It is proposed that dredging component would be carried out using a cutter suction dredger and excavators. Therefore the negative impact of sedimentation is unavoidable even with the construction of sandy bund walls. The impacts of sedimentation are short termed since the monsoonal currents will aid in the dispersal and removal of fine suspended materials when the dredging operation is ceased.

The mitigation measures for coastal impacts shall include

Silt screens or Sediment curtains could be used, to expedite the dredging and reclamation component. One of the most appropriate methods for limiting the re-suspension of fines at the reclamation site would be to enclose the reclamation site by building a peripheral bund around the edge of the site, using dredged material. In addition to this, the coastal protection structure such as sheet piling around the perimeter of the reclamation site, could be constructed prior to the reclamation works. Solid construction wastes generated during dredging works are also not allowed to be discharged directly into the sea. They shall be collected and transferred for onshore disposal, to avoid causing of any adverse impact on the marine environment.

The project components which likely to have an environmental impact on terrestrial environment are from site clearance, transportation of material, operation of machineries and disposal of waste

The core new development area will be the new terminal building, which is planned to be developed on the south eastern side of Hulhule by reclamation. Hence, this component will not have any impact on vegetation. No loss of vegetation is proposed due to the expansion activities. Removal of vegetative cover and the subsequent excavation activities required for Infrastructure construction will also have limited impact on the existing drainage patterns in the area. The noise generated from use of heavy machinery and high noise producing activities during construction will be restricted to within the project boundary. The project site is an isolated island away from population centres

Improper storage or handling of hazardous or flammable materials, including fuel, paints and solvents) could result in soil and water contamination during the construction period. Use of heavy equipments, high levels of dust and noise aggravate the issues of health and safety of the workers.

Wastewater disposal method can have a considerable impact if this is not properly addressed. The proposed method of wastewater disposal for the airport is through a treatment plant and disposing the treated effluent to the open sea.

The Emissions and Dispersion Modeling System (EDMS) was used to assess the air quality impacts of proposed airport development projects. EDMS is a combined emissions and dispersion model for assessing air quality at civilian airports and military air bases. It was concluded that there will be an increase in air traffic volume at MIA after the expansion however the observations at the designated receptors indicate that it will have a very small increment in concentration to the baseline air quality and that ambient air quality shall remain within the prescribed WHO guideline. Based on the predicted concentrations and the post project concentrations of concerned pollutants, it can be inferred that the ambient air quality of the area is unlikely to be affected significantly due to up-gradation of the airport.

To predict the impact on the existing noise levels in the study area due to the proposed up-gradation of the airport, the model Integrated Noise Model (INM), Version 7.0 developed by Federal Aviation Administration (FAA), Office of Environment and Energy, USA was used.

The results of the study indicate that the bulk of noise impact remain located close to the runway. The average maximum exposure level to noise on the population outside the airport is 65 dB(A). However, it is anticipated that the development of new technologies for building aircraft and strict environmental policies will result in decline in average noise levels in future years. The spread of noise is observed to be high in the Northwest and Southeast direction, while some extent of spread is towards the South. It is suggested to provide noise barriers in the three directions to avoid disturbances due to airport operations.

The proposed new master plan has landscaping components that are incrorporated in to the new terminal building area. Hence, with the introduction of trees for landscaping, the overall environment will have a positive impact. Increased plantation along the fence line shall also act as noise barrier act to reduce the propagation of noise from the airport. Arrangements will be made with contractors and subcontractors to ensure that the vehicles used for transporting building materials to the site are appropriately sealed and covered to minimize dust while transporting debris and materials. Dust producing building materials such as sand or cement will be stored away from drainage areas where they could easily be washed away during rainfall.

The machineries and equipments will be maintained properly to avoid any spillage or pollution. All fuels and other hazardous materials stored will be on hard floor and protected from rain and wind.

Therefore, all underground wastewater conveyance pipes, storage tanks, sump wells etc, should be constructed with impermeable material, preferably concrete lined with sulphur resistant paint or any other material that do not deteriorate when exposed to toxic gases in the sewer.

The construction site will be provided with sufficient and suitable toilet facilities for workers to allow proper standards of hygiene. At the construction site, the contractor will be asked to provide first aid facilities, Personal Protection Gears, adequate training for operation of machinery

and related health and safety issue to construction workforce. Noise propagation from operation of flights and related activities to be minimised by installing appropriate noise reduction measures and barriers at locations identified through modelling activities.

An increase in job opportunities is stated as possible in airline and MIA operations including schedule and charter flights for passengers and freight, MIA maintenance, air traffic control and regulation and activities directly serving air passengers such as check –in, baggage-handling, and on-site retailing and catering facilities. An increase in employment opportunities could also be associated with increase in ticketing centres and so on outside MIA at other locations.

The expansion and the modernisation of the MIA is believed to have positive impact on all the sectors that are linked to the MIA. Indirect employment involves jobs created in the supply chain to the aviation industry.

At present cargo handling services within the MIA are basic. When cargo handling facilities and services are strengthened this can result in availability of a wider range of goods and services improving the consumers' choice through price and variety. Improving the cargo handling facilities with the expansion and modernization of the MIA will be of immense benefit for the fish exporters in the country. This will result in the producers being able to operate more effectively and strengthening the trade efficiency between supplier and consumer.

Developments associated with world class MIA are many. Increase in city hotels and guest houses and convention centres both in Male' and Hulhumale' can contribute in achieving a cosmopolitan city. A modern MIA is of utmost significance to attract knowledge, activity, skilled labour, international tourists and business elite.

As highlighted above expatriate labor force is on an increasing trend and many respondents during survey were very much concerned with a foreign company taking over the management of the MIA. Expanding and modernising the MIA is associated with more people settling down in Hulhumale' with a potential increase in traffic between MIA and Hulhumale'. All these activities though have positive impacts are also associate with negative issues within community.

1.4 Environmental Management and Monitoring Plan

An Environment Management Plan has been proposed to ensure that the project implementation carried out by taking appropriate mitigative actions to reduce any adverse environmental impacts during its life cycle. The plan outlines existing and potential problems that may adversely impact the environment and recommends corrective measures where required. The plan outlines roles and responsibility of the key personnel and contractors who are charged with the responsibility to manage the project site. A solid Waste Management Plan outlining the means for segregation of water and recommending bio-methanation of organic waste has been good.

A Environmental Management Cell has also been proposed for the implementation of the Environmental Management Plan. The organizational set up and tasks for ensuring its effective implementation of mitigation measures and to conduct environmental monitoring.

An Environment Monitoring Programme covering all aspects of airport operations that have the potential to influence the environment has been suggested in the report. Such areas include continuously understanding and reporting the status and changes to reef health, the beach line, lagoon water and ground water quality, terrestrial biodiversity, solid waste generation, energy production, noise, air quality, fuel handling and wastewater etc.

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Appendices

1 INTRODUCTION

The Government of Maldives (GoM), is implementing a long term Concession Agreement for rehabilitation, expansion, modernisation, operation and maintenance of the Male' International Airport (MIA) with private developers under the aviation sector reform program and privatization plan. In August 2009, the GoM appointed the International Finance Corporation (IFC) as its Lead Advisor to assist in the structuring and implementation of the MIA project ("**Project**"). In June 2010, GIL – MAHB Consortium was selected as the successful bidder for undertaking the modernization of the Airport. The proposed modernization project shall be beneficial for the Republic of Maldives since it involves installation of state-of-the-art infrastructure and facilities with the aim of upgrading the existing airport to an international level and cater to the future requirements.

In brief, the upgrading of the airport Project will mainly consist of:

- Dredging and reclamation of the airport lagoon;
- Construction and rehabilitation of the existing infrastructure; and
- Development of new infrastructure.

As per the Concession Agreement, the Consortium was required to incorporate a special purpose company for implementation of the Project and the Consortium has incorporated a GMR Malé International Airport Private Limited ("**GMIAL**"). GMIAL has engaged AECOM in association with Water Solutions, Maldives for undertaking Social and Environmental Impact Assessment (SEIA) for the Project and obtaining the Environmental Decision Statement (EDS) from the Ministry of Housing and Environment, Government of Maldives.

The aim of this SEIA study is to assess the potential environmental and social impacts due to the project and identify mitigation measures for minimizing the adverse impacts, while undertaking the project in the most environmentally friendly manner. The SEIA takes into consideration, issues and concerns that will be considered as the most critical with respect to sustainable development and environmental and social management.

For determination of the final scope of the EIA study, a detailed scoping meeting was held with Environmental Protection Agency (EPA) of Republic of Maldives on *20 October 2010*. The meeting was presided by Director General, EPA and included representatives of regulatory agencies (EPA, Ministry of Housing and Environment, Ministry of Tourism, Arts and Culture, Department of Civil Aviation, Ministry of Fisheries etc); Stakeholders (Sea Plane Operators, Maldives Airports Company Limited, Housing Development Corporation); and representatives of GMIAL, AECOM and Water Solutions. During the scoping meeting, concerned environmental and social issues and areas relating to the proposed expansion and modernisation of the Airport were discussed. Based on the meeting a Terms of Reference (ToR) has been approved by the EPA for the SEIA study.

The SEIA has focused on areas of concern that are considered most significant, the approved ToR and applicable national and international environmental and social aspects for such projects.

1.1 Scope of the SEIA Study

The scope of the study has been guided by the Terms of Reference (ToR) approved by EPA, Ministry of Housing and Environment, Maldives. The key tasks provided in the ToR for the SEIA include the following:

Task 1: Description of the Proposed Project

Task 2a: Description of the Environment (from past available data)

Task 2b: Description of the Environment (Baseline Field Assessment)

- Physical Environment
- Biological Environment
- Terrestrial Environment
- Coastal Environment

Task 3: Legislative Regulatory Considerations

Task 4: Potential Impacts of the Proposed Project

Task 5: Analysis of Alternative to the Proposed Project

Task 6: Mitigation and Management of Negative Impacts

Task 7: Development of a Monitoring Plan

Task 8: Stakeholders Consultation and Inter-Agency Coordination

Task 9: Presentation and Timeframe

Approved Terms of Reference for the Environmental Impact Assessment is enclosed as Annexure A.

1.2 Limitations

This report has been prepared to assist GMIAL, in obtaining the EDS from EPA. The report has relied on available secondary information, primary environmental baseline data generated during the study period (October-November, 2010), project information provided by GMIAL, available document reviews and public consultation with stakeholders. The Airport Project area and the associated impacts have been considered for area and aspects as discussed with EPA, Ministry of Housing and Environment, Republic of Maldives and the Terms of Reference for Environmental Impact Assessment issued by EPA on 31st October, 2010. The site drawing(s) provided within this report is conceptual and indicative and of smaller scale. These maps have been used to present the general relative locations of environmental and social features of the study area.

The historical information provided is based on the discussions with the GMIAL, stakeholders and information obtained from MACL.

The Project Team AECOM and Water Solutions accepts no responsibility for application or interpretation of the results by any other parties

1.3 Contents of the SEIA report

This SEIA report has been organised in the following way:

Non Technical Summary

Section 1: provides ***Introduction*** – Project Background, Purpose, Scope and limitations

Section 2: outlines ***Project Description***

Section 3: describes applicable ***Policy, Legal and Administrative Framework***

Section 4: details ***Existing Baseline Environment of the Project Area***

Section 5: provides an ***Analysis of Alternatives***

Section 6: analysis ***Environmental Impact*** *due to the Project Activities*

Section 7: provides ***Environmental Management Plan***

Section 8: gives ***Conclusion***

1.4 Project Consultants

1.4.1 AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, environmental and energy. With 45,000+ employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. AECOM is able to address complex challenges and can draw upon a wider spectrum of technical expertise through our global network of professional service firms.

Some of the salient credentials of AECOM are given below.

- AECOM is listed in New Your Stock Exchange
- AECOM is a Fortune 500 company and ranked 353 and #14 in shareholder return
- Engineering News-Record (ENR) magazine ranks AECOM as No. 1.
- Financial Times names AECOM for Best Workplaces.
- Newsweek includes AECOM on its list of Greenest Big Companies.
- With 44,000 employees around the world, AECOM serves clients in more than 100 countries with about 700 offices
- AECOM had revenue of $6.1 billion during its fiscal year 2009

AECOM's global environmental practice is a leading worldwide environmental services provider serving private and government clients by providing sustainable environmental solutions to meet compliance, business and operational needs. AECOM's breadth of services and depth of expertise place us among the top environmental consultancies in the world. Our experienced environmental management staffs address client projects across the full business life cycle – from project planning, development and operations, to site remediation, restoration and reuse, through a comprehensive array of professional services.

Successful project permitting and compliance requires an understanding of the intricacies of environmental regulations, the complexities of the resources affected by development, and solid working relationships with regulators. Drawing on our full range of technical specialists—resource scientists, environmental engineers, planners, and regulatory specialists—AECOM's global environmental practice helps clients streamline the approval process and comply with environmental laws.

1.4.2 Water Solutions Pvt. Limited

Water Solutions (Pvt) Ltd. (WS) is a private consultancy firm registered in Maldives in 2005. WS is a dedicated firm which has undertaken various important projects in the field of environment, water and wastewater. WS has undertaken several environmental consultancy projects and EIA reports. WS has coordinated towards the successful implementation of one of the first sewerage projects financed under tsunami rehabilitation aid from the United States.

The company has achieved great success in delivering such services within the Maldives. WS has a team of dedicated professionals who are able to provide the best solutions whether it is environment or water and who have had the most relevant experience in the Maldives. WS services are oriented to deliver a complete solution which therefore makes its services multidisciplinary in nature. More specific areas of focus are water, coastal and wastewater engineering specializing in project management, monitoring and evaluation, geodetic surveys and mapping, feasibility studies, environmental impact assessment and awareness campaigns and events.

Since inception in 2005, Water Solutions has a wide experience in consultancy and advisory services. It has undertaken many investigations, urban drainage, coastal engineering, water resource planning and modeling studies and projects. During the recent past, Water Solutions successfully completed studies involving the above components for different organizations. In fact,

Water Solutions is proud to have undertaken most of the EIAs in the Republic of Maldivessince its incorporation. Water Solutions has carried out some of the important resort development/renovation projects of similar nature.

2 PROJECT DESCRIPTION

2.1 Introduction

The proposed expansion and modernization of Malé International Airport will be carried out in compliance with International Civil Aviation Organization (ICAO) Standards. The proposed project primarily consists of construction of a new passenger terminal with associated apron, VIP/CIP terminal, rehabilitation and expansion of runway, capacity augmentation and relocation of fuel farm and other constructions like a new cargo terminal and apron, setting up of sewage treatment plant etc. Besides this, the capacity of existing terminal will be increased to meet the projected demand for year 2014 when the new terminal building will be commissioned.

This chapter presents the information related to various attributes of the proposed up-gradation of the airport and the associated infrastructure facilities. The present and future air traffic projections have also been described in this chapter.

2.2 Project Location

The Malé International Airport is located on the Hulhulé Island which is formed on a large reef in the south eastern side of North Malé Atoll. The Hulhulé Island was reclaimed and constructed in year 1964 for creation of airport and now services the majority of visitors to Maldives. Hulhulé Island is located at about 6km North-East of Male'. Hulhumalé and Farukolhufushi islands are also located in the same reef system. Hulhulé Island is elongated along an approximate South-North axis and is about 3.5km long and 0.5km wide. Within the reef boundary the majority of the area has been reclaimed over the past several years for airport expansion and as a result, there is limited space available in the lagoon. Although there has been reclamation and modification to the island, large part of the eastern lagoon has not been reclaimed and is used as a seaplane taxiway.

2.3 Project Justification

Tourism being the largest industry in Republic of Maldivesplays a significant role in its economy. It accounts for 28% of GDP and more than 60% of Maldives' foreign exchange receipts. The proposed expansion and modernization plan of Malé International Airport will help in boosting the tourism sector by increasing the inflow of tourists into the country. This will augment the economy of the country since tourism contributes a major share of revenue to the central government budget. The project will also generate employment opportunities for the local population.

The traffic forecasts (Section 2.7) indicate that the total number of passengers at Malé International Airport is expected to increase from the current level of 2 million to 3 million by 2014 and 5.2 million by year 2035. It is apparent that the airport with current facilities will not be able to cater to the projected increase in the passenger traffic while providing quality service to its users. The expansion and modernization Project will increase both the number and efficiency of the aircraft gates, and increase and reallocate the terminal building to achieve higher effective capacity. The project aims at optimizing the airport landside and airside areas and thereby limiting the environmental impact. The sustainable design approach to master planning drives the keenness to be environmentally friendly and providing an efficient runway & taxiway system design along with modern architecture for Male' International Airport.

The proposed up-gradation of airport will address the following specific key objectives. These objectives address major aspects of airport development and operation such as safety, security, efficiency, passenger convenience, flexibility & expandability.

- Bring Malé International Airport in to compliance with ICAO safety standards
- Increase terminal capacity so as to adequately handle projected traffic volumes by building a new terminal fully consistent with green design principles;
- Develop and enhance the position of Malé International Airport as the primary gateway for travellers to the Maldives;

- Increase service quality standards to provide passengers with improved overall airport experience in line with international best practices.

The proposed airport expansion plan is enclosed as **Appendix G: Plan Depicting Proposed Airport Expansion**.

2.4 Details of the Existing Malé International Airport

The existing Malé International Airport is located on Hulhule Island with a capacity to handle about two million passengers per annum. The airport comprises of following units for catering to various services to the passengers:

2.4.1 Terminals

The Airport provides facilities for domestic and international passengers arriving at, or departing from Maldives. The Airport consists of two terminals, namely, International Terminal and Domestic Terminal. In addition there are two seaplane domestic terminals. The international terminal and domestic terminals are located to the west of runway and seaplane terminals are to the east of runways in the shelter of the lagoon.

A. International Terminal

International Terminal is spread over two floors covering a total floor area of 11,600m^2. The capacity of international terminal is given in **Table 2.1** below.

Table 2.1: Capacity of Existing International Terminal

Process	Area (m^2)/Number	Assessed Capacity (One-way passengers per way)
Departures		
Entrance Security Check	3 no	650
Check-In Desks	24 no	960
Emigration	12 no	1,200
Centralized Security Check	2 no	1,200
Departure lounge	1,600m^2	900
Departures Gate Hold Area	1,100m^2	850
Departures Pier	2,800m^2	1,800
Arrivals		
Immigration	24 no	800
Baggage Reclaim Belts	3 no	900
Customs Queuing Area	145m^2	550
Customs Check Points	3 no	350

B. Domestic Terminal

Domestic Terminal has total area of 870m^2 and is located on the north of international terminal. Domestic operations are run by a government owned agency namely, Island Aviation Services. The capacity of domestic terminal is given in **Table 2.2** below:

Table 2.2:Capacity of Existing Domestic Terminal

Process	Area (m^2)/Number	Assessed Capacity (One-way passengers per way)
Check-in – Queuing area	$80m^2$	350
Check-in desks	8 no	500
Security Check	1 no	500
Departures Gate Hold Area	$190m^2$	200
Baggage Reclaim Belts	1 no	200

2.4.2 Seaplane Terminal

Two seaplane operators' namely Maldivian Air Taxi & Trans Maldivian airways operate Seaplane facilities at Male' International Airport. Due to far spread islands geography of Maldives, Seaplane operations play a critical role in ensuring fast & safe transport of tourists from airport to various island resorts. Both the operators have their own facility along with exclusive lounges developed for resorts.

2.4.3 Air-Side Components

- Male' International Airport has one runway in 18-36 orientation, 3200m long and 45m wide. The runway width is compliant with ICAO recommendations for Code E operations. The paved shoulders to each side of runway are currently less than the recommended width of 7.5m and will need to be widened and strengthened. Both runway ends have a stop way of 60m x 45m (paved) and a clearway of 300m x 150m. Runway end safety areas (RESAs) are provided of 54.6m at the runway 18 end and 88.66m at the 36 end. These are both below the ICAO required minimum and substantially less than the recommended 240 m and a minimum of 90m.
- There is an existing passenger apron and link taxiways located towards the west of runway with capacity to park approximately 6nos Code E, 2nos Code C and three smaller General Aviation aircrafts.
- The existing Air Traffic Control (ATC) tower was built in 2008 and is located on the east side of runway in close proximity to sea plane operations. The ATC handles movements of both land based airplanes & sea planes.
- Cargo traffic at Male' International Airport is mostly carried by passenger aircraft. For this reason, the cargo apron is very rarely used. The west side of cargo terminal has a boat harbor that allows cargo to be loaded directly into boats for further distribution. The cargo facility also has a smaller cold store facility for storing fish & perishables.
- At Male' International Airport, the runway is equipped with edge lighting and no centre line lights are provided. Both runways ends 18 & 36 are equipped with precision approach path indicator (PAPI) and Runway 36 is also equipped with simple approach lighting system of reduced length. Runway 36 is equipped with Category 1 instrument landing system (ILS) consisting of a localizer at runway 36 end and a glide path antenna to the south of the terminal on west side of runway. A landing direction indicator is also available on east side of the runway.

2.4.4 Airport Support Facilities

- The fire station is located to the north of the terminal zone, with direct access to the runway. It is a two-storey building with equipment stores, crew rooms and vehicle parking bays on the ground floor and offices and emergency room on the first floor.

- There is an existing fuel farm to the north-west of runway with eight fuel tanks. Out of which there are six Jet A1 tanks, two diesel tanks and a small petrol tank. The present airport operations are being handled with 3nos of 2200 KL and 3nos of 3400 KL Jet A1 tanks. During the peak season from October to April average consumption of Jet A1 is around 600 KL per day.
  The current capacities are:
  • Jet A1: 16.8 million litres
  • Diesel: 0.65 million litres
  • Petrol: 0.01 million litres
- At Male' International Airport, Island Aviation services provides maintenance services to aircraft. The facility is located towards the northern end of the island comprising of aircraft maintenance hangar, stores & offices.
- Security at Male' International Airport is under the control of Maldives National Defense Force (MNDF), whose facility is located on the east side of runway.
- The airport has a meteorological centre to the north of existing terminal building near fuel farm. The facility is under the control of meteorological department and provides aviation related meteorological services.

2.4.5 Water Supply

There is no natural source of potable water on the airport island. All potable water is locally produced through desalination plants located on the south west side of the island. Currently there are four desalination plants, two of 100 ton capacity and one each of 150 and 300 ton capacities. The existing daily water consumption of airport is 380 kld. Sea water is drawn from the ocean and filtered to remove suspended particles and then passed through a RO based desalination system to produce clean potable water. The potable water produced is stored in surface tanks in the vicinity of the plant and then further distributed to various airport facilities.

2.4.6 Drainage

There is no full fledged drainage system with treatment plants. Sewage is collected at various places and dumped into the sea.

2.4.7 Electric Power Supply

At Male' International Airport, power is generated by Diesel generating sets. The airport has two main sources of power supplies, the old power plant close to the terminal and the new power plant near ATC tower. The maximum and minimum load demand for the Airport is estimated to be 4430 kVA and 2241 kVA respectively. The new power plant has 3 nos. 2.50 MVA each diesel generating set. The old power plant has a number of diesel generating sets of various capacities. The details of various Diesel Generator sets are given in **Table 2.3**.

Table 2.3: Diesel Generator Sets

Location	Diesel Generator Set Number	Capacity (kVA)
New Powerhouse	**1**	2500
	2	2500
	3	2500
Old Powerhouse	**5**	375
	6	700
	7	625
	8	375
	10	1000
	11	1000

Location	Diesel Generator Set Number	Capacity (kVA)
	12	1250
	13	1250
Marine Station	**2**	82
Emergency Gensets (DG)	**1**	15
	2	15

2.5 Aviation Demand Trends

2.5.1 Air Traffic Trend

The historical trends of aircraft movements from year 2000 to year 2008 are illustrated in **Figure 2.1**.

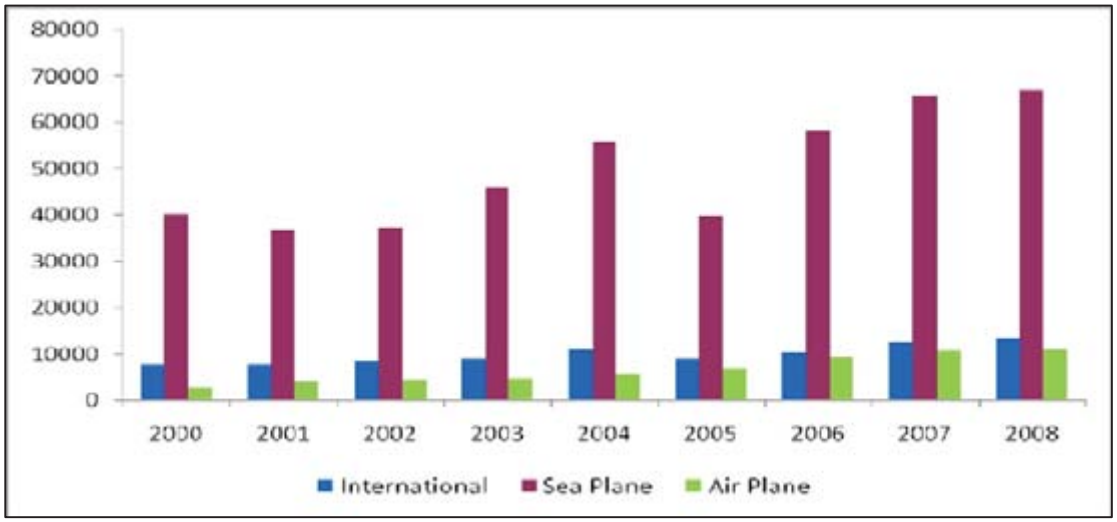


Figure 2.1: Historical Trends of Aircraft Movements from Year 2000 to 2008

The domestic schedule is driven by the schedule of the international flights. The domestic schedule is such that it is crowded around the international peak hour. The domestic operations are run by Island Aviation Services – government owned agency. The fleet consists of Dornier planes with a seating capacity of 37 – 50. The seaplane operations do not work on a specific schedule. It provides for transport within a service level agreement of two hours. The flight capacity is 15. The unscheduled operations along with small size aircrafts has led to high number of domestic ATMs.

2.5.2 Passenger Traffic Trend

The trend in passenger traffic at Malé International Airport is shown in Figure 2.2. The passenger traffic includes international traffic and domestic traffic. Domestic passenger traffic at Malé is driven by the international traffic. The domestic passenger traffic includes the purely domestic traffic and international traffic taking domestic connection. However, in Malé, the purely domestic traffic forms only 10%of the total domestic traffic. The graph permits the following conclusion:

- The overall trend in passenger traffic during the period 2000-2008 has been positive. Also the passenger traffic declined only in the year 2005 which was due to Tsunami.

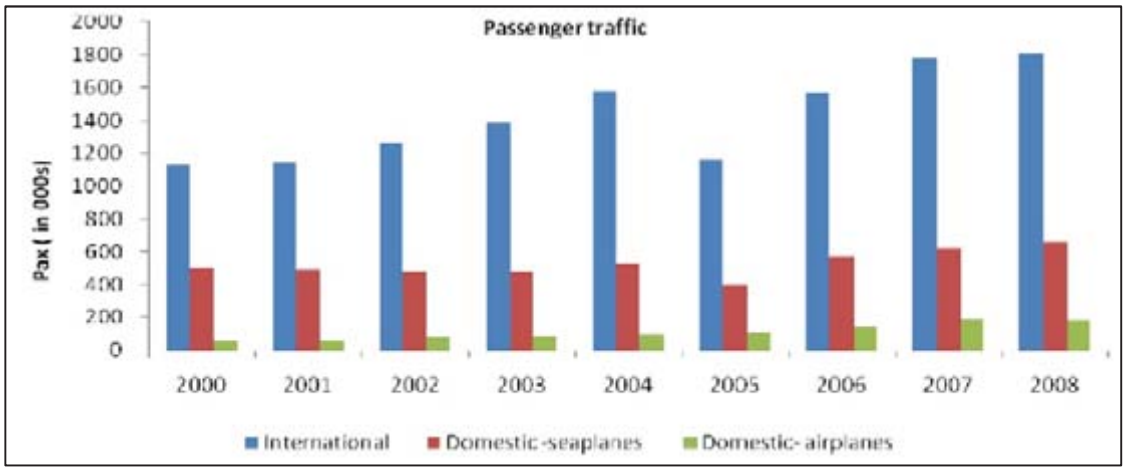


Figure 2.2: Passenger Traffic Trends at Malé International Airport from Year 2000-2008

2.5.3 Cargo Traffic Trend

Maldives relies almost entirely on imports for its day to day needs. Hence, cargo import consists of daily use consumption products for the native population and the visiting tourists. The growth hence has been commensurate to the growth in native and tourist population and the per capita consumption levels. Also the export cargo depends almost entirely on fishing industry. Republic of Maldivesis located on the East & West trade routes and has excellent connectivity with the European countries. These have contributed to growth of transit cargo in Maldives. This accounts for nearly 30% of the entire cargo handled at Male. With new routes coming up, this is only expected to increase in the future. The details of cargo traffic at Malé International Airport are shown in **Figure 2.3.**

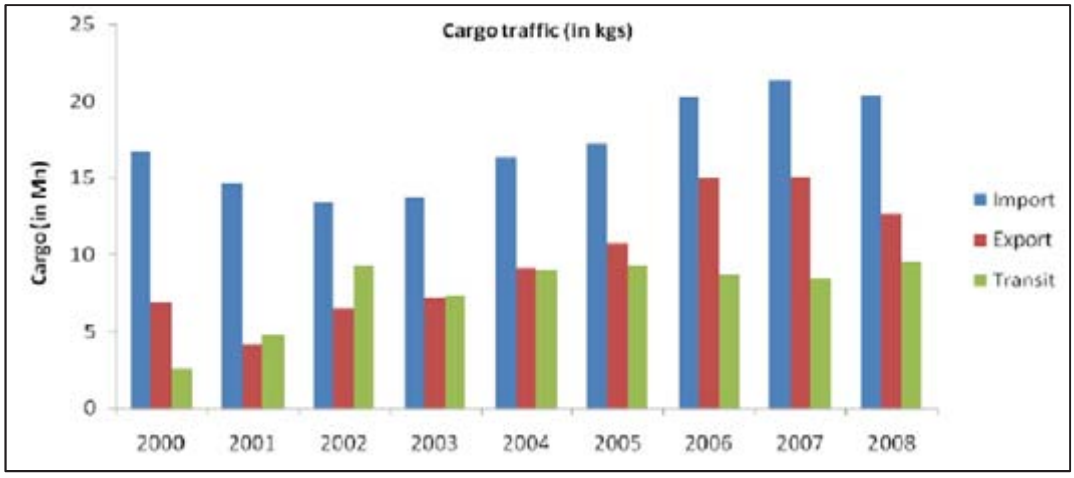


Figure 2.3: Cargo Traffic Trends at Malé International Airport from year 2000-2008

2.6 Aviation Demand Forecast

2.6.1 Air Traffic Forecast

International ATMs would depend upon the international passengers coming from various regions and the seating capacity of aircrafts being flown on various routes. Domestic ATMs comprise of seaplanes and airplanes. The forecast of International and domestic ATM has been done covering

all the existing routes over the concession period (till year 2035). The same is depicted in **Figure 2.4** below:

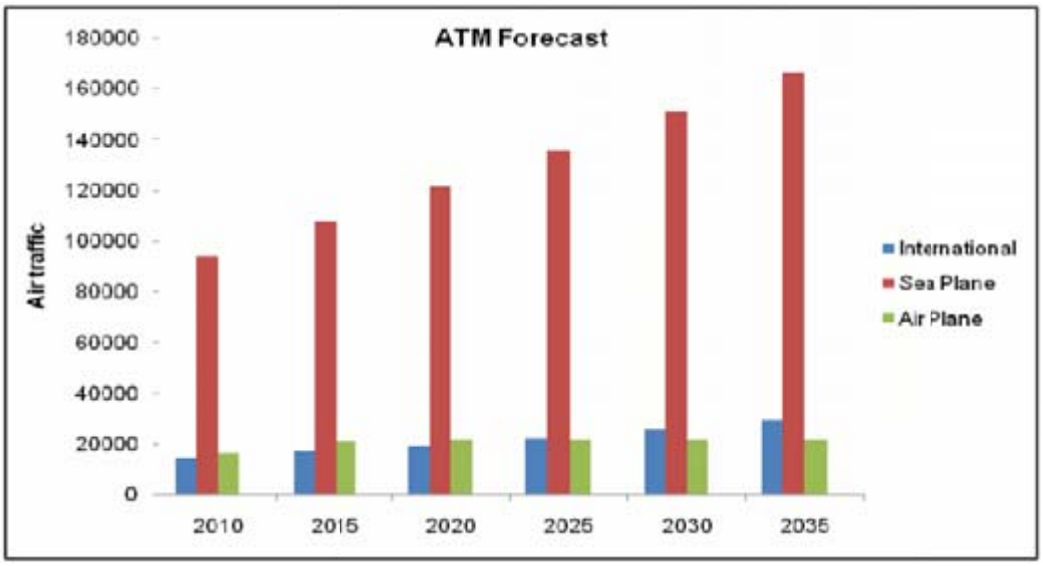


Figure 2.4: Air Traffic Forecast for Malé International Airport

2.6.2 Passenger Traffic Forecast

The passenger traffic forecast has also been done for Malé International Airport over the concession period (Figure 2.7). The domestic passenger traffic includes the purely domestic traffic and international traffic taking domestic connection. Similar to the historical trends, purely domestic traffic is expected to be around 10% of total domestic traffic. It has also been estimated that total passenger traffic will be approximately 5.2 million passengers per annum for the year 2035. Thus the existing passenger terminal with its support facilities designed to handle 2 million passengers per annum will be inadequate to handle the forecasted passenger traffic.

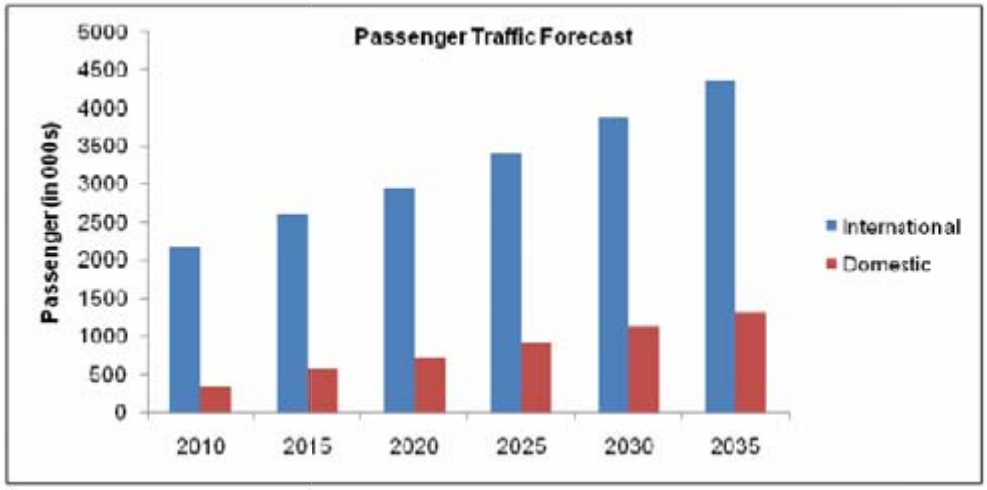


Figure 2.5: Passenger Traffic Forecast for Malé International Airport

2.6.3 Cargo Demand Forecast

Maldives is approximately 800 km from tip to tip in North –South direction. Thus the cargo which needs to be transported domestically, whether collection of cargo for exports or distribution of cargo imported, is transported using boats and ships. Maldives domestic air cargo is thus negligible in comparison to its international cargo. It is expected to remain around 1% of total international cargo

as it has been historically. Maldives is dependent upon imports for most of its food needs like vegetables, dairy products. As imports mostly comprise of consumables of daily use specially the perishables like vegetables, dairy products etc, they are expected to grow in line with the growth in international passengers and population growth. The export cargo from Maldives mostly comprises of fish products. Transit cargo has been ~30% of export and import cargo. It is mostly governed by the fact that Male provides better direct connectivity to various locations in Western Europe as compared to other airports in the region. Thus it is expected that Male would be able to sustain its high volume of transit cargo in future. The expected trends in Cargo traffic over the period year 2010-2035 is been shown in **Figure 2.6**.

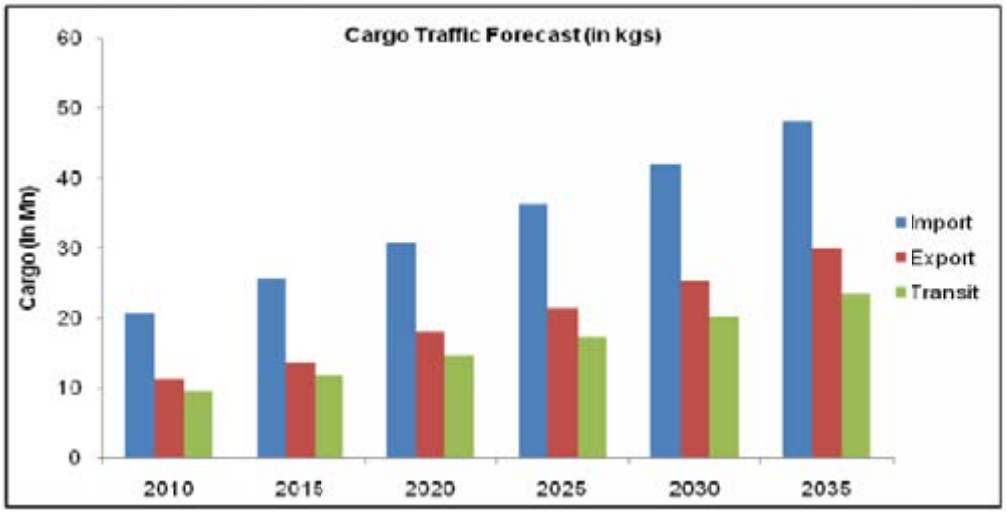


Figure 2.6: Cargo Traffic Forecast for Malé International Airport

2.7 Project Scope and Components

The Project Scope was prepared using information provided by GMIAL. The emphasis of the Project Scope is on those activities that have the greatest potential to cause environmental and/or socio-economic impacts.

The proposed expansion and modernization of Malé International Airport project involves six key components:

1. Work items for compliance with aerodrome licensing
2. Terminal related work
3. Air-side work
4. Land Reclamation
5. Support Facilities
6. Land-side Development

In the proposed up-gradation of airport, a prospective passenger capacity of atleast three million passengers per annum by the end of year 2014 is considered and matching facilities will be created. A minimum of “C” level of service as defined by the International Air Transport Association (IATA) and LEED silver certification is proposed to be achieved by the project proponent.

The details of proposed components in the expansion and modernization of airport are given below:

2.7.1 Work items for compliance with aerodrome licensing

Critical repairs are to be carried out on certain segments of the runway and to develop the entire Airfield to meet ICAO specifications. At present the runway strip width is 75m on either side of runway centerline which will be widened to 150m on each side to be Code 4E compliant. This will necessitate reclamation and grading for a total strip width of 300m of around 330,534m^2. The existing Runway 18 of Malé International Airport will also be extended at the north by about 200m requiring land reclamation of 59,968m^2. Other developments include provision of Runway end safety areas (RESA) of 190m for Runway 18 and 90m for Runway 36, construction of new turnaround pad

at runway 18 end, security fencing of Airside, installation of blast fence and amendment of airport emergency plan.

2.7.2 Terminal Buildings

The terminal related activity entails expansion of existing terminals and construction of new terminal buildings. This comprises of following expansion and relocation activities:

- A New Passenger Terminal (PTB) will be constructed with an area of 45,000m^2 catering to passenger traffic of three million passengers per annum projected for year 2014, which is planned to be expanded to an area of 55,000m^2 to cater to passenger traffic of 5.2 million passengers per annum projected for year 2035. The terminal will be located to the east of the runway. The height and key levels of passenger terminal building is illustrated in Figure. The terminal will have Gate holding lounges with direct access to 11nos Code C stands and 6nos Code E stands which shall include aerobridges to 4nos Code E & 1 No Code C stand. The design of new passenger terminal building will ensure a low carbon emission building that meets LEED silver certification requirements. The aerodynamically profiled one-way curve roof, resembling crests of wave, will provide openings to the north. The design will explore the maximum use of natural light, innovative green technologies like geothermal / deep sea cooling, photovoltaic generation and rain water harvesting. The architect's impression of proposed terminal building is shown in **Figure 2.7**.

Figure 2.7: Architect's Impression of New Passenger Terminal building

- The capacity of the existing terminal building will be enhanced to meet peak hour demand of 930 passengers per hour projected for the year 2014 after which the new passenger terminal will be commissioned. A summary of capacity enhancement analysis to meet 2014 peak hour demand is given in **Table 2.4**:

Table 2.4:Capacity Enhancement Analysis for Existing Terminal Building

S. No	Processors	Required (Nos)	Available (Nos)	Shortfall (Nos)
1	Hold Baggage Screening	5	3	2
2	Check-in Counters	30	24	6
3	Emigration	12	12	0
4	Hand baggage security	5	5	0

5	Immigration	23	24	0
6	Baggage claim	4	3	1
7	Customs	3	3	0

- A Separate self contained VIP/CIP terminal and apron with minimum 1no Code C and 1no Code E stand will be built towards the north-west of PTB. The building complex will be a simple single storey rectangular pavilion standing on water with total area of 2,400m^2.
- Cargo Building/ Terminal will be constructed to accommodate the air cargo forecast of 75,000 tonnes in year 2025. The terminal will accommodate a new cargo apron with minimum parking for 2nos Code C cargo aircraft and a cargo warehouse with total area of 8000m^2.

Figure 2.8: Proposed VIP/ CIP facilities at Malé International Airport

2.7.3 Air-Side Work

Air-Side work will aim at improving the overall runway occupancy time and also reducing fuel burn due to decrease in taxiing distance after landing. These works will consist of the following:

- Provision of a partial parallel taxiway to Code E standards with separation of 182.5m east of the runway centerline. This taxiway will also be connected to the Runway 36 to improve runway capacity. An additional turnaround pad will also be constructed at a distance of approximately 1,800m from runway 36 threshold. The effect of both of the above measures (i.e. additional turnaround pad and the partial parallel taxiway) is expected to increase the runway capacity from 12 movements per hour presently, to at least 18 – 20 movements per hour.
- New Terminal apron will be designed so as to enable 6nos Code E and 11nos Code C aircraft to be parked at any one time. It will accommodate 4nos Code E stands and 1no Code C stand with passenger boarding bridges. Sufficient area will be provided and clearly designated on the stands for the storage of ground support equipment required to facilitate efficient apron operations.
- A new VIP/CIP apron providing parking space for 1no Code C and 1no Code E aircraft with its supporting terminal facilities will be built towards the north-west of PBT. It will require an area of

around 2,400m^2 in VIP/CIP terminal building complex. This construction will necessitate relocation of MNDF facilities consisting of 20,000m^2.

- A new cargo building of around 8,000m^2 with provision of apron to accommodate 2nos Code C aircraft will be constructed in the south of new terminal complex. A new aircraft maintenance complex with two Code C stands will also be developed adjacent to the cargo building.
- A new Code C aircraft stand taxi lane connecting partial parallel code E taxiway will be constructed.
- Approximately 21,000m^2 of airside roads will be constructed to facilitate safe and efficient operation and movement of airside vehicles to and between all airside infrastructure facilities.
- Strengthening and rehabilitation works will be carried out after identification of extent of damage to various areas of runway so as to ensure a minimum pavement life of 20 years.

2.7.4 Land Reclamation

Land Reclamation activities are driven by the other construction components of project. For the up-gradation Malé International Airport, the construction activities will require total reclamation of about 787,899m^2 of land and 2,500,000m^3 of total soil quantity. The break-up of land reclamation work is given below:

- Construction of New passenger terminal – 133,820m^2
- Full 300m wide runway strip – 330,534m^2
- Triangle portion on north-east of terminal near ATC – 19,527m^2
- Fencing work – 75,900m^2
- Extension of runway 18 on the north – 59,968m^2
- End connection of taxiway to runway 36 – 22,000m^2
- MNDF – 20,000m^2
- Additional reclamation on east side of terminal – 126,150m^2

Details of reclamation areas with types of protection are illustrated below in **Figure 2.9**.

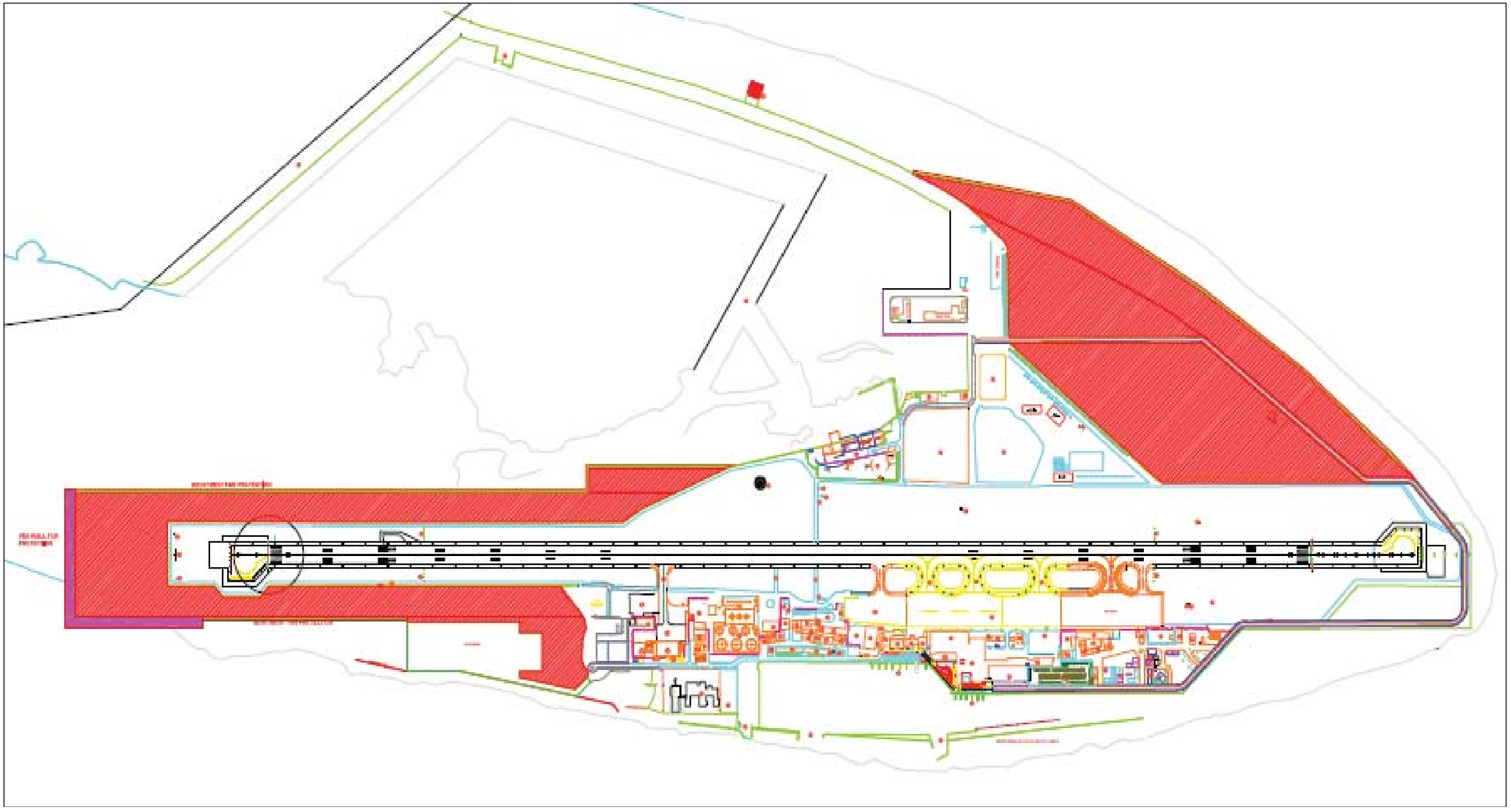


Figure 2.9: Reclamation Areas

2.7.5 Support Facilities

The proposed construction and up-gradation of support facilities form an integral part of expansion and modernization project. These support facilities consist of the following:

- The existing aviation fuel farm will be relocated and expanded to meet the future storage requirements. The new fuel farm for an initial storage capacity of 24,000 KL with provision for future expansion as required will be located on land which is already partially reclaimed north of the existing location.
- A new storage facility will be constructed in the area vacated by the fuel farm in an area of atleast 650m^2.
- A new ground handling base will be provided for the storage and maintenance of Ground Support Equipments. An airport maintenance workshop of 200m^2 will also be constructed near ground handling base.
- The utility services systems for Malé International Airport will be conceptualized based on factors including conservation of energy, optimization of resources, eco-friendliness and future expandability. The various components of utility services systems are detailed below:

Air Conditioning System

The air-conditioning system planning and design will be based on ASHRAE standards. The system will be designed to provide air-conditioning in area of 33,650m^2. The anticipated cooling load requirement for terminal building is 1,500 tonnes. The system will be designed to suit the requirements for achieving LEED silver certification. Sustainable features like use of high efficiency Chillers, pumps, fans etc, generation of cooling by adsorption chillers utilizing waste heat from diesel generating sets will be considered. To maintain indoor air quality CO_2 sensors will be installed in public areas and fresh air modulation will be undertaken if higher CO_2 concentrations are detected inside the building.

Power Requirement

The average maximum and minimum power requirement for the existing Malé International Airport is 4000 kVA and 2500 kVA respectively. It has also been estimated that preliminary load requirement for passenger terminal building will be in the range of 2700kW to 3000kW. The additional power requirement after proposed up-gradation of airport will be met through existing diesel generator facilities. Energy efficient lamps will be used for general lighting.

Water Requirement

After proposed up-gradation and modernization of airport, the water demand will increase to 630kld from existing 380kld. The water would be required for domestic use by airport staff, passengers (domestic and international), flight kitchen, sanitary facilities, make-up water for HVAC, cleaning and maintenance requirements at the airport. The required water will be sourced from the existing desalination plants. However, if required capacity augmentation will be done to supplement existing capacity. Water distribution within the Main Terminal Building will be done with the help of Hydro pneumatic systems for domestic water and flushing/ Ac make-up. To minimize water consumption all sanitary fixtures and fittings will be designed on low flow concept. Drinking water fountains will be located at strategic locations and individual RO systems will be provided to generate drinking water from desalinated water network.

Sewage Treatment Plant

To treat the sewage generated in the airport, a completely automatic Sequential Batch Reactor (SBR) of capacity 850 KLD will be installed in an area of about 2 acres. The effluent water will be used for irrigation purposes and flushing after post-disinfection treatment by dosing with hypochlorite or peracetic acid. An emergency sewerage system will also be laid on the island for emergency sewage outfalls. The sludge from the treatment plant will be taken to Thilafushi island for disposal.

Fire Fighting Facilities and Alarm System

A new Fire station complex will be constructed in an area of about 2,800m^2 in area vacated by the old fuel farm. The terminal building and its surroundings will be provided with fire hydrant posts which will be supplied water from existing fire pump house. Based on fire strategy study, necessary fire fighting and alarm systems will be provided. Portable fire extinguishers of water (gas pressure) type, foam type and carbon-dioxide type will be deployed at various public and service areas.

Storm Water Drainage

Storm water drainage will be designed on a 50 year return period. Storm water will be drained into the sea through a series of connected drains. The rain water from terraces and other open spaces will be collected through rain water down-take pipes and passed to channels in external area for rainwater harvesting.

Aircraft Stand Drainage

Aircraft Stand Drainage system will be designed as per NFPA 415 requirements. It will be ensured that fuel or its vapour does not enter the drainage system. Fuel will not be allowed to collect on the aircraft-refueling areas where it may pose fire threat.

2.7.6 Landside Development

Landside development for airport includes the construction of a new terminal forecourt, parking and seaplane and boat facilities. These construction activities are discussed below in brief:

- A 240m terminal forecourt will be developed along the full length of terminal frontage. It will be covered by a 36m spanning roof canopy. Commercial and catering outlets will be provided in the forecourt for the comfort of visitors.
- Parking for cars will be constructed in an area of approximately 3,500m^2 next to the forecourt.
- A new ferry pier with a hotel hospitality center will be developed to the north of new passenger terminal. Hotel hospitality center aims to provide hotel guests with a covered, landscaped waiting area, with the view of Malé.
- A new boat jetty facility will be developed on the east of the runway for accommodating speed boats plying to and from airport resorts. Also a parking for 200 speed boats will be constructed.
- Seaplane operations in Malé international Airport is expected to increase to 160,000 by year 2035. Up-gradation of seaplane facilities including length, number and operation of runways on lagoon for seaplanes will be done. However, passenger terminal facilities will continue to be provided by the existing two seaplane operators. Brief description of Malé International Airport project is given below in **Table 2.5**.

Table 2.5: Brief description of Malé International Airport expansion and Modernization Project

S.No	Facilities	Existing Design Features- Male (Capacity 2 MPPA)	Proposed Design Features- Male (capacity 5.2 MPPA)
1	**Runway**		
	Runway Orientation	18/36	No change
	Runway Length	3200m with two turn pads at either end	200m extension and two new turn pads
	Runway Width	45m +7.5m shoulder on either side	No change
	Lighting System	Simple Approach Lighting System on runway approach 36	Modified as per extension of runway
2	**Taxiways**	Stub links linking current apron on the west of the runway	New Apron planned on the east of the runway to be connected by Partial Parallel Taxiway with two connecting taxiways for Code E operations

S.No	Facilities	Existing Design Features- Male (Capacity 2 MPPA)	Proposed Design Features- Male (capacity 5.2 MPPA)
			1no Code E apron taxiway
			One Code C apron taxiway for terminal aprons
3	**Parking Apron**	5nos Code- E stands and domestic/ Cargo apron on the west of the runway	New apron planned on the east of the runway
			6nos Code E Stands, 11nos Code C stand for passenger aprons
			1no Code E + 1no Code C VIP apron
			2nos Code C for Cargo apron
			2nos Code C for Maintenance apron
4	**Passenger Terminal**		
A	Built up Area	15,600m^2 on the west of the runway	45,000m^2 +2,400m^2 VIP terminal to be built on the east of the runway
B	Aerobridges	NIL	5 No.
5	**Cargo Terminal (Built up area)**	2800m^2	8000 m^2
6	**Fuel Facility**	Fuel Farm 16500 KL to be decommissioned and dismantled on start up new fuel farm further north	New main tanking – 24,000 KL expandable to 35,000KL
			Two Day tanks 1500 KL each
			Fuel Hydrant system to passenger stands fed from day tanks
7	**Other Facilities**	All associated Airport Facilities	Fire Station - CAT -9 Operations to be built on the west of the runway
			Ground Handling Base including open area on the east of the runway
			Airport Maintenance building including open area on the east of the runway
			Other associated facilities
8	**Dredging & Reclamation**		About 2.5 million m^3 of filling is required in the new terminal area
9	**Boat Jetties**	Currently provided on the west of the existing terminal	While the west jetty continues to be operational, partial operations shall be shifted into the lagoon on the east of the runway
11	**ATC tower & Power house**	East of terminal	No change
12	**Sewage treatment**	Insignificant facility	New enhanced facility to be constructed

2.8 Construction Phase

The details of construction phase of proposed project are given in sections below:

2.8.1 Project Schedule

It is anticipated that the completion of proposed expansion and modernization of Malé International Airport will take approximately 42 months. The mobilization will begin after the EIA is approved.

2.8.2 Labour Requirement

During construction phase the projected demand of workers will be between 200nos and 1000nos. Accommodation ensuring approximately 25ft^2 area per worker will be provided within the Airport Island. A common kitchen facility and one toilet per 10nos. workers will be provided. However, the location of worker's colony will be decided later.

2.8.3 Construction Material Requirement

Variety of material including stone, sand, cement and other construction material will be required for the construction phase. Approximately seven hundred tonnes of stone, four hundred tonnes of sand and about a million tonnes of other construction material will be required. These materials will be imported to the Airport Island by barges and ships and stored near existing terminal or hulhumalé. The tentative location of procurement of construction material is given in the **Table 2.6**. However, to ensure the quality of construction material and cost effectiveness of procurement, the final locations will be decided later.

Table 2.6: Procurement locations for Construction Material

S. No	Construction Material	Procurement Location
1	Sand	India/ Sri Lanka
2	Stone	India/ Sri Lanka
3	Timber	Malaysia/ Indonesia
4	Cement	India/ Pakistan
5	Steel	India/ Ukraine/ Vietnam

2.8.4 Power Requirement

The power required for the construction phase will be in the range of 500kVA to 1.2mVA. It will be procured from main power source (Diesel generators sets) and an additional transformer of 630kVA will be installed near terminal site.

2.8.5 Water Requirement

An additional 200 to 300 KLD of water will be required for the construction phase. This water demand will be met through the existing water declination plants. Additional desalination plants will be installed in the airport if required. However, groundwater will not be used for construction purposes.

2.8.6 Waste Management

It is expected that 20,000 metric ton of construction and demolition waste will be generated from the proposed up-gradation of airport during the construction phase. The solid waste and hazardous waste will be collected daily and sent to Thilafushi island for further treatment. The waste water and sewage will also be treated to the required international standards and discharged.

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The project conforms to the requirements of the Environmental Protection and Preservation Act of the Maldives, Law no. 4/93. The EIA has been undertaken in accordance with the EIA Regulation 2007 of the Maldives by registered consultants. Furthermore, it adheres to the principles underlined in the regulations, action plans, programmes and policies of Ministry of Housing and Environment, Ministry of Transport and Civil Aviation and Ministry of Agriculture and Marine Resources. These are discussed in detail in the following sections.

3.1 Relevant Environment Legislations and Guidelines

3.1.1 Environmental Protection and Preservation Act

- The Articles of the Environmental Protection and Preservation Act (Law No. 4/93) addresses the following aspects of environmental management:
- Guidelines and advice on environmental protection shall be provided by the concerned government authorities.
- Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MEEW.
- Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
- An EIA shall be submitted to MEEW before implementing any developing project that may have a potential impact on the environment.
- Projects that have any undesirable impact on the environment can be terminated without compensation.
- Disposal of waste, oil, poisonous substances and other harmful substances within the territory of the Republic of Maldivesis prohibited. Waste shall be disposed only in the areas designated for the purpose by the government.
- Hazardous / Toxic or Nuclear Wastes shall not be disposed anywhere within the territory of the country. Permission should be obtained for any trans-boundary movement of such wastes through the territory of Maldives.
- The Penalty for Breaking the Law and Damaging the Environment are specified.
- The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

The proposed project will fully abide to the Environmental Preservation and Protection Act. Disposal of oil, chemicals and other hazardous materials will be strictly controlled and managed. Such materials will not be disposed in to the local or the regional environment, but will be transported to designated waste disposal site, that need to be identified by the Ministry of Housing and Environment. All mitigation measures will be implemented in the interest of the environment.

3.1.2 Land Law

The law governs the allocation of Maldivian land for different purposes and uses and other issues regarding the issuing of land, issuing of state dwellings for residential purposes, conduct regarding state dwellings or private dwellings constructed for residential purposes and the sale, transfer and lease of Maldivian Land. All transactions concerning the issuing, receiving, owning, selling, lease, utilizing and using Maldivian land shall be conducted in compliance with this Act.

3.1.3 Environmental Impact Assessment Regulation 2007

The Ministry of Environment, Energy and Water issued the EIA Regulation in May 2007, which guides the process of undertaking the Environmental Impact Assessment in the Maldives. This Regulation provides a comprehensive outline of the EIA process, including the roles and responsibilities of the consultants and the proponents. This regulation outlines every step of the IEE/EIA process beginning from application to undertake an EIA, details on the contents, minimum requirements for consultants undertaking the EIA, format of the EIA/IEE report and many more.

The guidance provided in this Regulation was followed in the preparation of this EIA report. The EIA has also been prepared by registered consultants.

3.1.4 Post EIA Monitoring, Auditing and Evaluation

The environmental monitoring programme given in EIA reports is an important aspect of the EIA process. The monitoring programme outlines the objectives of the monitoring; the specific information to be collected; the data collection program, and managing the monitoring programme. Managing the monitoring programme requires assigning institutional responsibility, reporting requirements, enforcement capability, and ensuring that adequate resources are provided in terms of funds, skilled staff, etc.

The monitoring programme outlined in this report will comply with the EIA Regulations 2007.

3.1.5 Regulation on sand and aggregate mining for building construction

This regulation addresses sand mining from uninhabited islands that have been leased; sand mining from the coastal zone of other uninhabited islands; and aggregate mining from uninhabited islands that have been leased and from the coastal zone of other uninhabited islands for the purpose of building construction.

Neither sand nor aggregate will be mined for this project for the purpose of building construction. Aggregate and sand used for this project will be imported. The reclamation component will be undertaken with the required permit from Ministry of Housing and Environment. This regulation would not have any implication on the proposed project.

3.1.6 Civil Aviation Regulations

Civil Aviation Regulations of the Republic of Maldivescomprise important regulatory measures such as authorization of place for use as an aerodrome, charging for use, obstruction clearance and marking, waste disposal, storage and safety measures for aviation fuel, aeronautical and dangerous lights, smoke emissions and noise.

The following subsections briefly look into the various aspects of relevant legislative measures covered in the Civil Aviation Regulation, Division A - Aerodromes.

Use and size of aerodromes

According to the Civil Aviation Regulation, aircrafts shall not land at any place in the Republic of Maldivesunless the place has been licensed and the use of the place is authorized by the Director of Civil Aviation according to the terms prescribed in the Regulation. These include the applicant's competency and sound safety measures, having regarded in particular to the physical characteristics of and the surrounding of the aerodrome.

The Regulations also states that any licensed aerodrome open to public use shall be open to any aircraft used in the service of the Republic of Maldivesand also to any aircraft which possesses the nationality of a Contracting State on the same terms and conditions as for Maldivian aircraft. All aircraft which possesses the nationality of a Contracting State shall also be entitled to use such aerodromes and such visual and non-visual aids to air navigation as open to public use.

Obstruction Clearance and Marking

The Civil Aviation Regulation specifies, Whenever any object located in the vicinity of the aerodrome for public use constitutes an obstruction or potential hazard to aircraft moving in the vicinity of the aerodrome, the occupier of the place, or in the case of a movable object, the person having the management of it shall comply with terms of the notice from the Civil Aviation Department.

According to the Civil Aviation Department, it is ideal to have the runway away from the island vegetation. This will ensure maximum safety in terms of obstruction to aircraft flight path and also reduce the number of accidents due to ignorant crossing on the runway by trespassers.

Zoning of Land and Waters in the Vicinity of Aerodromes

Under the Civil Aviation Regulation, with effect upon publication in a local newspaper, the Director of Civil Aviation may by order restrict the use of land or waters in the vicinity of an aerodrome for public uses for the purpose of protecting the approach and transitional surfaces of an aerodrome in accordance with the material standards and recommended practices for air navigation services prescribed under the Chicago Convention. Such an order may provide for;

- Prohibition of the erection of or limitation of the height of buildings, structures or things;
- Prohibition of the planting or limitation of the height of any trees;
- Prohibition of sowing or growing any plant or crop; and
- Prohibition of the bringing of vessels or vehicles or anchoring, mooring or parking of any vessel or vehicle.

However, different provisions may be made with respect to different areas and an order only becomes effective upon publication in a local newspaper.

Dumping of Rubbish

Birds will create potential hazard to aircraft using or flying in the vicinity of the aerodrome. To minimize the attraction to birds, therefore, waste foodstuff or other rubbish has to be kept in closed containers. The runway building floors should be swept clean at all times.

Delivery of Aviation Fuel and Checking Quality

Civil Aviation Regulations 13.11 requires the following guidelines for aviation fuel installation.

A person who manages an aviation fuel installation on an aerodrome shall not permit any fuel to be delivered or cause to be delivered to that installation or from it to an aircraft unless;

a. when the aviation fuel is delivered into the installation,
    i. the installation is capable of storing and dispensing fuel so as not to render it unfit for use in the aircraft;
    ii. the installation is marked in a manner appropriate to the grade of fuel stored or if different grades are stored in different parts each part is so marked;
    iii. in the case of delivery into an installation from a vehicle or vessel, the fuel has been sampled and is of a grade appropriate to that installation or that part of the installation as the case may be and is fit for use by aircraft;
b. When any aviation fuel is dispensed from the installation, he is satisfied as result of sampling, the fuel is found to be fit for use in aircraft.

These regulations do not apply in respect of fuel, which has been removed from an aircraft and is intended for use in another aircraft operated by the same operator as the aircraft from which it has been removed.

A person shall not cause or permit any aviation fuel to be dispensed for use in an aircraft if he or she knows or has reason to believe that the fuel is not fit for such use.

3.1.7 Noise

According to Civil Aviation Regulation, an aircraft shall not land or take off in the Republic of Maldivesunless in respect of the aircraft there is in force a noise certificate issued or validated by the competent authority of the country whose nationality the aircraft possesses to standards the same as or substantially equivalent to those prescribed in pursuance of the Convention.

Various aircraft noise mitigation measures have been included in the Civil Aviation Regulation, as follows:

For the purpose of limiting or mitigating the effect of noise or vibration caused by aircraft, whether landing, taking off, on an aerodrome, the Director may, by notice published in such manner as the Director considers sufficient:

(1) Direct the operator of an aircraft which is to take off or land at an aerodrome to secure that, after the aircraft takes off, as the case may be, before it lands at an aerodrome, such requirements as specified in the notice are complied with;
(2) Direct the operator of an aircraft which is within an aerodrome to secure compliance with such directions with respect to the taxiing of the aircraft and the running of power plants (whether installed in an aircraft or otherwise) as are specified in the notice; or
(3) Prohibit aircraft from taking off or landing at an aerodrome during certain periods, or limit the number of occasions on which they may take off and land at an aerodrome during certain periods.

The Regulation also includes penalties for non-compliance with noise and vibration suppression measures described above.

3.1.8 Other Safety and Environmental Considerations

Air Navigation Aids

Civil Aviation Regulations requires that Aeronautical Radio Stations shall be licensed and purpose approved by the Director and the equipment shall be of a type the specification of which has been approved by the Director for the purpose for which it is to be used and such conditions as are specified in the approval are complied with. Only those approved and checked for the specified purpose shall provide navigational aid to aircraft, except unless the aeronautical radio station is used solely for the purpose of enabling communications to be made by or on behalf of the operator of an aircraft and the pilot in command of an aircraft.

Aeronautical Lights and Dangerous Lights

Aeronautical beacons and aeronautical ground lights at an aerodrome licensed under the Civil Aviation Regulation shall be established, maintained or altered only with the permission of the Director of Civil Aviation and in accordance with the conditions of the permission. A person shall not exhibit a light which (i) because of its glare may endanger aircraft taking off or landing at an aerodrome or using an A.T.S route or (ii) because it may be mistaken for an aeronautical ground light, may endanger aircraft.

Fuel Venting Requirements

An aircraft shall not land or take-off in the Maldives, unless (i) the aircraft or (ii) the engines fitted to the aircraft, are of a type which have been certified as complying with the requirements relating to fuel venting by the competent authority of a Contracting State whose requirements are the same or are substantially equivalent to the standards prescribed in pursuance of the Convention and in the case of aircraft powered by gas turbine engines manufactured on or after 1 May 1986 and for which a certificate of airworthiness was issued after 1 May 1986 and turbo jet and turbo fan engine manufactured on or after 1 May 1986, that the aircraft is fitted with the engines specified in the certificate.

Smoke Emission Requirements

An aircraft powered by turbo jet or turbo fan engines shall not land or take off in the Maldives unless those engines are of a type which have been certified as complying with the requirements relating to smoke emissions by the competent authority of a Contracting State such requirements being equal in stringency to the standards prescribed in pursuance of the Convention.

3.2 Desalination Regulations

The Desalination Regulation states the requirements for application, plant capacity determination, intake and source water, plant operation and maintenance, brine discharge as well as water quality monitoring requirements of desalination plants that are installed in Maldives. The Desalination Regulation of the Maldives came into force from 2002.

The desalination plant at Malé International Airport has to be registered under this Desalination Regulation at Environment Protection Agency.

3.3 Guidelines for Domestic Wastewater Disposal

The guideline is developed by the Maldives Water and Sanitation Authority and is implemented by the Environment Protection Agency. The guideline is to improve public health through improved sanitation and cleaner and safer environment by regulating the disposal of domestic wastewater.

The proposed project has been proposed based on the requirements of this guidelines and EIA has been undertaken within the parameters defined by this regulations.

3.4 Ban on coral mining

Coral mining from the house reef and the atoll rim has been banned through a directive from the President's Office dated 26th September 1990. Coral would not be mined in any stage of the project. Rock boulders will be used for breakwater construction, if any.

3.5 Ambient Air/ Noise and Water Quality Standards

Republic of Maldiveslacks the necessary environmental standards for the measurement of ambient air and noise quality or water quality. Therefore, for these quality standards, typically WHO standards or international standards or standards of developed countries are referred.

3.6 Environmental Permits Required for the Project

3.6.1 Environmental Impact Assessment Decision Statement (EDS)

The EIA Decision Statement is issued on successful evaluation of the EIA report by the EPA, Ministry of Housing and Environment. EIA Decision Statement governs the manner in which the EIA project activities must be undertaken.

Responsible Institutions

The main government institutions that have roles and responsibilities relevant to this project are summarised below.

Ministry of Housing and Environment

The Ministry of Housing and Environment is mandated for the effective implementation of the Environmental Protection Act of the country and has the statutory power over issues related to the environment. It has the central control over the environment protection, management, conservation and environmental emergencies. The Ministry operates mainly at a policy level and the more regulatory and technical assessment activities are mandated to the Environmental Protection

Agency (EPA). In this respect EPA has now been mandated to manage all issues relating to Environmental Impact Assessment of individual projects.

Environmental Protection Agency

The Environment Protection Agency (EPA) of the Ministry of Housing and Environment has responsibility for efficient operation of the EIA process. This encompasses a number of tasks, including screening of projects and provision of general procedural advice to the project proponents throughout the EIA process. The EPA manages the review of the EIA report and is responsible for any approvals or recommendations associated with the EIA. It is also responsible for verifying that environmental protection measures are properly implemented by undertaking environmental audits in collaboration with other government as well as non-government agencies with a role for environmental protection and preservation.

EPA also implements the Desalination Regulations and hence keeps a register of all the desalination plants that had to be registered under the Desalination Regulations.

Civil Aviation Department

Civil Aviation Department (CAD) under the Ministry of Civil Aviation and Communication is the Maldivian Aviation regulator. CAD aims to develop and administer policies and regulations to ensure safe, secure, orderly and economic development of aviation in the Maldives. CAD places great emphasis on adopting highest common standards of safety and environmental protection in civil aviation. CAD has a vision to achieve regulatory excellence in aviation safety and security through a well motivated work force.

The main tasks of CAD are setting up national safety standards which are compliant with international standards; economic and safety regulation through regulation of airports, air traffic services and airlines.

Maldives Energy Authority

The Maldives Energy Authority (MEA) at Ministry of Housing and Environment regulates the energy sector of the Maldives. All the power houses are registered and regulated by MEA. Any capacity enhancement or creation of new power house at Malé International Airport, will require registration at MEA.

Maldives Food and Drug Authority

Maldives Food and Drug Authority (MFDA) regulates the food outlets that are registered at the Authority. All the food outlets have to have a Hygienic Certificate issue from the MFDA. The food outlets that would be developed by the proposed development would apply for such certificate from MFDA.

Ministry of Tourism, Arts and Culture

The Ministry of Tourism, Arts and Culture is solely responsible to the affairs relating to development and operation of all tourism developments in Maldives. All regulations released by Ministry of Tourism and other agencies pertaining to the operation of tourism projects are monitored and implemented by the Ministry.

3.7 Relevant Policies

3.7.1 National Energy Policy

The National Energy Policy looks at existing issues, constraints and emerging issues. The policy addresses issues of energy supply, consumption, environment, renewable energy, energy efficiency and sustainability. Sustainable supply and consumption is the main focus of the policy. According to

the policy document, only 3% of energy is from biomass and solar energy while the rest is from refined petroleum products with diesel fuel accounting to 83% of the total energy consumption in the Maldives. Therefore, there is a great deal of work that needs to be done if carbon neutrality were to be achieved by 2020.

3.7.2 Carbon Neutral by 2020

In March 2009, the President Nasheed announced the target to make Maldives carbon neutral by 2020. Hence, in the implementation of the project, careful attention needs to be given to ensure energy efficiency and reduce transport related fuel consumption.

3.7.3 National Adaptation Programme of Action (NAPA)

The adaptation policies and strategies of the Maldives are given in the Maldives National Adaptation Programme of Action (NAPA). A coastal protection project at Hulhule to protect the Malé International Airport is one of the priority project that had been included in the National Adaptation Programme of Action that Maldives had prepared and submitted to the UNFCCC secretariat.

3.8 International Conventions

3.8.1 Montreal Protocol

The upgrade and redevelopment considers the Maldives commitments to the implementation of the Montreal Protocol on Substances that depletes the Ozone Layers. The accelerated HCFC phase-out schedule for Maldives for consumption and production of HCFC as agreed Montreal Protocol is presented in table below. Hence the new infrastructure that would be added for the development in the area of cooling and refrigeration systems would comply with the national requirements that had been outlined by the Ministry Housing and Environment.

Control measure	Schedule
Baseline	Average of 2009 & 2010
Freeze	2013
90% (10% reduction)	2015
65% (35% reduction)	2020
32.5% (67.5% reduction)	2025
0% (100% reduction in manufacturing)	2030
Annual average consumption of 2.5% (for servicing)	2030 to 2040

3.9 Convention on Biological Diversity

The Maldives is a party to the United Nations Convention on Biological Diversity. The objective of the convention is “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding”. The proposed development activities outlined in this project does not fall on any area recognised for its ecological value. Therefore it is unlikely there will be a major loss of biodiversity. The loss is not going to be significant at atoll or national level. Yet, it is recommended that the developer ensures that silt screens are used during excavation and reclamation works, construction of the jetty and breakwaters to minimise any impact on the marine biodiversity.

3.10 International Plant Protection Convention

The Maldives has become a party to the International Plant Protection Convention (IPPC) as a step to protecting native plant species in the Maldives from the risk of diseases introduced by imported plant varieties. The Maldives adhered to the IPPC on 3 October 2006 and the Convention requires that certificates of phytosanitary condition and origin of consignments of plants and plant products be used for import and export of plants and plant materials. Contracting parties have the full authority to regulate entry of plants and plant products and may prescribe restrictions on imports or

prohibit importation of particular plants or plant products. Thus it is advisable that the proponent be aware of the requirements of IPPC and obtains the necessary phytosanitary certificates if any plants are to be imported for landscaping.

3.11 Climate Change Convention and Kyoto Protocol

The Maldives is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to the UNFCCC. The objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The greenhouse gas inventory of the Maldives forms an integral part of the First National Communication of the Maldives to the UNFCCC.

In March 2009, the President of the Maldives has announced the target to make Maldives carbon neutral by 2020. Hence, in the implementation of the project, careful attention needs to be given to ensure energy efficiency and reduce transport related fuel consumption. Furthermore, planting of beach vegetation and landscaping would help in mitigation of greenhouse gas emissions from the project.

3.12 Third National Environment Action Plan (NEAP III)

The aim of NEAP III is to protect and preserve the environment of the Maldives and to sustainably manage its resources for the collective benefit and enjoyment of present and future generations.

The following principles outlined in the NEAP III to in environment protection and environmental management are;

- Environmental protection is the responsibility of every individual
- Achieve results - The actions, activities, regulations, supervision, reporting, incentives, information and advice for environmental management shall be directed and well co-ordinated to achieve the results the citizens want.
- Promote and practise sustainable development
- Ensure local democracy
- Inter-sectoral co-ordination and co-operation
- Informed decision making
- Precaution first
- Continuous learning and improvement
- Right to information and participation
- Environmental protection complements development

NEAP III contains environmental policies and guidelines that should be adhered to in the implementation of the proposed project activities.

The airport development will also be in accordance with the main strategies of the NEAP II. The proponent is committed to the EIA and the proposed monitoring programme. The monitoring programme proposed in this report outlines the environmental management strategy and plan. This EIA has also been prepared in consultation with the key stakeholders, especially the island community of Hulhumalé, Malé and relevant stakeholders. Therefore, these measures address the key strategies outlined in the NEAP III.

4 EXISTING BASELINE ENVIRONMENT

The baseline information of the proposed project and surrounding area were collected through primary data collected during the study period (October-November, 2010) and available secondary data. The environmental baseline data includes general geography, meteorology, (precipitation, temperature, humidity, wind conditions), demographic status, geology, ecologically protected areas, terrestrial and marine environment, bathymetry, tidal conditions, etc. A detailed description of baseline data compiled through the surveys and monitoring is provided in the following subsections:

4.1 Geographic Setting

Maldives has a total of 1,192 islands, distributed over 26 natural atolls that encompass an area of approximately 107,500 km^2 of which less than 0.3 percent is land area. The country's total land area is estimated to approximately 300 km^2, with islands varying in size from 0.5 km^2 to 5.0 km^2. Only 197 of the islands are inhabited. The islands consist of coral, sea grass, seaweed, mangrove and sand dune ecosystems which are of great ecological and socio-economic significance.Maldives is considered as one of the ecologically sensitive marine habitats in shallow and intertidal zones.

The Ministry of Housing and Environment, Maldives has identified certain islands as protected areas. The following table shows the list of protected areas in Malé atoll and their respective distances from the Male International Airport, Hulhule Island:

Table 4.1: List of the Protected Areas in Male Atoll, 2005

Area	Distance from project site (km)
Male' Atoll	
Lankan Thila	-
Makunudhoo Kandu Olhi	40
Rasfaree and the enclosed reef	28
Thamburudhoo Thila	14
Gaathugiri / Ad' dhashugiri	-
Giraavaru Kuda Haa	13
Dhekunu Thilafalhuge Miyaruvani	-
Kollavani in the centre of Gulhifalhu	6
Emboodhoo Kandu Olhi	10
Guraidhoo Kandu Olhi	31

Source: Ministry of Housing and Environment

From the above table, it is apparent that except Kollavani in the centre of Gulhifalhu, most of the identified islands are situated beyond 10 km from the airport island,

4.2 Topography and Island elevation

At Malé International Airport, no topographical point is more than about 1.7 m above highest water level. The height point of the runway is 1.2m above mean sea level and thus has only about 0.5m clearance at highest high water level. The edge of the turning apron and shoulders are lapped by the sea at high water in several places and on the northeast end, which is comparatively sheltered, the retaining wall consists of loose piled coral blocks (MHHE, 2001).

4.3 Key Coastal Features

The coastal environment of the island can be described as having three characteristics. They are:

1. breakwaters build on western side of the island
2. seawall built all around the island and
3. lagoon between the breakwaters and sea walls

In order to assess the coastline, a coastal assessment survey was undertaken using handheld GPS, to determine the beach line of the island.

4.4 Geological Conditions

The islands occupy the central portion of the 3,000 km-long Laccadive-Chagos submarine ridge, which is a major feature of the Indian Ocean seafloor. They form a double chain of north-south oriented parallel atolls separated by an inner sea. The atolls rest on a submarine plateau that is 275-700 m deep, 700 km long and up to 130 km wide. Several east-west trending deep channels (~1000m) separate the atoll groups.

The islands are low-lying and began forming between 3,000 and 5,500 years ago. They represent the most recent deposition along a submarine plateau that is underlain by approximately 2,100 m of mostly shallow-water carbonates resting on a slowly-subsiding volcanic foundation. The islands are primarily composed of reef-derived carbonate sediment that has been deposited by waves and currents. In simple terms, the islands tend to have taken one of three forms:

- **seaward-edge islands** on the peripheral atoll rim, formed of sand and gravel with steep, coarse beaches along their seaward margins and sand beaches along their lagoon shores;
- **lagoon-edge islands** composed mostly of sand with minor amounts of gravel; and
- **sand-clay type islands** that form on peripheral rims and within lagoon, reef-top settings.

The reef foundations have been in existence for millions of years. The islands, however, are some of the youngest land surfaces on earth. Because of their unconsolidated nature, the islands should be considered ephemeral from the perspective of geologic timescales.

Island shorelines consist of sand, gravel, and a variety of engineering structures. The country's beach systems are highly dynamic and subject to seasonal conditions, especially from monsoons. Although Maldives is located away from the main pathways of tropical cyclones, the presence of gravel beach ridges and cemented conglomerates attest to the fact that storm waves are an important element in the development of the islands.

Erosion and accretion are, in fact, ongoing processes to which local communities have adapted in the past. Increases in population and the development of permanent infrastructure in close proximity to shorelines, however, have made erosion a prominent hazard to the country's social and economic well-being.

It is estimated that 80% of the islands are one metre or less above mean sea level. Their low elevation makes them particularly vulnerable to storms and changes in sea level. The prospect of global sea level rise and its potentially catastrophic impact on low-lying islands makes erosion management all the more urgent.

4.4.1 Historic Shoreline Changes

The best way to appreciate the historical changes on the shoreline is through the study of the aerial Photographs. Tthe aerial photographs of the island from 1969, 1999, 2001, 2005, 2008, 2009 and field data of 2010. **Error! Reference source not found.** shows the modifications and changes that

had been made to the shoreline of the island. The most noticeable changes that had happened to the island is the disappearance of the lagoon on western side of the island and expansion of the island to the eastern side of the lagoon through reclamation.

Figure 4.1: The Metamorphosis of Malé International Airport through time

4.5 Meteorological Conditions

Meteorology at Maldives is monitored by the Maldives Meteorological Service (MMS) through three stations as detailed in **Table 4.2** below. The stations monitor rainfall, temperature, wind and tide levels at the islands. The secondary data presented in this section has been sourced from recordings of MMS monitoring stations.

Table 4.2: Geographical Coordinates of the Meteorological Centres in Maldives

Location	Latitude	Longitude	Tide gauge
National Meteorological Centre, Malé	04.19°N	73.53°E	Yes
Haa Dhaal Hanimaadhoo Meteorological Office	06.75°N	73.17°E	Yes
Laamu Kadhdhoo Meteorological Office	01.86°N	72.10°E	No

Source: Maldives Meteorological Service

Hourly meteorological data was also collected for Hulhule (MIA) for the period 1990-2009. The data includes parameters such as atmospheric pressure, temperature, humidity, wind speed and direction and precipitation which is provided in the subsequent section

4.6 Climate

Maldives is located at the equator and experiences monsoonal climate. Maldives has two distinct seasons; dry season (northeast monsoon) and wet season (southwest monsoon). In these two seasons the temperature remains more or less the same. . Northeast monsoon extends from January to March. Since Maldives consists of small islands and are surrounded by sea, hot days are often tempered by cooling sea breezes and evening temperatures drops. Throughout the year, temperature remains almost same in the Maldives. However, daily temperature ranges from around 31^{o}C in daytime to 23^{o}C in night-time. The mean daily maximum temperature for Central parts (Hulhule) of the Maldives is 30.5^{o}C and minimum temperature is 25.7 ^{o}C. On the other hand, mean daily maximum and minimum temperature for South (Gan) is 30.9^{o}C and 24.5 ^{o}C, respectively.

The wet season- southwest monsoon runs from mid-May to November. In this season Maldives experiences torrential rain. Central, Southern and Northern parts of the Maldives receive annual average rainfall of 1924.7mm, 2277.8mm, and 1786.4mm, respectively. The highest rainfall ever recorded in the Maldives with in 24 hour period was on 9th July 2002 at Kaadedhdhoo Meteorological Office and amounts to 219.8mm of rainfall. Maldives being located at the equator, receives plentiful of sunshine throughout the year. On average Southern atolls (Gan) of the Maldives receives 2704.07 hours of sunshine each year. Furthermore, on average central (Hulhule) parts of the country receives 2784.51 hours of sunshine per year. The relative humidity in Maldives ranges from 73% to 85%.The monthly average sunshine and rainfall is presented in the figure below

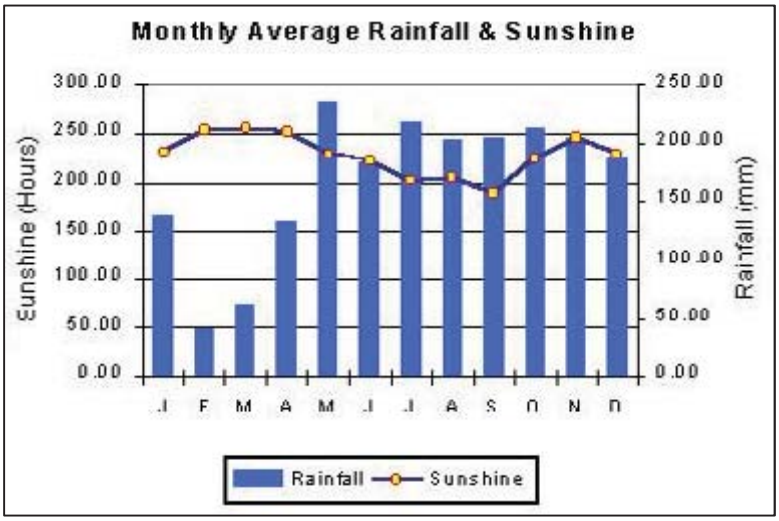


Figure 4.2: Monthly Average Rainfall and Sunshine
(Source: Maldives Meteorological Service)

The month wise rainfall data for Maldives recorded for the month of 2009 is as provided below:

Table 4.3: Month-wise Rainfall Data for Maldives, 2009

Locality	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Male'	2,201	85.2	12.8	36.8	86.6	175.1	213.3	275.9	416.4	193.3	107.5	409.2	189.4
Hanimaadhoo	1,635	2.6	7.6	31.5	55.5	145.4	156.6	218.7	234.8	177.3	83.9	234.4	286.9
L.Kadhdhoo	2,158	58.3	193.1	30.9	149	244.5	187.7	42	295.3	165.4	203.8	336.1	252.5
Kaadedhdhoo	2,023	242.7	50	60.5	124.3	307.3	32.5	83.2	318.1	180.8	188	155.2	280.6
S.Gan	2,307	247.3	23.6	54.1	134.6	253.7	105.1	252.8	165.2	224.9	322	261.3	263.1
Source: Maldives Meteorological Service													

Table 4.4 provide details of the average daily maximum and minimum temperature of Maldives for 2009.

Table 4.4: Month-wise Rainfall Data for Maldives, 2009

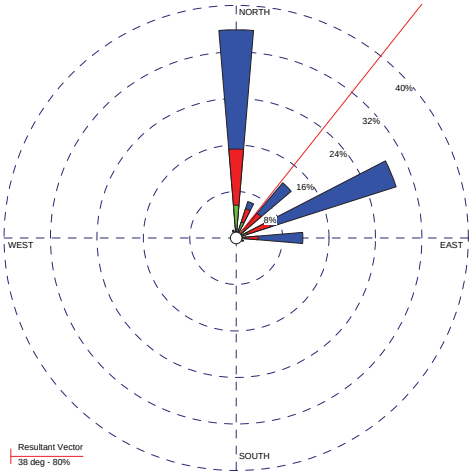
Locality	Yearly Avg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AVERAGE OF DAILY MAXIMUM TEMPERATURE (°C)													
Male'	31.1	30.5	31.0	31.9	31.7	31.7	31.2	31.2	30.3	30.7	31.6	30.6	30.6
HDh.Hanimaadhoo	31.3	30.7	31.5	32.4	32.1	32.1	31.1	30.9	30.6	30.8	31.6	31.0	31.1
L.Kadhdhoo	31.3	30.6	30.7	32.1	32.3	32.2	31.3	31.4	30.6	31.3	31.4	30.8	30.9
GDh.Kaadedhdhoo	31.1	30.8	31.0	31.8	31.6	31.6	31.1	31.1	30.4	31.1	30.9	30.2	30.9
S.Gan	31.1	30.7	31.1	31.7	31.5	31.2	31.1	30.9	30.6	31.2	31.1	30.5	31.3
AVERAGE OF DAILY MINIMUM TEMPERATURE (°C)													
Male'	26.3	25.8	26.1	27.1	26.9	26.7	26.6	26.2	25.2	26.1	26.7	25.8	26.0
HDh.Hanimaadhoo	25.5	24.6	24.2	25.5	26.3	27.3	26.0	25.4	25.5	25.8	25.3	25.2	24.7
L.Kadhdhoo	25.7	25.8	24.6	26.0	26.6	26.7	26.1	26.1	25.0	26.1	25.6	25.1	24.7
GDh.Kaadedhdhoo	24.6	24.6	24.5	24.6	25.4	25.1	25.2	24.4	23.8	24.6	24.2	24.4	24.6
S.Gan	25.4	25.2	25.5	25.9	25.8	26.0	25.8	24.9	24.7	25.6	25.0	24.9	25.2
Source: Maldives Meteorological Service													

4.7 Wind Conditions

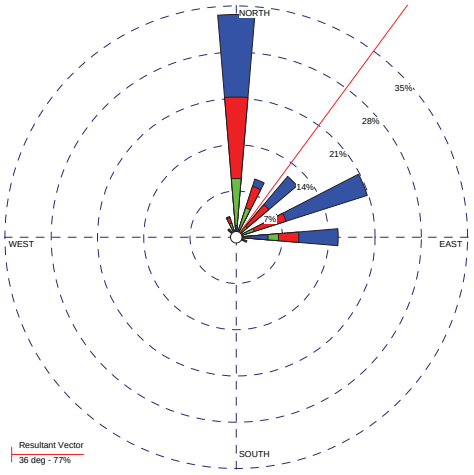
The National Meteorological Center for Maldives provides data for wind speed as recorded at Hulhulé meteorological station, for the period 1990-2010. The month wise windrose for the period of 20years

Figure 4.3: Monthly Wind Rose Diagrams for Hulhulé Station, 1990-2010

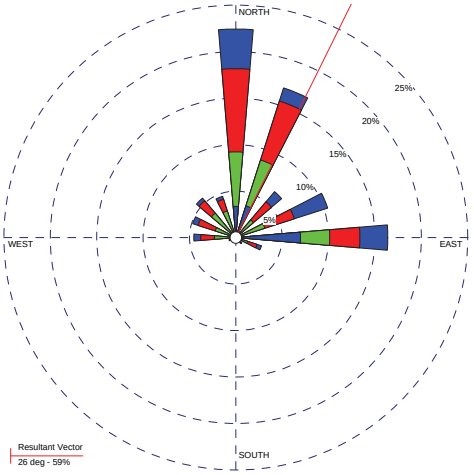
January



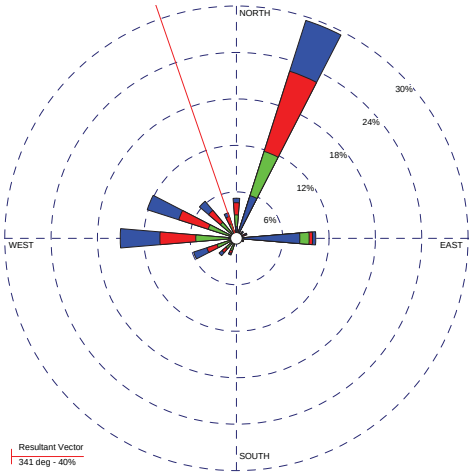
February



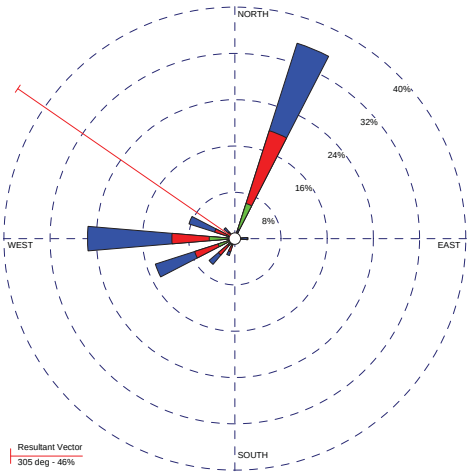
March



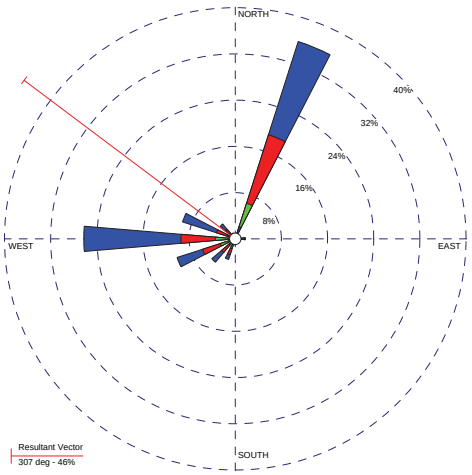
April



May

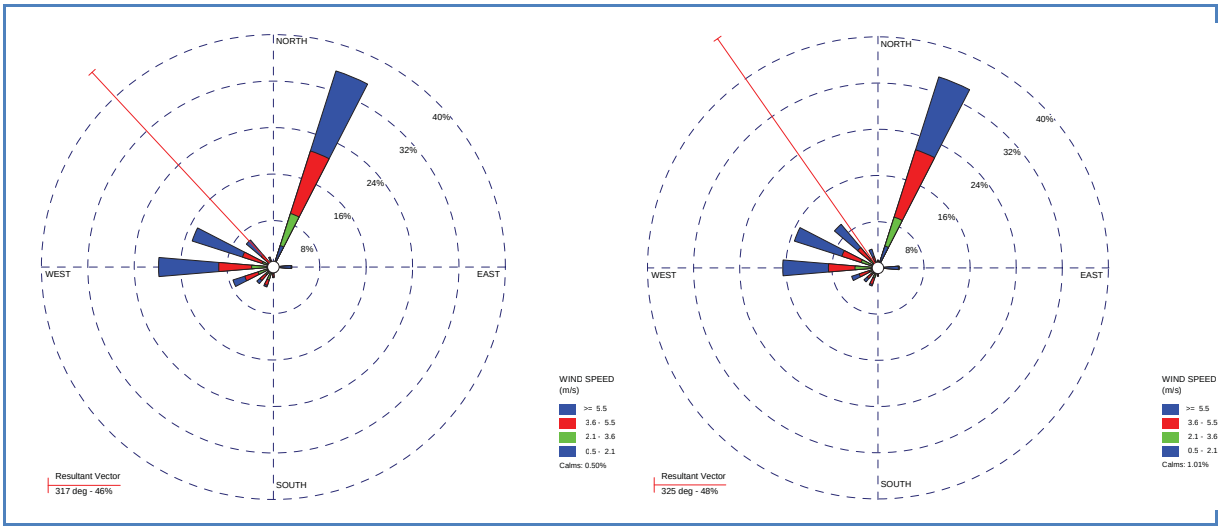


June

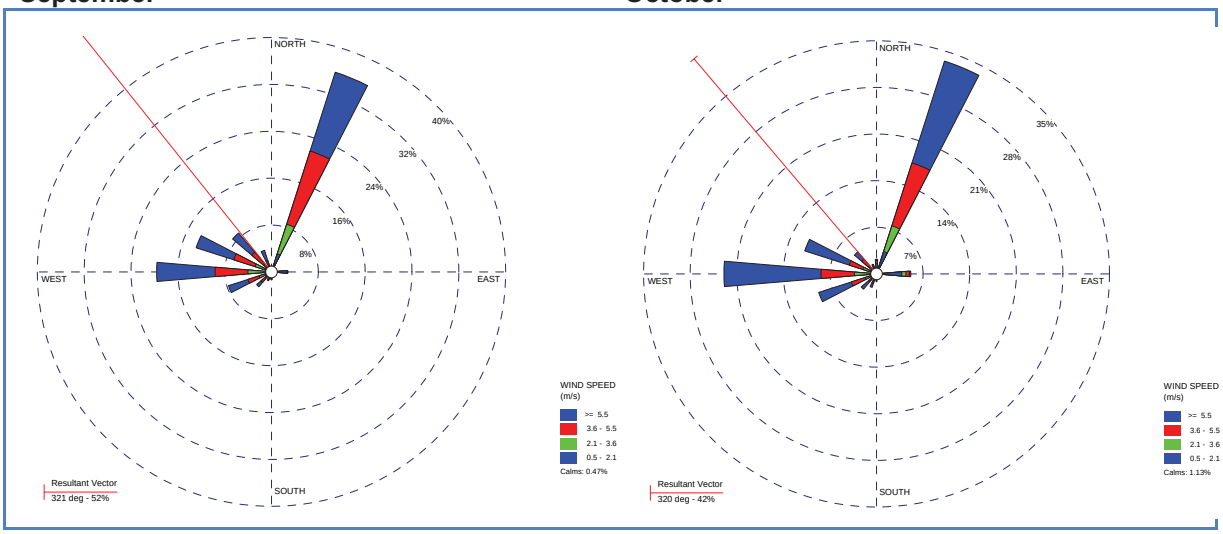


July

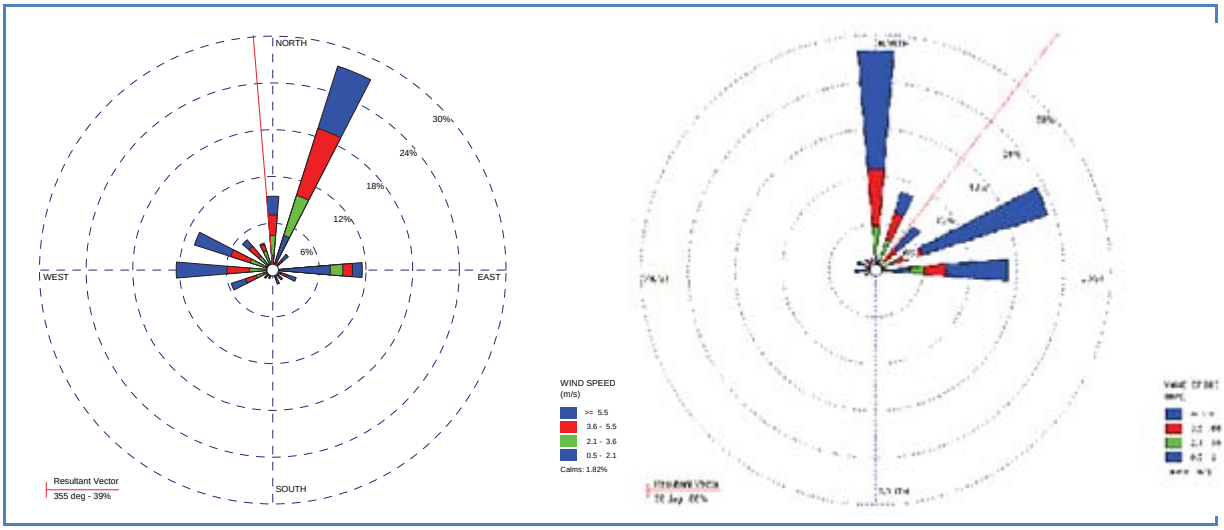
August



September **October**



November **December**



Source: National Meteorological Center, Maldives

Wind Speed

The average monthly wind speed over last 10 years at Hulhulé has been derived from the above windrose diagrams and presented in table below. The maximum average wind speed has been observed in the month of January and lowest in March.

Table 4.5: Average Monthly Wind Speed of Hulhulé (1990-2010)

Month	Average Wind Speed (m/s)
January	6.02
February	4.99
March	3.88
April	4.04
May	5.54
June	5.72
July	5.23
August	5.04
September	5.25
October	5.52
November	4.58
December	5.51

Wind Direction

The predominant wind direction throughout the year is from North and North-East. The calm periods are low at less than 2% throughout the year. The month wise breakup of the wind direction and the resultant vector for Hulhule is provided in **Table 4.6**:

Table 4.6: Monthly Wind Direction (1990-2010)

Month	Predominant Directions	Calm Percentage	Resultant Vector
January	North (36%) Followed by East North East	0.27%	North East (35°)
February	North (34%) Followed by East North East	0.62%	North East (36°)
March	North (22%) Followed by North North East	1.95%	North North East (26°)
April	North North East (29%) Followed by West	1.94%	North North West (341°)
May	North North East (36%) Followed by West	0.38%	North West (305°)
June	North North East (36%) Followed by West	0.27%	North West (307°)
July	North North East (36%) Followed by West	0.50%	North West (317°)
August	North North East (36%)	1.01%	North West (325°)

Month	Predominant Directions	Calm Percentage	Resultant Vector
	Followed by West		
September	North North East (36%) Followed by West	0.47%	North West (321°)
October	North North East (34%) Followed by West	1.13%	North West (320°)
November	North North East (28%) Followed by West	1.82%	North West (320°)
December	North (36%) Followed by East North East	0.97%	North East (38°)

Table 4.7 presents the seasonal distribution of wind statistics, sourced from Globocean database. The following periods have been defined in the database:

- December to March: NE Monsoon
- April: Transitional season - 1
- May to October: SW monsoon
- November: Transitional season - 2

Table 4.7: Wind Occurrence Frequency per Directional Sectors (%)

Season >		NE Monsoon	Transitional Season 1	SW Monsoon	Transitional Season 2
Wind Directional Sectors		Dec. to March	April	May to Oct.	November
S1	N15°-N105°	71.35	15.28	1.43	23.96
S2	N105°-N225°	6.13	16.55	17.65	17.62
S3	N225°-N315°	8.42	56.74	77.61	41.11
S4	N315°-N15°	14.10	11.44	3.32	17.31
Source: Globocean database from 1993 to 2004					

These results clearly indicate the prevailing directional sectors during the monsoon seasons:

- N15° to N105° during the NE monsoon, with about 71% of the observations,
- N225° to N315° during the SW monsoon, with about 78% of the observations.

4.8 Seasonal Fluctuation of Sea Level

Regional mean sea level is affected by a seasonal fluctuation of 0.2 m:

- increase of about 0.1 m from February to April
- decrease of 0.1m from September to November

4.8.1 Tide

4.8.2 Tide Datum

Tide data is important information in any costal development project as it determines the elevation of the structures relative to a datum. A permanent tidal record stations has been established at Malé International Airport by Maldives Meteorological Services. The maximum tidal range recorded at this tide station is 1.20m. The highest astronomical tide level is +0.64m (MSL) and the lowest astronomical tide level is -0.56m (MSL). **Table 4.8** gives a summary of the tide levels for the tide datum that has been widely used in Maldives.

Table 4.8: Summary of the Tide Levels Hulhule Island, Male Atoll

Tide level	Water level referred to Mean Sea Level (MSL) (m)
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

4.8.3 Tide levels

The tidal regime is semi-diurnal with diurnal inequalities (twice daily). That means 2 high tides and 2 low tides per day, with different heights. Typical spring and neap tidal ranges are approximately 1.0 m and 0.3 m, respectively.

Table 4.9 below gives the tidal levels in islands of Maldives, including Malé, as sourced from Admiralty Tide Tables for 2007.

Table 4.9: Maldives Tidal Level (in mm)

	Geo. Coordinates		LAT	MLLW	MHLW	MSL (ML)	MLHW	MHHW	HAT
	Lat. (°N)	Long. (°E)							
Standard Port: Cochin (West coast of India)	9° 58’	76° 16’	-0.2	0.3	0.6	0.6	0.8	0.9	1.2
Maldive Islands									
Ihavandhoo	6° 57’	72° 55’	-	0.3	0.6	0.68	0.9	1.0	-
Goidhoo Atoll	4° 51’	72° 55’	-	0.3	0.5	0.6	0.8	0.9	-
Girifushi	4° 19’	73° 55’	-	0.3	0.4	0.58	0.7	0.9	-
Malé	4° 11’	73° 31’	-	0.3	0.5	0.65	0.8	0.9	-
Vattaru	3° 15’	73° 24’	-	-	-	0.7	0.9	1.0	-

Source: Admiralty Tide Tables, 2007

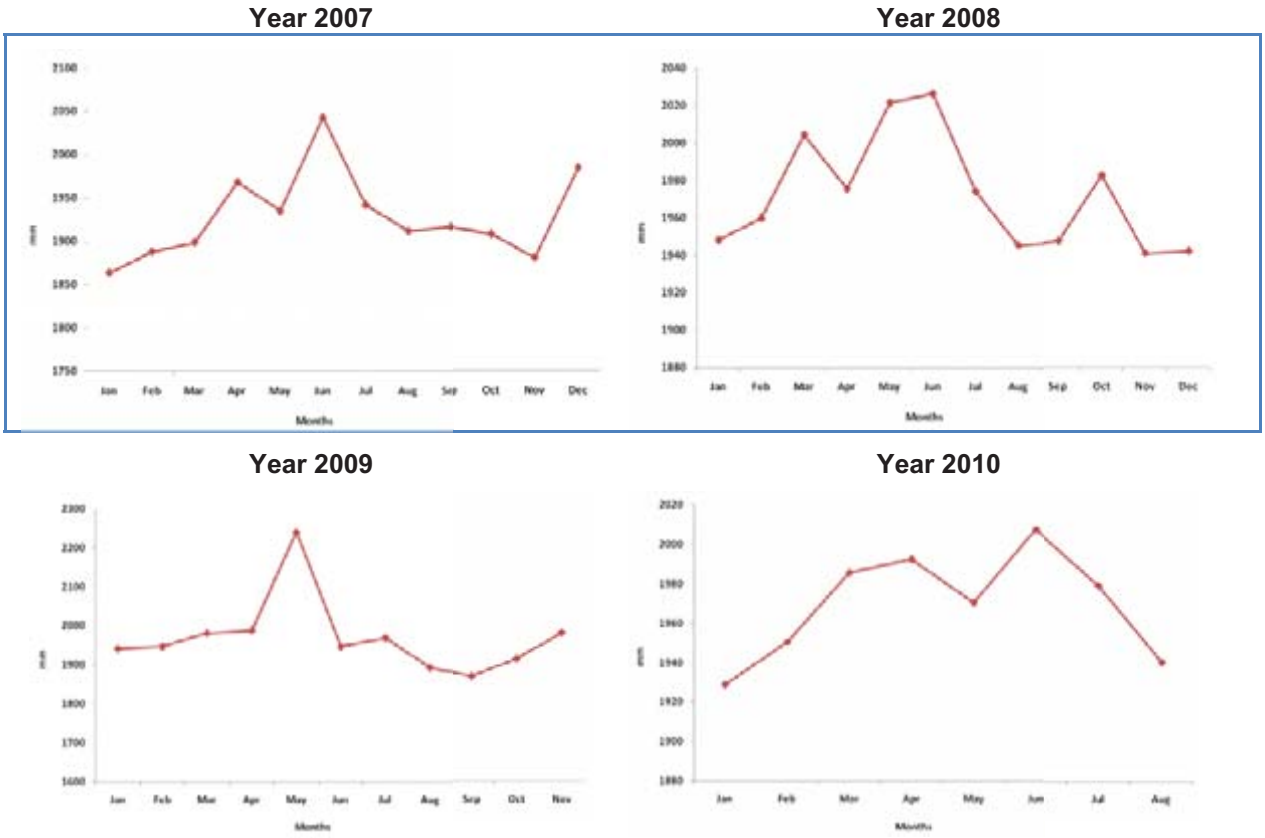
Note: LAT - Lowest Astronomical Tide; MLLW - Mean Lower Low Water; MHLW - Mean Higher Low Water; MLHW - Mean Lower High Water; MHHW - Mean Higher High Water; HAT - Highest Astronomical Tide

4.8.4 Sea Level Rise

The Maldives, being a low lying small island state, is very vulnerable to climate change and its associated impacts, especially sea level rise. Although the country contributes only 0.001% of global GHGs, it is one of the most susceptible to climate change impacts. The average elevation of Maldivian islands is 1.5 m above mean sea level (MSL). More than 80% of the land area of Maldives is less than 1 m above MSL. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report predicts that sea-level rise of up to 0.88m by 2100 will submerge the Maldives completely.

Malé International Airport on Hulhulé Island is the only gateway to the Maldives. The height of the runway is only 2 m above MSL and is extremely vulnerable to climate change related sea level rise. The University of Hawaii Sea Level Center (UHSLC) monitors and gathers data on mean sea level for several stations including Hulhulé. The following graphs show the trend of monthly mean sea level as monitored at Hulhulé station for the period 2007 to 2010.

Figure 4.4: Mean Sea Level (in mm) from University of Hawaii Sea Level Center



Source: University of Hawaii Sea Level Center (UHSLC)

The present estimates for the sea level rise at the Maldives due to the climatic changes are in order of about 0.5 cm per year. This is based on the fact that the sea level has risen 20cm over the past century (MHHE, 2001).

4.9 Waves

Information on the swells around Maldives is limited, but there have been a few studies carried out around Male. Wave data for Male that were recorded for the period between June 1988 and January 1990 revealed that the maximum significant wave height (Hs) recorded for the month of June 1989 was 1.23m with a mean period (Tm) of 7.53s. For the month of July 1989 maximum recorded Hs was 1.51m and the corresponding Tm was 7.74s. In June and July 1989 mean wave periods were 5.0 – 9.0s and the peak wave periods within 8.0 – 13.0s. Wave data for the period between September 1988 and July 1989 shows a probability of exceedance of Hs = 1.0 m was approximately

0.1 and of Hs = 1.5 m was approximately 0.0015 based on the wave data of period September 1988 to July 1989. JICA, (1992) reported that the wave climate in Male region is generally higher in the months of June, July and August with a predominant wave direction of S (180º). During October-December the waves have a shorter period with wave directions varying from S and W (180 º -270 º). It is estimated that the maximum wave height outside the flat reefs can reach more than 3m (ocean side, easter side of Hulhule), whereas on the flat reef areas the wave height can reach from 0.6 to 1.2 meters (maximum). During the field visit, monsoonal wind generated waves were experienced at the western side of the island, wave activity was minimal and well below 0.5m. Wind direction during field survey was south westerly direction.

4.10 Storm Surge

Storm surge may increase the water level due to:

- the effect of atmospheric pressure variations - A water level variation of 10 cm occurs with a pressure variation of 10 hPa,
- wind effects, especially in shallow water areas

4.11 Currents

Several currents affect the Maldives Islands. These currents are divided mainly into ocean currents and tidal currents. The ocean currents are stronger than the tidal currents.

A general view of the seasonal current patterns in the Indian Ocean is shown in Figure 4.5. The currents flow westward during the northeast monsoon period, and they flow eastward during the southwest monsoon period.

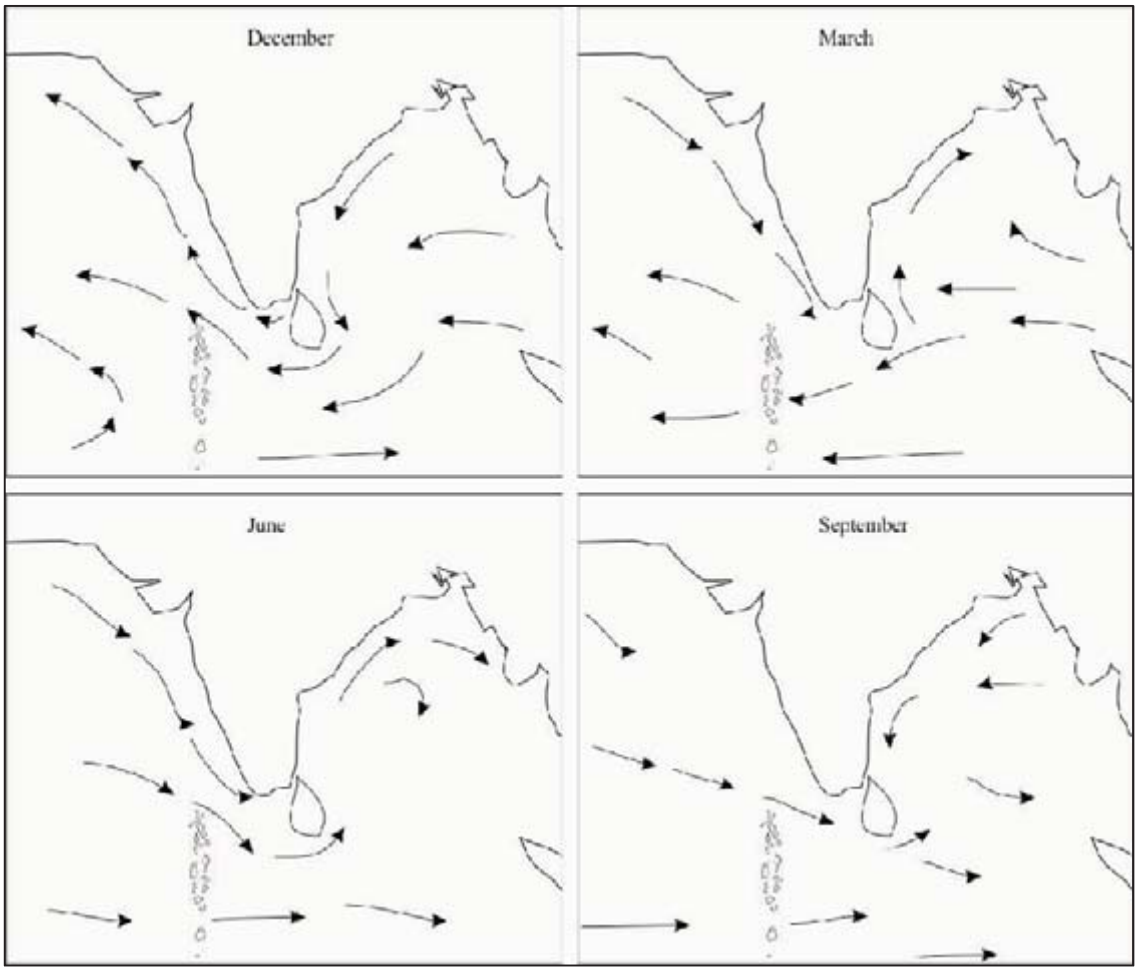


Figure 4.5: Surface Currents around Maldives (by JICA, 1992)

The ocean currents flowing by the Maldives islands are also driven by the monsoonal winds. In the northern part of the Maldives, constant currents flow westward during the northeast monsoon period from December and April and eastward during the southeast monsoon period from May to August.

General, the tidal currents are eastward in flood and westward in ebb, the velocity, however varies by island areas. The current patterns result from reef forms.

Currents tend to be monsoonal in origin, generally setting W during the NE Monsoon (January to March) and E during the SW monsoon (May to October). During the transition months, the currents are variable. Ocean currents flowing through channels between the atolls are driven by the monsoon winds. Current speeds of 1 to 1.5 knots are reported in the Admiralty pilot. However, the current in the E/W channels of the Maldives may attain 5 knots.

4.11.1 Tidal Currents

Generally, tidal currents in the Maldives are Eastward in flood and Westward in ebb.

4.11.2 Currents

A rapid assessment of the current around the project site was carried out during the field data collection using drogue tests.

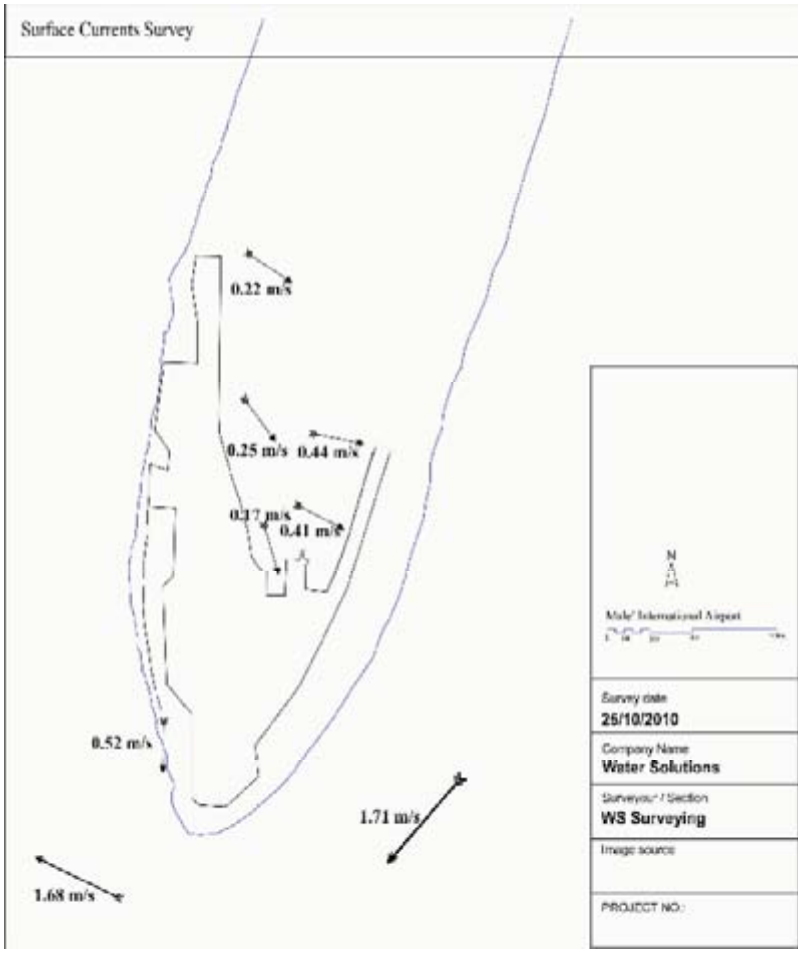


Figure 4.6: Current patters around the Malé International Airport

4.12 Offshore Wave Conditions (in deep water)

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon and are typically strongest during April and July in the SW monsoon period. During this season, swells generated north of the equator with heights of 2-3 m and periods of 18-20 sec have been reported in the region. However swells originating from cyclones and storm events occurring

well south of the equator may occur. Local wave periods are generally in the range 2 to 4 sec and are easily distinguished from the swell waves.

4.13 Cyclones

This paragraph presents information extracted from (UNDP- Developing a Disaster Risk profile for Maldives – May 2006) presenting the characteristics of cyclones in the Maldives.

The islands of the Maldives are less prone to tropical cyclones. The northern islands of the country have been affected by weak cyclones that formed in the southern part of the Bay of Bengal and the Arabian Sea. The number of cyclones directly crossing the Maldives is small. Only 11 cyclones crossed the islands over the entire span of 128 years between 1877 and 2004.

Most of the cyclones crossed the Maldives north of 6.0°N and none of them crossed south of 2.7°N during the period. Hence the Malé International Airport in Hulhule Island can be considered relatively safe from cyclones since it is spread within 4.10°N to 4.12°N.

All the cyclones that affected the Maldives were formed during the months of October to January except one, which formed in April. The Maldives have not been affected by cyclones since 1993.

In the northern islands, the probable maximum storm tide due to cyclones has been estimated to be around 1.82 m (storm surge of 0.84 m) for a return period of 100 years. This storm surge was computed taking into account probable maximum winds and probable maximum pressure drops.

4.14 Chlorophyll Concentration/Productivity for Marine Water

Chlorophyll concentration/ Productivity is an index of phytoplankton biomass and it is the most common property that characterizes marine first tropic level. Chlorophyll concentrations derived from satellite remote-sensing images of ocean colour, provide a unique synoptic view of the marine ecosystem including eutrophication, fisheries.

A major value of ocean colour lies in the long-term monitoring of the marine environment which will improve the understanding of the ecosystems functioning. It also helps to assess the response to anthropogenic pressures like agriculture, urban development and global change. It was observed that the Chlorophyll concentration was higher along the periphery of Male Atoll which may be attributed to increase in the concentration of nutrients due to sewage disposal in coastal waters.. Nutrient enrichment of the waters stimulates the growth of phytoplankton, leading, in certain circumstances, to the phenomena of algal blooms and to anoxia in the lower part of the water column with destruction of the benthic fauna and flora. In addition, insufficient and selective sewage treatment can increase the input of nutrients into coastal marine waters and modify the natural ratio between them (removal of phosphorous compared to nitrogen) that may lead to changes in algal quantity and composition.

Aqua Satellite with MODIS sensor provides daily chlorophyll data in the Maldive area. The data provides the **Chlorophyll** range between).01 to 10 mg/cu m. Weekly composites of chlorophyll concentration were prepared using the AQUA Satellite data.

Table 4.10: Productivity Data for Chlorophyll for Male Region, 2008-2010

Year 2008		
Location	**Week**	**Chlorophyll Concentration/Productivity range (mg/m^3)**
November (Post monsoon)		
Male Atoll	1st week	0.5- 2.0 (almost 1 mg/m along the periphery of atolls)
Male Atoll	2nd week	0
Male Atoll	3rd week	0.5-0.75
South of Male Atoll	4th week	0.7-0.85
Male Atoll	4th week	0.6-0.8 with patches of zero (0) productivity
December (Post monsoon)		
Male Atoll	1st week	0.6-1.5
Male Atoll	2nd week	0.6-1.5
Male Atoll	3rd week	0.6-1.5
Male Atoll	4th week	0.8-2.5
Year 2009		
Location	**Week**	**Productivity range (mg/m^3)**
January (Winter season)		
Male Atoll	1st week	0.7-3 (3 mg/m Along the periphery of Male Atoll
Male Atoll	2nd week	0.7-3 (3 mg/m Along the periphery of Male Atoll
Male Atoll	3rd week	0.7-2.5 (2.5 mg/m Along the periphery of Male Atoll
East of Male Atoll	4th week	0.1-0.4
West of Male Atoll	4th week	0.5-0.8
Male Atoll	4th week	0.7-1.0
February (Winter season)		
Male Atoll	1st week	0.7-2.0 with decreasing productivity towards east
Male Atoll	2nd week	0.7-1.0 with decreasing productivity towards east
March (Pre Monsoon)		
Male Atoll	1st week	0.7-2.0 with patches of zero productivity towards east side
Male Atoll	2nd week	0.7-2.0 with decreasing productivity towards east of atoll
Male Atoll	3rd week	0.7-2.0 with decreasing productivity towards east of atoll
Male Atoll	4th week	0.7-2.0 with decreasing productivity towards east i.e around 0.10 mg/m
April (Pre Monsoon)		
Male Atoll	1st week	0.6-1.5 with decreasing productivity towards east i.e around 0.10 mg/m
Male Atoll	2nd week	0
Male Atoll	4th week	0.7-2.5 with decreasing productivity towards east i.e around 0.10 mg/m
May (Pre Monsoon)		
Male Atoll	1st week	0.7-2.0
Male Atoll	2nd week	0.7-2.0 with patches of zero productivity

Male Atoll	3rd week	0.7-1.5 with mostly large patches of zero productivity
Male Atoll	4th week	0.7-3.0 with small patches of zero productivity
June (Southwest Monsoon)		
Male Atoll	1st week	0.7-2.5 (2.5 mg/m Along the periphery of Male Atoll
July (Southwest Monsoon)		
Male Atoll	1st week	Mostly zero productivity with value of 0.7-0.8 towards north
Male Atoll	2nd week	0.7-2.0 with patches of zero productivity
Male Atoll	3rd week	0.7-2.0
Male Atoll	4th week	0.7-2.0
August (Southwest Monsoon)		
Male Atoll	1st week	0.3-1.0
Male Atoll	2nd week	0
Male Atoll	3rd week	0.6-1.5 with decreasing productivity towards west of atoll
September (Southwest Monsoon)		
Male Atoll	1st week	Mostly zero productivity with patches of 0.7-0.8 around Male Atoll
Male Atoll	2nd week	Mostly zero productivity with patches of 0.7-0.8 towards SE direction
Male Atoll	3rd week	0.7-2.0
Male Atoll	4th week	Mostly zero productivity with patches of 0.7-0.8 around and south of Male Atoll
October (Post monsoon)		
Male Atoll	1st week	0.6-1.5 with decreasing productivity towards west of atoll
Male Atoll	2nd week	0.7-2.0
Male Atoll	3rd week	0.6-1.5 with decreasing productivity towards west of atoll and patch of zero south of Male atoll
Male Atoll	4th week	0.7-1.5 with small patches of zero productivity
November (Post monsoon)		
Male Atoll	1st week	0
Male Atoll	2nd week	0.7-2.0
Male Atoll	3rd week	0.7-1.5
Male Atoll	4th week	0
December (Post monsoon)		
Male Atoll	1st week	0.7-2.0
Male Atoll	2nd week	0.7-1.5
Male Atoll	3rd week	0.8-2.0 with large patches of zero productivity
Male Atoll	4th week	0.8-2.0 with large patches of zero productivity
Year 2010		
Location	**Week**	**Productivity range (mg/m^3)**
January (Winter season)		
Male Atoll	1st week	0
Male Atoll	2nd week	0.7-1.0 (almost 2.5 mg/m Along the periphery of Male Atoll

Male Atoll	3rd week	0.7-2.0 with patches of zero (0) productivity
South of Male Atoll	3rd week	1-2.5
Male Atoll	4th week	0.7-2.5 with patches of zero (0) productivity
February (Winter season)		
Male Atoll	1st week (day 1)	0
Male Atoll	2nd week (day 9)	0
Male Atoll	3rd week (day 22)	0.1-0.5
Male Atoll	4th week (day 28)	0.1-1.0
March (Pre Monsoon)		
Male Atoll	1st week	0.1-0.5
Male Atoll	2nd week	0.1-0.5
Male Atoll	3rd week	0.1-0.4
Source: INCOIS		

The chlorophyll data suggests that the productivity in and around Male-Hulhule area is lowly productive with the max Chlorophyll vale of maximum 3 mg/ cum. The productivity is more during January to May and rapidly decreases with the onset of monsoon. The productivity is maximum between January and February months.

4.15 Coral Reef System

Malé International Airport is found on a large reef which is located south eastern side of North Malé Atoll. Hulhumalé and Farukolhufushi islands are also located in the same reef system. The total area which reef encloses is estimated to be 1,310.6 hectares. The total length of the reef is estimated to be 17,830 km.

4.16 Lagoon

A proper lagoon only exists on the north eastern side of Hulhule Island. This lagoon is presently used as a water runway by the sea planes. The shallow part of this lagoon is about 1.2 m below the mean seal level and covers an estimated area of 614,513m^2. The deeper part of the lagoon consists of medium-fine size sandy floor and scattered patches of coral colonies (patch reefs). Sea grass has been covered in an approximately 44.4 hectares area on is no scientific baseline data on the lagoon available at present.

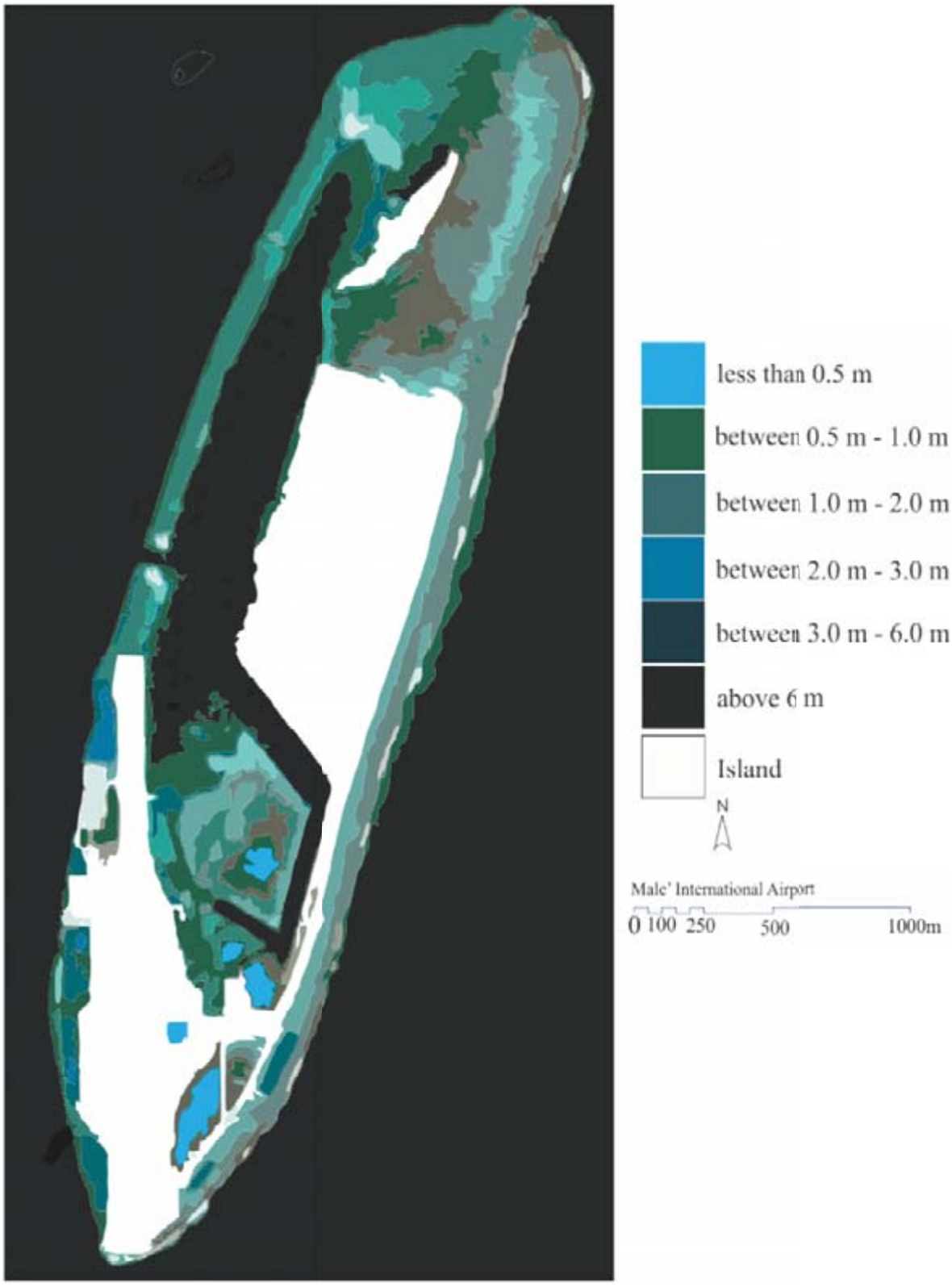
Table 4.11: Area of Hulhule and the Region, Extent of Coverage by the Island's Lagoon

Island name	Area (ha.)	Beach Length (km)
Hulhule	184.5	12.0
Hulhumale	196.6	6.8
Farukolhufushi	11.3	2.1
Courseway between Hulhule and Hulhumale	6.0	2.7
Lagoon	918.3	-
Reef System	1310.6	17.8

4.17 Bathymetry around the Island

Bathymetric survey is important in order to estimate the required fill volume and the size of the area that will be dredged to obtain the fill material.

A rapid bathymetric survey was undertaken to assess the baseline condition of the lagoon, proposed borrow area and reclamation areas. The bathymetric survey was undertaken using a spot depth meter and a Trimble GPS. The information generated during initial field surveys were over laid over satellite imagery of Hulhule lagoon. **Figure 4.7** shows an estimation of the lagoon depths at Hulhule lagoon.

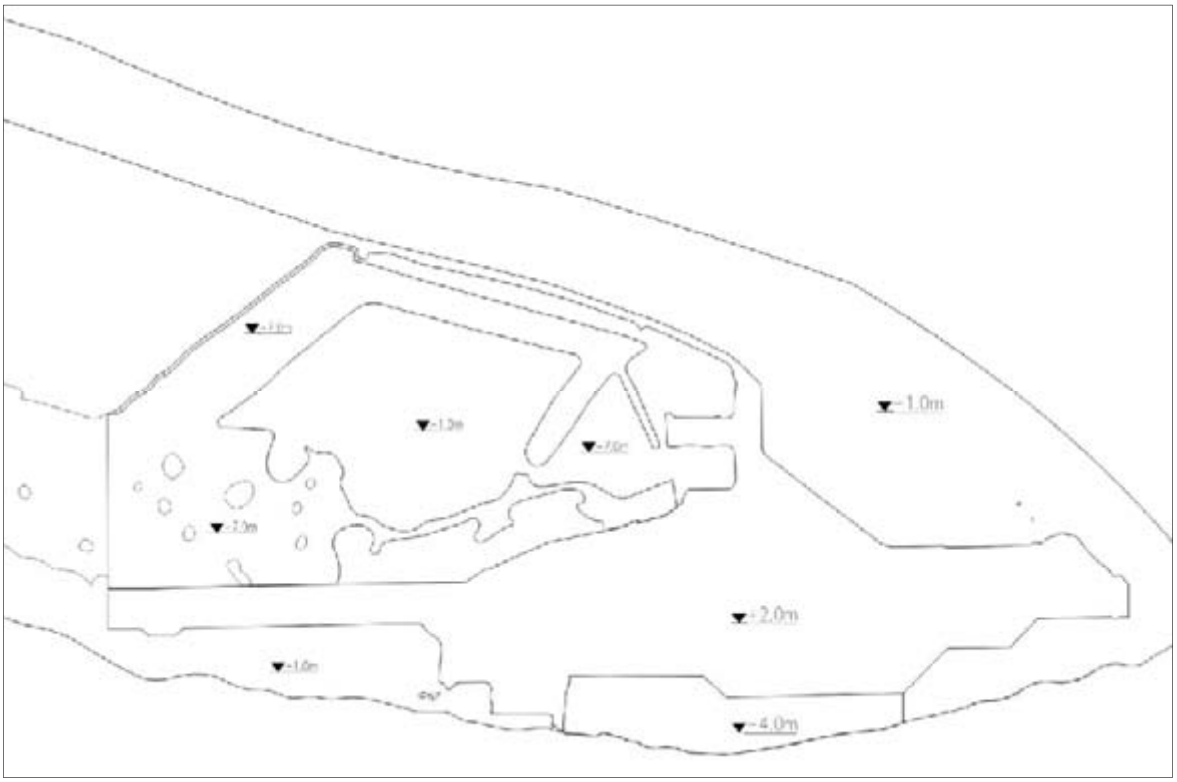


Source: Water Solutions

Figure 4.7: Rapid Assessment of the Bathymetry of the Hulhule Lagoon

A rapid bathymetric calculation based on the analysis of the satellite photo indicates a significant area of the lagoon on western side and north eastern side of the island has been excavated. In addition, there are also areas on the south eastern side that has been excavated for various

purposes. The preliminary assessment also indicates that most of the proposed fill area on the south-east side has been dredged. Several other bathymetric surveys and studies have been undertaken for the area. The following is an illustration of the bathymetric survey undertaken by Boskalis in 2006.



Source: Boskalis, 2006

Figure 4.8: Bathymetric Survey Undertaken by Boskalis In 2006

The average depth of the lagoon on western side of the island is estimated to be 2.5 m below the mean sea level. The proposed location for the sea plane runway is estimated to have a depth of 1.2 m below the mean sea level.

GMIAL undertook a bathymetry survey in the lagoons in the airport area. The survey data is presented in Appendix G. The maximum depth was recorded in about 11 m. The minimum depth is around 0.2m.

4.18 Beach

Hulhule Island is not a typical Maldivian island with beach as historically the shore line was altered for the construction of the airport and its associated facilities.. Coastal protection structures have been constructed all along the shoreline of the island.

4.19 Seawalls and Breakwaters

The island has undergone many changes in the past 60 years and most of it is reflected on the shape of the island. The island shape is very much defined by the existing seawalls and

breakwaters that had been placed all around the island. **Table 4.12** shows the existing seawalls and breakwaters that had been constructed at Malé International Airport.

Table 4.12: Existing Seawalls and Breakwaters at Malé International Airport

Description	Seawall Length (m)	Breakwater Length (m)
Materials – Sheet Pile	4964	682
Material – locally made sand cement bags	4273	780
Total	**9237**	**1462**

Some sections of the breakwater which has been constructed on the south western side of Malé International Airport have failed due to rough weather in south west monsoon that had swept the country. This section of the breakwater fails very often as it had been constructed using sand cement bags.

The breakwater on western side of the island needs to be redesigned as to prevent the overtopping of waves during the south west monsoon.

4.20 Marine Environment

Hulhule' island and its surrounding coral reef have undergone a dramatic change in landscape during the island's development into an international airport.

Quantitative studies of the Hulhule' reef do not exist from its early years. However, during literature research for marine data from Hulhule', available reports from 2007 and 2010 were reviewed. In 2007, 'Energy Consultancy' prepared an EIA for the "*Proposed Male' International Airport Quay Wall Extension and Reclamation Project*" (Ref: Energy Consultancy, 2007), for which a marine grid survey of the reef slope on the north-western side of the runway was performed (Site "7" in this report). During this survey, trail dives have been carried out 30m in vertical and 1150m in horizontal direction to check for any abnormalities on the reef. High resolution photos are available from 16 grids along 12m vertical dives are available from this survey; however, live coral cover was not quantified in this survey, just like as in the EIA for "*Coastal Protection and Erosion Control on West of Runway 18*" from 2010 (Ref: Sandcays, 2010).

Hulhule' reef has been a point of interest since 1981 due to a sunken ship on its south-western side. The 110m long "Maldives Victory" cargo vessel lies on the sea bottom in 30m depth with its mast still intact, surrounded by a number of attractive fish, and covered in a variety of corals and other invertebrates. It is located near survey Site "2" in this report (Figure **4.20:**) in 30m depth and marked with a surface buoy.

Detailed marine survey was conducted to assess:

1) establish baseline conditions in areas that are expected to be impacted by the proposed project and
2) to assess present environmental conditions in areas that will be completely transformed (reclamation sites)

Both qualitative and quantitative methods have been applied. Qualitative assessments included visual inspections of near shore impact sites by using snorkelling equipment, an underwater camera and writing slate to take notes. This method was preferred for a large-scale survey of areas, particularly such without live coral coverage and sites that will be reclaimed, thus completely transformed.

Table 4.13 lists the GPS positions of all qualitatively and quantitatively surveyed sites to which the following section refer to. The positions were recorded using a Trimble Juno ST handheld GPS receiver.

Table 4.13: Position of Survey Sites in Hulhule'

Survey Site No	GPS location (Latitude/Longitude)	Water Quality	Marine benthos and fish (quantitative)	Qualitative surveys
1	4°10'58.9"N, 73°31'34.7"E	✔		✔
2	4°10'53.4"N, 73°31'39.4"E	✔		✔
3	4°10'47.6"N, 73°31'52.1"E	✔		✔
4	4°10'46.0"N, 73°31'55.0"E	✔		✔
5	4°11'07.2"N, 73°32'03.9"E	✔		✔
6	4°10'35.1"N, 73°31'57.8"E	✔	✔	
7	4°12'28.2"N, 73°31'38.6"E	✔	✔	
8 (Control Site)	4°11'26.1"N, 73°32'37.5"E	✔	✔	
9 (Control Site)	4°12'20.9"N, 73°32'44.6"E	✔	✔	

The photograph of Hulhule' from the year 1969 (Figure **4.9:**), indicates that the marine environment has been modified for the purpose of the construction of the International airport. Hulhule' possessed a natural lagoon on its western side, and an extensive reef flat on its northern and eastern side. With the construction of the harbour on the western side, the natural lagoon has been artificially extended up to the reef slope, and is interrupted by the Hulhule Island Hotel and a newly reclaimed rectangular land, 1.1m above mean sea level, on its northern side. North of this 380x120m reclaimed land area, the sea bottom has been deepened from an initial 1.0 (min) – 3.2 (max) depth (Ref: EIA by Energy consultancy, 2007) up to an average depth of 3.3m (Ref: EIA Sandcays, 2010).

Wave breaking walls have been erected to protect boats and the shore. Quay walls protect the island from erosion. The reef flat, which the island shared with Farukolhufushi, has been largely excavated in order to create the artificial island Hulhumale' and a seaplane take off and landing site south of it. This area is now partly covered in seagrass, which could be benefiting from trapped nutrients in the sandy lagoon.

The only marine component that has not been directly modified, but certainly impacted, is the island's house reef, which is now being shared with Hulhumale' and Farukolhufushi. Parts of the south-eastern lagoon have been enclosed by a land bridge and incorporated into the island system, connected with five pipes to the remainders of the eastern reef flat. About 170 meters of reef flat, measuring from the reef drop off, have been spared from reclamation; however, two pools of 240x60m and 390x90m have been excavated from this reef flat. The artificial lagoon between Hulhulé and Hulhumalé has been artificially separated from the eastern reef by a land bridge which is now a paved road for vehicles travelling between these two islands (Figure **4.20:**).

Figure 4.9: Hulhule' and its marine environment in 1969

4.21 Qualitative surveys

Visual inspections were carried out along the quay wall on the south-western side of the runway (Site “1” and “2”), in both enclosed water bodies on the eastern side of the runway (Site “3” and “5”), and eastwards of the larger enclosed water body across the existing street in the surrounding area of the pipe that connects the ocean to the enclosed pond (Site “4”). Due to denied access in the seaplane take-off and landing area during the day, the lagoon between Hulhule’ and Hulhumale’, a visual inspection of this site could not be carried out. Fish counts were performed as part of the visual inspections in order to get a broad overview about the presence or absence of fish in the concerned water bodies, and in case of presence, the dominant species observed.

Sites “1” and “2” were chosen in order to assess the existing conditions of a potential reclamation site, since it is possible that the developer considers reclamation of the lagoon on the south-western side of the runway as well. According to the current development plans, Sites “3” and “5”, as well as parts of Site “4” will be definitely reclaimed. The ecological value of these two ponds has been assessed in this report. Site “4” is currently part of the eastern airport lagoon which would be reclaimed in order to enlarge the future airport terminal.

Visual inspections of potential reclamation sites started on the south-western side of the island at a water pump station. The marine benthos at this Site “1” consists mainly of coral rock and rubble (Figure **4.10:** 0), with occasional coral heads (*Pocillopora meandrina, Favia sp., Acropora sp*.) attached, some of them entangled in fishing lines (Figure **4.11**). The most abundant fish species at this site are the Damselfish *Abudefduf vaigiensis* and *Chrysiptera biocellata,* Soldierfish *Myripristis sp*. and Sweeper *Pempheris venicolensis*. Surgeonfish were represented by *Acanthurus lineatus* and *A. nigricauda*, whereas Butterflyfish were represented by *Chaetodon xanthocephalus* and *C. citrinellus*. Further, the “Monocle Bream” *Scolopsis bilineatus*, “Moorish Idol” *Zanclus cornutus* as well as Squirrelfish *Neoniphon sammara* were encountered at Site “1”.

Fish species at Site “2” further south are restricted to patches of scattered live corals (*Acropora sp, Pocillopora sp. and Porites sp*.) (Figure **4.13:**). There, *Thalassoma hardwicke ,T. janseni* as well as other wrasses were encountered, in addition to the relatively abundant *Acanthurus triostegus*, *Stegastes nigricans* and other Pomacentridae. Visibility is lower than at Site “1” and a small fraction of beach is entirely polluted with solid waste (foam, styrofoam, plastic bottles, metal waste and more, see Figure **4.12:**). Site “3”, located on the East of the runway, and Site “5” (Figure **4.17:**) are shallow saltwater ponds semi-enclosed by a road leading to the seaplane terminals. These ponds are connected to the eastern lagoon via a pipe that allows water flow into and out of the ponds (depending on the tides). On 27th October 2010, around 16:00, around one hour after high tide, seawater was sucked into the ponds with great force (Figure **4.18:**).

Fish, as well as waste, can enter these ponds through three connections (Site “3”) and two connections (Site “5”), respectively. Reportedly juvenile sharks enter and exit these ponds at some times. Seabirds were observed using the pond’s shores. The benthos is largely covered in coral rubble, silt and turf algae. Interestingly, these two relatively large semi-enclosed areas are currently acting as a fish nursery. Predominantly juvenile fish were found in the ponds, dominated by the “Two-spot Damsel” *Chrysiptera biocellata*, followed by the Sandperch *Parapercis sp*., the Dusky Wrasse *Haliochoeres marginatus*, juvenile Parrotfish *Leptoscarus vaigiensis*, juvenile *Lutjanus fulviflamma*, *Chromis viridis* and *Cheilodipterus quinquelineatus* (Apogonidae). The juvenile fish of a favoured reef fish in the Maldives, the Oriental Sweetlip *Plectorhinchus vittatus*, enjoyed the fresh water flow into the pond (Figure **4.14:**). However, not only oxygenized seawater, but also loads of solid matter flow into the pond and are deposited over time in the benthos.

The opposite side of the connection canal was inspected up to a reclaimed portion of the lagoon (Site “4”). It can clearly be seen that suspended solids are entering the ponds from all over Site “4”, as suspended matter flows in the lagoon in masses. We suspect that it derives from a sewer outfall nearby which discharges aircraft waste directly into the reef flat.

Fish encountered around the water inlet were *Acanthurus triostegus*, *Abudefduf sordidus* and *A. vaigiensis*, as well as another unidentified Pomacentrid species. Towards the reclaimed portion of the lagoon, *Acanthurus triostegus, Abudefduf vaigiensis, Stegastes sp, Thalassoma lunare* and various other fish species were observed, with a particular high abundance in Scaridae and juvenile *Chrysiptera biocellata*.

Figure 4.10: Typical seafloor at survey Site "1" - coral rubble on a rocky sea floor

Figure 4.11:. Corals are often seen entangled in fishing lines at Site "1"

Figure 4.12: Beach corner filled with accumulated garbage at Site "2"

Figure 4.13: Typical seafloor at Site "2", with coral rubble and occasional live corals, mainly Acropora sp. and Pocillopora sp.

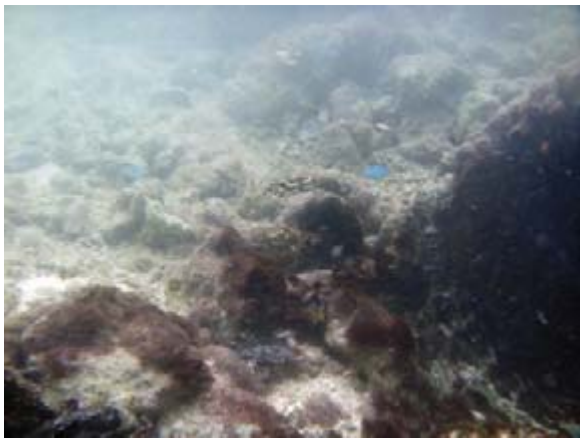


Figure 4.14: Juvenile fish, like this Oriental Sweetlip (Plectorhinchus vittatus) gather around the seawater outlet. Sea floor covered in turf algae.

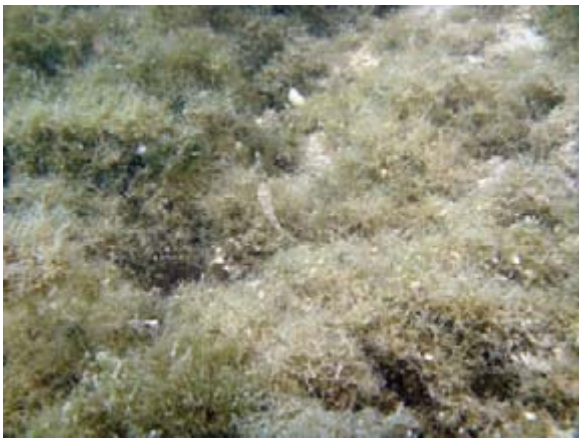


Figure 4.15: Typical seafloor at saltwater pond at Site "3", covered in algae with suspended solids trapped.

Figure 4.16: Large amounts of suspended solids enter Site "3" through an inlet originating at Site "4". Possible source is a sewage outfall discharging aircraft waste.

Figure 4.17: Seawater outlet at Site "5"

Figure 4.18: Seawater inlet at Site "4" during high tide, where water is sucked into the ponds at Sites "3" and "5"

Figure 4.19: Typical seafloor (coral rock and rubble) at Site "4" at the edge between the reef flat and the dredged area

4.22 Quantitative surveys

Quantitative marine surveys were carried out at two main sites (Sites “6” and “7”) which are expected to be impacted, but will not be transformed, by the proposed project. First, reef zones and depths were chosen, and then suitable sample sites within this habitat were decided haphazardly. Since the condition of the reef at various depth zones were available from previous surveys at Hulhumale’, a line transect at 3 and 8 meters depth was appointed as it is common for quantitative reef surveys. Since the reef is situated in a high-energy wave breaking environment, corals at three meters depth are scarce. They become more abundant at 8-12 meters depth; therefore, the survey was conducted at 8 and 15 meters depth. Coral cover from 15m depth of the same reef system, but further away from the impact site, was determined at two control sites (Sites “8” and “9”).

Site “7” is located on the western reef slope, approximately 270m south west of the upper end of the runway and was chosen since it will be impacted by the widening of the runway. Site “6” is located on the south eastern side of the island on the reef facing the proposed terminal which is expected to receive a considerable amount of sand load during reclamation.

The quantitative surveys conducted for this EIA provide baseline data for further monitoring of the coral reef surrounding Hulhule’ island.

4.22.1 Reef benthos

In order to record percent coral cover, abundance, diversity and the presence of other sessile marine invertebrates, the 'photo quadrat method' was used. At 8 and 15m depth, a 20m transect line was laid parallel to the reef. Photo quadrats of 60x60cm side length were positioned every 2m along the transect line and photographed. Since environmental change needs to be monitored over time, each site was marked with an iron rod, hammered vertically into the reef at 8m depth, and a yellow plastic marker attached. Photos taken during the survey were analyzed on a PC using Coral Point Count with Excel extensions (CPCe) software (Kohler and Gill 2006).

4.22.2 Fish census

A fish census was performed at 8 m depth at both sites to estimate the abundance and community composition of fish. Both cryptic and migratory fish species visible were recorded within a belt transect of three meters width along the 20m transect line. The observer swam at a constant speed and was careful to not count the same fish or group of fish twice as they can move away from the diver along the transect.

4.22.3 Marine water quality

Marine water quality was assessed where quantitative and qualitative surveys were undertaken (Sites "1" to "9"), as well as at sites where sedimentation is expected to increase during reclamation works (Sites "10" and "11") shown in **Figure 4.20:** . Temperature, pH, Salinity, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were analyzed in situ using an HACH SensIon5 meter and a HANNA pH/EC meter. Both instruments were calibrated prior to the study in the National Health Laboratory, Male'.

All other parameters were analyzed in the Male' Water and Sewerage Company (MWSC) laboratory, after sampling into clean glass bottles transferred in a cool box to the lab. Water samples were taken at 1m depth from mean sea level or from mid water depth at shallow areas.

Figure 4.20: Marine benthos (Sites 6 - 9) and visual (Sites 1 - 5) survey sites in Hulhule' island. Water quality samples were taken at all sites (1 – 10). Photo: Google Earth

4.23 Quantitative Surveys

The observations from the quantitative surveys undertake are presented as below:

4.23.1 Reef benthos

In terms of live coral coverage versus non-living matter, all four surveyed sites (two "impact" and two "control" sites) showed similarities in 15m depth (Figure **4.26:**), and so did the two surveyed impact sites in 8m depth (**Figure 4.21**)

Depth: 8 meters (at mean + 22cm) –

Figure 4.21 to 4.25

Live coral cover was almost identical at Site "6" and "7" in 8 meters depth: 26.5 ± 7.89% (mean ± SE) at Site "6", compared to 27.5 ± 7.4% at Site "7". Differences in these two locations – one on the outer atoll rim and the other one facing the North Male' Atoll lagoon - were more obvious when looking into non-living matter such as coral rock and sand/silt. Coral rock and rubble dominated Site "6" with 72.0 ± 7.66%, whereas sand and silt was the predominant substrate at Site "7" (41.7 ± 9.15%).

Acroporidae were the most abundant coral family at Site "6", covering 13.3% of the transect, followed by Poritidae with 5.7%. At Site "7", Poritidae dominated the transect with 19.7%, followed by Acroporidae with 4.9%. Pocilloporidae were only present in the transects at Site "6" (with 5% covering the transects), but were absent at Site "7". "Other" coral species were less abundant and belonged to the Faviidae (*Favia, Favites, Pavona*) and Merulinidae (*Hydnophora*). Corals that could not be identified from the photos were classified into this group as well.

No bleached corals were found during the survey, and "recently dead" corals (i.e. such of which the morphology resembles much a living coral, but already overgrown with epiphytes), were seen rarely, only at Site "7".

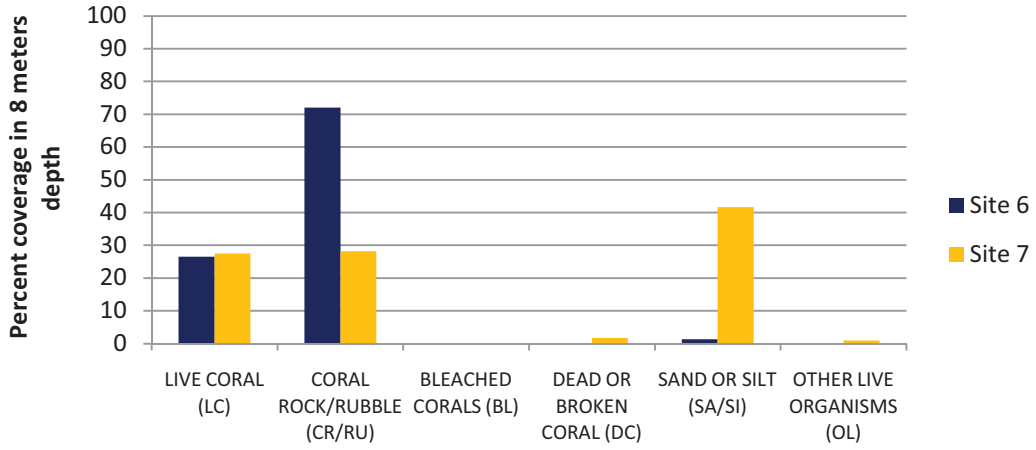


Figure 4.21: Reef Composition at Sites 6 and 7 at 8m depth

Figure 4.22: Typical reef benthos at Site "6" in 8m depth. An exceptionally large table coral (*Acropora* sp.) in front of a school of Yellowback Fusiliers (*Caesio xanthonota*)

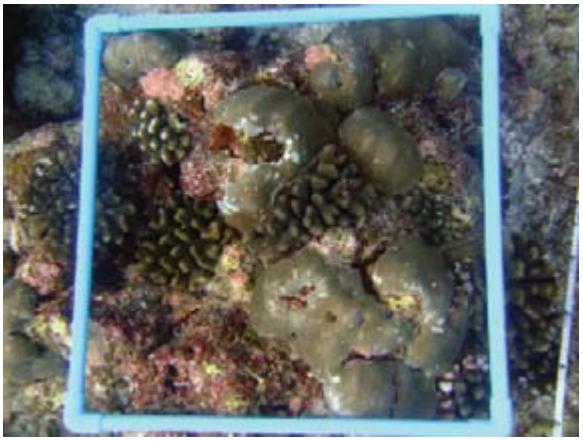


Figure 4.23: Photo frame at Site "6" in 8m depth, where *Pocillopora* and *Porites* can be seen

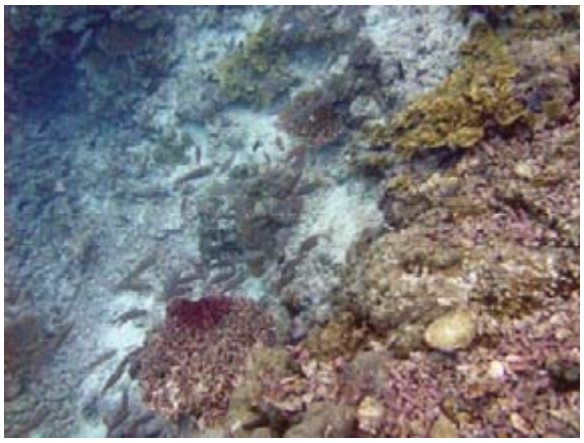


Figure 4.24: Typical reef topography at Site "7" in 8-10m depth

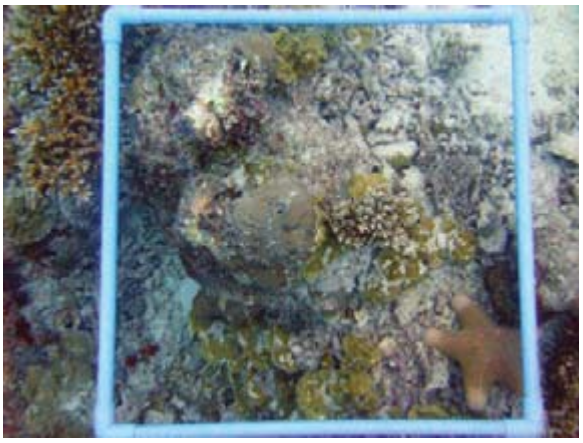


Figure 4.25: Photo frame at Site "7" in 8m depth, where sand and silt are more abundant than at Site "6"

Depth: 15 meters (at mean + 18cm) – Figure 4.26

Live coral cover was generally lower in 15 meters depth, compared to 8 meters. Sites "6", "8" and "9" are located on the outer atoll reef, where less silt deposition is expected than at Site "7", facing the inner Atoll. Our reef benthos surveys confirm this: sand and silt (predominantly silt) was covering larger areas of the reef at Site "7" (49 ± 7.41%) than on other surveyed sites (Site "6": 18.4%; Site "8": 4.67%; Site "9": 2.91%).

Coral family composition (Acroporidae, Pocilloporidae, Poritidae and "other" families) was equally distributed at Site "6". At Site "7", Pocilloporidae were absent at 15m in the transects. At Sites "8" and "9", Faviidae and other non-Acroporids/Poritids/Pocilloporids dominated the transects (15.6% and 4.9%, respectively).

No bleached corals were found during the survey, and "recently dead" corals were seen rarely, only at Site "7" and Site "8".

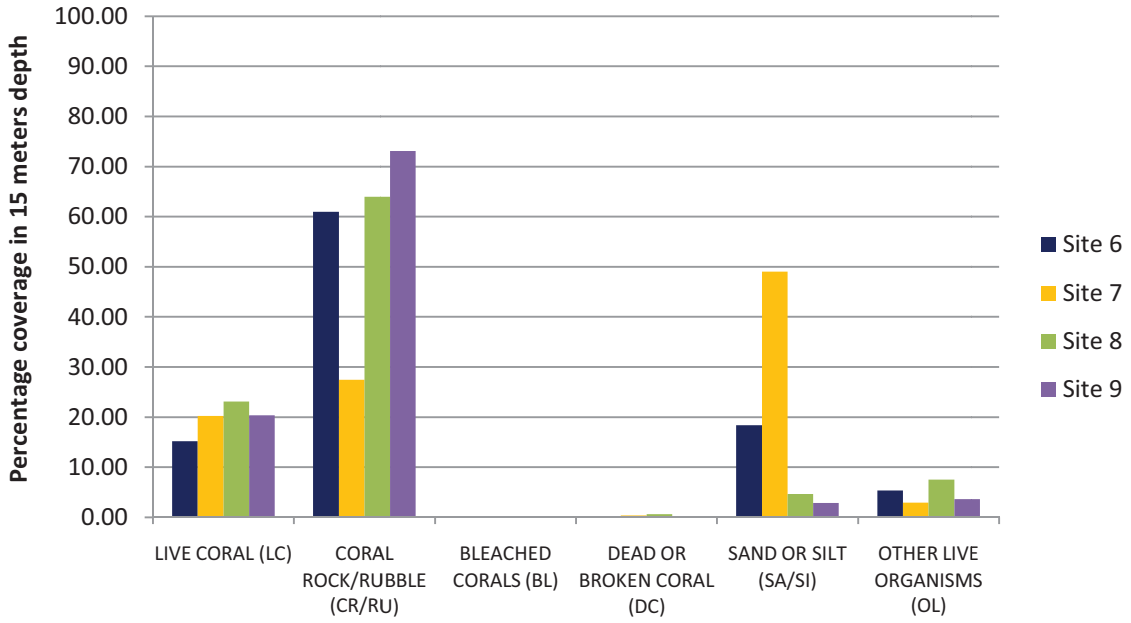


Figure 4.26: Reef composition at Sites "6", "7", "8" and "9" at 15m depth.

(Sites "6" and "7" are impact sites, Sites "8" and "9" are control sites)

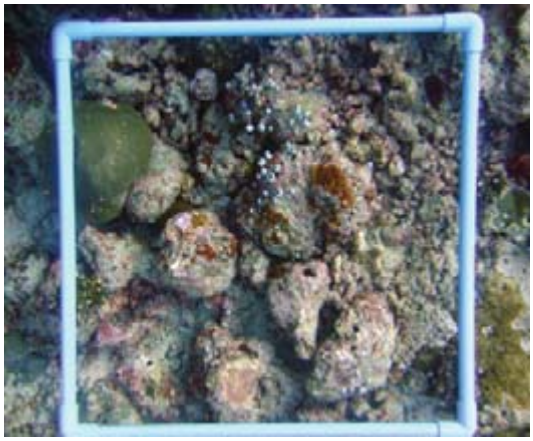


Figure 4.27: Typical benthic composition at Site "6" in 15m depth: coral rock and rubble, Ascidians (*Didemnum molle*) in the upper mid section of the photo frame and a 20cm *Porites* in the upper left half

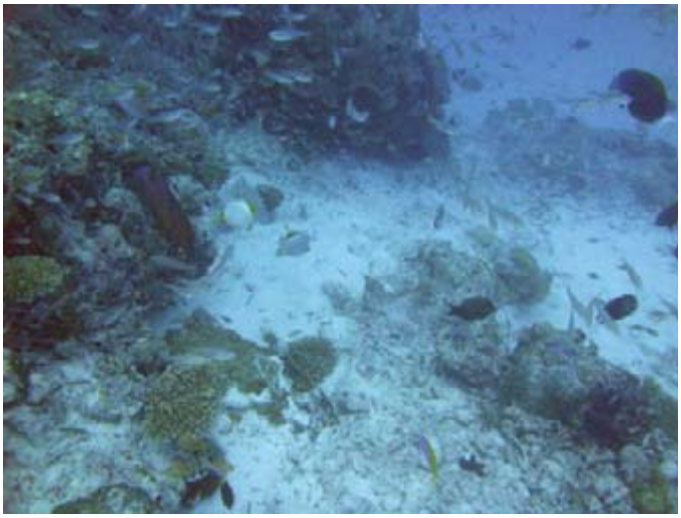


Figure 4.28: Busy fish life at Site "7" in 15-18m depth

4.23.2 Fish census

Fish are generally abundant at both surveyed sites, with at least 7 families observed within a 20m transect at Site "6", and members of 12 fish families at Site "7". Planktivores, herbivores, corallivores and omnivores are present at both sites. In addition to fish present within the 20 x 3m belt transect.

Table **4.14:**), various other families/species were observed in close vicinity, such as *Zanclus cornutus* (Zanclidae), *Pseudanthias squamipinnis* (Serranidae, Anthiinae), another unidentified school of Caesionidae, further *Cephalopholis argus* and *Plectropomus laevis* (Serranidae).

Within the belt transects, the most abundant fish family at Site "7" were the Cardinalfish with a schooling group of estimated more than 100 individuals. Even the 22 individual Scaridae counted belonged to a small travelling group, as well as two species of Butterflyfish, the "Collared" and

"Racoon" Butterflyfish (*Chaetodon collare* and *C. lunula*). Whether Site "7" is indeed richer in diversity as the fish census suggests, although not statistically confirmed, can only be said after conducting a large-scale fish count at both sites at various depths, since the reef topography varies enormously between Site "6" and Site "7". The reef slope drops down steeper at Site "7" than at Site "6", with caves and crevices where fish can seek shelter in. However, large fish interesting for the food industry (f.e. large groupers, Serranidae) lack here just as in many other areas of the Maldives. Their stocks are said to be dwindling (see Reference Marine Research Centre) due to their commercial exploitation.

During the time of our survey, we encountered one turtle and an eagle ray at Site "6", and two more turtles at Site "7" – two marine organisms favoured by SCUBA divers.

Generally speaking, fish life at both sites can be considered "3" (good) on a scale from "1" (poor) to "5" (extraordinary good).

Table 4.14: Fish abundance and diversity at Sites 6 and 7, Hulhule' reef, 8m depth

Fish family	Site 6	Remarks	Site 7	Remarks
Pomacentridae	12	*Chromis viridis, Pomacentrus spp.*	9	*Chromis viridis, Pomacentrus spp.*
Acanthuridae	21	*Acanthurus spp. (A. leucosternon, A. nigricauda et alias)*	7	*Acanthurus spp., Ctenochaetus sp.*
Scaridae	0	-	22	*Scarus spp.*
Labridae	16	*Thalassoma spp. (T. janseni, T. lunare), Gomphosus caeruleus,*	2	*Thalassoma lunare, Labroides bicolor*
Chaetodontidae	6	*Chaetodon kleinii*	17	*Chaetodon spp. (C. xanthocephalus, C. triangulum, C. lunula, C. collare), Forcipiger longinostris, Heniochus acumiatus*
Cirrhitidae	2	*Paracirrhites forsteri*	0	-
Lutjanidae	3	*Lutjanus kasmira*	0	-
Caesionidae	>20	*Caesio xanthonota, C. varilineata*	0	-
Holocentridae	0	-	9	*Myripristis sp., Sargocentron sp.*
Pempheridae	0	-	2	*Pempheris vanicolensis*
Haemulidae	0	-	1	*Plectorhinchus vittatus*
Tetraodontidae	0	-	2	*Canthigaster valentini*
Balistidae	0	-	5	*Odonus niger, Melichthys indicus*
Mullidae	0	-	1	*Parupeneus sp.*
Apogonidae	0	-	>100	*Cheiliodipterus macrodon (1) and* schooling Apogonidae

Fishing and collection of Black coral, Triton Shell (Conchs), Giant Clams, Berried and small lobsters, Turtles, Napolean Wrasse, Dolphins, Whale Sharks, Whales Black coral, Triton Shell (Conchs), Giant Clams, Berried and small lobsters, Turtles, Napolean Wrasse, Dolphins, Whale Sharks and Whales are prohibited in the Maldives. These rare and endangered species are not observed in Hulhule reef.

4.23.3 Marine water quality

Baseline marine water quality data have been collected from various sites around Hulhule' island. Sites "3" and "5", only connected to the open ocean through five pipes, have higher pH values and higher salinity (only Site "5") than the surrounding seawater. Results as summarized in **Table 4.15,** indicate that the water quality is uniform at all the sites observed.

Table 4.15: Marine water quality results from selected sites around Male' International Airport (October 2010).

Parameter ↓ Site →	1	2	3	4	5	6	7	8	9
Temp. [°C]	28.3	28.5	28.9	28.7	29.0	28.4	28.0	29.8	30.2
pH	8.65	8.74	8.95	8.91	9.01	8.75	8.8	8.23	8.19
Salinity [‰]	35.7	35.6	35.6	35.8	36.1	35.6	35.7	35.0	35.1
EC [mS/cm]	54.0	53.8	53.8	54.1	54.5	53.8	54.0	-	-
TDS [g/L]	27.0	26.9	26.9	27.0	27.3	26.9	27.0	-	-
Turbidity [NTU]	-	-	-	-	-	0.135	0.155	0.154	0.182
TSS [mg/L]	-	-	-	-	-	0	0	0	0
DO [mg/L]	-	-	-	-	-	7.28	-	-	-
Nitrates [mg/L]	-	-	-	-	-	0.8	-	0.6	0.5
Phosphates [mg/L]	-	-	-	-	-	0.09	-	0.06	0.04
Hydrocarbons [mg/L]	-	-	-	-	-	-	-	-	-
Chrome [mg/L]	-	-	-	-	-	-	-	-	-
Copper [mg/L]	-	-	-	-	-	-	-	-	-

4.24 Terrestrial Environment

The assessment of terrestrial environment includes Ambient Air Quality Monitoring, Ambient Noise Quality Monitoring, Groundwater Quality Monitoring, Vegetation and Flora, Fauna of the study area.Aerial photos acquired were used in the terrestrial assessment. Aerials photos provide useful information such as assisting the analysis of terrestrial environment, including the identification of vegetation clusters, their types and thus verify and strengthen the results of ground surveys. Satellite images with infrared bands were used to identify vegetation clusters in the island. Aerial photos were purchased from DigitalGlobe and they have been used extensively in the terrestrial assessment. Numerous different satellite images with different resolutions have been reviewed for this assessment. Quick bird imagery was identified as the best to review and monitor environmental aspects and hence, Quick bird imagery taken over Hulhule airport in 2008 and 2009 were used for analysis.

4.24.1 Terrestrial Ecology

The baseline survey for terrestrial environment aimed to collect and record the following data.

- Diversity of flora in Hulhule island
- Identification of ecologically sensitive areas like, national parks, endangered species and wildlife (birds, turtles etc).
- Faunal diversity with respect to identifying baseline data on bird species.

This section covers the specific methodologies used to collect data for assessing the existing terrestrial environmental conditions. The existing environment is limited to the project boundary only but covers marine flora and fauna.

4.24.2 Terrestrial floral survey

The baseline terrestrial environment of Hulhule Island was studied by undertaking a detail vegetation mapping exercise, and also using high resolution satellite images coupled with ground truthing. As the island has very limited vegetation, effort was made to map all mature and significant trees in the island by surveying a transect line. The survey concentrated on identifying mature vegetation types, their abundance and occurrence, rather than focusing on small clusters of vegetation. The methods used to assess the tree types and abundance were using tree counting and mapping using mobile GIS on a selected transect line. A mobile differential GPS was used to record the tree types and their height. Average heights were estimated. The location of these mature trees were then mapped. Three transect lines two with a length of 200 meters and the third at 350 meters.

The terrestrial survey was undertaken by dividing the island of Hulhule in to twelve (12) grids for easy management of data as illustrated later in this section of the report.

The island of Hulhule is at its present stage is an artificial island that has been modified since its first development in to an airport. Since then, the island has undergone several changes to the shape as well as vegetation. Vegetation in Hulhule island cannot be considered significant as there are no significant vegetation clusters in the island that can be considered ecologically important. In Hulhule, neither natural vegetation nor outstanding biological resources exists. This includes both the inland and coastal vegetation. It can be said that more than 95% of the vegetation is human induced vegetation, meaning that they have been planted as part of landscaping. Trees have been planted at different areas, mostly on the western side of the runway as part of landscaping. Most notably, coconut trees have been planted along various areas of the island itself for landscaping. Along the side of the existing runway, dense growth of grasses is noticed, which is also seen from the infrared satellite photos. These grass patches are constantly kept mowed as to meet international regulations. Large mature trees have been recorded on the western side of the runway where most of the existing facilities in the airport are located. These facilities include the terminal, restaurants, airport office and staff buildings, fuel handling, airport hotel, airport cargo, mosque, warehouse and other facilities buildings. Large trees are sparsely found within the territory of these buildings and locality. Large coconut trees have also been planted along the existing main road of the airport that runs from the north to south. In some of the areas of the coastline, young vegetation patches were also observed, but these do not account to any significant vegetation patches. In the newly developed area of the island, which is on the eastern side of the runway, there exists mature trees which has been planted for landscaping. As this area is recently developed, not proper landscaping exists and young vegetation along the coastline were observed in addition to large trees that are planted.

On the overall, the floral profile of Hulhule indicates a relatively higher frequency of Coconut palms and hence Coconut palms (*Cocos nucifera*) are the most abundant type of trees recorded in the island. Among the protected species, Banyan trees have been recorded to exist, scattered in the island. Most of the Banyan trees are found on the western side of the island. The new airport terminal which is planned on the eastern side of the island is therefore not expected to require relocation of these Banyan trees. The average height of coconut trees range between 8 m to 10 m approximately. The coastal environment of Hulhule also does not possess any characteristic island style vegetation as the coastline is heavily altered through the construction of seawalls, sheet piles and revetments. Nevertheless, to some extent, young vegetation is observed.

4.24.3 Results of the vegetation transects

The three transect lines were done after randomly selecting a line of length 200m, 200m and 350 me respectively from the northern to the southern part of the island respectively, which is also on the west of the runway. There are no significant vegetative issues to be considered in Hulhule.The following photos illustrate the condition of the existing environment along these transect lines. Appendix G includes Infrared Images and Maps of Terrestrial Survey.

Figure 4.29: Photos along Transect 1

The following table summarizes the results of the three transect lines. The combined length of the transect line is 750 meters long. The transects were concentrated in the areas where existing vegetation is present, and on the western side of the runway.

Table 4.16:: Summary of the three vegetation transect lines (combined length 750 m).

Common Local Name	Scientific name	Frequency	Percentage
Banyan tree	*Ficus benghalensis*	9	4.57
Cocnut palm	*Cocos nucifera*	113	57.36
Dhigga	*Hibiscus tiliaceus*	11	5.58
Fithuroanu	*Casaurina equisetifolia*	26	13.20
Funa	*Calophyllum inophyllum*	4	2.03
Hirundhu	*Thespesia populnea*	1	0.51
Others	*Scaevola taccada*	26	13.20
Kuredhi	*Pemphis acidula*	5	2.54
Dates	*Phoenix dactylifera*	1	0.51
Epil epil	*Leucaena leucocephala*	1	0.51

From the above table, the dominant species in Hulhule is Coconut palm or *Cocos nucifera* accounting to more than 57 percent. The following figure illustrates the result graphically. While these are the most abundant, they are also observed as the most mature and the tallest with an average height of 10 meters. The height of coconut trees along the transect line ranged from 4 to 10 meters. About 4.5% of the trees account to *Ficus benghalensis* or Banyan tree, which is a protected species in Maldives.

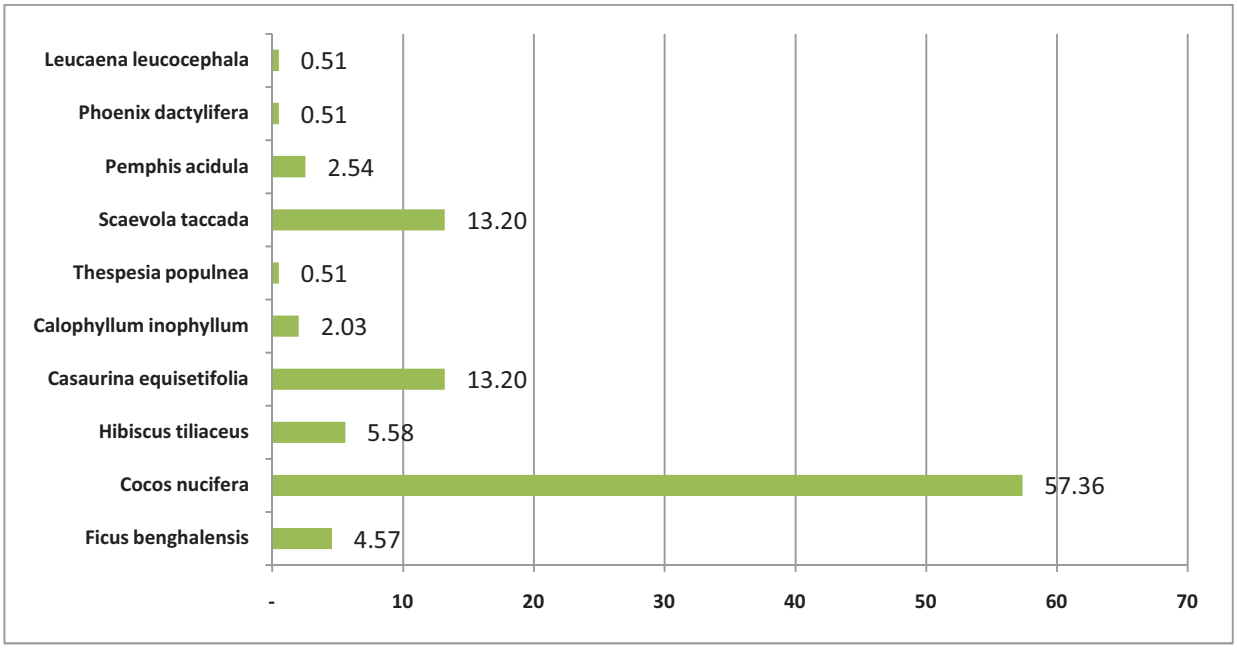


Figure 4.30: Graphical Representation of the Composition of Tree species along the Transects

Although terrestrial environment of Hulhule does not comprise any significant vegetation of biological value, satellite imagery with infrared bands were used to analyse the extent of the vegetation in order to verify and support the ground surveys. The following pages illustrates the existing terrestrial environment, most importantly vegetation cover of Hulhule island.

4.24.4 Terrestrial faunal survey

The island of Hulhule is not known to contain any specific fauna species but many bird species inhabit the island and is therefore considered the most significant fauna for this project. Fauna such as turtles are not relevant for this project as Hulhule does not have any beach. However, other kinds of birds and their habitation patterns were observed and recorded during the survey. Information on fauna was gathered from existing literature on reported species as well as observations in the field. Observations were made particularly to assess the presence of birds in the terrestrial and coastal environments. Information was obtained from the airport staff in the area about the presence of any significant species as well as reports from bird strike incidents obtained from Airport Staff.

Fauna in Maldives is generally very limited and not considered diverse. Fauna is considered more in forests of uninhabited islands due to the lack of disturbance from humans. Therefore, the faunal characteristics of Hulhule island is nothing similar to other islands of the Maldives. There are no special or rare species found in the island of Hulhule. During the survey period, crow, mosquitoes, lizards, rats, giant ants, common ants, cockroaches and few other bird species were observed. There are no endangered or rare animal species in the island.

4.24.5 Rare and endangered species

Under Environmental Protection Law of Maldives, some bird species are protected. These includes White Tern , Lesser Noddy , Brown Noddy, Sooty Tern , Birdled Tern , Common Tern , Lesser / crested Tern , Great Crested Tern , Sterna Crested Tern , Black-naped Tern, Gull-billed Tern , Audobon' s Shearwater , Wedge-tailed, Shearwater , Fiesh-footed Shearwater , Lesser Frigatebird, Great Frigatebird and White-tailed Tropicbird. During the survey, none of these were observed.

4.24.6 Mammals

As the islands of Maldives do not have wild mammalian fauna, no detail survey was undertaken as it is not relevant for Hulhule island. Even mammals like rabbits are almost non-existent in the wild.

Nevertheless, during the course of the survey period for the EIA study, the presence and distribution of mammals were observed and recorded.

During the course of the survey period, the thick grassy areas and coastal vegetation on the eastern side of the runway and the bushy area adjacent to the ponds were observed for the presence of any animals. The extensive growth of bushes in these areas provides suitable hide outs for animals like rats. During the survey, only wild rats were observed. Due to their lack of importance as a faunal species, the no traps were laid to do a detail count or estimate their numbers. No cats were recorded or observed during the survey. However, reports from airport indicate that cats are a common inhabitant.

Domestic mammals like cow; goat and dogs are not found in Maldives.

4.24.7 Amphibians and Reptiles

During the time of survey no Amphibian species were noticed. Reptiles like lizard were noticed east of the existing runway.

4.24.8 Birds species and bird strike incidents

Presence of large number of birds in airports is a concern throughout the world, especially in island environments, where airports being close to the sea and the beaches are at high risk. The reason being that these places naturally harbour many types of birds. According to a report by the Environmental research Centre in 2005, the presence of birds at Male' International airport is considered a major threat to the aviation safety. This is clearly indicated by the number of reported bird strike incidents from 1st May 2002 to October 2002, which totalled to 27. This is on average four strike incidents per month, which is quite high. The report also highlights the probability of bird strike incidents is likely to increase with the increasing number of flights unless measures are not take.

Available baseline information from the above mentioned study indicate atleast six species of birds in Hulhule island, most of them Waders. Reef Herons, the largest resident bird found in Maldives were found in large numbers in the immediate vicinity of the runway. It was also found that herons and cattle egrets collide with airplanes more frequently than any other species found in Hulhule.

Factors favouring bird population

According to the study, the large bird population in Hulhule island is caused by many factors. They include:

Food: The short grass covered areas on either side of the runway, the enclosed lagoon to the east of runway and the garbage dumping site are all excellent feeding grounds

The grass covered areas: The short grass covered areas host a large number of small insects such as crickets, small flies and worms. These are all preferred food for most waders. They also provide basic elements of security for birds from humans and other predators.

Enclosed lagoon: The enclosed lagoon found to the east of runway created during the making of the link road to Hulhumale has trapped the fish population within it, and which has inevitably attracted high number of herons to the site.

Garbage: Garbage in Hulhule island is not managed properly. Improper garbage disposal not only attracts unwelcome "guests", but garbage itself could be a direct threat to airplanes from flying plastic bags, debris etc.

Shelter areas and perching sites: Several conducive resting, roosting and nesting areas in safety for birds are found at the airport. The most prominent resting areas are the open fields with short grass.

Herons appear to be the major bird species that use open fields for resting and socialization. The existing settings around the airport have become particularly favourable for herons. The easy accessibility to food from the enclosed lagoon and enormous space for resting is attracting an increasing number of herons to the airport.

4.24.9 Air Quality

Air quality monitoring were conducted through Netel India Limited at three Islands in Maldives, namely Male Island, Hulhule Island, Hulhumalé Island. Total four locations were selected for Air quality monitoring for a period of two weeks. Netel (India) Limited is well equipped with a modern laboratory having all requisite testing facilities and recognized by the Ministry of Environment & Forest, Government of India.

The monitoring commenced initiated with effect from 21st October 2010. The Principal objective of the ambient air quality monitoring is to access background environment status and to check the conformity to the applicable standards of ambient air quality. In the absence of any National Ambient Air Quality Standards, the WHO guidelines were considered to assess the air quality.

4.24.10 Monitoring Stations

Table 4.17 below shows the sampling locations that were selected for monitoring ambient air quality.

Table 4.17: Details of Ambient Air Monitoring Locations

S. No	Location	Date of Sampling	
		I WEEK	II WEEK
1	SKAI Lodge, Male' Island	26/10/2010 & 27/10/2010	01/11/2010 & 02/11/2010
2	Site Office, Hulhule (Airport) Island	26/10/2010 & 27/10/2010	30/10/2010 & 31/10/2010
3	Central Store, Hulhule (Airport) Island	28/10/2010 & 29/10/2010	30/10/2010 & 31/10/2010
4	HDC Building, Hulhumale Island	28/10/2010 & 29/10/2010	01/11/2010 & 02/11/2010

The location of sampling and their coordinates is provided in the figure below:

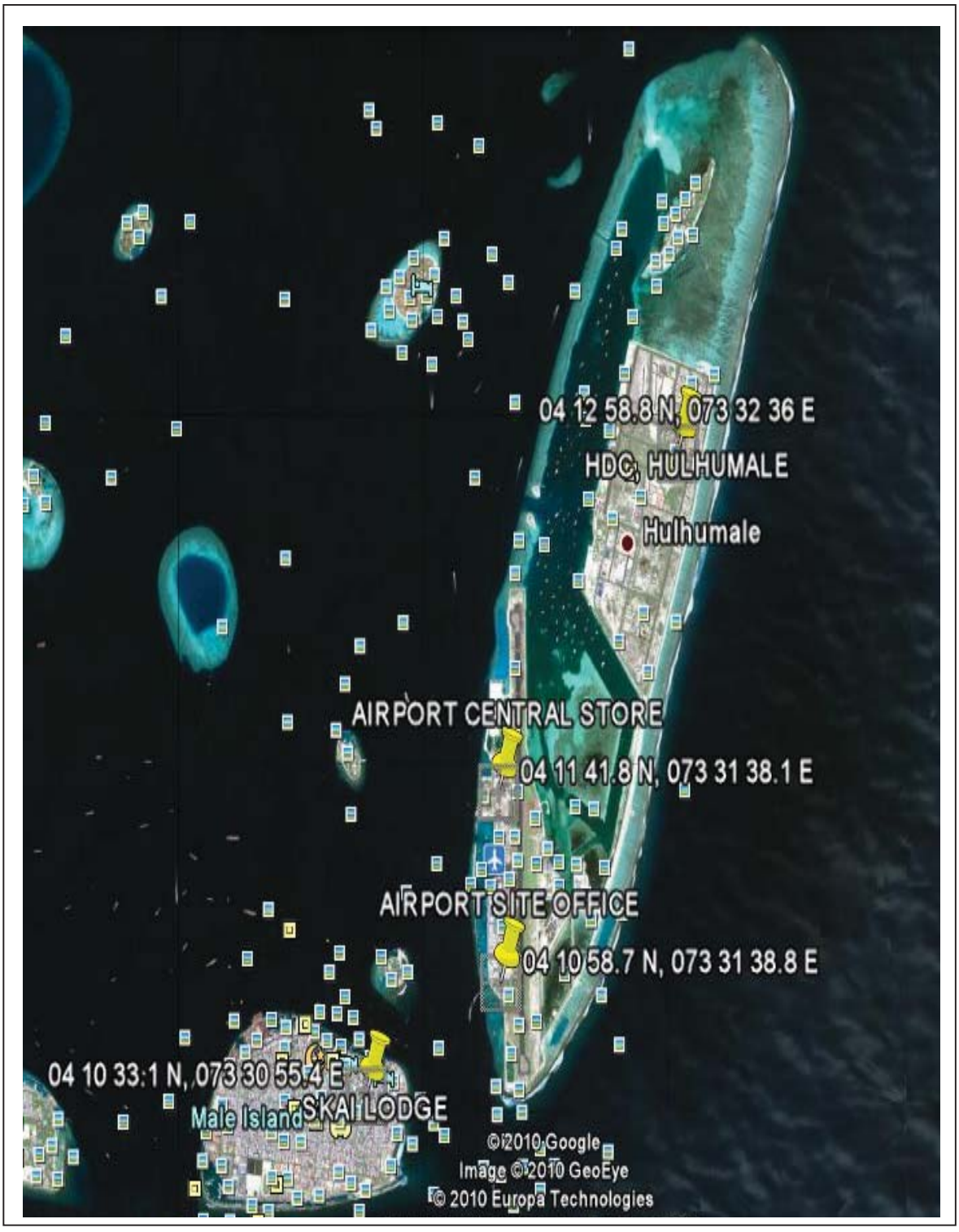


Figure 4.31: Ambient Air Quality Monitoring Locations with Geographical Coordinates

4.24.11 Sampling Period, Frequency And Parameters

On each sampling day during the month of October-November, 2010, 1 set of 24-hour average samples were collected continuously. The following air pollution parameters were measured by sampling continuously during the sampling period.

1.PM_{10}
2. $PM_{2.5}$
3. Sulphur dioxide (SO_2)
4. Oxides of nitrogen (NO_x)
5. Carbon Monoxide (C0)

Sampling and Analytical Procedure:

A brief description of the sampling and analytical procedures followed during the ambient air quality survey is as follows:

- Particulate Matter
  - PM_{10}

  The sampling of ambient air for evaluating PM_{10} levels were performed with a Fine Dust Sampler **NPM-FDS 2.5 A without $PM_{2.5}$** Inlet. The PM_{10} concentrations were evaluated gravimetrically and computed from the average air flow rate, sampling Period and the mass of particulate matter collected over the filter paper
  - $PM_{2.5}$

  Ambient air enters the **NPM-FDS 2.5 A with impactor** through an inlet designed to provide a clean aerodynamic cut-point for particles greater than 10 microns. Particles in the air stream less than 10 microns proceed to a "WINS" impactor that has an aerodynamic cut point at 2.5 microns. The air sample and fine particulates exiting from the $PM_{2.5}$ impactor is passed through a 47mm diameter filter membrane that retains the Fine Particulate Matter. The $PM_{2.5}$ concentrations are evaluated gravimetrically and computed from the mass of $PM_{2.5}$ collected on filter paper and total volume of air sampled.

- Sulphur Dioxide

  The sampling of ambient air for evaluating the gaseous pollutants was performed with a Multi-gas Sampler, using the vacuum created by the sampler for drawing the air samples through the impingers. For SO_2, air was drawn at a measured and controlled rate of 400 to 500 ml/min through a solution of potassium tetrachloromercurate. After completion of the sampling, the used absorbing reagent was treated with dilute solutions of sulfamic acid, formaldehyde and para-rosaniline hydrochloride. The absorbance of the intensely colored para-rosaniline methyl sulphonic acid was measured and the amount of SO_2 in the sample was computed. The ambient SO_2 concentrations were computed from the amount of SO_2 collected and the volume of air sampled.

- Oxides of Nitrogen

  Air was drawn at a measured and controlled rate of about 500 ml/minute through an orifice-tipped Impinger containing solutions of sodium hydroxide and sodium arsenite. After completion of the sampling, an aliquot of the used absorbing solution was treated with solutions of H_2O_2, sulphanilamide and NEDA. The nitrite ion present in the Impinger was calculated from the absorbance of the resulting solution. The ambient NOx concentrations were computed from the total nitrite ion present in the impingers, overall efficiency of the Impinger and the procedure, and the volume of air sampled.

- Carbon Monoxide

Rubber Bladder and Aspirators have been used to collect the samples for carbon monoxide. The CO levels were analyzed by NDIR Technology.

TECHNIQUES FOR MEASUREMENT

The techniques used for measurement of pollutants may be summarized as under:

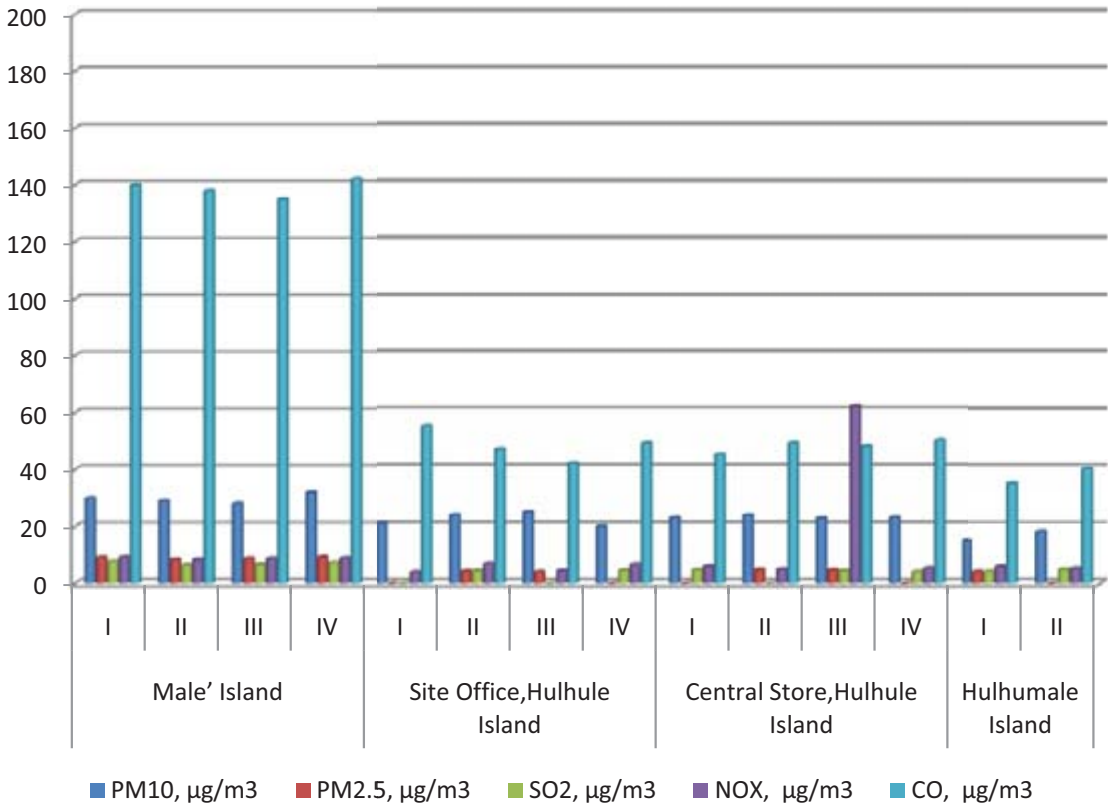
Table 4.18: Measurement Techniques

Sr.	Parameters	Code of Practice	Sampler	Instruments used for analysis
2	Respirable Particulate Matter	IS: 5182 (Part-IV)	Fine Dust Sampler NPM-FDS 2.5 A with PM_{10} & $PM_{2.5}$ Inlet	Balance, Desiccators
3	Sulphur Dioxide	IS: 5182 (Part-V)	FDS Sampler	Spectrophotometer
4	Nitrogen Dioxide	IS: 5182 (Part-V)	FDS Sampler	Spectrophotometer
5	Carbon Monoxide	IS: 5182 (Part-X)	Bladder & Aspirator	Infrared gas analyzer

Table 4.19: Ambient Air Quality Results

		SKAI Lodge,Male' Island				Site Office,Hulhule Island				Central Store,Hulhule Island				HDC Building,Hulhumale Island							WHO guidelines
	Parameters	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	MIN	MAX	AVG	
1	PM_{10}, µg/m^3	30	29	28	32	21	24	25	20	23	23.9	22.8	23.1	15	18	19	17	15	32	23.2	50 (24-hour mean)
2	$PM_{2.5}$, µg/m^3	9.1	8.5	8.8	9.3	BDL	4.3	4.1	BDL	BDL	4.9	4.8	BDL	4.1	BDL	BDL	BDL	4.1	9.3	6.4	25 (24-hour mean)
3	SO_2, µg/m^3	7.7	6.5	6.8	7.4	BDL	4.5	BDL	4.6	4.8	BDL	4.5	4.1	4.1	4.9	4.6	4.3	4.1	7.7	5.3	
4	NO_X, µg/m^3	9.2	8.5	8.8	8.9	4	6.8	4.5	6.6	6	5	62	5.3	5.8	5.2	6	5.4	4	62	9.8	20 (24-hour mean)
5	CO, µg/m^3	140	138	135	142	55	47	42	49	45	49	48	50	35	40	32	38	32	142	67.8	

The ambient air quality results obtained from the monitoring undertaken indicate that all parameters were within the WHO guidelines for ambient air quality. The results are presented graphically as below.



4.24.12 Ground water Quality

The overall objective of the water-quality sampling programme was to document baseline water quality conditions in the project area. The water quality sampling programme is intended to be indicative. The degree of compliance of all pollution indicator parameters is documented. The data is used to establish "action levels" for determination of whether the proposed development may have an adverse effect on groundwater. Groundwater assessment was undertaken from several locations in Hulhule island and they are listed with their geographical coordinates in the subsequent sections. Ground water samples were collected from existing wells in the island and analyzed in situ as well as from the National Health laboratory.

Samples were collected at a depth of 1m. All samples were collected in pre-cleaned sampling bottles. Samples for microbiology were collected in sterilized sample bottles provided by the National Health laboratory. The following parameters were analysed on all of the water samples. These are the parameters which have been identified in the TOR.

- Temperature
- salinity
- conductivity
- pH
- e.coli
- nitrates
- phosphates

Temperature, Salinity, conductivity and pH were measured in situ at all sampling stations using a YSI Model 680 and a portable Sension HACH meter. E.coli, nitrates and phosphates were tested at the National Health Laboratory.

4.24.13 Groundwater investigations

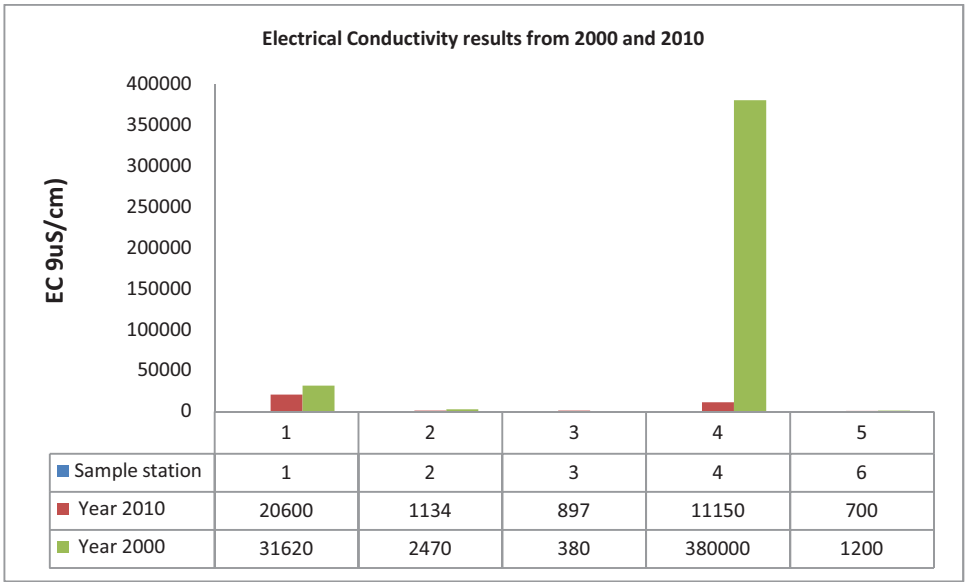
Groundwater assessment was conducted to assess the ambient conditions of groundwater in Hulhule island. Ground water samples were collected from the existing wells of the areas and analyzed both in situ and at the National Health laboratory. A total number of eight samples were collected. Generally, the islands of the Maldives have superficial groundwater lenses below about a metre of coralline sandy soil with a very narrow humus layer on top. The groundwater lenses so formed are formed due to density differences between percolated rainwater and saltwater beneath the island. The freshwater lens floats on top of the saltwater. This makes it extremely fragile and prone to saltwater intrusion due to over-abstraction. The depth of the freshwater lens or aquifer depends on the groundwater level above mean sea level on small islands. The typical ratio between the height of the water lens above mean sea level compared to the depth of freshwater below mean sea level is of the order of 1:20. Groundwater levels above mean sea level on small islands may be 0.10 to 0.50m above sea level, resulting in a freshwater lens depth of 2-10 m thick.

Groundwater levels measured by in November 2010 were on average 0.8 meters below the ground surface. It is expected that fluctuations in ground water levels will occur with the changing tide as has been observed in all the islands of Maldives. The ground water was analyzed for the following parameters as outlined in the following table.

The existing wells in Hulhule were visually inspected, and samples were tested for all the parameters outlined in the TOR. They are electrical conductivity, pH, TDS, Nitrates, Salinity, temperature, Turbidity and Faecal coliform. Summary of the water quality results are outlined in **Table 4.20**.

During the survey, it was observed that pumps are used to draw water from almost all the wells, while some of the wells were used on a daily basis to withdraw water while others were used only and when required. The minimum true groundwater conductivity recorded in Hulhule was 575 µS/cm. Table 4.17 outlines the result of the water quality survey. Only one sample tested positive for Coliforms.

Average Water table depth	0.81
Average temperature	28.95
Average pH	8.63
Average salinity (ppt)	1.39
Maximum EC (µS/cm)	20,600.00
Minimum EC (µS/cm)	575
Maximum TDS (mg/L)	10031
Minimum TDS (mg/L)	288
Percentage of wells with EC below 2500 µS/cm	62.5
Percentage of wells with EC above 2500 µS/cm	37.5
Percentage of wells with EC below 1500 µS/cm	62.5



	1	2	3	4	5
Sample station	1	2	3	4	6
Year 2010	20600	1134	897	11150	700
Year 2000	31620	2470	380	380000	1200

Figure 4.32: Water Quality Results of Electrical Conductivity (2000 to 2010)

Table 4.20 outlines the summary of water quality in Hulhule island undertaken in November 2010. **Figure 4.32** illustrates the comparison of groundwater results from 2000 an 2010 from the same wells 1, 2, 3, 4 and 6. It is assumed that the freshwater can be defined by a maximum limit of 2500 µS/cm. WHO guidelines suggest a maximum Chloride content of 250 mg/l for potable uses which equates to a salinity of approximately 1,500 µS/cm. However experience in other small island states confirms whilst this is desirable, a more realistic limit is 2,500 µS/cm (Falkland, 2001). Using this definition, it is clear that Hulhule does have a considerable percentage of wells which can provide freshwater which can be used even for drinking (Assuming that other parameters fall within their respective limits).

More than sixty two percent (62.5%) percent of the wells in Hulhule island can be considered fresh (taking EC levels below 2500 µS/cm). The electrical conductivity (EC) of these samples are also below 1500 µS/cm which is the threshold limit for drinking water. Only thirty seven percent (37%) of the wells have electrical conductivity exceeding 2500 µS/cm. The above assumption assumes the freshness of water in terms of Electrical conductivity. Only one sample tested positive for bacteriological contamination.

In summary, majority of the wells have low salinity level and bacteriologically, the water lens can be considered uncontaminated. The results of this survey can be used to establish a healthy baseline of the groundwater status of Hulhule island. Despite their use for various purpose, the groundwater lens can be considered fresh and free from bacteriological contamination.

Table 4.20: Analytical Results of Groundwater Quality of Hulhule Island

Sample station No→	1	2	3	4	5	6	7	8
Parameter ↓								
Date sampled	7-Nov-10	7-Nov-10	7-Nov-10	7-Nov-10	7-Nov-10	7-Nov-10	7-Nov-10	7-Nov-10
	4°10'58.0"N, 73°31'38.5"E	4°11'10.299"N, 73°31'55.67"E	4°11'31.35"N, 73°31'49.18"E	4°10'58.9"N, 73°31'34.7"E	4°11'42.56"N, 73°31'41.11"E	4°11'31.95"N, 73°31'40.69"E	4°11'30.64"N, 73°31'41.5"E	4°11'29.27"N, 73°31'38.59"E
Type of water	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well
Physical appearance	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles
Odour	No	No	No	slight odour	slight pungent smell	No	No	No
Depth of Water table (m)	0.5	1	1.3	0.2	-	1	0.5	1.2
Sampling depth (m)	1	1	1	1		1	1	1
Temp. [°C]	28.7	28.5	29	28.7	29	29.7	29	29
pH	8	9	8	9	9	9	8	9
Salinity [ppt]	1	0.6	0.4	6.3	1.9	0.3	0.3	0.33
Electrical Conductivity-EC [µS/cm]	20600	1134	897	11150	3560	700	575	623
TDS [g/L]	10031	567	448	5570	1780	350	288	315
Turbidity [NTU]	0	0	0	0	0	0	0	0
Nitrites [mg/L]	-	-	0.001	-	0.001	0.001	0.014	0.014
Faecal Coliform (E.Coli)/100 ml	0	1	0	0	0	0	0	0

Carried out by Water Solutions in November 2010

4.24.14 Noise Level

Noise monitoring sites includes three Islands in Maldives, namely Male Island, Hulhule Island, Hulhumale Island. Total 25 locations were selected for for Noise Monitoring. Out of 4 Location, 2 locations were from Hulhule (Airport) Island, one from Male Island and one from Hulhumale Island. For Noise Monitoring 11 Locations were selected from Male Island, 4 Locations from Hulhumale Island & 10 Locations from Hulhule (Airport) Island.

Nosie was monitored at 25 locations continuously for 24 hours. The day time was considered as 10 a.m. to 6.00 p.m. while the night time was considered as 7.00 p.m. to 5.00am. The results obtained from the monitoring are presented below.

Table 4.21:: Summary of Noise Quality Results for Hulhulé, Male and Hulhumalé Islands

S. No	Location	Leq(Day)	Leq(Night)
1	SKAI Lodge	57.2	55.7
2	Wataniya Gallery	71.1	64
3	City Bakery	67.3	65.3
4	Sultan Park	54.6	51
5	Maldives' Port Authority	66.7	65.2
6	Republic Square	61.6	55.6
7	Water & Sewerage Company	67.3	55.5
8	Bank of Maldives	66.4	65.7
9	STELCO Power House	68.4	68.9
10	Indira Gandhi Hospital	60.9	56.8
11	Male Sport Complex	57.3	55.1
12	Hulhumale Hospital	54.6	49.7
13	Residential Colony	57.4	49.7
14	Industrial Area I (Near Eureka Showroom)	54.8	48.8
15	Industrial Area I (Near JAUSA Building)	54.6	43.6
16	Airport International Terminal Main Gate	63.4	58.6
17	Cargo Section Seaside	65.4	61.5
18	Island Hotel Seaside	56.1	58.7
19	In-flight Catering building	58	57
20	Site Office	56.5	51.1
21	Air-Taxi Hangover	64.9	58.6
22	Power House	61.1	59.6
23	Airport Radar Area	61.1	58.5
24	6/9 Runway Signal Light	61.4	57.8
25	Ramp Section (Runway Side of Terminal)	67.6	63.2

The ambient noise levels were moderate to high considering the international standards. The higher background noise can be attributed to the roar from the sea, windy conditions and closely packed residential areas and movement of boats. The highest day time equivalent noise Leq day was observed at Wataniya gallery while the highest night time noise Leq night was observed at STELCO power. The noise level observations are graphically presented as below.

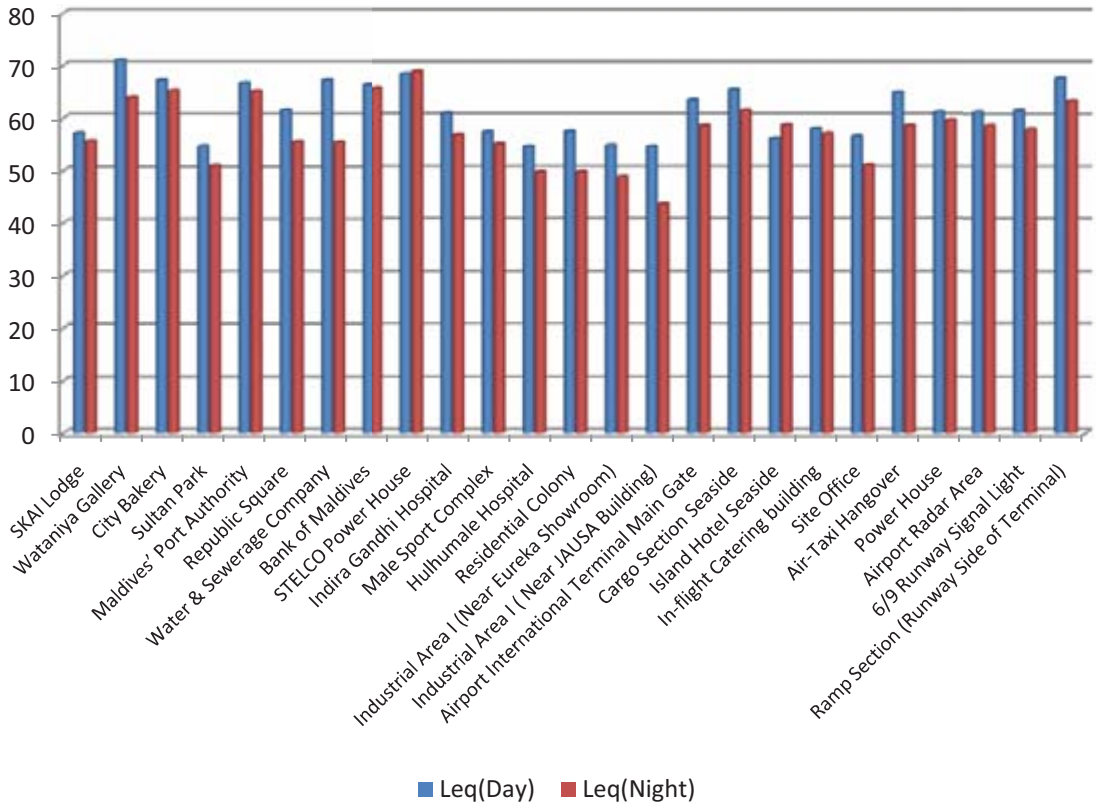


Figure 4.33: Noise Level Observations

4.25 SOCIAL BASELINE

4.25.1 Demographic Conditions

Maldives is an island nation located in the Indian Ocean. It consists of 1,192 islands grouped into a series of atolls, of which only 197 are inhabited. As per the Census 2006, Maldives has a population of 298,968. The GDP per capita is approximately USD 3,000. Male is the capital of Maldives, having an area of 2 km^2. The island has a population of more than 100,000, which is almost 30% of the total population of Maldives. The details of the population of Maldives have been presented in **Table 22** below:

Table 4.22: Total Population by Atolls - 2000 and 2006

Locality	2000	2006
Republic of Maldives	**270,101**	**298,968**
Male' Total	**74,069**	**103,693**
Male' (excluding other areas)	**72,230**	**102,377**
– Henveyru	18,100	23,597
– Galolhu	13,878	19,414
– Machchangolhi	13,589	19,580
– Maafannu	22,372	29,964

Locality	2000	2006
– Villingili	4,291	6,956
– Hulhumale'	-	2,866
– Dhafthar	-	-
Other Areas	**1,839**	**1,316**
– Hulhule	-	334
– Thilafushi	-	-
– Harbour	-	982
– Others	1,839	-
Atolls	**196,032**	**195,275**
Source: Department of Planning and Statistics, Maldives		

4.25.2 Male' Population

The total population of Male' stands at 103693 by 2006 and the land area being 192.07 hectares the population density is 540 people per hectare. Graph 1 illustrates the increasing trend of the urban population of Male'. With continuing migration from the islands the growth rate of Male' is estimated at 5.59 per annum compared the country's growth rate of 1.69 per annum. More than a third (34.7%) of the country's total population of 298,968 resides in the capital city of Malé. Nearly one-half (46.3%) of the population is very young (under 20 years). The sex ratio is 103.7 and population is growing annually at 1.69 percent.

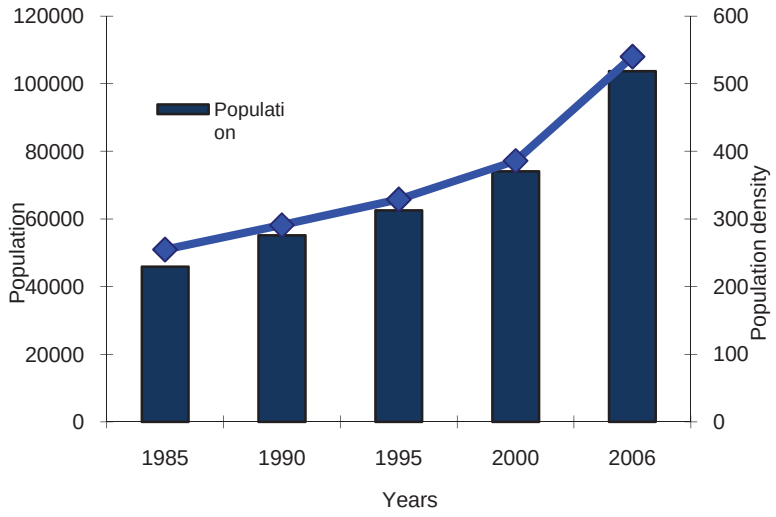


Figure 4.34: Population and Population Density of Male' 1985-2006

(Data Source: Department of Planning, 2006)

To ease the urban density and its related issues of Male', the government has focused on decentralisation and to establish regional urban areas within the country. Hulhumalé is also being developed with the same objective of easing the urbane density within Male' the capital

4.25.3 Vulnerability and Poverty

The VPA of 2004 is compared with the VPA of the 1997 to understand the vulnerability and poverty situation of Male'. Three different poverty lines: a) the median income of the atoll population in 1997, MRF 15.00 per person per day; b) half the median income, Mrf 7.50 per person per day; and c) an in-between line of Mrf 10.00 per person per day are compared. For all three poverty lines, the

headcount ratio has declined, in the atolls and especially in Male' where by 2004 income poverty had virtually disappeared.

Table 4.23:: Head Count Ratio Poverty Incidence by Poverty Line- Percentages

Poverty line (Mrf)	Maldives		Male'		Atolls	
	1997	2004	1997	2004	1997	2004
7.50	13	3	5	0	16	5
10.00	23	8	8	0	28	11
15.00	44	21	19	3	52	28

Source: Department of Planning, 2004

In order to place Male' in the national context in terms of vulnerability and poverty the VPA of 2004 was reviewed in **Table 4.24**. The figures illustrate the capital city's position in terms of poverty and vulnerability compared to the national average.

Table 4.24:: Vulnerability and Poverty of Male' - 2004

Index	Male'	National Average
Income poverty Index	0.1	0.10
Electricity Index	0	0.01
Transport Index	0	0.31
Communication Index	0.29	0.28
Education Index 1	0.0	0.17
Health Index	0.00	0.23
Drinking Water Index	0.00	0.23
Consumer Goods Index	0.17	0.23
Housing Index	0.53	0.24
Environment Index	1.00	1.00
Food Security	0.24	0.28
Employment	0.29	0.36
Recreation Index	0	0.18

Source: Department of Planning, 2004

The indexes are based on other dimensions and is measured on scale of 1-10, where the higher the score the higher the vulnerability. As depicted in **Table 4.24** the Income Poverty Index of Male is 0.1 while the national average is 1.0. A score of 0.1 indicates that performance of Male' is far above than the National average of 1.0. Compared to the national average all indices show a similar picture except for Housing Index and the Environment Index. It should also be noted that the VPA 2004 was undertaken few years back improvements would have occurred and the indicators would have changes for the better.

4.25.4 Housing

In Male' the most pressing issue is that of housing congestion and the lack of housing for growing population. Geography of the island of Male' limits the available land for housing. Male' remains one of the world's most densely populated cities. With the economic importance of Male' the capital,

migration to Male' with population growth and urbanization has contributed to a number of social problems that impacts the lives of Male' people.

Housing in the Maldives is very expensive with prices in Malé exceeding 12 times the average annual income. This is partly due to the shortage of land as well as the high cost of construction given the reliance on imported building materials. In Malé, the shortage of housing itself raises rents and prices. Due to land scarcity today, the government has stopped allocating housing plots in Male'. New housing is being made available through housing development projects. In 2006 there were 14,107 households in Male' compared to just 9,700 in 2000. The average household size in the Maldives is 6.47 and this figure is slightly higher at 7.35 for Malé. The SAP (2009-2013) highlights that efforts to improve housing opportunities through development of Hulhumalé and Vilingili islands around Malé have not relieved the housing pressures in Malé due to the continued inflow of people from the provinces.

4.25.5 Economic Sectors

The main economic sectors of the country are tourism, fisheries and agriculture.

a. Tourism

Tourism is the key economic sector, contributing 28% of GDP and with 48.4 percent in revenue in 2010. Since the first resort was established in 1972, more than 97 islands have been developed, with a total capacity of 24650 beds by 2009. In 2009, 655,852 tourists (mainly from Europe) visited the Maldives. The average occupancy rate is about 70%. . The average tourist stay is 8 days. The Maldives has embarked on a rapid tourism expansion plan with the goals being

- Facilitating growth and investment,
- Enhancing public share
- Increasing employment opportunities and community participation
- Development and maintain support infrastructure
- Ensure environmentally- responsible tourism
- Continue positioning Maldives as a top ranking destination
- Continue to strengthen the legal and regulatory framework

The Tourism Master Plan highlights that in terms of the infrastructure and support services for the tourism sector, MIA is limited in capacity constraining the development of the tourism. The current capacity of the MIA is insufficient to cater for the planned expansion of the tourism industry. Table illustrates the resort expansion plan that is underway at present. The planned geographical expansion by locating resort in all atolls necessitates development of the MIA.

Table 4.25: Bed Capacity of New Islands Leased for Tourism Development by Province

	Upper North province	North province	North Central province	Central province	Upper Central province	South Central province	South province
Bed Capacity of resorts	600	200	0	0	400	400	0
Bed Capacity of Rent Open Islands	170	190	0	0	0	296	0
Bed Capacity of Rent controlled Island	592	600	0	60	380	150	0
Hotels with Regional MIA	400	0	0	0	200	0	0
Population Consolidation Resorts	200	600	0	0	0	200	0
Islands Leased to AIM	200	600	200	200	200	600	0

	Upper North province	North province	North Central province	Central province	Upper Central province	South Central province	South province
Other Tourist Establishment associated with an MIA	200	600	200	200	200	400	200
Island leased to MTDC	1200	444	0	220	0	480	0
Other island + City hotels	0	0	0	0	0	0	1356
Lagoon Resorts	200	0	200	400	200	0	0
Transport Network project	50	50	50	50	50	50	50

Source: Statistical Year book, 2010

b. Fishing

This sector employs about 11% of the labor force. The fish catch has recorded an unusually sharp decline over the past few years to about 100,000 metric tons in 2009. With the decline in the production contribution of fisheries to GDP has declined to about 3%. About 50% of the fish catch is exported, largely to the European Union, Sri Lanka and Thailand. Fresh, chilled, frozen, dried, salted, and canned tuna exports accounted for 94% of all marine product exports. Total export proceeds from fish were about $80 million in 2009.

c. Agriculture

Poor soil and scarce arable land have historically limited agriculture to a few subsistence crops, such as coconut, banana, breadfruit, papayas, mangoes, taro, betel, chilies, sweet potatoes, and onions. Almost all food, including staples, has to be imported. Agriculture provides about 2% of GDP. Import of food requires suitable cargo handling facilities with Male' International MIA.

4.25.6 Urbanization and its related issues

Urbanization and its related issues are severe in Male'. High population density, increasing migration, unemployment with unfulfilled expectation have increased social problems in Male'. Many young secondary school graduates from atolls are ambitious and have high expectations with many preferring to seek employment in Male' or close to Male', where urbanization is at peak. With not enough employment youth unemployment are on the rise along with associated social issues.

Today the country is witnessing an alarming increase in drug abuse among adolescents and young people, with 46 percent of drug abusers being aged between 16 and 24 years. Drug trafficking and abuse are causes of serious and growing concern for the socio-economic development of Maldives. The number of drug abuse cases reported to the police has more than tripled between 2000 and 2004, from 220 to 697 cases respectively. Close to 50 percent of drug abusers are aged between 16-24 years. Similarly increase in crimes and violence has been observed during recent years.

4.25.7 Employment

The country's labour force is 110,231 according to the census of 2006. Unemployment rate stand at 14 percent. Today three key challenges are at the forefront with regard to the employment.

a. There is a large disparity between male and female participation rates with male unemployment rate at 8 percent and female unemployment at 24 percent.
b. A large number of youth are also unemployed.
c. Increase in number of the expatriate workers.

According to the VPA II of 2004, about 40 percent of the young women and over 20 percent of the young men are unemployed, not only because they lack the skills required in the labour market but also because of limited job opportunities. Unemployment is challenge highlighted in the Strategic Action Plan. To alleviate this, one of the major economic goals put forward is to create an environment conducive for growth and generate employment.

With regard to expatriate labour force it is noted, a large number of semi skilled and unskilled occupations are filled by expatriate workers. Fourteen percent of the 72,308 expatriate workers registered in the country at the end of September 2009 fall in the professional and highly technical occupations while 44 percent comprises of semiskilled and 46 percent unskilled In 2006, 30.5 percent of expatriates were engaged in construction sector, 20.6 percent in tourism and 15.4 percent in community, social and personal services. All these issues are challenges that required efforts towards creating of new job opportunities and skilled labour within all sectors and needs an integrated approach between the government, public and the private sector. As a consequence, the economy is highly dependent on skilled and semi-skilled expatriate labour. Employers, including the Government, recruit and hire expatriate workers in the absence of properly trained or qualified Maldivians. From 1995 to 2000, the Maldivian labour force grew by 5% annually while expatriate labour grew by 8%.

4.25.8 Transport services between Male' and MIA

Transport service between MIA and Male' are provided as follows;

Ferry service between Male' and the MIA

The ferry service between Male' and the MIA is regular efficient service that has been established through a boat owners association for number years. Owners of 48 boats are operating this service between MIA and Male' based on demand. Boats leave every 10 to 30 minutes range. The charge is Mrf 10 per person and no extra charge is levied on the luggage.

MTCC express service

MTCC express service is a newly introduced speed boat transport service to MIA. Speed boat with a capacity of 18 people leaves from the MTTC ferry terminal at every 30 minutes reaching the MIA with 5 minutes.

4.25.9 About Hulhumale'

Hulhumale being the other island being proximal to the MIA has also be covered to understand the baseline. Hulhumale' is an artificial island formed between 1997-2002 through reclaiming 188 hectares of land from Hulhule Farukolhufushi lagoon 1.3 km North West of Male'. Residential development and was completed in 2004 followed by the first settlement of 1000 people in 2004. Hulhumale' was formed to as an effective solution to the growing problem of congestion within Male' in terms of housing, industrial and commercial development

4.25.10 Infrastructure

Hulhumalé is being developed by HDC which performs three functions. They are;
1. Delivering the master plan of the Hulhumalé in manner that is feasible and commercially viable.

2. Investing the infrastructure including development of roads, landscaping and ensuring the basic and essential infrastructure are available.

3. Regulates by overseeing detailed planning and overseeing the necessary guidelines

HDC deals with lease and sale of land as well as developing property focusing on real estate, residential, commercial and industrial development. Over the years a significant number of infrastructure facilities have been established to cater for the island population. **Table 4.26** outlines some of the main infrastructure that has been established over phases as part of the development of Hulhumalé.

Table 4.26:: Main Infrastructure Development Undertaken by HDC

Housing infrastructure	Public infrastructure
Apartment complex 280 room (2,3, 4 bedroom units	Primary and secondary school(20 classrooms)
232 Condominium housing units	Public building for social and government requirements (32 units)
Basic housing units120	A hospital with50 beds capacity
Beach plot 169	A mosque1500 persons
Standard plots56,	An asphalt-paved road network approximately 12.5 km long
Terraced houses132	Commercial buildings4 each with 48 units
Housing units 280	Land space Cultivation of indigenous plants and imported varieties
Resident beach front plots 57	A public building with 32 public units
Residential beach plots109	15 Industrial and commercial land plots with an average of 1000 sq mts per unit
Residential standard plots 56	Jetty and harbour
Plots for terraced housing 132	
Housing units 1900	

Source: Housing Development Corporation, 2010

As foreseen by HDC by the target completion date for the development, the year 2020 transforming Hulhumalé into a world class city where 60,000 people will live, work and raise their families. As well as providing a superb living environment for its residents, Hulhumalé will also serve as a catalyst for broad based investments in the fields of commerce, education, health, recreation, tourism, fisheries and a number of other related areas by both foreign and national parties.

4.25.11 Population

In terms of population, the 2006 census recorded Hulhumale' population as 2866 with 1620 as males and 1246 as females.

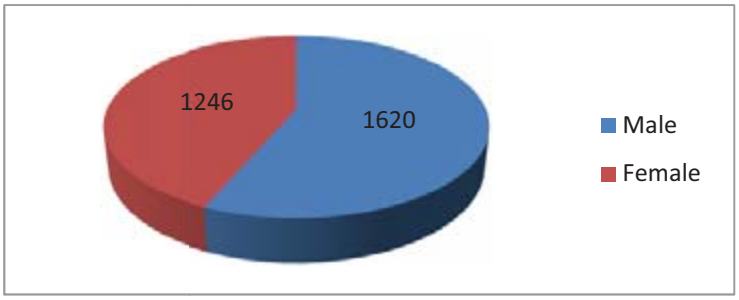


Figure 4.35: Population of Hulhumale' -2006
Source: Department of planning 2006

People are living in 412 households with an average household having 7 members. Though the registered population is around 3,000 it is estimated that around 12,000 people will be living in Hulhumalé at present. Hulhumalé is a recreation and leisure island for a number of people living in Male'. It is estimated that 8000 people visit Hulhumalé during weekend for leisure purposes.

4.25.12 Transport

Hulhumalé transport services at present consists of the following;

a. MTCC bus service within Hulhumalé'

The main mode of transport within Hulhumale' is bus service provided by the MTCC and is serviced to and from the ferry terminal. The local population and the visitors to Hulhumale' use the bus service on a regular basis. The bus charges Mrf 5

b. MTCC bus service to the MIA

MTCC bus services to and from the MIA have been initiated and buses commute every 40 minutes to 2.30 hours throughout the day. These buses commute MIA staff and passengers to and from the MIA. The charge is Rf 15 per person. The guest house operators also hires buses to transfer their passenger from the MIA to Hulhumalé according to demand.

c. Taxi

At present there are 14 taxis operating within Hulhumalé'. The customers for these taxi drivers are from

1. the local population of around 12000 people living in Hulhumalé'
2. an estimated 8000 visitors from Male' who visits Hulhumalé' during the weekend
3. The tourist visiting Hulhumalé' as transit passengers and visiting tourists

At present the HDC determines the number of the taxis in service based on demand.

4.25.13 Employment avenues

As illustrated in **Figure 4.36** employment avenues existing in the islands centers around 67 privately owned shops, 4 private guest houses, 13 cafes and 14 taxis.

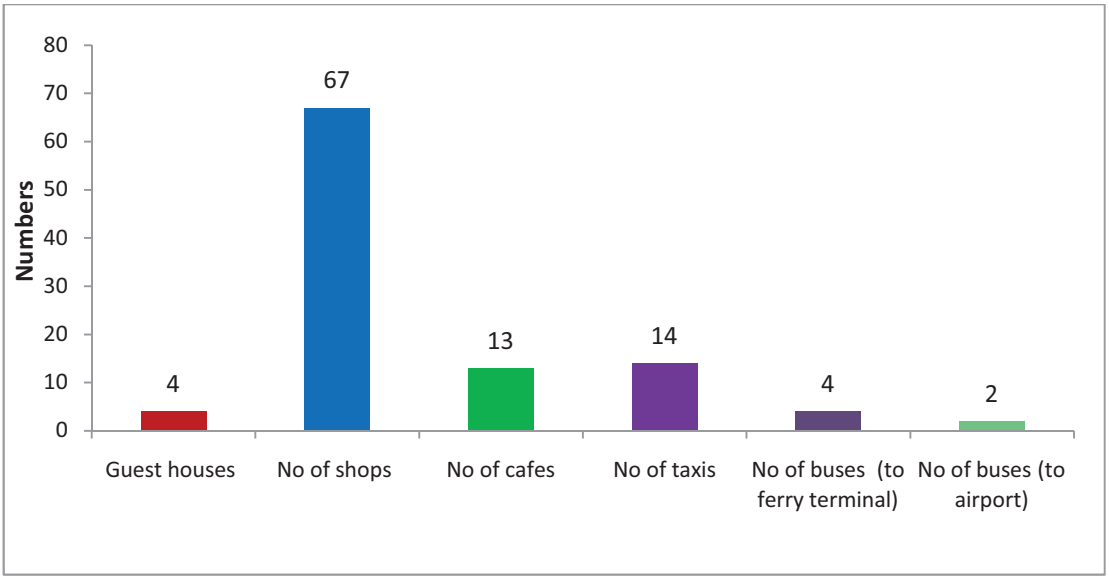


Figure 4.36: Main Infrastructure and Services in Hulhumale' -2010

Employment through guest houses is gaining momentum within Hulhumale'. MIA is the key connection point for tourists visiting Maldives. Hulhumale' is connected to the MIA by 1.8 km road and is within a distance of 15 minutes travel time by bus. Hulhumale' at present has 4 registered guest houses operating throughout the year to meet the needs of the transit passengers and tourists visiting Hulhumale'. The existing MIA has facilitated economic benefits to these guest houses through;

- Transit passengers coming from abroad staying for one day prior to leaving to their destination resort or yacht
- Transit passengers leaving Maldives to their home country also stays one day prior to their departure.
- Tourist coming and staying in Hulhumale'' for a period of 5-7 days.

At present direct economic benefits in the form of food and lodging to these guest houses are a source of income to these guest house owners.

4.25.14 Clubs and associations

A few associations and clubs have be developed and in operation in Hulhumalé i.e.:

1. Hulhumalé Association for Women's Improvement
2. Hulhumalé Innovative Youth Association
3. Hulhumalé Environment and Youth Development
4. Hulhumalé Women's Sports
5. Hulhumalé Youth Development Association

Hulhumalé Crime Prevention Committee has been formed by representatives of the NGO's in association with the police with objective of curbing the rise in crimes within Hulhumalé'.

5 ANALYSIS OF ALTERNATIVES

This section looks at alternative ways of undertaking the various alternatives of the proposed project. There are two basic options: (1) leave the island as its form without undertaking the proposed development (no project option) or (2) undertake the proposed development on the island (undertake the project options). If the project were to continue, it would be necessary to take technical and social aspects of the project into consideration and ensure that these concerns are adequately considered before taking decisions. It is therefore important to consider all practicable options and ensure that the best available option(s) is/are chosen. The following section details the development options.

5.1 NO DEVELOPMENT OPTION

The "No Development Option" implies not proceeding with the airport development project rather electing to leave the airport in its current state – somewhat degraded and unable to efficiently handle the forecasted passenger load. This option would likely lead to adverse socio-economic impacts including but not necessarily limited to the following:

- Continued operation of the airport in sub-optimal conditions for safety and environmental standards and passenger comfort;
- Inability to cater for forecast future air traffic and passenger growth;
- Failure to realize potential increased income from tourism and
- Failure to realize positive socio-economic benefits in the provision of jobs and the generation of revenue for the local community.

In view of the current status of the airport, it is evident that the airport needs modernazition and the socio-economic benefits would be enormous for Maldives. On this basis, it is considered that the positive benefits of airport expansion and modernization outweigh the potential negative environmental and social effects. Therefore, the "No Development Option" is not recommended.

5.1.1 Alternative Site Options

A detailed analysis was performed and six alternative site options were considered for the proposed expansion and modernization of Malé International Airport. **Figure 5.1** shows all the six alternatives considered for development.

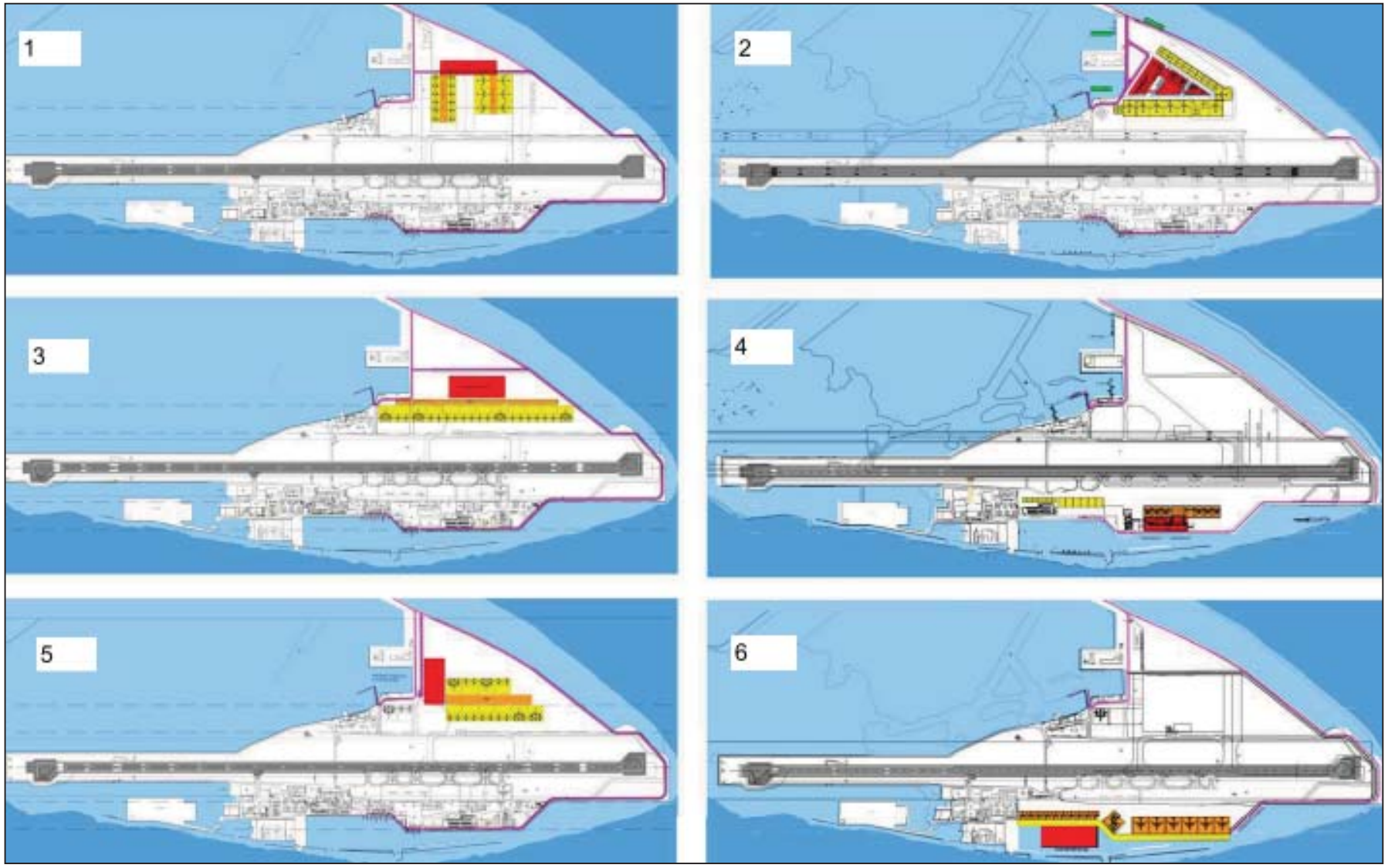


Figure 5.1: Plan Showing Various Alternate Options Considered

All the above alternatives were assessed on the following factors:

- Phased Expansion
- Interface with ferry pier
- Interface with Sea Plane Terminal
- Road access from Hulhumalé
- Land Use efficiency
- Passenger Convenience
- Level Changes (Arrival and Departure)
- Departure Changes (Arrival and Departure)
- Aircraft Maneuverings
- Sightline from ATC
- Modern Architecture
- Walking distance from the lounges to the stands (maximum 50m)

After the detailed review of **six alternatives** against the above mentioned key criteria, the second alternative with new terminal building in triangular form along with its associated facilities like aprons, link taxiways, VIP terminal etc., on the east side of runway was found to be most suitable. Due to land availability constraints on the western side proposed expansion is not possible. However, the selected site alternative provides sufficient area for phased development. Also the passenger convenience was found to be paramount in this case.

5.1.2 Alternative Location for fill materials

The Concessional Agreement between GMIAL and MACL for the redevelopment of Malé International Airport has identified Galufalu which is located 2.8 km west of Hulhule as an alternative location for the borrow material to undertake the reclamation work of the project. However, at this stage of the project, there is no plan to to borrow fill material from any other island for the reclamation work of the project. If need arises at a later stage of the project, to borrow fill material from other sources, a separate study would be undertaken to assess the environmental impact of this activity.

5.1.3 Alternative technological option for reclamation

The project requires up to 2,759,502.7m^3 of sand as fill material to reclaim 641,749 m^2 of new area of land to undertake the Malé International modernisation project. The possible alternative method to undertake the reclamation and sources of fill material are the following:

Trailing Suction Hopper

Sand from the seabed of the lagoon in the atoll to be dredged by a trailing suction hopper dredger with a pipeline system. The trailing suction hopper dredger will transport the sediments to the shore connection, where the trailing suction hopper dredger will be connected to a pipeline system (refer **Figure 5.2**).

This is a realistic alternative depending on the water depth of the seabed in the lagoon, and the available quantity of sand within the lagoon. Sand mining in the atoll can be done by a Trailing suction hopper dredger. As the water depth is between 20 – 80m, a large Trailing suction hopper dredger is required.

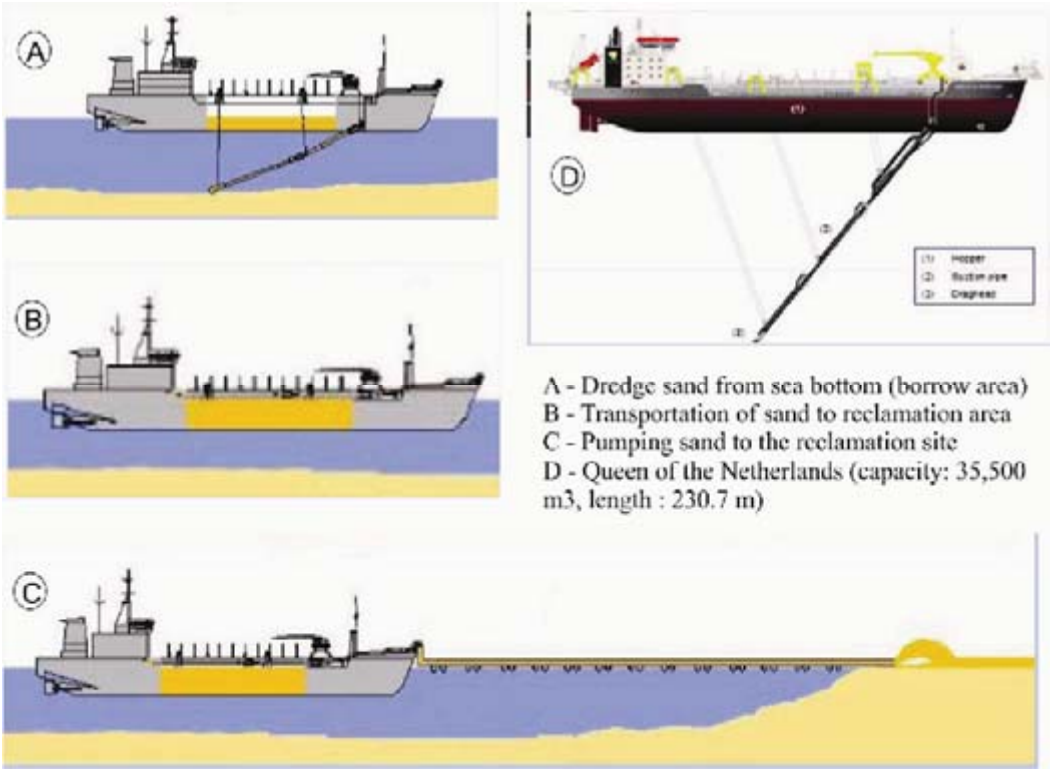


Figure 5.2: Methodology for the Implementation of the Reclamation Component of the Project

Bunding the reclamation area with Geotubes

Bunding is required to control the sedimentation, when the proposed project is undertaken to reclaim the area on north eastern, north western and northern end of runway. Geotube containment technology could be used as a bund and replace the sand bund to create entirely new shoreline by reclamation. Geotube technology has been used for island creation because of its ease of installation, ruggedness, and cost-effectiveness. Hundreds of meters of Geotube containers can be used to produce durable shorelines that can be filled in behind the units to produce stable land for building. Skyscrapers have been constructed on property reclaimed from the sea by using Geotube technology.

The process is simple: a large tube made of a specially engineered textile is filled with sand and buried under the beach. Geotube technology uses geotextile containers up to hundreds of feet in length. In most cases, installation is permanent—and invisible. Advantages of Geotube geocontainment technology is that the gentle original slope of the beach can be recreated. This improves the aesthetics of the shoreline by providing a natural-seeming habitat—and blocking lights from shore that can confuse sea turtles and other creatures.

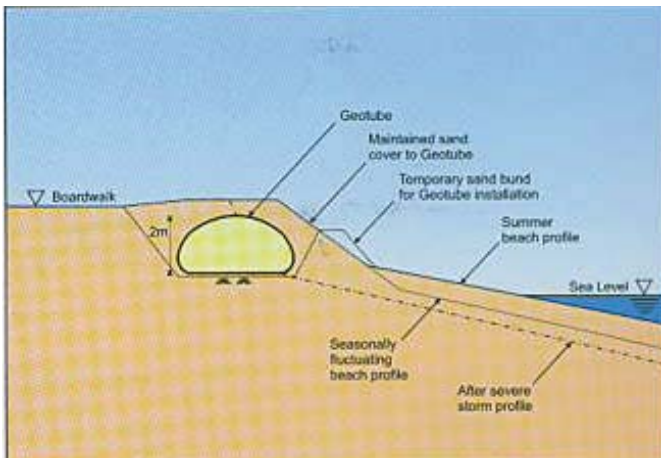


Figure 5.3:: Cross Section of the Geotube Retaining Wall

The alternate options provided indicate that the current project option with the advance technological options will be the most appropriate option in the existing scenario.

6 ENVIRONMENTAL IMPACT

This section provides with the identification and evaluation of potential social and environmental impacts that can occur as result of expansion, modernization and operation of the MIA. The impacts from the proposed project have been categorised under four broad categories as

- Impact on Marine environment (corals, fishes, other fauna , water quality etc.)
- Impact on Coastal environment
- Impact on Terrestrial environment
- Impact on social set-up

6.1 Impact Identification Criteria

The impact identification has been carried out using interaction matrices using project actions and environmental factors. The impact identification process used the following definitions as defined by Canter (1991). A summary of the environmental impacts due to the implementation of the project on each component of as defined above.

SB – Significant beneficial impact; represents a highly desirable outcome in terms of either improving the existing quality of the environmental factor or enhancing that factor from an environmental perspective.

SA – Significant adverse impact; represents a highly undesirable outcome in terms of either degrading the existing quality of environmental factor or disrupting that factor from an environmental perspective

B – Beneficial impact; represents a positive outcome in terms of either improving the existing quality of the environmental factor or enhancing that factor from an environmental perspective

A – Adverse impact; represents a negative outcome in terms of either degrading the existing quality of the environmental factor or disrupting that factor from an environmental perspective

b – Small beneficial impact; represents a minor improvement in the existing quality of the environmental factor or a minor enhancement in that factor from an environmental perspective

a – Small adverse impact; represents a minor degradation in the existing quality of the environmental factors or a minor disruption in that factor from an environmental perspective

O – No measurable impact to occur as a result of considering the project action relative to the environmental factor

M – Some type of mitigation measures can be used to reduce or avoid a minor adverse, adverse, or significant adverse impact.

NA – The environmental factor is not applicable or not relevant to the proposed project.

6.2 Impact on Marine Environment

The marine components involved in the proposed reclamation area of the project will be directly affected and and could be completely lost during the construction period, whereas habitats in the proximity will be adversely impacted by reclamation works due to increased sedimentation and possible nutrient influx. During dredging and reclamation works and related coastal development activities, a significant amount of siltation and sedimentation of the lagoon waters and reef slope is anticipated. These impacts may cause adverse conditions such as smothering of corals and reduced light penetration to corals which depend on sunlight, and other sessile benthic communities that are not able to move away from the sand. Even though corals have self cleansing mechanism and can withstand a certain rate of sedimentation, detrimental impacts such as reduced coral

growth, recruitment rate and eventually death are expected to happen in some areas during such a large-scale project.

Areas such as the south-western side of the runway, the reclamation areas which are expected to be influenced from the reclamation works and those on the north-western side of the runway which could be influenced during the extension works at the runway will be prone to elevated sedimentation during the dredging works in the seaplane area. A famous dive site, the "Maldives Victory" wreck, is located in 30m depth near south western side of the runway, which is of cultural importance.

Due to the loss of some of the reef systems, a negative impact on fish communities is expected. Fishes associated to coral may potentially lose their habitats and tend to move deeper during construction work and or permanently find other shallow areas.

Figure 6.1, shows marine areas that will be modified during the redevelopment of the Hulhule' airport (green) and also the estimated sites on which impact will be felt (yellow).

The project activities and the related impact on marine components are presented in the following subsection:

6.2.1 Runway extension

The runway at MIA has overall dimensions of 3,200m x 45m with a paved shoulder to each side. The runway width is compliant with ICAO recommendations for Code E operations, making it suitable for all passenger aircraft types except the A380. The shoulders are currently less than the recommended width of 7.5m and will need to be widened and strengthened. Both runway ends have a stop way of 60m x 45m (paved) and a clearway of 300m x 150m. Runway end safety areas (RESAs) are provided of 54.6m at the Runway 18 end and 88.66m at the 36 end. These are both below the ICAO required minimum and substantially less than the recommended minimum of 240m.

Additional land required for a full 300m wide runway strip requires an area of 330,534m^2, and another 59,968m^2 north of the runway (about 200m). Please refer to the respective section for details on dredging and land reclamation.

Part of the reef flat north and west of the existing runway will be permanently lost. It has to be mentioned that 46,400 m^2 of the western reef flat has been previously modified when it was excavated to an average depth of 3.3m to provide sand for a reclaimed area west of the runway (shown by white rectangle depicted in **Figure 7.1**)**Error! Reference source not found.**, which is 1.1m above MSL (Sandcays, 2010). The reef slope at this site is expected to experience sedimentation from sand being brought into the water column while widening the runway. Monitoring of the reef slope after the construction works are completed is necessary to determine the impact on the reef by comparing live coral coverage and generic composition with baseline data provided in this EIA report.

6.2.2 Construction of the new passenger terminal

A new passenger terminal building will be located in the south east corner of the island which requires reclamation of two semi-enclosed saltwater ponds and a 60-90m wide strip of the south-eastern reef flat. Part of this reef flat has been previously dredged to create a land bridge (road) around the southern end of the runway in order to take passengers to the seaplane terminals.

This strip of the reef flat will be permanently lost during reclamation. It is the area where large amounts of solid matter floating near shore were observed during the visual inspections of future reclamation areas.

The two saltwater ponds were part of the island's eastern shallow reef flat before it has been enclosed by a land bridge. They currently allow fish to breed under calm conditions and juveniles to develop before they start their life in the surrounding coral reefs. Seabirds use this habitat, surrounded by vegetation, to take off and land, and probably also to breed. During the construction of the new terminal, these two saltwater ponds will be entirely lost together with the species (see **Section 4.21 Qualitative Surveys)** associated with them.

It is expected that the reef slope east of the future terminal will experience sedimentation from sand being brought into the water column while reclaiming the 60-90m wide strip of the reef flat. Monitoring of the reef slope after the construction works are completed is necessary to determine the impact on the reef by comparing live coral coverage and generic composition with baseline data provided in this EIA report.

6.2.3 Reclamation on the south-eastern end of the runway

The road on the eastern side of the runway, starting on the northern end of the island and running along the Maldives In-flight Catering (MIC) complex, the Hulhule Island Hotel (HIH), the domestic and international terminal down around the southernmost tip of the runway and east up to Hulhumale', currently makes two 60° turns at the water pump station (Survey Site "1") and 220m south of it (at Survey Site "2"). It is not clear whether the lagoon (a mainly dead reef flat) between Survey Site "1" and the southernmost tip of the island will be reclaimed, but a visual study undertaken for this EIA suggests that there should not be a major negative impact on the lagoon since it mainly consists of coral rock with only occasional coral heads, around which fish are found. However, again the reef slope is expected to be impacted by sedimentation if this lagoon is to be reclaimed.

6.2.4 Development of a new seaplane runway

A new seaplane runway will be developed as part of the development. Sand and coral material from the existing shallow lagoon area would be dredged by a cutter suction dredger (CSD). This will generate suspended solids and would suck up any living and non-living matter. If the dredged material is used to fill the two saltwater ponds with no connection the ocean, the impact would be felt localized. Baseline marine water quality data have been collected during the surveys for this EIA; results from monitoring surveys after the construction works is finished will reveal the actual impact on the lagoon between Hulhule' and Hulhumale'. However, seagrass dredged from this lagoon should not be deposited in any open water body because nutrients from such large amounts of organic matter could lead to eutrophication.

6.2.5 Water contamination through solid and liquid waste

Solid waste is expected to be a significant residue from the development in construction phase. Waste will principally come from the building sites. A considerable amount of solid waste will be generated during the construction of buildings and the extension of the runway. Any mishandling of solid (non-biodegradable) waste, hazardous waste like oil spills or other toxic substances, will contaminate the marine environment.

Sewage, which is currently not treated, is contaminating the marine environment to an unknown degree. During construction, the existing sewerage system will be used to manage the sewerage management requirements. During operation, an SBR type purification plant will be used to treat the sewage in the airport.

Table 6.1 Summary of Environmental Impacts on the Marine Environment

Development	Impact area	Type of impact	Duration and severity	Impact Significance
Runway extension	Reef flat/lagoon north and west of runway	Habitat loss particularly for fish due to reclamation	Permanent adverse; irreversible	SA
	Reef slope west of runway	Sedimentation due to reclamation	Temporary during construction work, medium to major adverse	A
New passenger terminal	Two saltwater ponds south of the ATC tower	Habitat loss for juvenile fish due to reclamation, habitat loss for protected seabirds visiting the	Permanent adverse, irreversible; large habitat loss of a "nursery" ground for juvenile fish	SA

Development	Impact area	Type of impact	Duration and severity	Impact Significance
		ponds.		
	60-90m reef flat strip on the south-eastern side of the ponds	Habitat loss for coral and fish due to reclamation	Permanent adverse, irreversible	SA
	Reef slope east of proposed passenger terminal	Sedimentation due to reclamation	Temporary during construction work, medium to major adverse	A
Reclamation at the south-western end of the runway	Triangular lagoon/reef flat south-west of the runway	Habitat loss for coral and fish	Permanent adverse destruction to an already destroyed habitat (dead reef flat)	SA
	Reef slope on the south-western tip of the island	Sedimentation due to reclamation	Temporary during construction work, medium to major adverse	A
Development of a new seaplane runway	Lagoon between Hulhule' and Hulhumale'	Habitat loss particularly for fish, and sedimentation	Localized, temporary; due to already impacted area: minor adverse	a
Solid waste polluting the marine environment	General	Entanglement in corals, destruction (breaking) of corals. Unattractive for dive sites. Hazard for marine creatures (ingestion and entanglement) and boat propellers	Localized to regional; cumulative (micro particles ingested); between minor adverse (large solid waste floating) to major adverse (ingestion, entanglement). Can cause failure of boat propellers. Large amount of suspended matter could cause reduced light penetration, which is essential for hermatypic corals and other marine invertebrates.	a

Figure 6.1: Sites proposed for modification (green) and estimated marine impact sites (yellow). Photo: Google Earth

6.2.6 Mitigation for Marine Environment

It is evident from the impact summary for marine environment that there will be significant adverse impact on coral reefs and associated fauna. The impact can be minimised by application of mitigation measures as proposed below, however residual impacts will remain.

Mitigation measures to protect the marine environment around Male' International Airport must focus on the reclamation works to avoid coastal erosion, as well as sedimentation/siltation, which have detrimental effects on the health of corals.

Following mitigation measures are proposed for the:

1) Protection of the marine environment from the likely impacts of dredging and reclamation and other coastal development activities:
    - Deployment of silt screens between the eastern reclamation area (future passenger terminal) and the coral reef slope, wherever possible.
    - Construction of bund walls to fully enclose the reclamation area and to minimize the loss of suspended sediments from the reclamation area, if technically possible. Bunds should be constructed especially on the south-eastern (proposed terminal) side and on the west side to protect the coral reefs from receiving large amounts of sediment.
    - Reclamation of the two saltwater ponds should be started furthest from the connection pipes to the shallow lagoon. The connection pipes should not be closed at the beginning of reclamation to allow fish escape from these two pools. The change from high to low tide will facilitate particularly juvenile fish to escape the pools due to an out-flowing stream. If reclamation is begun from the wrong side, fish and marine invertebrates living in the ponds will be permanently trapped and buried under the sand. The connection pipes can be closed once reclamation has processed up to a point near them, to prevent sand flowing out into the lagoon.

2) Prevention of construction waste, including hazardous waste, entering the sea:
    - Construction wastes, including packaging, has to be separated and stored in the waste management area and later be taken to Thilafushi for disposal.
    - Contractors need to train their workers on how to dispose of food and drink containers, emphasizing the need to protect the environment
    - Waste collection bins have to be placed along the construction sites so that they can be disposed at regular intervals and in an organized matter.
    - In order to prevent accidental spill of oil or other toxic substances which could contaminate the sea, all machineries have to be properly maintained.
    - All paints, lubricants and other chemicals used on site to be stored in a secure and bunded location.
    - Oil, solid waste and hazardous waste have to be handled carefully and transported in sealed containers in properly bunded vehicles/vessels.
    - Construction needs to be carried out under the supervision of a suitably experienced person.
    - Storm water generated has to be collected in holdings tanks to ensure that suspended solids are removed before water is diverted into the sea.

3) Prevention of solid waste entering the sea during operation:
    - Waste collection bins have to be placed in all areas of the airport and emptied on a regular basis.
    - All kinds of solid waste has to be taken to Thilafushi

4) Prevention of eutrophication or contamination with raw sewage:
    - The present airport operation does not have a full fledged sewage treatment plant for the entire airport. As a part of environmentally sustainable development, it is proposed to install a sewage treatment plant to cater to the complete airport.
    - An Sequential Bio Reactor plant is proposed for installation. The SBR is a biological, suspended colonies type activated sludge purifier combining oxidation and sedimentation in the same tank that follow each other in sequence. The SBR plant is controlled by an electric panel and is completely automatic. The SBR, reactor besides the biological phase to eliminate the BOD-COD and SST is

equipped with a simplified nitrification and denitrification treatment system to reduce nitrogen and a simplified dephosphatising system to reduce phosphorus. A post-disinfection treatment will be given by dosing sodium hypochlorite or peracetic acid as the effluent is going to be used for flushing toilets. The treated water quality will meet the appropriate international standards. The treated water will be disinfected to eliminate the bacterial load and will be reused for toilet flushing.

- The sludge resulting from the wastewater treatment process will be taken to Thilafushi for disposal. Sludge will be periodically analyzed according to international requirements.
- The treated effluent need to comply with the maximum allowable concentrations in domestic and industrial waste water for deep sea discharge (Ref: National Waste Water Quality Guidelines Maldives)
- Aircraft sewage, which is currently discharged raw onto the reef flat at 4°10'39.42"N and 73°31'52.89"E, to be diverted into the sewage treatment plant.

6.3 Impact on Coastal Environment

The project components which likely to have an environmental impact on coastal environment are;

- Dredging
- Reclamation
- Levelling
- Development of new sea plan runways
- Development of new jetties
- Development of the mooring area for the speed boats

The environmental impacts have been identified for the main environmental components; air, water, land, biological and human and socio economic due to the proposed project activities. The project activities and the related impact on marine components are presented in the following subsection:

6.3.1 Constructional Impacts

Dredging

The dredging operation is to obtain the required fill material for the reclamation component of the proposed project at Malé International Airport. The dredging component of the project has following environmental impacts;

Dredging locations

There are only two locations that have been designated to borrow the sand for the reclamation work.

- The Hulhule lagoon - The dredging location proposed in the project is north eastern lagoon of Hulhulé.
- The Galufalu which is located 2.8 km west of Hulhule.

However the project propose to borrow sand from Hulhle lagoon for the reclamation component of the project. This limits the impact of dredging to the Hulhule lagoon.

Method of Dredging

It is proposed that dredging component would be carried out using a cutter suction dredger and excavators. Cutter suction dredger would do the bulk of dredging work while the excavator will facilitate the dredging operation.

A cutter suction dredger is a stationary dredger that dislodges the material with a rotating cutter head mounted on a ladder (**Figure 6.2**). The cutter head is equipped with a cutting teeth. The loosened material is sucked into the suction mouth located in the cutter head by means of a centrifugal pump, which is installed on the ladder of the dredger.

Figure 6.2: Typical Cross Section Illustrating Dredging Operation using Cutter Suction Dredger

Environmental impacts associated with dredging are mostly related to the deterioration of marine water quality, loss of marine habitat and sedimentation on coral reefs, increased suspended sediments in the marine water column.

It is proposed that dredging component would be carried out using a cutter suction dredger and excavators. Therefore the negative impact of sedimentation is unavoidable even with the construction of sandy bund walls. The impacts of sedimentation are short termed since the monsoonal currents will aid in the dispersal and removal of fine suspended materials when the dredging operation is ceased.

6.3.2 Suspension of sediments

The amount of material not entering the suction mouth may be as much as 30% of the total dislodged material. Much of this material will fall immediately to the seabed and will be dredged on the next cut. Only the finer particles will stay in suspension and will be distributed throughout the water column by the local currents.

With a cutter suction dredger, the creation of turbidity is a continuous process. The proposed area for dredging would need to provide all the fill materials of reclamation, the cutter suction dredger would create basin of about 8 – 12 m deep. The majority of the suspended sediments will stay within this created basin. As the cut material will be disposed by a discharge pipeline to the land reclamation site no additional turbidity will be created at the dredging site. **Error! Reference source not found.** shows the area of possible area of impact due to the suspension sediments, if the dredging is undertaken in South East monsoon.

6.3.3 Borrow area will get shallower with time

The borrow area for the land reclamation works is located inside the shallow lagoon on eastern side of the island. The dredging of the borrow area will create a basin of a depth of 7 – 9 meters. Due to the wave activities and the local currents, it is likely that sand will be transported from the surrounding areas into the basin area. In time this may result in changes in bathymetry and morphology around the borrow area.

6.3.4 Waste handling and pollution control by the contractor

At the working sites on land, as well as on board the dredger, waste water, oily wastewater and solid waste will be produced. To prevent pollution of the marine waters the following restrictions are set:

6.3.5 Impact on Marine Life

It is expected that on the sandy shallow area in lagoon, limited benthic communities are present, due to the limited water depth and the high water temperatures. Hence from an ecological point of view regarding the benthic communities, dredging at the shallow would not have much an impact on the benthic communities.

Benthic fauna communities also have the capacity to re-colonize areas of seabed fairly quickly after a dredging activity. The dredging activities caused a disturbance in the natural system, which interns responds by fast recolonisation of the benthic fauna communities. Recovery in highly dynamic systems is quick, taking anywhere from as little as a few months up to a few years.

Turbidity

The dredging operation would increase the turbidity of the marine water. Turbidity is a measure of the concentration of suspended particles in the water column. Increased concentration of suspended fine particles in the water column – i.e. increased turbidity – degrades the water quality by decreasing the oxygen level in the water column. Fine suspended particles have a very high oxygen demand and thus depress the oxygen level in the water column with increased turbidity. The degree of oxygen depletion generally increases with depth and increasing concentration of total suspended solids and oxygen level usually increases with increasing distance from the source of suspension, due to dilution and settling of the suspended material. Increased turbidity would have the greatest impact on the reef around the island.

The geographic extend of the area which has high turbidity water would be close to the area where dredging is undertaken. The impact of high turbidity can be managed with implementation of the mitigation measures as described in the following section. Therefore, turbidity must be regularly monitored during the implementation of the dredging and reclamation component of the project.

Reclamation

The reclamation operation is going to have similar impacts as due to the dredging operation on the environment.

Shoreline of the island

The reclamation on the north end, east and western side of the northern section of runway and eastern side of the island would directly impact on the coastal shoreline of the island. Reclamation and changing the shape of the island would have impact on the littoral sediment transport regime of the system. This could have impacts on natural systems where beach is found. However, since Malé International Airport has engineering structures all around the shoreline, the impact on the island's shoreline due to the reclamation would minimal.

The impact on the shoreline of the island from the reclamation operation together with the dredging operation could be very significant. However, with the limited time available for this study it would not be possible to quantify the impact on the shoreline as a result of dredging and reclamation. The impact on the shoreline due to the dredging and reclamation could be studied through the implementation of the monitoring programme that has been outlined in the later section of this report.

Sedimentation

Figure 7.3 shows the area of direct influence by suspended sediments generated at the borrow area and from the reclamation area run off. It shows the temporary increase in suspended sediment concentrations may be measured at any time during the dredging and reclamation works, depending on weather conditions, tide and currents. The plan also shows the areas where temporary reduction in visibility may be observed during, and for a short time after, storm events.

These areas will be monitored during dredging and reclamation works as part of the water quality monitoring program as outlined in this report. When suspended sediment concentrations exceed warning levels, appropriate actions will be taken. This Figure is based on the assumption that the outflow of water from the reclamation area is directed through the channel on north western side (just northwest of the proposed borrow area), while the entrance to the borrow area is as close to the harbour entrance as possible to minimise the area in which suspended sediments are released.

Figure 6.3: Possible area of direct influence (yellow) and less direct influence (blue shades) of suspended solids released from the proposed borrow area and reclamation area under worst case conditions

6.3.6 Operational Impacts

Jetties

The jetties are proposed to be constructed on concrete columns. The columns will be precast and placed in the location where it is needed using excavators. The jetties would allowing free flow of waters and sediments. These structures will have very low impact on sand and sediment transport around the island.

Development of Mooring Area

The development of the mooring area on western side will have an operational advantage of providing safe mooring and access to the Malé International Airport throughout the year, even during rough weather. Presently, the harbour on western side of the island get very rough in south west monsoon and ferries and speed boats get difficult to alongside the jetties to allow passengers to access the airport. This will result in increased satisfaction of passengers, tourist and airport users as well as dhoni (ferry) and speedboat crew.

Table 6.2: Summary of environmental impacts on the coastal environment

Development	Impact area	Type of impact	Duration and severity	Impact Significance
Dredging	Water quality, marine fauna, Coral reefs proximal to dredging sites	Deterioration of marine water quality, loss of marine habitat and sedimentation on coral reefs, increased suspended sediments in the marine water column.	Temporary during construction work, medium to small adverse	a
Reclamation	Immediate surrounding of reclaimed area	changing the shape of the island would have impact on the littoral sediment transport regime	Permanent adverse, irreversible	A
Sedimentation	Immediate surrounding of reclaimed area	high turbidity, disruption to faunal movement	Temporary, adveres	a
Jetties	Area around the Jetties	will allow free flow of waters and sediments	Permanent beneficial	b
Mooring Areas	western side	will enhace safe access	Permanent beneficial	b

6.3.7 Mitigation of Coastal Impacts

It is evident from the impact summary for coastal environment that there will be some adverse impact on immediate vicinity. The impact can be minimised by application of mitigation measures as proposed.

Mobilisation Impacts

It has been observed that a significant damage to the natural environment happens at a project site during the mobilization phase of a development. These include storage of materials such as river sand, gravel, stones and pipes/columns on the beach. This disrupts natural sand movement patterns around the island.

To minimize the impact of mobilization to the island's environment, a detail mobilization plan shall be developed. In this plane details shall be provided on the location of the labor camps, storage of construction materials, water production and waste water disposal methods.

Dredging Impacts

Scientific literature on environmental impacts of dredging and reclamation suggests prolonged dredging operations have greater impact on the environment (Binnie Black & Veatch (SEA), 2000). The use of silt screens in dredging projects is quite commonly suggested method for mitigating environmental impacts from fine sediments. However, silt screens works effectively in very calm environments. In the proposed project, dredging also occurs within a huge lagoon at considerable distances from the reef.

Control of Sediment and Turbidity

Turbidity is an indicator to control sediment which are produced due to the dredging and reclamation process. Turbidity need to measures regularly when the dredging activity is undertaken. When turbidity levels reach 12 NTU, then dredging activities need to be managed as to reduce the turbidity level. Silt screens or Sediment curtains could be used, to expedite the dredging and reclamation component.

Reclamation Impacts

One of the biggest short-term impacts related to reclamation operation is the re-suspension of fine particles due to erosion of the edges of the reclamation. Erosion would occur at the edges due to wave and current action and as a result of runoff. This would cause re-suspension of fines in the lagoon. One of the most appropriate methods for limiting the re-suspension of fines at the reclamation site would be to enclose the reclamation site by building a peripheral bund around the edge of the site, using dredged material. In addition to this, the coastal protection structure such as sheet piling around the perimeter of the reclamation site, could be constructed prior to the reclamation works.

Management of Waste Generated from Dredging Operations

Wastewater and solid waste handling facilities, to collect and handle the wastewater and the solid waste generated by the equipments that are used for the dredging and reclamation activities. Disposal of wastewater and solid waste directly into marine environment is not allowed.

Oily wastewater and oily contaminated material generated from the construction machinery during the construction activities is also not allowed to be discharged directly into the marine environment. These wastes need to be collected and transferred for treatment/disposal, to avoid causing any adverse impact on the marine environment.

Solid construction wastes generated during dredging works are also not allowed to be discharged directly into the sea. They shall be collected and transferred for onshore disposal, to avoid causing of any adverse impact on the marine environment.

6.3.8 Impacts on Terrestrial Environment

Terrestrial Environmental impacts of the proposed project have been examined through a number of processes. These include consultations with the stakeholders, field surveys, observations and assessment, and field experience gained from similar development projects implemented throughout the country. Potential positive and negative impacts on the environment have been considered. The impacts of the proposed project on the terrestrial environment of the proposed area have been looked into and are considered to be insignificant. The assessment was based on the impact area and comparing the total size of the island to calculate the percentage of land clearing or project activities that required land clearing or affecting large and mature trees.

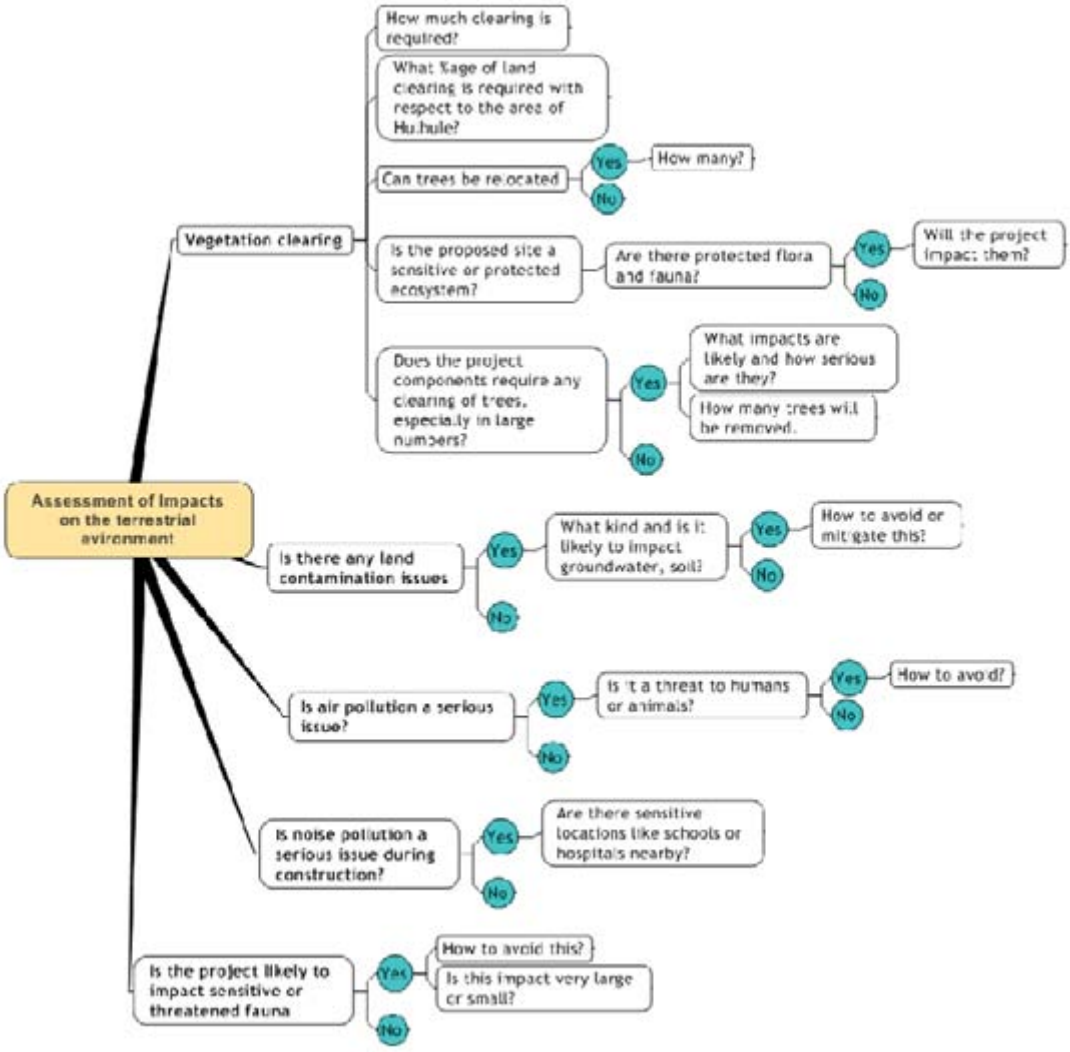


Figure 6.4:Terrestrial Environmental Impact identification methodology

6.3.9 Uncertainties in impact prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geo-morphological or social conditions in a particular place. There is also limited data and information regarding the particular site under consideration, which makes it difficult to predict impacts. However, the level of uncertainty, in the case of this project is expected to be low due to the very limited tree cover in Hulhule. With limited tree cover, the biodiversity and the life forms that depend on trees are also very limited. Hence, there is very little uncertainty in predicting terrestrial impacts as the likely impacts can be very accurately predicted.

6.4 Impacts on Terrestrial Environment

The following table outlines the impacts during construction stage for terrestrial environment as well as the cost of mitigation for each impact identified.

The project components which likely to have an environmental impact on terrestrial environment are:

- Site Clearance
- Transportation of Material
- Operation of machineries
- Disposal of waste

The environmental impacts have been identified for the main environmental components; air, water, land, biological and human and socio economic due to the proposed project activities. The project activities and the related impact on marine components are presented in the following subsection:

6.4.1 Construction Phase

Loss of vegetation and tree felling

The core new development area will be the new terminal building, which is planned to be developed on the south eastern side of Hulhule by reclamation. Hence, this component will not have any impact on vegetation. No loss of vegetation is proposed due to the expansion activities. Assuming if all the trees in the island are to be removed, it would still not have any significant impact on soil erosion and drainage patterns. Roads are paved and drainage on both sides of the runway are constructed to convey runoff water to the ground as well as avoid flooding of the island through means of discharge pipes to the sea. Removal of vegetative cover and the subsequent excavation activities required for Infrastructure construction will also have limited impact on the existing drainage patterns in the area.

Noise pollution due to use of vehicles and equipments

The noise generated from use of heavy machinery and high noise producing operation will be restricted to within the project boundary. The project site is an isolated island away from population centres.

Even in the worst case scenario of continuous operation day and night, construction noise will not be an issue as the island is completely isolated from population centres. Noise from construction activities will not be felt to Male' or Hulhumalé, assuming if work is to be undertaken 24 hours.

Transportation and Storage of Construction Materials

Transportation of machinery / vehicles and building supplies/materials implies heavy traffic temporarily for the island can lead to possible negative impacts to the surrounding area (dust, spillage, emissions and noise). Improper storage of building materials, especially gravel, sand, cement and chemicals on the construction site could lead to inadvertent dispersal of materials during heavy rains or high winds. This could have a negative impact on the island environment as well as the surface water.

Improper storage or handling of hazardous or flammable materials, including fuel, paints and solvents) could result in soil contamination during the construction period.

Ground Water

Use of machinery, equipments, storage of materials such as fuels, chemicals, their transport, storage and use all can contaminate the ground and groundwater if they are not stored or handled properly. Excavation for foundations and for the construction of deep footings will require dewatering. However, considering the worst case scenario, that the foundation of the new terminal building would need to be laid below 5 meters from the ground. Even in this scenario, the aquifer would not have any impact mainly because, the new terminal building is planned to be developed on reclaimed land. Since the time between reclamation and construction would be very short, the freshwater aquifer in this area is not expected to develop and hence, if dewatering is required, it would not affect the groundwater.

Quantifying the impact on groundwater shall be followed up through monitoring. There are a multitude of activities during the construction stage that may have a direct or indirect impact on groundwater.

Siting of Construction Camp for Construction

During the construction period, camps for workers/laborers would be set up the project area leading to need for sewerage and sewage treatment facilities, stress on the local ecological

resources like forests for firewood, disposal of solid waste, fire hazard at the camp, indoor air pollution in the camp, etc. Lack of Sewerage and Sewage Treatment Facilities could lead to water pollution.

Misuse of local ecological resources would result in destruction of vegetation in the surrounding area, improper handling of solid waste generated could lead to unhygienic conditions , improper use of fuel could lead to fire hazard at the construction camp or leakage / spillage of fuel leading to soil contamination, incomplete post-use clearance and rein-statement of base camp would lead to degradation of soil and use of biomass fuel for cooking would lead to indoor air pollution in the camp.

Safety of Workers

During the construction activities, workers are exposed to a wide level of hazards arising due to the dredging activity, reclaiming activity, construction of various components of the project. Use of heavy equipments, high levels of dust and noise aggravate the issues of health and safety of the workers.

6.4.2 Operation Phase

Impacts on groundwater

Wastewater disposal method can have a considerable impact if this is not properly addressed. The proposed method of wastewater disposal for the airport is through a treatment plant and disposing the treated effluent to the open sea.

This method will eliminate the need to dispose even the treated effluent to the ground and hence, prevent and risk of groundwater contamination.

The baseline groundwater quality results indicate very minimal bacteriological contamination and hence, with a proper treatment plant, there will be minimal or negligible bacteriological contamination.

Contamination through Stalinization is a possibility if groundwater is extracted at its present level. The baseline water quality results indicate very high salinity in some wells where water is withdrawn for various use.

Ambient Air Quality

Air Quality Impact Analysis

The Emissions and Dispersion Modeling System (EDMS) was developed in the mid-1980s as a complex source microcomputer model designed to assess the air quality impacts of proposed airport development projects. EDMS is a combined emissions and dispersion model for assessing air quality at civilian airports and military air bases.

The model was developed by the Federal Aviation Administration (FAA) in cooperation with the United States Air Force (USAF). The model is used to produce an inventory of emissions generated by sources on and around the airport or air base, and to calculate pollutant concentrations in these environments.

The Emissions and Dispersion Modeling System (EDMS) is designed to assess the air quality impacts of airport emission sources, particularly aviation sources, which consist of:

- Aircraft
- Auxiliary power units
- Ground support equipment
- Ground access vehicles
- Stationary sources

EDMS is one of the few air quality assessment tools specifically engineered for the aviation community. In 1998, FAA revised its policy on air quality modeling procedures to identify EDMS as the required model to perform air quality analyses for aviation sources instead of the preferred

model. This revised policy ensures the consistency and quality of aviation analyses performed for FAA

In addition, EDMS contains an Aircraft Performance Module and Aircraft Emissions Module that are common to components in Aviation Environmental Design Tool (AEDT).

The emissions processor uses a combination of EPA models and best available models from other sources such as Committee on Aviation Environmental Protection (CAEP), ICAO for calculating aircraft emissions, on-road and off-road vehicles emissions, and stationary source emissions. On-road vehicle emissions are calculated by the version of EPA's MOBILE model selected. The dispersion-modeling module generates input for the EPA-developed dispersion model, AERMOD. EDMS offers the flexibility of allowing the user to perform an emissions inventory only or in additional also perform dispersion modeling.

The view modules permit the user to view output, receptor concentrations and system data stored in the database. They also allow the user to view a graphical representation of the various sources in the database. EDMS contains a reporting component for generating emissions inventory results formatted for the printer. Dispersion results and reports are generated by AERMOD. In addition, the model incorporates utilities for importing and exporting some types of data, and allows the user to add customized aircraft types and ground support equipment to the system.

Dispersion Modelling

The intent of dispersion modeling is to assess the air pollutant concentrations at or near the airport or air base resulting from identified emissions sources. These pollutant concentrations are calculated to determine whether emissions from the site result in unacceptably high air pollution levels downwind by comparison with the applicable standards.

To perform dispersion modeling, EDMS requires

- the coordinates (in meters or feet relative to the user-specified origin) of each emissions source,
- the specification of an emissions rate (derived from emission factors) and its variation through time.
- (for some sources), the release height, temperature and gas velocity are also required.
- The identification of spatial points in the coordinate system for concentration estimation (receptors), and
- the availability of weather data for individual hours.

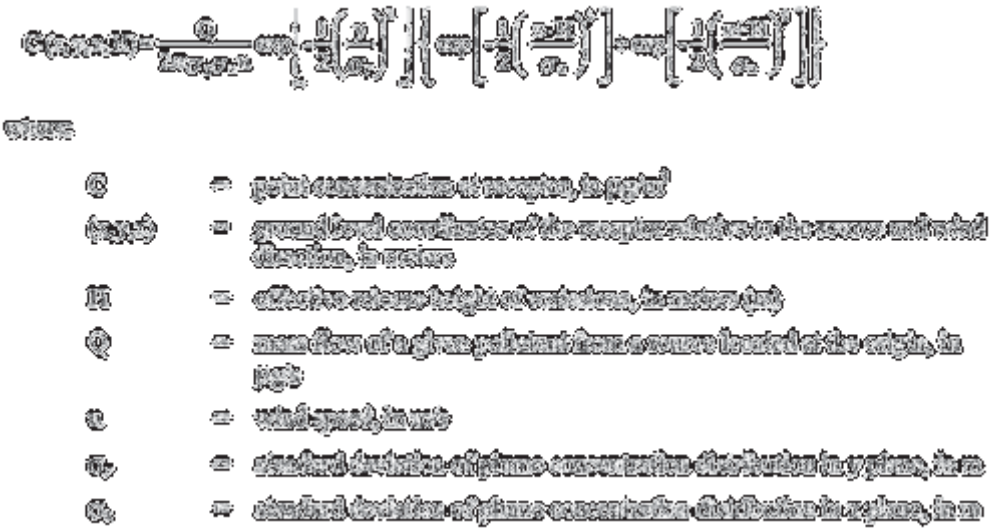
In order to perform dispersion modeling, EDMS has to know both when and where any emissions took place. This requires that performance-based aircraft modeling (for airborne movement) and sequence modeling (for taxiing) be used. Buildings are not considered to have emissions, but can affect airflow for dispersion. So the Buildings option under the Airport menu is disabled when dispersion is not enabled.

Sequence modeling is one of the Taxi Time Modeling Options and is required for dispersion, but can also be used for emissions inventories if a detailed modeling of taxi emissions is desired. To use sequence modeling, we must define the gates ,taxiways, runways, taxi paths, and runway configurations for the airport.

EDMS generates input files for use with EPA's AERMOD dispersion model, its meteorological preprocessor, AERMET, and its terrain preprocessor, AERMAP. AERMOD is a steady-state plume model that assumes a Gaussian concentration distribution in both the horizontal and vertical directions in the stable boundary layer. In the convective boundary layer, dispersion is Gaussian in the horizontal direction, with the vertical direction being modeled by a bi-Gaussian probability density function..

Equation:

The basic Gaussian equation, a mathematical approximation that simulates the steady-state dispersion of pollutants from a continuous point source is given below.



Inputs Required

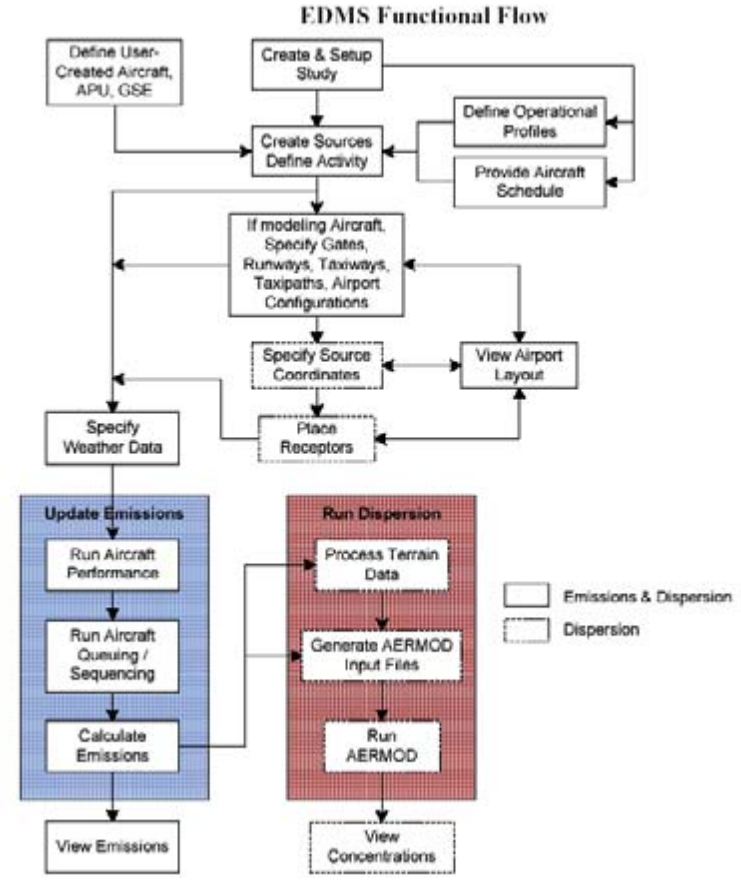


Figure 6.5: EDMS Functional Flow Chart

The amount of data required to perform a dispersion analysis is significantly greater than the data necessary for just an emissions inventory. All of the inputs necessary for the emissions inventory are also necessary for dispersion modeling. These include, accurate operational profiles or a schedule , hourly weather data and receptors.

An emissions inventory must first be generated before dispersion can be performed, since the set of emissions that are dispersed is the same as that produced from the annual inventory. The dispersion algorithms use the selected operational profiles or aircraft schedule to vary the source activity based upon time. It is important that accurate profiles be developed to represent the variation of individual source activity as this can affect the outcome of dispersion significantly. Two similar parameters found in all of the emissions source screens are the values for Yearly and Peak Quarter Hour activity. The dispersion pre-processing routines use the Peak Quarter Hour value in the computation of an emission rate. Site specific operational profiles were arrived based on winter schedule. The details of input parameters are provided as **Appendix**

	Air Craft Type	Day-1	Day-2	Day-3	Day-4	Day-5	Day-6	Day-7	Type Total	Annual
1	A319	3	2	2	3	2	2	1	15	780
2	A320	7	10	9	8	7	11	9	61	3172
3	A321	2	3	2	3	2	3	3	18	936
4	A330	7	8	6	6	7	6	5	45	2340
5	A340	9	7	6	8	7	5	8	50	2600
6	A330-300		2		4			3	9	468
7	A333-300	1		1	1	1	1	1	6	312
8	A330-200	3	3	2	1		2	5	16	832
9	B737-800	1	1	1	1	1	1	1	7	364
10	B747-400	1		1		1	1	1	5	260
11	B767	2		1		1			4	208
12	B-767-200					2	1		3	156
13	B777	10	5	6	5	5	6	5	42	2184
14	B767-300	2	5		2			7	16	832
15	B767-300ER		1	1			1		3	156
16	B777-200				1		1		2	104
17	DH8C	2	2	2	2	2	1	2	13	676
	Day Total	50	49	40	45	38	42	51		16380

Emissions

An emissions inventory is a summary of the total annual emissions of the modelled pollutants for the sources defined in a study. Depending on the purpose of the study, the emissions inventory may be an end in itself or an intermediate step towards performing a dispersion analysis.

The EDMS calculates emissions for various pollutants which include CO2 (carbon dioxide), CO (carbon monoxide), THC (total hydrocarbons), NMHC (non-methane hydrocarbons), VOC (volatile organic compounds), TOG (total organic compounds), NOx (nitrogen oxides) SOx (sulfur oxides), PM-10 (particulate matter, 10 microns) PM-2.5 (particulate matter, 2.5 microns), and others. In the present case only, for SO_2,NO_X and PM10 were calculated.

Aircraft emissions: Aircraft activity is specified by adding records in the Aircraft Operations and Assignments window found under the Emissions menu heading. EDMS models aircraft activity with 6 modes of operation corresponding to the following portions of a Landing-Takeoff (LTO) cycle. These modes of operation only apply to the aircraft main engines; APU emissions are calculated and presented separately.

Each aircraft activity is expressed as either an Arrival, a Departure, an LTO cycle, or a Touch and Go (TGO), and each type consists of different modes of operation. An Arrival consists of the Approach and Taxi In modes. A departure consists of the Startup, Taxi Out, Takeoff, and Climb out modes. An LTO cycle consists of an Arrival and a Departure, and therefore consists of one of each of the six modes of operation. A TGO consists of the Approach mode, followed immediately by the Takeoff and Climb out modes. TGO operations are generally performed for training purposes, usually occur at military bases or smaller civilian airports, and generally have a flight profile that starts and ends at a much lower altitude than a regular LTO cycle

Aircraft engines are the actual source of emissions for aircraft. EDMS treats each aircraft as a combination of a specific aircraft type and engine type. For each aircraft type there may be several different engine types available for use and emission factors may vary from engine to engine. In the absence of availability of respective engine details of all aircrafts standard assumptions have been assumed. Consequently, different aircraft may generate identical emissions because they are equipped with identical engines, or older aircraft may be outfitted with technologically newer engines and generate fewer emissions.

Auxiliary Power Units (APU): Auxiliary power units (APUs) are most often on-board generators that provide electrical power are shut down. Some pilots start the on-board APU while taxiing to the gate but, for the most part, it is started when the aircraft reaches the gate. The on-board APU is, in effect, a small jet engine and the calculations for the emissions generated by it are similar to that of an aircraft engine operating in one power setting only.

On-Road Vehicles The Roadway Length field is used exclusively for emissions inventory purposes to determine the total amounts of pollutants generated by vehicles traveling the length of the roadway on their way to and from the airport. On-Road Vehicles in Parking Facilities Motor vehicle activity in parking facilities is specified in the Parking Facilities window (under the Emissions menu heading). The Number of Vehicles (Yearly or Per Peak Quarter Hour) refers to the distinct number of individual vehicles using the parking facility.

Ground Support Equipment (GSE): Emissions are generated by ground support vehicles while the aircraft is parked at the gate. The following sections cover Ground Support Equipment (GSE). GSE can be modeled both by assignment to an aircraft and by population. GSE that are assigned to an aircraft will have their operations depend on the activity of that aircraft. GSE that are modeled as a population operate independently from aircraft activity.

Upon arrival at a gate, aircraft are met by GSE to unload baggage and service the lavatory and cabin. While an aircraft is parked at a gate, mobile generators and air conditioning units may be in operation to provide electricity and conditioned air. Prior to aircraft departure, GSE are present to load baggage, food and fuel. When an aircraft departs from a gate, a tug may be used to push or tow the aircraft away from the gate and to the taxiway.

S.No	Ground Support Equipment TYPE	Fuel	Population	Yearly Operation Time
1	Air conditioner-(Diesel-1)	Diesel	2	8760
2	Air conditioner- (Diesel -2)	Diesel	5	8760
3	Aircraft tractor	Diesel	3	1520
4	Baggage tractor	Diesel	3	1500
5	Cabin service truck(pick-up)	Diesel	19	1600
6	Cabin service truck (Bus)	Diesel	7	1600
7	Cargo tractor	Diesel	2	1349
8	Catering truck	Diesel	1	1600
9	Fork lift	Diesel	3	976

10	Generator (DG-set)	Diesel	15	7500
11	Lavetory Truck	Diesel	2	4000
12	Others(Jeep)	Diesel	21	365
13	Sweeper	Diesel	2	2000

Ground access vehicles: Ground access vehicles (GAVs) produce exhaust, evaporative and idling emissions. The activity of GAVs is separated into two categories: roadway and parking lot. In general, roadway activity consists of the segment of GAV operations that occur on roadways (both on- and off-airport). Parking lot activity refers to the segment of GAV operations that occur in airport and air base parking lots. Parking lot activity does not include vehicles that enter parking lots but are not customers and do not stop (e.g., parking lot and rental car shuttle buses).

Parameter	Parking Area	Road way1	Road way2
Vehicle Type	Default Fleet Mix (all types, fuels & ages)		
Fuel	Gasoline		
Average Speed	10 mph	20 mph	25 mph
Average Distance Traveled	250.00 meters		
Average Idle Time	1.50 mins		
Number of Levels	1		
Release Height	1.50 meters		
Level Spacing	1.83 meters		
Road way length		1.82 miles	1.81
Roadway width		20.00 meters	20
Number of Vehicles per year	120000	17520006	209500

Stationary sources: An entry and an exit of the parking facility with any idling and vehicle movement together, count as one operation. The average speed of vehicles traveling in the parking facility (Speed) is one of the parameters necessary to determine the emission factors Emissions Inventory Output The following sections describe the components of the emissions inventory, and the outputs available to the user. EDMS allows the analyst to view the emissions inventory on the window in an interactive manner, to print a formal emissions inventory report, or export the emissions inventory to a semicolon delimited text file.

Meteorological Data

The following weather parameters are used by EDMS Mixing Height, Temperature (ambient, daily high, daily low) , Relative humidity, Wind direction, Wind speed, Sea level pressure, Cloud ceiling height , Horizontal visibility. Surface Data: Surface data for the year 2009 for parameters – wind speed, Wind direction, temperature , Cloud Height were used as input. Upper Air Data: In the absence of site specific upper air data, Radio Sonde data which was carried aloft by a weather balloon. This data was collected as part of data required for AERMOD. This has been obtained from NOAA for the nearest station and were used. The station has been selected based on lat /long co-ordinates. In Radiosonde temperature, pressure, and humidity sensors are bundled with a radio transmitter and are either sent aloft on a balloon (rewind sonde) or tied to a small parachute and dropped from a plane (drop sonde). Either way, the location of the sonde is observed (either visually or with GPS), the data from the radio transmitter recorded, and the result is an ascii file that contains a header (of varying length) with descriptive information followed by a table of information. For rawindsondes, the first entry for the table is actually the surface data from the weather station, but the remaining entries are from the sonde. Also, the wind is inferred from the position of the balloon. Since this is real data, there are missing values – which arise all the time.The data so collected for the period 2009 was analysed and put to the required format for AERMOD.

Receptor Locations

The receptor locations were chosen, based on the following criteria:

- Places of expected maximum concentrations;
- Places where the general public has access over the time periods
- Reasonableness.

The receptor locations are as under:

S. No.	Location	Latitude (°N)	Longitude (°E)
1	Hulhumale	4.207599°	73.536373°
2	Kurumba	4.226424°	73.520157°
3	Male	4.176836°	73.517121°
4	Male Airport	4.188706°	73.534408°

Further, cartesian coordinates from either side of runway upto a distance of 10,000 at every 500 m were also identified.

Air Modelling Output

Emission calculations were carried for the year 2009 based on the Winter Schedule and proposed new layout. The emissions by pollutant and source are given in the Annexure. The incremental concentrations were estimated for the study period. The incremental concentrations distribution of pollutants NO_x, SO_2 and PM_{10} on hourly basis were drawn and presented in isopleths. These are given in **Figures-6.6, 6.7 and 6.8** respectively. The maximum incremental GLCs for NO_x, SO_2 and PM_{10} due to the proposed airport are superimposed on the maximum baseline concentrations of the respective pollutants monitored during the study period to arrive at the likely resultant concentrations after implementation of the proposed expansion of the airport. The cumulative concentrations (baseline + incremental) after implementation of the project are given below in Table-6.7. Based on the predicted concentrations and the post project concentrations of concerned pollutants, it can be inferred that the ambient air quality of the area is unlikely to be affected significantly due to up-gradation of the airport.

Table 6.3:Incremental Pollutant concentrations

			Monitored concentrations			**Incremental concentrations**			**Resultant Concentrations**		
	X	Y	NOX	SOx	PM10	NOX	SOx	PM10	NOX	SOx	PM10
Hulhumale	120	4600	6.0	4.9	19	0.03874	0.00202	0.00216	6.038	4.9002	19.002
Kurumba	-590	5750	6.3	4.3	23	0.01672	0.000070	0.00050	6.017	4.300	23.0005
Male	-700	2800	9.2	7.7	32	0.01921	0.00130	0.00135	9.209	7.7001	32.0014
Male Air port	260	3500	6.0	4.9	19	0.03954	0.00163	0.00148	6.039	4.9002	19.0015
Recptor 1	3200	1600	6.3	4.3	23	0.12650	0.00823	0.00890	6.313	4.3008	23.0009
Receptor 2	1900	1100	6.3	4.3	23	0.04808	0.00198	0.00038	6.348	4.3002	23.000

 # Average values used where monitoring was not undertaken
All values are in µg/m^3 on 24 hourly basis

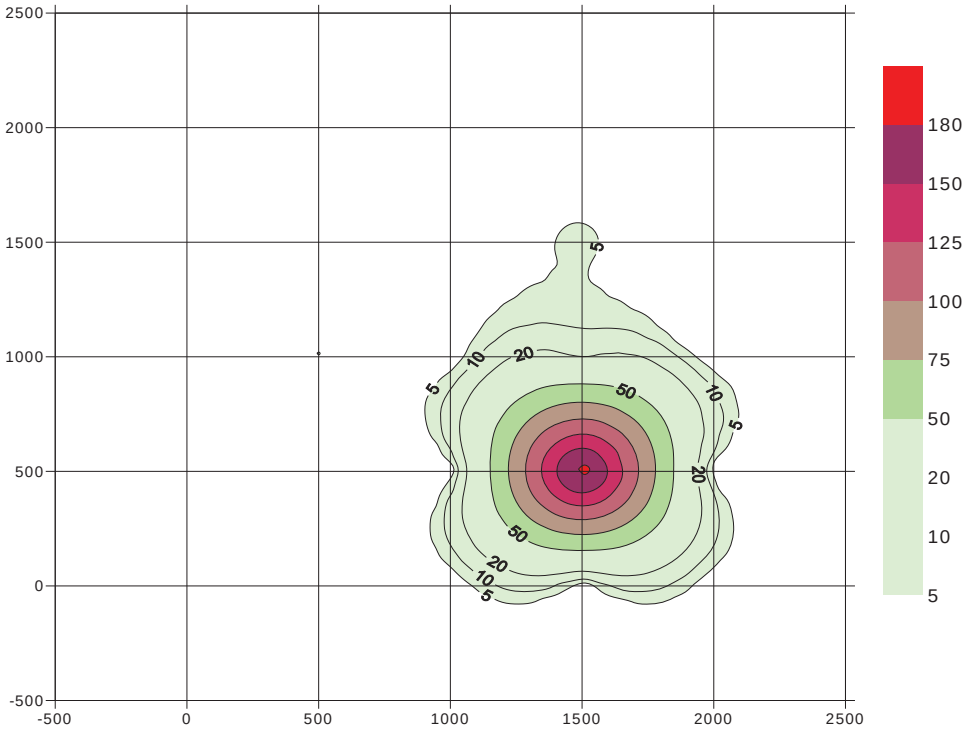


Figure 6.6: NOx- Isopleths

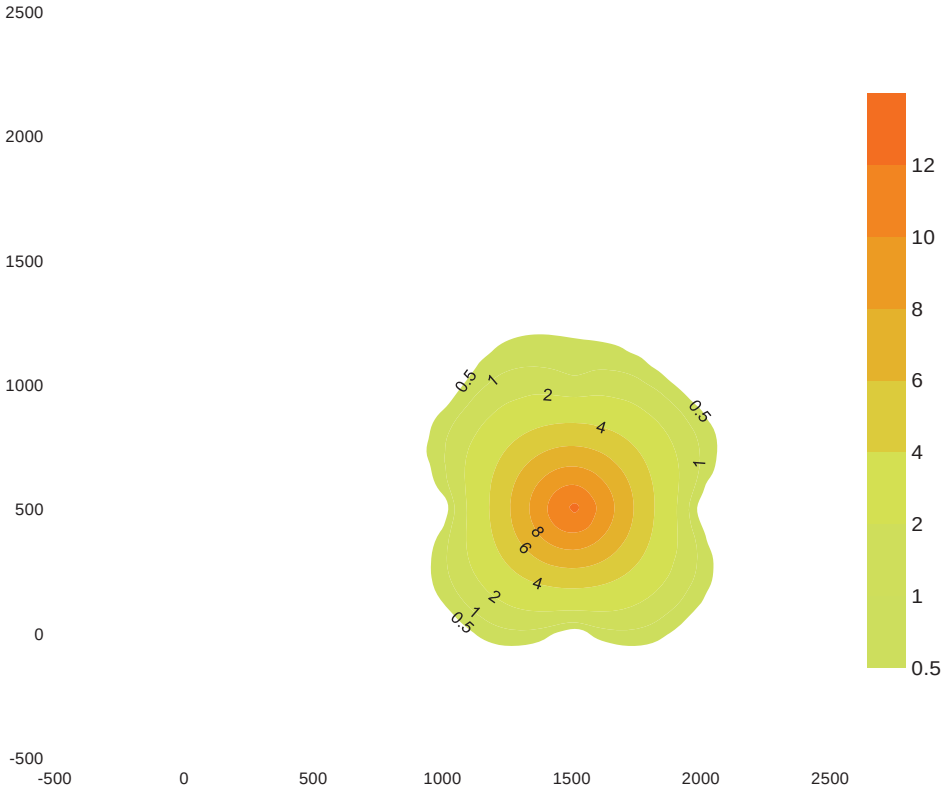


Figure 6.7: SO_2 Isopleths

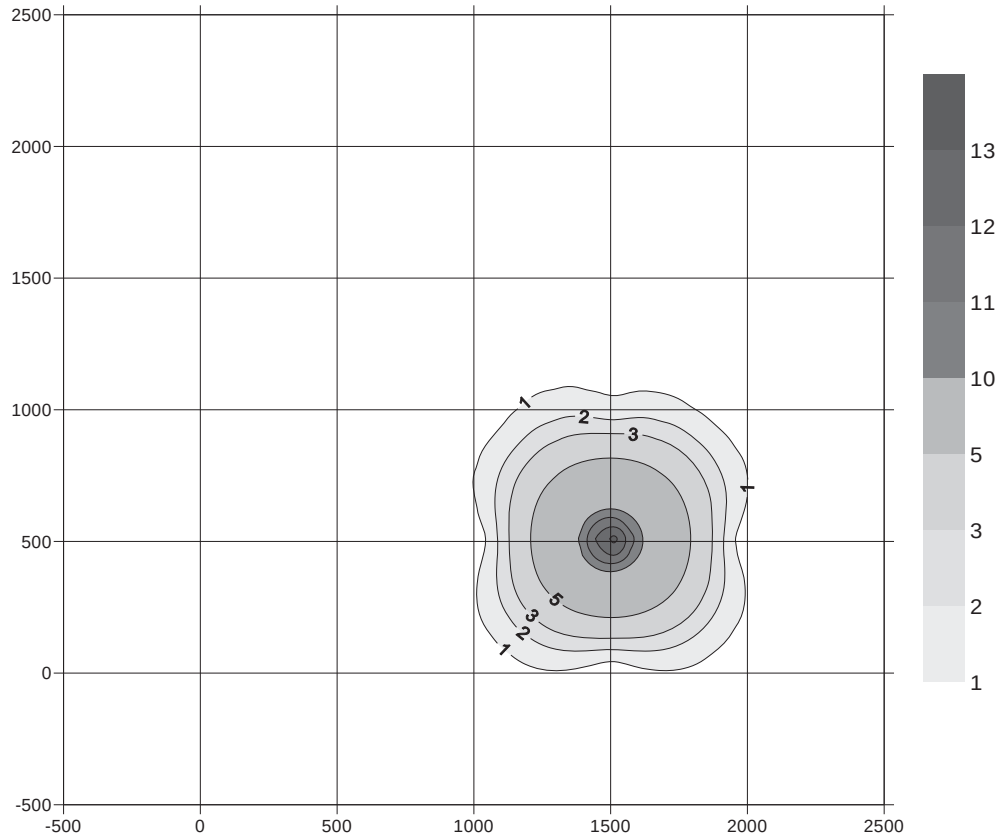


Figure 6.8: PM_{10} Isopleths

Conclusion

There will be an increase in air traffic volume at MIA after the expansion however the observations at the designated receptors indicate that it will have a very small increment in concentration to the baseline air quality and that ambient air quality shall remain within the prescribed WHO guideline.

Based on the predicted concentrations and the post project concentrations of concerned pollutants, it can be inferred that the ambient air quality of the area is unlikely to be affected significantly due to up-gradation of the airport.

Impact on Ambient Noise Levels

Unwanted noise and unpleasant sounds are generally classified as noise pollution. Normally a person begins to identify sounds when a level of 10 to 15 dB is reached. The other end of the scale is known as the threshold of pain (140 dB), or the point at which the average person experiences pain. Noise is generally measured in frequency-weighted scales and noise quality measurements are generally represent in the 'A' level and reported as dB (A).

1. **Sources of Noise Emissions Surrounding the Site**

   The major source of noise will be due to the take off and landing of flights. Noise will also be generated due to the ground support equipment , Auxillary power units. The impacts from these sources are expected to be captured in the levels of noise measured in the site-specific background noise monitoring study.

2. **Methodology of Background Noise Quality Monitoring**

A site–specific background noise quality monitoring program was conducted for the existing project site. The basic considerations for designing noise quality surveillance programme include:

EIA Study - International Airport at Male , Maldives'

- Vehicle Movement Within the Impact Zone
- Activities in Surrounding areas
- Ecologically Sensitive Locations

Noise monitoring was conducted at different locations within the impact zone. Sound Pressure Level (SPL) measurements were automatically recorded to give the noise level for every hour, continuously for 24 hours in a day. Accordingly one full day (i.e. 24 hourly values) of data was collected at each of the locations.

3. Baseline Background Noise Quality Monitoring in the Study Area:

For Noise Monitoring 11 Locations were selected from Male Island, 4 Locations from Hulhumale Island & 10 Locations from Hulhule (Airport) Island.

Monitoring of Noise Level at Male City

Results of baseline background noise quality monitoring results are presented in the following table ,

Table 6.4: Monitoring of Noise Level at Male City

S. N	Location	Date of sampling	Leq(Day)	Leq(Night)	Ldn
1	SKAI Lodge	20/10/2010	57.2	55.7	62.4
2	Wataniya Gallery	21/10/2010	71.1	64.0	72.4
3	City Bakery	21/10/2010	67.3	65.3	72.1
4	Sultan Park	22/10/2010	54.6	51.0	58.1
5	Maldives' Port Authority	23/10/2010	66.7	65.2	71.9
6	Republic Square	23/10/2010	61.6	55.6	63.5
7	Water & Sewerage Company	24/10/2010	67.3	55.5	66.7
8	Bank of Maldives	22/10/2010	66.4	65.7	72.2
9	STELCO Power House	25/10/2010	68.4	68.9	75.2
10	Indira Gandhi Hospital	24/10/2010	60.9	56.8	64.1
11	Male Sport Complex	25/10/2010	57.3	55.1	61.9

Interpretation of Background Noise Quality Monitoring Results

The daytime noise level exceeded marginally the permissible standards at all the monitoring locations except at one location while the night time noise level marginally exceeded the permissible standards at three locations. The major reasons for exceedances of noise level maybe due to occasional windy condition during the monitoring period, movement of tractors, and use of DG sets by the road.

Noise Impact during Operation

During the operational phase, aircrafts movement will be the major source of noise pollution from the airport. Noise will also be generated from the traffic and DG sets but will be localized in comparison to the noise levels from the aircraft, which can be felt at longer distance also. Hence, noise from the aircraft movement at the airport has been considered for the noise modeling. Airport operation will cause noise pollution due to aircraft or its components, during various phases of a flight: on the ground while parked such as auxiliary power units; while taxiing; on run-up from propeller and jet exhaust during take off; underneath and lateral to departure and arrival paths; over-flying while en route or during landing time. The noise level of the proposed site and its surrounding area will get adversely affected due to the aircraft operation. Further, noise from sea planes will also contribute to the noise and are considered in the exercise.

Integrated Noise Model (INM)

To predict the impact on the existing noise levels in the study area due to the proposed up-gradation of the airport, the model Integrated Noise Model (INM), Version 7.0 developed by Federal Aviation Administration (FAA), Office of Environment and Energy, USA was used.

This model has inbuilt information on the various latest new generation aircraft and has capability of assessing changes in noise levels resulting from runways or runway configurations, new traffic demand and fleet mix, revised routings and airspace structures, alternative flight profiles and modifications to other operational procedures like reverse thrust. The Integrated Noise Model (INM) is a computer program developed by Federal Aviation Administration's (FAA) Office of Environment and Energy (AEE), United States. INM evaluates aircraft noise in the vicinity of airport using flight track information, aircraft fleet mix, standards defined aircraft profiles, user-defined aircraft profiles and terrain. INM supports three different types of aircraft: civil airplanes, military airplanes and helicopters. The INM program requires the input of the physical and operational characteristics of the airport. Physical characteristics include runway coordinates, airport altitude, temperature and optional topographical data. Operational characteristics refer to various types of aircraft data, which includes not only the aircraft types and flight tracks, but also departure and arrival procedures that are specific to the operations at the airport. The model produces noise exposure contours that are used to create land use compatibility maps.

The INM has been used to analyze the following:

- Assessing change in noise impact resulting from new or extended runways or a new runway configuration;
- Assessing change in noise levels due to new traffic demand and fleet mix;
- Assessing the area of influence of aircraft noise;
- Assessing the tentative population to be affected by the up-gradation;
- Assessing the affected sensitive locations around the airport within the noise affected areas.

The model also calculates predicted noise at specific sites. Sixteen predefined noise metrics are supported that include cumulative sound exposure, maximum sound level and time above metrics from both the A-Weighted, C-Weighted and the Effective Perceived noise level.

Aircraft Flight Tracks:A flight track represents the plan view where an aircraft flies. These are defined within as either a series of connected points (X-Y coordinates) or as vectors (straight line segments and arcs). In this impact assessment study, flight tracks were entered as vectors. The standard approach and departure tracks at Male Airport have been used.

Traffic Distribution by Route: The proposed airport has only one track. In order to conduct this modelling, it is assumed that aircraft may approach/departure from either direction, which represents the 100% usage of runway in both approach and departure operation mode. The INM has been used to analyze Assessing noise impact and Assessing the area of influence of aircraft noise.The parameters included for the exercise to generate the noise contours are : Average daily Air Traffic Movements; Runway orientation; Flight track information; Aircraft fleet mix; Standard defined aircraft profiles; Information on location points. Exposure based, A-weighted Noise Metrics (LAEQ - LAeqT) have been produced and analyzed. Further, the model was used to create noise contours.

Results & Discussion

Noise contours have been predicted for one day-night aircraft movements using the FAA prediction methodology, the Integrated Noise Model (INM) version 7.0a**.** A 3 degree approach angle is used for the modeled aircraft and the ground topography is assumed to be flat. The model default headwind of 8 knots and soft ground lateral attenuation is assumed for noise impact evaluation. Noise exposure contours have been calculated for single noise metric DNL (Day Night Average Sound Level) at an interval of 5 dB (A) in the noise contour level range of 55-85 dB (A). and The actual pattern of departing aircraft is dispersed about the route's main track. The Noise contours are given in **Figure 6.14**. The degree of dispersion is normally a function of distance traveled by an aircraft along the route after take-off and on the form of route. The INM allows this dispersion about the departure tracks to be taken into account. The effect on the contours is to slightly widen the contours where departure noise dominates.

The results of the study indicate that the bulk of noise impact remain located close to the runway.

The average maximum exposure level to noise on the population outside the airport is 65 dB(A). However, it is anticipated that the development of new technologies for building aircraft and strict environmental policies will result in decline in average noise levels in future years.

The model was run to estimate noise levels and the area of influence. The noise levels at identified locations and the influenced area are given below:

Table 6.5: Noise Levels at identified Location

S.No	Location	Prediction of Noise in dB(A)
1	Hulhumale	61.9
2	Kurumba	48.0
3	Male	75.5
4	Male Air port	75.2

The result of the noise modelling of the operational activities is provided in the table below.

Table 6.6: Noise Levels And Area of Influence

S. No	Noise Levels	Area of Influence (km^2)	Maximum Distance
1	85.0	-	The predicted noise levels fall within the airport boundary
2	80.0		-do-
3	75.0	4.13 Km^2 of area from centre of runway of the airport	Within 3km from the centre of the airport
4	70.0	9.9 Km^2 of area from centre of runway of the airport	Within 5km from the centre of the airport
5	65.0	About 22.97 Km^2 of area from centre of runway of the airport	Within 7.5km from the centre of the airport

The noise levels within the airport will range from 65-85 dB(A). The background noise levels beyond airport in the residential areas are in the range of 51-57 dB(A). There will not be minor incremental change in the noise levels due to the proposed up-gradation of the airport, as the proposed project envisages expansion of an already operation airport.

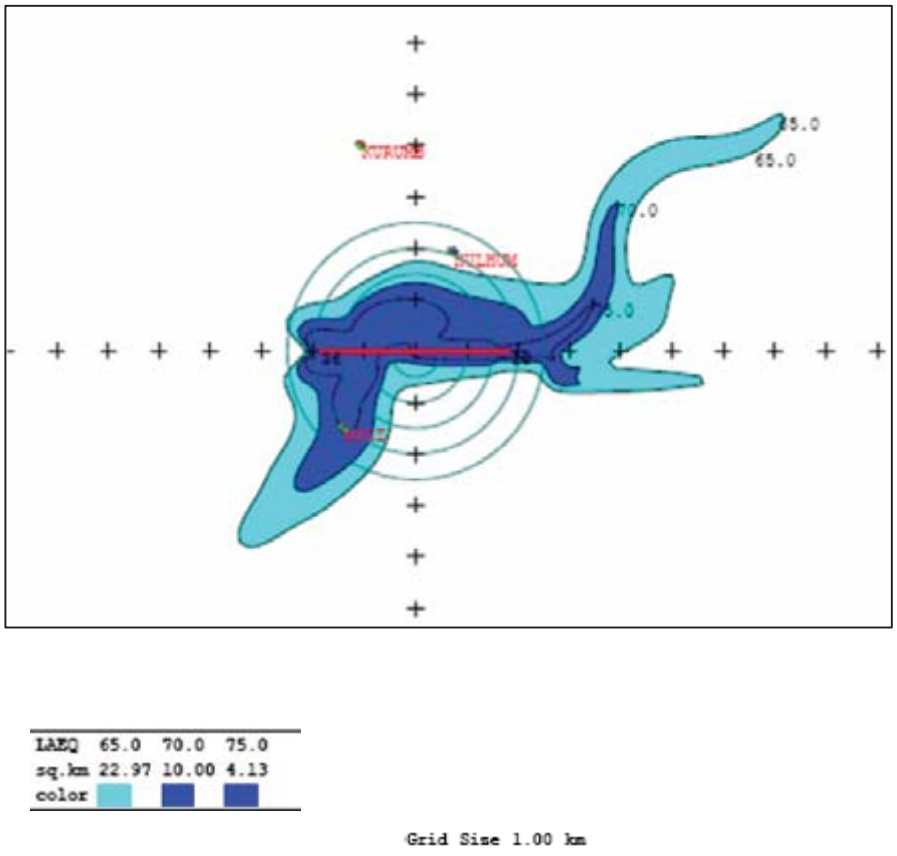


Figure 6.9: Noise Contour

The spread of noise is observed to be high in the Northwest and Southeast direction, while some extent of spread is towards the South. It is suggested to provide noise barriers in the three directions to avoid disturbances due to airport operations.

Table 6.7: Summary of environmental impacts on the terrestrial environment

Development	Impact area	Type of impact	Duration and severity	Impact Significance
Site Clearance				
Loss of Vegetation	Immediate surroundings of reclaimed area	loss of green cover	Temporary and insignificant	O
Construction works				
Noise pollution due to use of vehicles and equipments during construction stage.	Immediate surroundings of airport area	disruption due to noise	Temporary and insignificant	O
Soil erosion and change in drainage patterns	Immediate surroundings of construction area	loss of soil	Temporary and insignificant	O
Health and Safety	Workers at construction site	Injury to workers	Temporary and adverse	A
Transportation and Storage of Construction Materials	Borrow area and approach road	Dust generation, runoof into water.	Temporary, small and adverse	A

Development	Impact area	Type of impact	Duration and severity	Impact Significance
Ground Water pollution	reclamation area	contamination of aquifers	Temporary and insignificant	O
Operation				
Air Pollution	within airport area	contamination of air	Temporary and insignificant	O
Noise Levels	Upto 7.5km around the airport area	disturbance to surrounding	Temporary, moderate and adverse	A

6.4.3 Mitigation

The mitigation measures to be employed for Terrestrial environment shall include:

The proposed new master plan has landscaping components that are incorporated in to the new terminal building area. Hence, with the introduction of trees for landscaping, the overall environment will have a positive impact. Increased plantation along the fence line shall also act as noise barrier and reduce the propagation of noise from the airport. Plantation to be undertaken subject to birds and fruit bat study in order to avoid accumulation of birds and bats around the airport area.

Arrangements will be made with contractors and subcontractors to ensure that the vehicles used for transporting building materials to the site are appropriately sealed and covered to minimize dust while transporting debris and materials. Dust producing building materials such as sand or cement will be stored away from drainage areas where they could easily be washed away during rainfall.

Hulhule island presently has ample open spaces, especially on the eastern part where the majority of the new development will take place. Material storage shall therefore be confined to these areas to avoid any negative impacts on the environment as a result of their handling and use

The machineries and equipments will be maintained properly to avoid any spillage or pollution. The site supervisors will be required to check the matter on regular basis. All fuels and other hazardous materials stored will be on hard floor and protected from rain and wind.

- All temporary fuel, oil and chemical storage must be sited on an impervious base within a bund and secured. The base and bund walls must be impermeable to the material stored and of an adequate capacity. Storage at or above roof level should be avoided.

- Leaking or empty oil drums must be removed from the site immediately and disposed.

- Washings from concrete mixers, paint or paint utensils should not be allowed to flow into the ground.

- Excavation for foundations will only be to the minimum and if de-watering is required, then it will be done according to the guideline set by MWSA.

Temporary noise barriers may be provided to prevent noise during construction subject to site constraints..

Although bacteriological contamination of the groundwater can be reduced totally with the installation of a treatment plant, this ultimate result would not be achieved if the system of pipes and wastewater conveyance methods are not up to the standard or maintained properly. Therefore, all underground wastewater conveyance pipes, storage tanks, sump wells etc, should be constructed with impermeable material, preferably concrete lined with sulphur resistant paint or any other material that do not deteriorate when exposed to toxic gases in the sewer.

The construction site will be provided with sufficient and suitable toilet facilities for workers to allow proper standards of hygiene. At the construction site, the contractor will be asked to provide first aid facilities, Personal Protection Gears, adequate training for operation of machinery and related health and safety issue to construction workforce.

Noise propagation from operation of flights and related activities to be minimised by installing appropriate noise reduction measures and barriers at locations identified through modelling activities.

6.4.4 Social Impacts

In accordance with the EPPA (Law 4/93), NEAP (2009-2013), and the Maldives NSDS the key policies that guides the development of GMIAL aims at environmental protection, controlling negative social impacts and attaining equity and distributional objectives. This necessitates as part of the EIA a Social Impact Assessment (SIA) prior to the implementation of the project. SIA is defined as the process of identifying, assessing and mitigating the social and economic effects that are likely to follow from specific policy actions or project developments, particularly in the context of appropriate environmental policies. SIA provides a useful up-to date representative picture of the socio-economic situation and the community values of the region that is on the brink of this significant change.

The purpose of social assessment is to investigate the potential impacts that the expansion and modernization of the MIA might have on the affected communities. In particular, the assessment considered:

- existing socio-economic conditions in Male' and Hulhumalé'
- Potential positive and negative impacts with regard to the expansion and modernization of MIA according the views of the respondents
- perceptions about the proposed expansion and modernization of the MIA

For the field work the target respondents are the general population categories and include;

- People working in the MIA
- Businesses/services inside the MIA and in the neighboring areas
- Residents of the areas surrounding the MIA – Hulhumalé' community and to some extent residents of Male' and Vilingili
- Users of the MIA including tourist resort representative, businessmen, students, patients going abroad for medical purposes, holidays makers, government officials, cargo handlers
- Relevant government organizations

METHODOLOGY

The MIA is located in Hulhule, a separate island now connected by 1.8 km link road to Hulhumalé. Male' the capital is located within a distance of 10 minutes travel time by ferry from the MIA. Male' Hulhumalé and Vilingili depict a cross section of Maldives with people of all islands living in Male'. Male', is the commercial centre and where all government offices are located therefore people from all over Maldives travel to and from Male'. The selection of the study areas Male', Hulhumalé' and Vilingili is determined based on the geographic proximity to the MIA. For the purpose of the socio-economic assessment, and to capture the possible indirect effects, particularly the effects of induced development caused by expansion and modernization of the MIA it is felt that Male', Hulhumalé' and Vilingili will be the ideal geographic scope.

The SIA primarily relied on the on the views, needs and perceptions of the people of Male' Hulhumalé and Vilingili. The findings are based mainly on the participatory methods of focus group discussions, key informant interviews, natural interviews. These methods are well established and have been widely used in environmental and sustainability research. The method goes beyond the superficial and gives depth and intensity to the discussion and incorporates the local point of view within a short period.

In the primary research a list of open-ended questions are used in both the focus group discussions and the individual interviews. A two-person research team carried out the discussions and the interviews.

Focus Group Discussions

Focus group discussions were held with the randomly selected MIA staff and the Hulhumalé NGO representatives. These groups encompass a wide age range, as well as both genders, and people from the entire communal spectrum. Their views would represent a substantial and sizeable cross-section of the MIA staff and the Hulhumalé community.

Figure 6.10: Focus Group Discussion held with MIA staff

Natural Interviews

Where ever possible natural group discussions are also conducted. Natural group discussions are interviews conducted with 'naturally' occurring groups. The method has the advantage of being interviewed at a time and place of their convenience, and is suitable from the point of view of the interviewee. The result is frank and open discussion in a more relaxed and informal manner.

Key informant interviews

To verify and cross check the information collected from the focus group discussions interviews were also held with key informants such as concerned government authorities including the MHE and MTAC. Members of the community who are interested in providing information are always welcomed and their concerns were listened and noted.

Secondary source Members of the Hulhumalé' Crime Prevention Committee explaining locations of Hulhumalé'

Secondary data is used where ever possible and is an integral part of the assessment. Secondary data includes socio-economic data pertaining to the population, social and housing infrastructure. The Statistical Yearbook 2010, the SAP 2009-2013, Census 2006 and, reports produced on the issue covering both qualitative and quantitative information are used.

Stakeholders consulted

During the information gathering phase following stakeholders were consulted

1. MIA staff
2. Shop keepers within the MIA premises
3. Ferry service operator at the MIA
4. Hulhumalé residents with different occupations
5. Hulhumalé guest house owners
6. Visitors to Hulhumalé
7. Police services within Hulhumalé
8. Non Governmental Organization within Hulhumalé
9. Randomly selected Male' residents
10. Randomly selected Vilingili residents
11. Tour operators and travel agents
12. TMA
13. MTAC
14. MHE
15. EPA
16. MATI
17. MATATO
18. Island Aviation Company
19. Tourist Resort Owner
20. Privatization Committee

. Fauzee who is originally from one of the southern island of Maldives, has been working as a manager of souvenir shop at the MIA for 4 years. He is very optimistic about the change he is going to witness with the expansion and modernization of the MIA. He emphasizes at present the infrastructure of the MIA needs an overhaul and pointed out to the leakages in the roof of his shop during the rainy season. He reiterated that tourism being the backbone of the nation necessitates a state of the art airport and he says it should have been done long before. He is confident of the future with increase in the tourist arrivals resulting increase in the sales of soveniour items from his shop. Fauzee said that Maldives is country that has promoted its tourism well. The country has resorts of international standard. Today, he says. we are one of the premier destinations of the world for holidaying Europeans with year-round sunshine, excellent hotels and beaches, with first-class service. The country is reached by air but until now the MIA is small with limited facilities for the sophisticated traveller. Fauzee says, an international MIA complex with first-class shopping, restaurants, entertainment facilities and service for the airlines and passengers is must for the Maldives.

Positive Impacts

Generally the respondents perceive that proposed project has the potential for the Hulhumale' region to undergo immense socio-economic development. Expansion and modernisation of the MIA is believed to be a very important avenue for direct and indirect employment opportunities and wider economic growth to the MIA region. The positive effects associated with increase in employment and economic growth is perceived to spread to Hulhumale' providing ease to the congestion within Male.' The positive impacts associated with the expansion and modernisation of the MIA includes;

1. Increase in direct employment opportunities
2. Increase in indirect employment opportunities
3. Increasing the share of locals and youth in the economic sector
4. Benefits associated through strengthening cargo infrastructure within MIA
5. Socio-economic development to Hulhumale'
6. Contributing in facilitating a conducive environment for the foreign investor

7. Promoting the image of the Maldives
8. Contribute in alleviating the pressure on the carrying capacity of Male'
9. Contribute in developing the tourism sector
   i) Contribute in increasing the employment opportunities and income of the air transfer sector
   ii) Contribute in increase guest houses and city hotel within Hulhumale'
   - Increasing employment opportunities for women
   - Increasing the share of locals within the tourism sector
   - Increase in income earning opportunities of the soveniour shop owners and tour guides through visiting tourists to Male' and Hulhumale''

Potential increase in direct employment opportunities in the operation of the MIA

As highlighted in section 5.1.6 unemployment is a major challenge confronting the country. Expansion and modernisation of the MIA to cater for five million passengers will create demand for a corresponding increase in new jobs. Taking into account, that aviation industry involving activities that are directly dependent upon transporting people and goods by air, increase in employment opportunities is foreseen in a number of areas. An increase in job opportunities is stated as possible in airline and MIA operations including schedule and charter flights for passengers and freight, MIA maintenance, air traffic control and regulation and activities directly serving air passengers such as check –in, baggage-handling, and on-site retailing and catering facilities. An increase in employment opportunities could also be associated with increase in ticketing centres and so on outside MIA at other locations.

Potential increase in the indirect and induced employment opportunities.

The expansion and the modernisation of the MIA is believed to have positive impact on all the sectors that are linked to the MIA. Indirect employment involves jobs created in the supply chain to the aviation industry. Starting from the construction industry during the construction phase to other business and services, an increase in indirect employment is foreseen by the respondents.

Operation of MIA involves operation of duty free shops, restaurants, coffee shops and retail stores within the MIA premises. Expansion and modernisation of the MIA is associated with the expansion of the chain of supply of goods and services to operationalise these businesses. With an increase in indirect and direct employment induced employment will also increase,Induced employment is the employment created by employees in the aviation sector and those indirectly supported by the aviation industry using their income to purchase goods and services for their own consumption.

Increasing the share of locals and youth in the economic sector

Creation of the job opportunities direct and indirect through the expansion and modernisation of the MIA also implies a corresponding increase the share of local and youth being employed. This is an import goal to be achieved highlighted in the SAP 2009-2013. As highlighted above youth unemployment rate in stands at 16.2 percent in 2006, and is critical challenge that needs to be addressed. Over the next three years, it is projected that a large number of young people will complete secondary education. A significant number of school leavers will continue to tertiary education and at least 40 to 60 percent of them will potentially enter the labour market annually. The expanding labour force demands a corresponding increase in job opportunities. Analysis of youth unemployment reveals that white collar jobs are preferred by the youth. Many foresee that expansion and modernisation of the MIA will create while collar jobs the easing the youth unemployment which is major challenge confronting the country. Many people reflect that this will help in contributing the alleviation of the major social problems such as drug abuse and violence confronting the youth of Male' and Hulhumale'

Benefits associated through strengthening cargo infrastructure within MIA

The Maldives economy is very open. Maldives with limited natural resource base is import dependent and many products including perishable goods like fruits and vegetables are imported of through air cargo. Cargo import consists of daily use consumption products for the population and the tourists. Strengthening air transport and connectivity fosters trade and improve market linkages. At present cargo handling services within the MIA are basic. When cargo handling facilities and services are strengthened this can result in availability of a wider range of goods and services improving the consumers' choice through price and variety.

Export cargo is driven by the fishing industry. In terms of exports, fish and fish products account for a majority of exports and many products like frozen fish and live tropical fish are exported by air cargo. European Union is a major market and maintaining the quality of fish exports is an important factor. Respondents stated that storage services within the MIA are very rudimentary and at times fish get rejected due to contamination partly due to poor storage facilities within the MIA. Packed fish at the MIA does not have proper storage facilities and if flight are delayed packages are left in the sun. Seafood exporting enterprises have to produce to the requirements of their International markets and demonstrate acceptable conformity to food safety regulations. Improving the cargo handling facilities with the expansion and modernization of the MIA will be of immense benefit for the fish exporters in the country. This will result in the producers being able to operate more effectively and strengthening the trade efficiency between supplier and consumer.

Wider benefits to Hulhumalé'

According to many respondents expansion and modernization of the MIA also has the potential of bringing wider benefits to the Hulhumalé' city. Generally it is believed to be an impetus to retain and expand the existing businesses within Hulhumalé'. Also the presence of big, efficient and modern MIA is a critical factor in attracting new inward investment from outside the area especially companies from overseas. Hulhumalé' adjacent to the MIA is planned to serve as a catalyst for broad based investments in the fields of commerce, education, health, recreation, tourism, fisheries and a number of other related areas by both foreign and national parties. Many foresee the expansion and modernization of the MIA as an important factor towards achieving this objective.

Contribute in facilitating a conducive environment for the foreign investor

Developments associated with world class MIA are many. Increase in city hotels and guest houses and convention centres both in Male' and Hulhumale' can contribute in achieving a cosmopolitan city. A modern MIA is of utmost significance to attract knowledge, activity, skilled labour, international tourists and business elite. This will have the potential creating a more attractive environment capable of attracting more economic benefits. Such a virtuous cycle of growth creates conditions in which the local population of Male' and the adjoining city Hulhumale' will benefits.

Maldives is also well positioned to take advantage of political stability, high economic growth, social harmony and strategic geographical location to act as a point for distribution of goods Private sector dynamism and a sound investment climate are critical for embracing these opportunities. Modernisation and expansion of the MIA and its associate benefits will facilitate the foreign investors, traders and clients the ease in finding accommodation and proximity to the concerned government agencies based in Male'. This will provide sound investment climate that are critical for embracing investment in the country. The Doing Business Indicators places Maldives in a fair position for investments. The entry regulations of the Maldives have one of the lowest costs of registering a company at 15.6 percent of per-capita income, in comparison to the rest of the South Asia at 45 percent. A modern and an international MIA will be an added advantage and will contribute in facilitating a conducive environment for the foreign investor.

Promoting image of Maldives.

Expanding and modernising the MIA, the gateway to Maldives also has the potential of enhancing the general tourism profile of the country. A modern MIA will provide a good destination image with

good infrastructure facilities such as lounges and safe deposits for guest satisfaction. The Free Individual Traveller who comes without any assistance from any travel agency will find themselves more at ease and comfortable to travel to a destination with a modern MIA with all the necessary services available from the MIA. Such infrastructure and associated services will attract more tourism business, which can expand the tax base at the same to enhance the appeal of the city and the country. A modern MIA is foreseen to be equipped with a lot of modern state of the art facilities which at present is lacking in the existing MIA.

Alleviating pressure on the carrying capacity of Male'

With a population density of 540 per hectare and with an increasing trend the carrying capacity of Male' is at its peak. The disparity of Male and the atolls is the main reason for the urban pull toward Male'. Creation of more employment opportunities within the MIA through expansion and modernisation of MIA will attract people towards settling in Hulhumale'. MIA being is closer to Hulhumale' than to Male' and being linked by road to MIA might be factor that might attract people who are working in the MIA to settle down the Hulhumale rather than Male'. As more people settle down in Hulhumale' the rate at which the necessary social infrastructure being established within Hulhumale' will pace up. With necessary social infrastructure and good income opportunities people would opt to stay in Hulhumale' rather than Male' in the near future.

Tourism development

Economically, tourism has become the key platform for national economic development. At present capacity limitations in the MIA is a major constraint confronting the tourism sector toward developing new resorts. The current capacity of MIA and the domestic MIAs is insufficient to cater for the planned expansion of the tourism industry. The tourism master plan highlights that international arrivals by air are expected to grow. The newly operating GIA is expected to receive directly some of the tourists destined for Addu Atoll, while the other half will transit in Male' and take on domestic flights.

Expansion and modernization of the MIA is a development that is urgently required to negate these limitations and to strengthens the vital link between the tourist generating area and the destinations. Good accessibility is a fundamental condition for the development of tourism the country and is associated with a lot of commercial advantages. Investing in additional resorts will become more attractive for the investors. A multiplier effect within the tourism sector will occur as tourist arrivals increase. More investment within the tourism sector will boost all the sectors that are serving the tourism sector starting from the construction and other business and service industry. As more tourists arrive money passing from the hands of the tourist to the local community will increase. The money injected to these sectors and to the community will create new money flowing in. The initial spending is circulated through business which serves as suppliers increasing the income of the general population. The proposed project also has the potential to increase the foreign exchange inflow through increase in the number of tourist arrivals and their expenditure in the country. Specific benefits associated with tourism development are highlighted by the respondents are summarised below.

Increase in the employment opportunities and income of the air transfer sector

TMA and AT operates its own sea plane terminal at MIA with exclusive resort lounges and a fleet of air-conditioned buses and baggage vehicles for intra-MIA transfers. The doorstep delivery and pick up at the resorts is done at floating platforms. Trans Maldivian transports about 300,000 passengers per year.

Use of sea plans to transport tourists to island based resorts is a significant component of the tourism industry. Sea planes are in use from 1997 and the usage has increased gradually as resorts are being developed away from Male' resulting in major in major benefits for the national economy. Initially, resort development was concentrated in the central region of the country within easy reach of the Male'. International MIA. However, under a recent policy decision, islands for

resort/hotel development have been released across the country, along with plots of land for city-style hotel development in inhabited islands.

With this development sea –planes have become the main mode for transferring the tourist to their destination resort. According to TMA today 60% of the tourist arrivals are transferred to their destination resort by sea –plane and the trend will continue as the tourism capacity increases. According to Statistical Year Book, (2010) new islands leased for resort and hotel development total to 84.

Increase guest houses and city hotel within Hulhumalé

In Hulhumale' today 4 guest houses are registered and operating at almost full capacity throughout the year. With the increasing in demand new guest houses are being constructed and will be operational in the near future.

With the opening up of the guest houses organised tourism is gradually gaining ground within the Hulhumale'. This has the potential of creates a chain effect with a gradual increase in the tourism related job opportunities within the Hulhumale'. Today fixed salary jobs in the guest houses are providing income earning opportunities within Hulhumale'. As tourism develops the island communities would be able to develop tourist shops and other attractions including specialised restaurants to serve the tourists. As the number of tourist who visit the island increases opportunities for the island community to initiate other attractions, such as selling soveniours will come up.

Mr Ibrahim Thoyib owns Fuana Inn a hotel in Hulhumale' Beach Road, located on the beachfront; offering superb views of a long strip of white sand, a shallow turquoise water lagoon, and just beyond, a glimpse of the waves gently breaking on the reef. Within 1.8 km away is the MIA connected by a link road to Hulhumale'. Thoyib has run Fuana Inn for a couple of years and is pleased with the development that is going to come. Thoyib believes that Hulhumale' has great future and things would pace up with the expansion and modernization of the MIA. He believes that guest would prefer to stay in hotels in Hulhumale' than in Male. The quiet environment and the clear, shallow lagoon in front of Fuana Inn is an excellent spot for snorkeling or bathing. Thoyyib also added that even locals come over to his hotel to spend their weekends. Ibrahim Thoyib believes, that expansion and modernization of the MIA will be one of the best investments towards developing tourism within Hulhumale' city. He is one of the first persons who has been involved in developing a guest house in Hulhumale'. His guest house is working almost full capacity throughout the year. Ibrahim Thoyib is keen and eager for the development of the tourism industry. He cautioned stating that expansion of the MIA should also go hand in hand with the development of the support service such a regular and efficient transport services between MIA and Hulhumale' necessary for the tourism development

Transit hotel within an inhabited island would open up several gainful economic opportunities associated with community based tourism. Art and craft industry which is heavily dependent on cheap and imported items may also decline with the start of Hulhumalé community producing these items at the local level.

Increasing employment opportunities for women

Tourism development through city hotels and guest houses are associated with lot of other advantages. Today within the tourism industry a stark contrast in female and male labour force participation rate exists in Maldives. Reviewing the statistics of the tourism reveals that share of women in paid jobs is the lowest. As tourists resorts are located away from the home island women's participation is limited due to cultural and societal restrictions on mobility of women working away from their home island. In contrast to this norm for women who lives in Male' and Hulhumale' opportunities exists for to work in the in the guest houses and city hotels established in Male' and Hulhumale' where they live. For women who live Hulhumale' opportunity to working in a hotel or guest house operating in their place of dwelling offsets the cultural and societal restrictions that exist in working away from Home Island. Hotels in Male' and Hulhumale' are home-island based, and with spouse support and extended families assistance, child support facilities can be accommodated, providing an encouraging and conducive environment for mothers to work. Expansion and modernisation of the MIA is associated with increase in flights and consequently in the number of arrivals increasing e the demand for guest houses. Increase employment for women is a major goal identified by the SAP 2009-1013.

Increase in the share of locals within the tourism sector

Development of tourism within inhabited islands like Hulhumale' also has the potential of increasing employment for locals another major goal identified in the SAP 2009-2013.In the case of the tourism industry only half of direct employment opportunities are taken by locals. Various reasons such as staying away from family in a different islands has hindered in the low employment opportunities for the locals. Greater local participation is foreseen within Hulhumale' tourism sector through MIA and modernisation and expansion project.

Increase in income earning opportunities of the soveniour shop owners and tour guides through visiting tourists to Male' and Hulhumale'

Male' and Hulhumale' are 2 contrasting examples. Hulhumale' is a contrasting attraction for the ordinary tourists who mainly spend their time in island resort-oriented setting. As a planned city Hulhumale' is developed above 3 meters sea level while most islands are above one meters sea-level. Hulhumale' is an attraction of its kind different and unique for the general Maldivians setting and very different from Male'. An increase in city hotels guest houses due to the expansion and modernization of the MIA will pave way for these outsiders visit and explore the city of Hulhumale' which ' offers a much more relaxed pace of life with wide tree-lined streets that help give the island a sense of space. than the busy capital of Male', Visiting Hulhumale' is a fascinating opportunity to look into the future of the Maldives, as increasingly more residents move there from the crowded capital and other islands beyond. As more tourist visits the income earning opportunity for the souvenir shop owner and tour guides also increases.

Similar benefits are associated for Male' souvenir shop owners and tour guides with the increase in tourist arrival. An increase in the tourist that visits Male would provide conditions which the local population of Male' would benefit. In Maldives the city of Male' itself is generally a contrasting attraction for the ordinary tourists who mainly spend their time in island resort-oriented setting. Male' being a small island city with one of the highest population densities in the world also has a culture of its own which can be an attraction for the outsider. The vulnerability and uniqueness of these low lying islands are seen in a different form in Male' compared to the island resorts.

CONCERNS

Increase in expatriate labor force within the country

As highlighted above expatriate labor force is on an increasing trend and many respondents are very much concerned with a foreign company taking over the management of the MIA. Taking the tourism industry's situation as an example many staff and the general population highlighted that labor from India and neighboring countries are cheaper that local labor reasoning out why expatriate labor force is increasing in Maldives. Respondents stated that benefits associated with increased in employment opportunities can only be realised if rules and regulations regarding employing local labour is enforced. They emphasized and stressed that to utilize the benefits of increase in employment opportunities the government and the concerned authorities must ensure that benefits of the employment opportunities are focused towards the local population. Many commended and referred to the success of Dhiraagu and MWSC management practices with regard to employing local labor

Issues with regard to sea plane operations

Within Hulhule island sea planes of TMA and AT are also in operation. Presently space available for the sea-plane operators are used to its maximum and space cannot be adjusted or compromised to include additional services within that area. TMA highlighted that even at present the yachts which are anchored in Hulhumalé lagoon encroach to the sea-plane area during rough season of June and July. With this existing conflict still not resolved, TMA as well as other key informants emphasized that plans to use space within this area to initiate launch service to bring passengers to the new terminal will not be viable and could be even disastrous. According to them the height of the speed boats could interfere with landing and takeoff of the sea-planes. Detail discussion between the concerned stakeholders is stated as of paramount importance prior to implementing such a plan

Concerns of some Hulhumalé residents

Though Hulhumalé community is generally positive about the development that would occur with the expansion and modernization of the MIA many respondents have also raised their concerns.

a. Risks from accidents

Few respondents have stated that the objective of government is to gradually transform Hulhumalé into a world class city where 60,000 people will live, work and raise their families. Some people are settling down in Hulhumale' enjoy a superb living environment for themselves and their family. MIA being adjacent to Hulhumale' might not provide that ideal environment for its residents. Fuel supply and cargo facilities of MIA are located on the same landmass and if an accidents happens Hulhumale' residents will be at risk. The outbreak of Black Widow Spider was cited as an example

b. Increase in crime

Expanding and modernising the MIA is associated with more people settling down in Hulhumale' with a potential increase in traffic between MIA and Hulhumale'. All these activities though have positive impacts are also associate with negative issues within community. Possible increase in crime is highlighted as a concern by the Crime Prevention Committee of Hulhumale'. Crime Prevention Committee is made up of representatives from NGO's of Hulhumale' and representatives from the police within Hulhumale'. With regard to this almost all are open minded and generally are with the view that the benefits outweigh the costs and with proper regulations and standards the negative issues have to be minimised.

Mohamed Shujah works in the Hulhumale' preschool and is married to Shama Mohamed who is member of the Hulhumale' Association for Women. He is skeptical and concerned about the welfare of the Hulhumale' community. He said that Hulhumale' being connected to the MIA by land will results in Hulhumale' as the target community for some negative effects. He says that he still remembers the black widow spider outbreak from the cargo a few years back. Air pollution and noise pollution are also his concerns with increase in air traffic. He emphasized that GMIAL should focus Hulhumale' as their target for GMAIL's CSR component and assist them in providing education and establishing social infrastructure

d. Noise pollution

Some of Hulhumale' residents raised the issue of noise pollution associated with air-craft landing. Even at present sea- planes go over the Hulhumale' and many respondents feels that with air traffic increasing with the expansion and modernisation of the MIA, Hulhumale' might not be the ideal environment to live in the future. While some people does not consider this as a disadvantage given the benefits that may accrue to them with the expansion and modernisation of the MIA

Corporate Social Responsibility

Some respondents believe that Hulhumalé' at present lacks essential infrastructure like schools and mosques and requires a lot of assistance in terms of infrastructure development. Respondent stated that GMIALshould understand that Hulhumalé' being the target of the possible negative effects the company should focus on Hulhumalé' under the company's CSR component.

Support services to the tourism sector within Hulhumale'

The business community, specially the guest house owners within Hulhumale' states that with the modernization and expansion of MIA the support necessary to expand the tourism sector is of paramount importance. The guest house owners stated that a timely transport to and from MIA is of very importance to the overall development of Hulhumale' tourism and business sector. Even at present they are unable to cope with the demand for transport of guest from the Hulhumale' to the MIA in a timely manner and related to an example where a flight was missed for some guests who were staying in Hulhumale'.

OTHER STAKEHOLDERS PERCEPTION

Ministry of Environment and Housing and Environmental Protection Agency

MHE and the EPA referred to the environmental guidelines and considerations with regard to the MIA expansion and modernization project. In particular these organizations highlighted that stringent measures should be taken to protect the MIA taking into hindsight the Tsunami of 29th December 2004 when sea induced flooding occurred from the eastern side. Reflecting on sea level rise and climate change and its possible effects, MHA and EPA stated that MIA is critical infrastructure and coastal protection measures should be in place as emphasized in NAPA formulated under the NCCP. Environmental guidelines should be followed in establishing environmental infrastructure such as waste management sewerage systems as well as utilities infrastructure including powerhouses and desalination plants and their distribution systems.

Moreover, EPA stated that Maldives being a party to the Montreal Protocol of Substance that Depletes the Ozone layer guidelines and norms under this program need to be incorporated into the current project. Maldives has successfully met the targets earlier than recommended with imports of CFCs banned since 2008. Imports of equipment dependent on CFC gas and vehicle older than 5 years have also been banned since January 2004. All imports of refrigerant gases are monitored through licensing system. Phasing out HCFCs is the current goal of the MHE, and the EPA with the plan to freeze the consumption by 2013, reduction of consumption by 35 percent in 2020 and 67.5 percent by 2025.

The government authorities including the MHE and MTAC reviewed that GOM's commitment to the NCNP of phasing out from fossil fuel to renewable energy by 2020 with planned 50% reduction in electricity generation by fuel by 2015. The organization stated The NCNP should be incorporated in the expansion and modernization of the MIA focusing on green policies using renewable energy and depending on natural lights where every possible to achieve the target of becoming carbon neutral by 2020.

Ministry of Tourism, Arts and Culture

MTAC as the government authority mandated to develop tourism at a national level, and carry out long-term planning, development, monitoring, and regulatory functions to ensure a sustainable tourism industry, also acknowledged that the expansion of the MIA is associated with tourism benefits including the increase in tourist arrivals. Nonetheless at the same time they also raised a number of concerns with regarding the expansion and modernisation of the MIA which they are as government regulatory body need to emphasis.

Once of their concerns is the inconvenience that the tourists might have to experience when changing to a new terminal in an operating MIA. They felt that it could be a chaotic situation for the tourist who are coming from long haul flights and who have to transfer to their destination resort. They emphasized that utmost care and mitigating measures should be taken to ensure the safety and comfort for the guest. Emergency measure should be in place for the safety of the tourists. Tourism is the main stay of the economy and MTAC enforces regulation of health and safety requirements at resort islands and access to first aid/medical care.

Similar to TMA and some other key informants, MTAC also raised their concern with regard to the existing issue of yachts in the Hulhumale' harbor encroaching the space allocated for the sea plane operators during the rough season. MTAC also stated that with this existing conflict still not resolved use of launch services to and from the new terminal where sea plane operations are in place will not be a viable alternative. Detail stakeholder discussion regarding this issue need to be undertaken prior to implementing such a plan.

MTAC is keen to know more about the detail planning of the expansion and modernization of the MIA. MIA is a key infrastructure and a support service for the development of the tourism industry

identified in the Third Tourism Master Plan 2009-2011. MIA is the gateway to Maldives and also has the potential of enhancing the general tourism profile of the country. A modern MIA with green principles, modern infrastructure incorporating tourist sector needs such suitable infrastructure facilities for the resort representative will provide a good destination image. During the discussion the MTAC stressed the expansion of the regional airports as an important infrastructure development and support service towards increasing the capacity of the tourism sector as expansion and modernisation of the MIA cannot be taken in isolation with regard to tourism development. The importance of connectivity for tourism development by strengthening the domestic airports towards streamlining the tourism to the outer atolls was reviewed. Strengthening the domestic airports in refuelling needs of sea planes as tourism spreads throughout Maldives is stated as an important area that need to be developed.

Island Aviation Service Limited

The national airline, Island Aviation Services stated that with the GMIALtaking over the management of the Male' International MIA a number of changes have occurred to their company. Over all the company has been narrowed down in terms of services and staff size. With this change only one Regional MIA is under the Island Aviation. In retrospect of their past financial history Island Aviation stated that this change will provide them with an opportunity for company to be more cost effective and viable in the future.

Housing Development Corporation

The HDC and believes that expansion and modernization of the MIA will create much needed demand towards attracting investment to Hulhumale'. The presence of big, efficient and modern MIA will attract new inward investment from outside the area both local and foreign companies. Hulhumale' is adjacent to the MIA and is planned to serve as a catalyst for broad based investments in the fields of commerce, education, health, recreation, tourism, fisheries and a number of other related areas by both foreign and national parties. HDC, foresee the expansion and modernization of the MIA as an important factor towards achieving this objective. The proposed project has the potential for Hulhumale' City to undergo immense socio-economic development. Socio-economically the public will be at an advantage with the completion of the project, in terms of employment opportunities, ease in transport and other opportunities linked to these sectors.

HDC is also positive towards establishing and improving the utilities within Hulhumale'. Improving the existing waste collection and disposal system in collaboration with the system that would be in place in MIA is one area which HDC is hopeful. The corporation believes that such a system would be more financially viable than the present system.

Maldives Transport and Contracting Company

MTCC also reflected similar prospects and is hopeful towards getting more attractive investment opportunities with the expansion and modernization of the MIA. MTCC deals in trading, contracting activities, marine transportation and renting and auctioning at present. In relation to MIA at present an efficient ferry services is in place between Hulhumale' and Male'. More recently MTCC has started and speed boat services between MIA and MIA.The company also operates bus services in Hulhumale' including bus services between MIA and Hulhumale' as well. The company is confident that these existing transport services to the MIA will strengthened as demand increase with the expansion and modernization of the MIA

Maldives Association for Industry

MATI is an NGO formed, for the purpose of promoting tourism in the Maldives. Its membership comprises of Maldives companies and individuals engaged in travel and tourism related activities; local and foreign travel agents; tour operators, dive bases, suppliers, airlines, banks and financial institution.

MATI acknowledged all the tourism benefits associated with expansion and modernization of the MIA. Expansion and modernization of the MIA is development that would strengthens the vital link between the tourist generating area and the destination. Good accessibility is a fundamental condition for the development of tourism in the country and with the expansion and the modernization of the MIA this vital link is strengthened with the potential of increasing the overall tourism sector. Investing in additional resorts will become more attractive for the investors. A multiplier effect will occur as tourist arrivals increase. More investment within the tourism sector will boost the all the sectors that are serving the tourism sector starting from the construction and other business and service industry. As more tourists arrive money passing from the hands of the tourist to the local community will increase. The money injected to these sectors and the community will create new money flowing in.

Maldives Association for Travel and Agents and Tour Operators

MATATO also reflected on similar lines. Both organizations highlighted the importance of spacious and a modern MIA towards development of the tourism industry. The organization emphasized that infrastructure facilities for air port representatives of travel agencies provide important functions and should be accommodated according to the needs of the travel agencies. Guest satisfaction is of paramount importance through good infrastructure like safe deposits and MIA lounges

Conclusion

According to almost all respondents expanding and modernisation of the MIA is associated with a lot of positive impacts. Most people believe direct and indirect employment opportunities will be created with the increase in capacity of the MIA. This includes direct employment in the MIA operations as well indirect employment starting from the construction industry during the construction phase to other business and services linked to the MIA. Most importantly increase in employment opportunities are linked to increase in share of women, locals and youth in the work force. This are important goal highlighted in the SAP2009-2013 .Many respondents state that unemployed is driving youth to get involved in drug abuse, crime and violence.

7 ENVIRONMENTAL MANAGEMENT PLAN

7.1 Introduction

Environmental Management Plan lists out mitigation measures and management strategies for construction and operation phases of the proposed airport expansion. The proposed mitigation measures are prepared considering all possible strategies oriented towards effective environmental management including pollution prevention and control, waste minimisation and management, and residual attenuation for the proposed project. The EMP also provides a delivery mechanism to address potential adverse impacts, to instruct contractors and to introduce standards of good practice to be adopted for all project work. The EMP can be developed into a stand-alone document covering each stage of the site preparation and operation.

The objectives of the EMP are to:

- Identify all the proposed measures to mitigate potential environmental impact of the project as identified though the EIA process;
- describe the tasks involved in the monitoring to ensure that the Client meets all of its environmental obligations, including:
  - environmental management commitments from the EIA process including effective implementation of identified mitigation measures; and
  - document responsibilities for implementing, managing and reporting compliance with the legal requirement and proposed mitigation measures; and
  - describe the procedures to be adopted to ensure proper management of emergency situations.

EMP ensures that the project implementation is carried out by taking appropriate mitigative actions to reduce any adverse environmental impacts during its life cycle. The plan outlines existing and potential problems that may adversely impact the environment and recommends corrective measures where required. The plan outlines roles and responsibility of the key personnel and contractors who are charged with the responsibility to manage the project site. The key benefits of the EMP are that it provides the organization with means of managing its environmental performance thereby allowing it to contribute to improvement of environmental quality. The EMP covering various aspects, as listed below:

- Marine Environment
- Ecological Environment (Flora and Fauna) Management
- Land Environment Management
- Air Quality Management
- Noise Environment Management
- Groundwater Quality Management
- Surface Water Quality Management
- Socio-Economic Environment
- Raw materials
- Energy
- Health and Safety
- Natural Disasters

7.2 Solid Waste Management Plan

Waste Collection, Segregation & Storage

Existing waste collection system at the airport needs to be upgraded. Since the quantity of waste generation will increase after expansion of the airport, the number of collection points also needs to be increased. Additional waste collection points will be identified.

Considering the type of waste likely to be generated from the operation of airport, it is recommended that 3 bin systems should be adopted so as to facilitate an organized and hierarchical system of waste collection and disposal. Use of plastic or metal containers with lid and capacity 10-15 litres is advised for the storage of food/biodegradable/wet waste. Similar size bins or plastic bags with or without lid may be used for storage of recyclable materials.

There are several solid waste management technologies, which are being followed in various parts of the world. Suitable technologies are chosen depending upon the type of waste and the area. Based on the type and quantity of waste that would be generated during operation phase of the airport and keeping in view the scarcity of land and the requirement to protect the fragile eco-system, biological processing technology of bio-methanation can be considered as a viable option. Majority of the waste generated consists of recyclable items such as plastic and glass bottles, cans, paper and Styrofoam boxes. These will be segregated, recycled and reused for certain airport activities. Remaining biodegradable waste will go to the bio-methanation plant that may be installed within the airport premises.

Installation of Bio-methanation plant with power generation is being considered for the proposed project. It is assumed that 55% of the municipal solid waste generated at the airport will consist of organic matter. Thus 27 TPD of waste (till the year 2014) will have 14.85 TPD of organic matter. A detailed Solid Waste Management Plan is provided as **Appendix**

The components of the environmental management plan, potential impacts arising out of the project and remediation measures are summarized below in **Table 7.1** below.

Table 7.1: ***Summary of Potential Impacts and Remedial Measures***

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
1.	Marine Environment	• Significant amount of siltation and sedimentation of the lagoon waters, • Increased turbidity. • Smothering of corals, • reduced light penetration to benthic communities, • increased rates of coastal erosion, • adverse impact on marine habitat	*Construction Phase:* • Dredging and reclamation works; *Operation Phase:* • Any sewage and waste water outfalls into marine water. • Storm water runoff may include pollutants associated with leaks and spills of oil, diesel, and jet fuels during operation and maintenance of ground service vehicles, and fuel storage and handling activities.	• Natural slopes will be provided in the runway strip to facilitate storm water run-off. • Extension of the runway strip to be constructed using porous asphalt. • Concrete drainages to be constructed on both sides of the runway to manage storm water runoff. • Any ecologically sensitive areas in the vicinity to be identified and avoided • Only treated waste water should be drained into sea through a diffuser	Residual impact will remain for longer duration, however minor impacts will be observed foe short period.	Mitigation measures will have to be followed effectively to minimize/ avoid adverse impacts. • Construction of bund walls to fully enclose the reclamation area • Silt screens to be used during excavation and reclamation works. • A SBR type waste water treatment plant is proposed for the operational phase. • Oil traps to be provided for storm water drains collecting from tank farm area.
2.	Terrestrial Ecological Environment (Flora and Fauna)	Disturbance to Flora and Fauna on site	Construction Phase • Site Development during construction.	• The Island being man-made is devoid of any natural vegetation, however local and viable species of trees and shrubs to be identified.	No significant adverse impact within project premises. Positive impacts in terms of development of vegetation and visual appearance.	• The proposed landscaping at the airport to be in accordance with local vegetation.

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
			Operation Phase	• No significant incremental impacts anticipated.	No significant incremental impact.	• No significant incremental impact.
3.	Land Environment	Soil contamination Solid wastes including hazardous wastes.	Construction Phase • Disposal of construction debris, • Storage of construction material, • Contamination of soil due to leakage of oil from vehicles • Spill from loading unloading of oil at tank farm • Construction and decommissioning activities may pose the potential for release of petroleum based products, such as lubricants, hydraulic fluids, or fuels during their storage, transfer, or use in equipment.	• Construction debris will be temporarily stored in a designated waste site and taken to Thilafushi for disposal. • Chemical storage will comply with international standards containment will be within weatherproof, sealed and bunded areas to ensure stability. • Bunded waste pallets and empty paint buckets will be sent to Thilafushi waste disposal site.	Minor negative impact inside airport premises. No negative impact outside the site. Short term.	• The contamination of soil to be avoided by suitable management of oil and fuel. • Care to be taken to compact the soil after refilling so that, soil erosion and consequent soil import is avoided. • Use of impervious surfaces for refueling areas and other fluid transfer areas • Train workers on the correct transfer and handling of fuels and chemicals and the response to spills • Provide portable spill containment and cleanup equipment on site and training in the equipment deployment
			Operation Phase • Dumping of municipal solid waste on land. • Airport operations may also generate liquid or solid hazardous wastes	• Development of a Solid Waste Management Plan • Segregation of the waste streams, all waste to be transported to Thilafushi waste disposal site for further treatment &	No waste dumping on Hulhule-Hulhumale island. Not Significant	• Solid Waste Management Plan to be put in place **(refer Appendix),** • Green procurement policy to be employed, • Waste segregation

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
			such as used lubricating oils and solvents from aircraft and ground service vehicle maintenance.	disposal. However biomethanation plant is recommended for treatment of organic waste and the residue will be used as a manure.		involving labeled waste containers in passenger terminals for metals, glass, paper, and plastics. • trainings to waste handling workers to be advocated. • All solid waste to be transported to Thilafushi island for proper disposal. • Development of a biomethanation plant to cater the operational requirement.
4.	Air Quality	Dust Emissions	<u>Construction Phase</u> • Dust and air emission particularly due to the excavation activities and reclamation activities, mobilization of equipments, movement of vehicles resulting in air pollution.	• Minimize dust from material handling sources, such as mixing, batching plants and bins, by using covers and/or water suppression. • Minimize dust from open area sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content • Dust suppression techniques should be implemented, such as	Minor negative impact inside airport expansion site premises. No negative impact outside the site. Short term.	• Provision of spraying water to reduce dust emissions. • The amount of exposed ground and stockpiles will be minimized so that re-suspension due to wind and subsequent dust fall is prevented. • Ensuring all vehicles, generators and compressors are well maintained and regularly serviced.

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
				applying water to minimize dust from vehicle movements		
		Emissions of SPM, SO_2, NOx and CO	Construction Phase • Dust and other exhaust atmospheric emissions generated by vehicle movement, concrete mixing machinery, concrete conveyers, bucket conveyers, air blowers, pneumatic vibrators, mechanical vibrators and water tankers and diesel generators	• Rapid on site construction and improved maintenance of equipment.	Minor Negative impact inside the premises. No impact outside the premises. Short term.	• Regular Monitoring of emissions and control measures to reduce the emission levels. • The construction workers will be provided with appropriate protective equipments (PPEs) wherever high particulate emission is expected. • Workers will not be allowed to work over a long exposure period.
			Operation Phase • Movement of aircrafts and Vehicular movement within the airport- • Increased movement of vessels to and from the harbor.	• Fuel efficient vehicles will be used and proper record of vehicles will be maintained • Efficient approach to the airport • Optimize ground service infrastructure to reduce aircraft and ground vehicle movements on taxiways and idling	No significant negative impact.	• Maintain record of vehicles • Exhausts from vehicles will be minimized by use of fuel-efficient vehicles. • Vehicles will be well maintained and will have Pollution Under Check (PUC) certificate. • Penalize non-compliance

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
5.	Noise Environment	Noise emissions	Construction Phase • Construction noise mainly due to mobilization of equipments, excavation, plying of vehicles, operations of cranes etc • Occupational Hazard to workers	• Use of well-maintained equipment fitted with silencers. • Providing noise shields near the heavy construction operations • Construction activity to be limited to daytime hours only. • Provide enclosures and adequate padding for high noise generating equipments	Minor negative impact near noise generation sources inside premises.	• Use of Personal Protective Equipment (PPE) like ear muffs, ear plug, In high noise areas. • The vehicles used will be with the standard limiting noise output. • Wherever this cannot be achieved, the area will be earmarked as high noise level area requiring use of ear protection gadget.
			Operation Phase • Noise movement of aircraft and traffic going to and from the airport.	• Ensure compliance with Maldives Civil Aviation Act and Maldives Civil Aviation Regulation. • Green Belt Development and development of silence zones for traffic movement.	Most significant adverse impact during operation. Residential areas in Hulhumale are located within 1.0 km from the airstrip and hence mitigation measures need to be implemented efficiently.	• In areas where significant impacts are anticipated, implementation of preferred procedures and routes for landing and take off (LTO) to minimize potential noise from approaching and departing aircraft for noise-sensitive areas.. • Minimize airframe noise, • Develop instructions on minimizing reverse thrust on landing.

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
						• Provision of Acoustic Enclosures to Generators within the Facility
6.	Groundwater Quality	Ground water contamination due to any accidental oil spill or toxic substance.	<u>Construction Phase</u> • Accidental spill during fuel handling • Wastewater generated from Construction workers/ Labor tents. Accumulation of water during excavations. • Sewage generated during construction.	• Fuel handling to be undertaken over impervious surface • Any spill on soil to be immediately cut and removed to hazardous waste storage • Adequate number of toilets will be provided at labour camp. • Existing sewerage system will be used to manage the sewerage management requirements from labour camps	Minor negative impact inside airport premises. No negative impact outside airport site.	• All excavation activities to ensure prevention of contamination to ground water. • All machinery to be properly tuned and maintained to avoid leaks. • All paints, lubricants, and other chemicals used on site to be stored in secured and bunded location with impervious surfaces below.. • Oil, solid waste and hazardous waste to be handled carefully and transported in sealed containers.. • Construction activities will be carried out under the supervision of a suitably experienced person.

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
			Operation Phase • Sewage generated, and treatment	• A main sewerage system to take care of wastewater discharges from the airport facilities will be developed. • SBR type purification plant to be installed.	Wastewater will not be soaked into septic tank system and there will be no direct discharge to the sea. No negative impact on ground water quality envisaged. Not significant.	• All the wastewater will be treated and recycled • All underground wastewater conveyance pipes, storage tanks, sump wells etc, should be constructed with impermeable material, preferably concrete lined with sulphur resistant paint or any other material
7.	Groundwater resource	Potential Ground Water Depletion	Construction Phase • Groundwater will not be extracted for the construction phase	• Water required for construction will be provided through existing desalination plants. • Seawater for desalination will be taken from the lagoon.	No significant impact on ground water quantity envisaged.	
			Operation Phase • Groundwater will not be used for any purposes on the island	• Rain Water Harvesting will be also explored.	No significant impact on ground water quantity envisaged as no GW is to be used.	

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
8.	Marine Water Quality	Marine water contamination	Construction Phase • Surface runoff from site during construction activity.	• Silt traps and other measures such as, additional on-site diversion ditches will be constructed to control surface run-off during site development.	No off site impact envisaged as no surface water receiving body in impact zone.	• Silt screens to be used during excavation and reclamation works.
			Operation Phase • Discharge of domestic wastewater to surface water body.	• In case of any event of discharge of water from the site, the applicable water quality standards will be maintained. • Storm water generated will be collected in holding tank to ensure that suspended solids are removed before they let into sea.	• No offsite impact envisaged	• Recycling and reuse of treated water for landscaping and in toilets.
9.	Socio-Economic Environment	No displacement of any local people involved	Construction Phase • Construction Activities leading to any relocation is not anticipated.	• There is no displacement of people.	No negative Impact	
			Operation Phase • Operation	• Employees will be provided direct employment opportunities. • In addition employment opportunities will be provided for persons engaged in operation and maintenance and allied	Beneficial Impact	Engage with community to develop a cordial relationship in line with the CSR policy of GMR.

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
				activities. • Airport expansion and modernization will attract more tourists and boost the economy through secondary development.	Positive Impact	
9..	Energy	Depletion of natural resources,	• The energy required for construction will be provided through existing generator sets. Additional generator sets to be installed, if required	<u>*Construction Phase:*</u> Suitable energy conservation measures to be under taken i.e., • Selection of Energy Efficient Electrical Appliances & Equipment. • Use of Energy Efficient Luminaries *viz* CFL & PL Lamps. • Provision may be made for passive solar devices, solar lighting, solar water heaters, etc.	Temporary	• Energy efficient generators to be used. • The airport is being planned as per LEED Silver rating which shall incorporate energy efficient aspects for the Airport.
10.	Health and Safety	• Unsafe construction activities can result in accidents and safety incidents. • Potential human exposure to high noise, vibrations and air	• Construction activities, fuel storage, operational activities, vehicle movement etc.	• Health and safety plan to be developed for construction **(refer Appendix)** and operational activities • Fire fighting plan to be developed • Adequate fire fighting	Temporary and long term	• Low noise and fuel efficient generators to be used. • Construction crew to be trained in Health and Safety aspects as applicable for the respective operations

S. No.	Environmental Components	Potential Impacts	Potential Source Of Impact	Controls Through EMP & Design	Impact Evaluation with controls	Remedial Measures
		pollutants. • Accidents, Fire Hazards, possible explosion, spillage or leakage of fuel bulk storage		facilities to be provided in the fuel storage area.		• Adequate personal protective equipments (PPEs) to be identified and used for unsafe activities e.g. use of safety harness during working on heights, safety shoes, goggles etc • H&S incharge to be deputed • H&S aspects to be reviewed regularly • Baseline air and noise quality monitoring to be carried out so as to ascertain baseline emissions and to ascertain exposure levels to workers during construction.
11.	Natural Disaster	• Loss of life and property	• Storm surges • Floods • Earthquakes	• Disaster Management Pan to be developed and executed **(refer Appendix)**	• Prevention and minimization of injuries and fatalities	• Review and update daily weather forecast information and respond accordingly.

7.3 Environmental Management Cell

Apart from having an Environmental Management Plan, it is also necessary to have a permanent organizational set up charged with the task of ensuring its effective implementation of mitigation measures and to conduct environmental monitoring. The major duties and responsibilities of Environmental Management Cell are given below and to be detailed out in the EIA report.

- To implement the environmental management plan,
- To assure regulatory compliance with all relevant rules and regulations,
- To ensure regular operation and maintenance of pollution control devices,
- To minimize environmental impacts of operations as by strict adherence to the EMP,
- To initiate environmental monitoring as per approved schedule.
- Review and interpretation of monitored results and corrective measures in case monitored results are above the specified limit.
- Maintain documentation of good environmental practices and applicable environmental laws as ready reference.
- Maintain environmental related records.
- Coordination with regulatory agencies, external consultants, monitoring laboratories.
- Maintain of log of common complaints and the action taken

7.4 Environmental Monitoring

The purpose of environmental monitoring is to evaluate the effectiveness of implementation of Environmental Management Plan (EMP) by periodically monitoring the important environmental parameters within the impact area, so that any adverse affects are detected and timely action can be taken.

A regular monitoring programme helps to compare the baseline status of the project, which existed before implementation of the project, with the changes taking place in the developments and also the effectiveness of the management plans.

This programme will be directed at all aspects of airport operations that have the potential to influence the environment. Such areas include continuously understanding and reporting the status and changes to reef health, the beach line, lagoon water and ground water quality, terrestrial biodiversity, solid waste generation, energy production, noise, air quality, fuel handling and wastewater.

Also, under the EIA regulations of Maldives, a detailed monitoring plan is a mandatory component of any EIA. Therefore, a comprehensive monitoring programme specify the location of monitoring points, the parameters to be analysed, and the frequency of such analyses with the estimated costs is presented in the following subsections:

7.4.1 Marine Environment Monitoring

Monitoring of the marine environment is crucial in order to estimate impacts that the proposed project will have on the environment and to make sure that mitigation measure are applied at all times.

Table 7.2: Marine monitoring locations, parameters and frequencies

Subject and location	Parameters to be monitored	Cost	Frequency and duration	Purpose
Reef slope west of runway,	Water quality: Temperature, pH, Salinity (EC, TDS), Turbidity, TSS	USD 50, excl transport	Every three months during construction stage and during operation, until turbidity and TSS levels have come down to baseline levels	To monitor the sedimentation generated during reclamation
Reef slope west of runway, Marine benthos and fish survey	Live coral coverage and fish census; line intercept transect or photo quadrat survey	USD 500	Six months after reclamation of impact. Every six months during operation, for two years.	To monitor the impact of sedimentation on the coral reef benthos
Reef slope east of proposed passenger terminal,	Water quality: Temperature, pH, Salinity (EC, TDS), Turbidity, TSS, DO, Nitrates, Phosphates	USD 70	Every three months during construction stage and during operation, until turbidity and TSS levels have come down to baseline levels	To monitor the sedimentation generated during reclamation, eutrophication, and the availability of oxygen for fish
Reef slope east of proposed passenger terminal, Marine benthos and fish survey	Live coral coverage and fish census; line intercept transect or photo quadrat survey	USD 1000	Six months after reclamation of impact. Every six months during operation, for two years.	To monitor the impact of sedimentation on the coral reef benthos
Lagoon between Hulhule' and Hulhumale',	Water quality: Temperature, pH, Salinity (EC, TDS), Turbidity, TSS at both sides. Additionally at Hulhumale: DO, Nitrates, Phosphates, Hydrocarbons, Chrome and Copper	USD 100, excl. transport	Every three months during construction stage and during operation, until turbidity and TSS levels have come down to baseline levels and until Hydrocarbons and heavy metals have come down to harmless levels	To monitor the sedimentation generated during reclamation, contamination with oils and heavy metals; to monitor the availability of oxygen for fish

7.4.2 Coastal Environment Monitoring

Coastal Zone Monitoring Programme

The parameters that are most relevant for monitoring the impacts on coastal environment that may arise from the proposed redevelopment are included in the monitoring plan. These include bathymetry, shoreline of the line and coastal protection structures. Monitoring will be carried out as part of the environmental impact assessment and mitigation of possible negative impacts from the proposed project.

Cost of Monitoring

The amount indicated is the total cost of monitoring during the construction and operational phase (2 years after the construction). Summary monitoring reports will be provided every two months and final report will be provided at the end of the construction stage and will adhere to Schedule M of the EIA Regulations, 2007.

Methods of monitoring

Environmental monitoring will be undertaken using standard methods described in the Methodology section. **Table 7.3** outlines the indicators for monitoring. These indicators in the table are not limited but have been considered as the important aspects of monitoring.

Table 7.3: Aspects of the Coastal Monitoring Program with Cost Breakdown

Monitoring Attribute	Indicator	Methodology	Monitoring Frequency	Estimated Cost
shoreline	Beach dynamics	D-GPS tracks along the beach at low tide (within 1m accuracy)	Once during the project, 2 months after the completion, there after once a year	US$ 2000 per survey
Hydrodynamic	Changes in the current movements	Drogue tracks at a recording interval of 60s at the four corners of the island	Once during the project, 2 months after the completion, there after once a year	US$ 400 per survey

Monitoring responsibility

Monitoring responsibility will be with the client and financial provisions will be made in the project to undertake the monitoring.

Monitoring Report

A detailed monitoring report will be compiled after the completion of the civil works based on the data collected for monitoring the parameters included in the monitoring programme. This report will be submitted to the relevant government agencies for compliance.

The report will include details of the site, data collection and analysis, quality control measures, sampling frequency and monitoring analysis and details of methodologies and protocols followed.

7.4.3 Terrestrial Environmental Impact Monitoring

Methods of monitoring

Terrestrial environmental monitoring will be undertaken using standard methods described in the Methodology section. Monitoring is only recommended for specific aspects of the terrestrial environment.

Monitoring time frame

The project activities will be monitored during after the completion of the project as there will not be any issue with loss of vegetation. Impact monitoring is therefore recommended during the operation stage to assess the overall terrestrial environment including an assessment of the total area of newly vegetated land within the island environment.

Monitoring aspects and reporting

Terrestrial flora

As the project takes place in a modified environment and an existing airport, no significant vegetation loss will take place. The upgrading project will increase the vegetation cover rather than reduce it.

With the airport upgrading and modernization, it is anticipated to increase the vegetation cover of the island. New landscaping will increase the floral footprint and therefore, this aspect will need to be monitored after the construction stage.

Terrestrial Fauna

Monitoring of terrestrial fauna is not recommended as it is not relevant to this project. The only relevant component is to record bird strike incidents as with airport upgrading, vegetation cover is likely to increase. The airport expansion will also have other secondary outcomes such as increased waste that could lead to more bird population and ultimately increase bird strikes if proper waste management is not undertaken. Bird strikes and their control will also be a good indicator of how well the waste is managed in the island.

Table 7.4:Terrestrial Environmental Monitoring Plan

Category	Indicator	Source	Monitoring frequency	Cost
Number of new trees planted in the island (limited to mature trees with heights more than 5 meters)	Type, size and number of trees	Data sheets and records from Airport management	Every six months	**USD** 500
Number of bird incidents	Type and number of birds	Data sheets and records from Airport management. Bird strike reports	Monthly	**USD** 500
Ground water from Existing wells	pH, EC, TDS, Faecal coliforms, and Nitrates.	Through field testing	Every three months during construction and Every six months after construction.	**USD** 200
Noise pollution	Noise levels	Survey	Annually after construction	**USD** 100

7.4.4 Monitoring Social Impacts

Expansion and Modernisation of MIA has the potential of contributing to a long term change in social, economic and environmental conditions over time. Therefore certain parameters need to be monitored over time for gauging the impacts. The central monitoring and evaluation requirement is to track systematically the key indicators over time and space and see how they change as a result of the expansion and modernisation of the MIA. A carefully designed monitoring program is necessary to identify positive as well as negative trends over the life of the project. If relevant social and economic parameters are adequately monitored important lessons can be learnt at relatively little cost with the advantage of having solid bases on which to identify guidelines for future development

Methods of monitoring

Quantitative and qualitative indicators that can be monitored over the life of the project are outlined in the following section. The information can be obtained from secondary sources such as household surveys, the island office, published reports, surveys, and MIA statistics.In addition

qualitative information can be collected to enhance the monitoring incorporating as much as possible the local point of view.

Continued measuring will provide a trend starting from the existing status to the life of the project providing a quantitative insight of the impacts.

Indicators to be monitored

Following are the key indicators that require careful monitoring through the project period. These include direct impact indicators and other indicators which can describe the improvement of the general socio-economic situation of the community.

Table 7.5:Some key indicators for the socio-economic impact monitoring

Indicator	Assessment question	Source of information
Population	What is the migration pattern of Hulhumalé and Male'	Census, HDC records,
Direct Employment	What are jobs of offered by GMAIL What is the structure and parameters of wages and salaries What is the expatriate and local labour force within the MIA	Own records
Indirect in MIA and Hulhumalé'	**Private sector Businesses (Enterprises)** Creating new businesses (Number, Activity, Location) Changes in sizes and/or activities of businesses	
Housing and public infrastructure in Hulhumalé'	What are the public infrastructure services (Hospitals, schools..etc) What are the housing infrastructure	
Education Creation of educational opportunities and skill improvement	No and type of training provided to the staff and others	Own records
Recreation facilities provided Creation of recreation activities for the staff	Facilities by type and frequency	Own records
Development in Hulhumale' Creation of employment with in economic sectors	Type of employment and number	Census/Statistics/ HDC records

Appendix A: Terms of Reference

Environmental Protection Agency
Ministry of Housing and Environment
Male', Republic of Maldives

Terms of Reference for Environmental Impact Assessment

The following is the TOR based on the scoping meeting held on **20th October 2010**for undertaking the EIA for **the Rehabilitation, Expansion, Modernisation, Operation and Maintenance of Malé International Airport, K. Hulhulhé**

1. Introduction - This TOR has been prepared for the Environmental Impact Assessment of the proposed Rehabilitation, Expansion, Modernisation, Operation and Maintenance of Malé International Airport, K. Hulhulhé. The purpose of the EIA is to identify, predict, evaluate and make recommendations to mitigate or reduce potential environmental and social impacts associated with the proposed development. The EIA should be completed prior to any construction works and contribute to the relevant decision making processes by the Ministry of Housing and Environment and the developer.

2. Stud y Area- Specify the boundary of the project site and the EIA shall focus on an area within the immediate footprint of the development including the potential borrow location(s) and reclamation area(s), whilst also taking into consideration the broader context of the Project site.

3. Scope ofWork - The following tasks will be performed:

Task 1:. Description of the Proposed Project - Provide a full description of the project, to include: brief description of the proponent; justification of the proposed development; objectives of the proposed expansion, modernisation, operation and maintenance of Malé International Airport, details of how the development relates to the National Development Plan and MDP Manifesto, a clearly labeled site plan of the project area indicating all changes to the marine and terrestrial environment around the area of proposed development; a description of construction activities and technologies, how the project activities will be undertaken including work method for construction, how demolition waste and emission will be managed during the project; a framework environmental management plan (including measures taken to avoid cutting down trees, plan to relocate any removed trees, water management and usage, sewage including sewer networks, sewage treatment and emergency out fall location(s), waste water management, fuel and waste oil management, power generation and management); a matrix of project inputs and outputs during the construction and operational phase; maximum employment; a detailed project schedule; and life span.

The EIA will also provide full descriptions of, inter alia, the following:

- *the relevant parts of the Project*
- *the intended duration of the Project construction*
- *the location map*
- *a scaled site plan showing the locations of proposed infrastructure, the setback of buildings from the high water mark and landscaped areas*
- *architectural plans or, at the least, sketches or architect's impressions of the Project*
- *description of the environmental condition of the study area based on existing literature and the required baseline field surveys (outlined in this TOR) and a description on how the environmental conditions at the study area will influence the implementation of the proposed project.*
- *the proposed source(s), treatment, storage, distribution, management and conservation of water during the construction and operation stages of the proposed project*
- *the proposed sewage and wastewater collection, treatment and management process supported by flow diagram*
- *the proposed source of energy, energy generation method(s), management and conservation of energy during the construction and operation stages of the proposed project*
- *Sustainability component, including the energy and water conservation measures included into the project during the planning stage.*
- *measures adopted to promote sustainable development during both the construction, and operational phases of the Project*
- *summary work plan of activities during the site preparation, construction, and operational phases of the Project and*
- *a framework environmental management system adopted for the Project operations.*
- *Projects contribution in achieving countries carbon –nutrient2020 goal and HCFC free 2020 goal.*

The EIA Report shall also identify and describe at least three alternatives to each of the proposed activities associated with the project that may have a significant impact on the environment, one of which shall be the no development option. These alternatives shall be evaluated using clearly defined criteria resulting in a preferred alternative/option.

Task 2a. Description of the Environment

Assemble, evaluate and present previously collected baseline data on the relevant environmental characteristics of the study area including the following:

- *Disposal sites of effluents, solid waste within the project site,*
- *Aerial or satellite photographs of the site*
- *Current waste management practices including the collection, handling, transportation, treatment and final disposal methods of municipal and hazardous waste*
- *Description of site characteristics including landforms, present land use, drainage systems*
- *Type of flora and fauna, rare or endangered species, birds, sensitive habitats of ecological importance including and water bodies in the area.*

- *Marine environment including sand and rocky bottoms, coral reefs, sea grass beds, fish etc.*
- *Beach systems; composition, stability; current, tide and wave data*
- *Description of surrounding infrastructure, including utilities*
- *Socio-economic characteristics including population (numbers, ages, density, distribution), economic activities, housing and utilities, employment statistics and available skills, labour availability, unique cultural characteristics.*
- *Other attributes of the locality eg: amenities, recreational values*
- *Hazard vulnerability: vulnerability of area of flooding and storm surge.*
- *Physical environment including geomorphology, meteorology (rainfall, wind, temperature, humidity and tides)*
- *bathymetry of possible dredge areas, reclamation sites.*

This section should provide a description of any gaps in baseline data. It is not necessary to include all the baseline data in the report, but it must be available for inspection, or submission, on request.

Task 2b. Description of the Environment (Baseline Field Assessment)

The EIA should undertake the following environmental baseline field studies to assist the description of the existing environment and subsequently the assessment of potential impacts on the environment. All survey locations shall be referenced with Geographic Positioning System (GPS) including sampling points.

Where baseline data is to be collected, careful consideration must be given to the design of the survey and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Physical Environment

- *baseline air quality monitoring for SMP,at Hulhulhe, Malé and Hulhumale*
- *Ambient noise levels at noise sensitive areas of Hulhumalé and Malé shall be determined.*
- *Estimate and identify typical waste generation quantities, including types of specific recyclable waste in the general waste and hazardous waste stream*
- *insitu marine water quality (including salinity, pH, temperature and turbidity) at sampling stations within the area defined (EPA to defined the locations of water quality sampling). All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas.*
- *habitat and vegetation type demarcation within the study area based on analysis of aerial or satellite photographs -,*
- *Analytical marine water quality (including, nitrite and nitrates, total phosphorus, faecal coliforms) within the defined area (EPA to defined the locations of water quality sampling). All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas.*
- *Groundwater investigation of Hulhule including measurement of groundwater level, salinity, conductivity, pH, e.coli, nitrates, and phosphates from locations defined (EPA to defined the locations of water quality sampling).*

Biological Environment

- *A quantitative assessment of the coral reef area environment (fish communities and coral communities) surrounding Hulhule,*
- *Coastal habitat of the impact area, rate or endangered species and sensitive habitats in the impact area*
- *Study the condition of the house reef using qualitative and quantitative methods. At least one Line Intercept Transect or quadrants at each potential impact area must be undertaken.*

Terrestrial Environment

- *A vegetation survey or vegetation map of the impact area due to the airport redevelopment should be included emphasizing on species and number of mature trees as well as the number of trees that need to be removed.*

Coastal Enviroment

- *Measurements of currents, tides, and waves of the project areas must be undertaken.*

The quantitative reef assessment should be undertaken using either line Intercept Transects or quadrat methodology at a given number of sampling stations believed by the consultant to be representative of the areas to be studied. The consultant is not required to seek agreement with the EPA on the consultant's proposed methodology to undertake the required baseline surveys, outlined in this TOR. Rather, the EPA will rely on the professional experience of the consultant to identify the appropriate number and location of sampling stations as well as the methodologies to undertake the required baseline surveys.

A photographic record should be made to assist an ecological assessment of the reefs.. Any uncertainties and assumptions involved in interpreting the data should be discussed.

Task 3. Legislative and Regulatory Considerations - Describe the relevant legislation, regulations and standards, environmental policies and International Conventions, (where ratified by the Maldives) that are applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project and the project site. The EIA Report will indicate how the project conforms to the above legislative and regulatory considerations and policies and, in the event of non-conformity, measures that will be taken to ensure conformity.

- *Describe the institutional arrangements for the construction and operational phase of the project.*
- *clearly identify who is responsible for each and every componend of the project during the construction and operational stage.*

Task 4. Determine the Potential Impacts of the Proposed Project – identify the impacts for both during the construction and operational phase. Distinguish between significant impacts that are positive and negative, direct and indirect and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making. Special attention will be paid to:

- *Visual Intrusion*
- *Land preparation and foundation works*
- *impact on groundwater*
- *impacts from the desalination plant, power generation and sewerage system*
- *impacts from dredging, excavation and reclamation*
- *Water supply and demand during operational phase*

- *Sewage, waste water and storm water management and treatment during operation phase*
- *Solid waste management during construction and operation phase*
- *energy needs to be concerned while during the construction phase, associated facilities, site and location needs to be considered*
- *Oil pollution from fuel farm*
- *Impacts related to construction works including noise, vibration, fugitive dust, passenger management.*
- *Impact of dredging and reclamation must be included with potential areas that may be affected by siltation.*
- *Noise concern should be included with reference to the existing noise concern for Hulhule and also the incremental noise due to the operation of the airport*
- *marine environment due to the proposed reclamation, dredging, excavation, construction of coastal structures, production and discharge of RO plant as well as sewage outfall*
- *Sourcing, transporting and storage of construction materials*
- *Building construction activities and phasing*
- *Employment (construction and operation phase)*
- *Social impacts related to project activities including the effects on tourist, residents of Malé, Hulhumalé, ferry operators and other stakeholders.*

Task 5. Analysis of Alternatives to the Proposed Project. – The EIA Report shall also identify and describe various alternatives to each of the proposed activities associated with the project that may have a significant impact on the environment, one of which should be the "no-development option". These alternatives should be evaluated using clearly defined criteria resulting in a preferred alternative/option. Distinguish the most environmentally friendly alternatives.

Consideration should also be made alternatives for;

- *Reclamation*
- *Methodologies and technologies for reclamations*
- *Methodologies and technologies for reclamations in particular for dredging and the source of borrow*
- *locations for borrow areas to obtain materials for reclamation*

Task 6. Mitigation and Management of Negative Impacts – Identify possible measures to prevent or reduce all the significant negative impacts identified to acceptable levels where possible. Giving special attention to identify the most environmentally feasible vibration and noise levels that can be used and construction methodologies, reclamation configuration, socioeconomic impacts, insurance plan in case of any damage caused to the surrounding environment due to project activities.

The mitigation measures should also include;

- *Bird frightening techniques that would be used at the airport during the construction and operation phase of the proposed development*
- *Approximate cost of the mitigation measures, commitment, equipment and resources required to implement these measures.*

Environmental Management Plan(EMP). The basic aim of the EMP is to include the environmental system in the management of the project to ensure that various deleterious environmental impacts are

minimized to the feasible extent and enhance the beneficial impacts to the maximum possible limits. The EMP would include:

(i) Itemized Management of the deleterious and beneficial impacts during the construction and operation stages
(ii) The setup of the Environmental Management Cell. The roles and responsibilities of the various staffs and the reporting system within the organization. .
(iii) Approximate Cost of the environmental Management Plan

Task 7. Development of a Monitoring Plan – it should contain provisions made for on-site monitoring during

- *site preparation*
- *construction/ implementation,*

operation The approximate cost of monitoring should be clearly stated in the EIA Report.

- *The framework Environmental Monitoring Plan will include the following components over the different project phases (site preparation, construction and operation phase, Work involved and proposed mitigating measures to prevent negative impacts on water course/ lagoon/ beach/ road users/ immediate neighbors*
- *management of general and hazardous waste and implementation of the waste management plan that would be identified in the Environmental Management Plan for construction and operation phase of the development.*
- *Oil pollution contingency plan*
- *Outline the relevant actions proposed in the EIA report including the mitigation measures and monitoring program in the framework Environmental Management Plan.*
- *Parameters to be monitored*
- *Monitoring methodology*
- *Monitoring locations and control stations*
- *Monitoring frequency and duration*
- *Persons to conduct the monitoring and undertake the data analysis reporting the institutional system by which monitoring data will be collected, analysed, interpreted and action taken, if necessary, to prevent or reduce unwanted impacts*
- *Procedure for reporting to the authorities fire outbreak, natural calamities)*
- *Statement that the developer will allocate the financial resources as required for the agreed monitoring programme.*
- *Maintenance component including building maintenance, daily and periodical maintenance of the site, setting up of appropriate maintenance teams for treatment plant, standby generator, etc.*

Task 8. Stakeholder Consultation and Inter-Agency Coordination – public and stakeholder consultation should be undertaken during the design finalisaiton and site selection. These consultation needs to be conducted to include but not limited to the Ministry of Tourism, Arts and Culture, Ministry of Housing and Environment, Environmental Protection Agency, Marine Research Centre, other relevant government authorities Maldives Association of Travel Agents and Tour Guides, Maldives Association for Tourism Industry, Housing Development Cooperation, Maldives

Airports Company Limited and Island Aviation and ferry owner/operator. The consultation should be focused for opinions, expectations and their knowledge of surrounding.

The this section of the EIA Report should include

- *A list of persons consulted including persons in statutory bodies, atoll and island offices, community groups and NGOs, local residents, local fishermen, tourism operators and any others likely to be affected by the proposed development*
- *Information on how, when and where the consultations were conducted, eg: stakeholder meetings in the affected area, individual meetings, questionnaires*
- *Summary of the outcome of the consultations including the main concerns identified*
- *Public consultation should include residents of male,hulhumaleand villingili*

Task 9 Presentation and Timeframe - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007.

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

.....

31st October 2010

Appendix B: Commitment Letter from GMIAL

MALÉ INTERNATIONAL AIRPORT
GMR Malé International Airport Pvt. Ltd.

GMR
Administration Building
Malé International Airport
Hulhule 22000
Republic of Maldives
T +960 3325511
F +960 3325512
E info@airports.com.mv
W www.male.aero

21st November 2010

Mr. Mohamed Zuhair
Director-General
Environmental Protection Agency
Male', Maldives

Dear Mr. Zuhair,

Sub: Commitment to undertake the environmental monitoring programme proposed in the EIA for the Rehabilitation, Expansion, Modernization, Operation and Maintenance of Malé International Airport ("Project")

GMIAL hereby confirms its commitment to carry out the mitigation measures proposed in the Environmental Impact Assessment (EIA) report prepared for the Project in accordance with environmental monitoring programme.

Thanking you

Yours Sincerely

GMR Malé International Airport Pvt. Ltd. C-0490/2010

P. Sripathy
Managing Director

Corporate Office:
IBC Knowledge Park,
Phase 2, "D" Block, 9th Floor,
4/1, Bannerghatta Road,
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Karnataka, India
T +91 80 40432000
F +91 80 40432180
W www.gmrgroup.co.in

Appendix C: Declaration by Water Solutions (Consultants)

Declaration of the consultants

This EIA has been prepared according to the EIA Regulations 2007, issued by the Ministry of Environment, Energy and Water. The EIA was carried out by a multidisciplinary consulting team representing AECOM (India) and Water Solutions Private Ltd (Maldives).

We certify that the statements in this Environmental Impact Assessment study are true, complete and correct, to our best of our knowledge and ability.

Name: Ahmed Jameel (EIA 07/07)

Signature:

Name: Abdul Aleem (EIA 07/07)

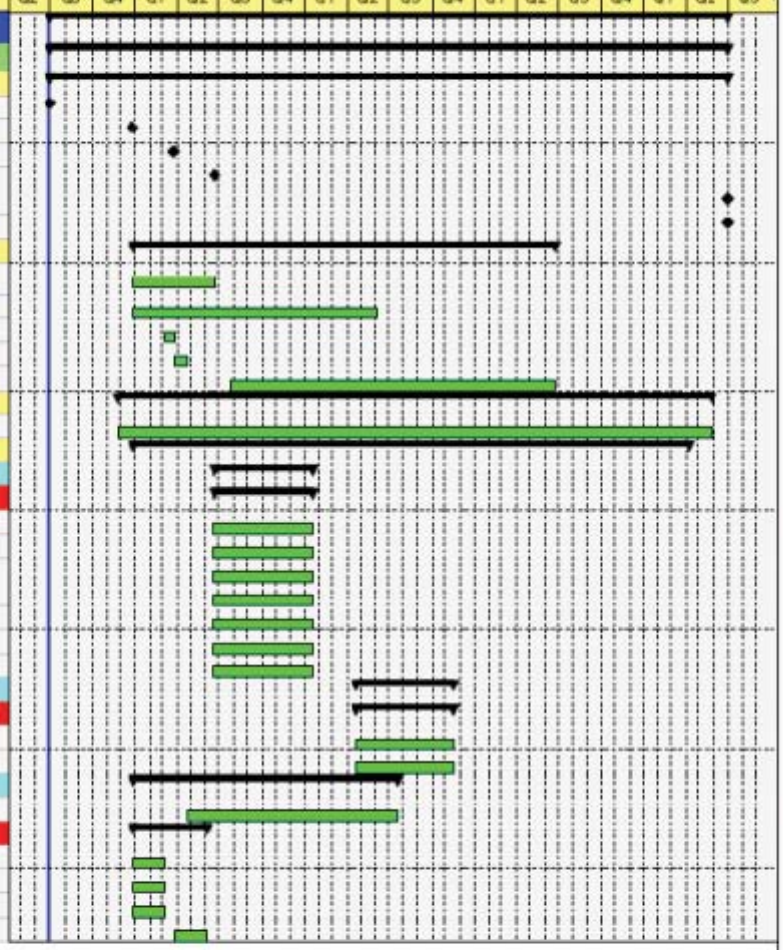
Signature:

Appendix D: Project Schedule

TENDER SCHEDULE OF MALE INTERNATIONAL AIRPORT LIMITED

PHASE I

Activity Name	Start	Finish
MALE INTERNATIONAL AIRPORT WORKS	30-Jun-10	01-Jul-14
Male International Airport Works	30-Jun-10	01-Jul-14
Mile Stone	30-Jun-10	01-Jul-14
Signing of Contract		30-Jun-10*
Effective Date		20-Dec-10
Handover Date		25-Mar-11
Works commence date	22-Jun-11	
ICAO Certification		30-Jun-14
Substantial completion of works		01-Jul-14
Engineering	27-Dec-10	23-Jun-13
Submit Master Plan	27-Dec-10	24-Jun-11
Engineering Design Pkg.submit to Independent I	27-Dec-10	03-Jun-12
Submit Environment Management Plan	06-Mar-11	26-Mar-11
Approval of EIA	26-Mar-11	25-Apr-11
Detailed Engineering	25-Jul-11	23-Jun-13
Procurement	23-Nov-10	28-May-14
Procurement	23-Nov-10	28-May-14
Construction	27-Dec-10	09-Apr-14
180 day Performance improvement works	22-Jun-11	17-Jan-12
Terminal improvements	22-Jun-11	17-Jan-12
Security channels	22-Jun-11	17-Jan-12
Check in counters	22-Jun-11	17-Jan-12
Baggage belt lengthening	22-Jun-11	17-Jan-12
Relocation of offices to under the new pier	22-Jun-11	17-Jan-12
Domestic terminal improvements	22-Jun-11	17-Jan-12
Forecourt facelift	22-Jun-11	17-Jan-12
Overall terminal facelift	22-Jun-11	17-Jan-12
Beyond 180 day Performance improvements	21-Apr-12	15-Nov-12
Airfield Improvements	21-Apr-12	15-Nov-12
Turn pad	21-Apr-12	15-Nov-12
Taxiway & Taxilane	21-Apr-12	15-Nov-12
Early works	27-Dec-10	18-Jul-12
Land reclamation & Consolidation	25-Apr-11	18-Jul-12
Site investigations	27-Dec-10	02-Jun-11
Geo technical survey	27-Dec-10	06-Mar-11
Topographical survey	27-Dec-10	06-Mar-11
Bathimetry	27-Dec-10	06-Mar-11
Site survey	26-Mar-11	02-Jun-11



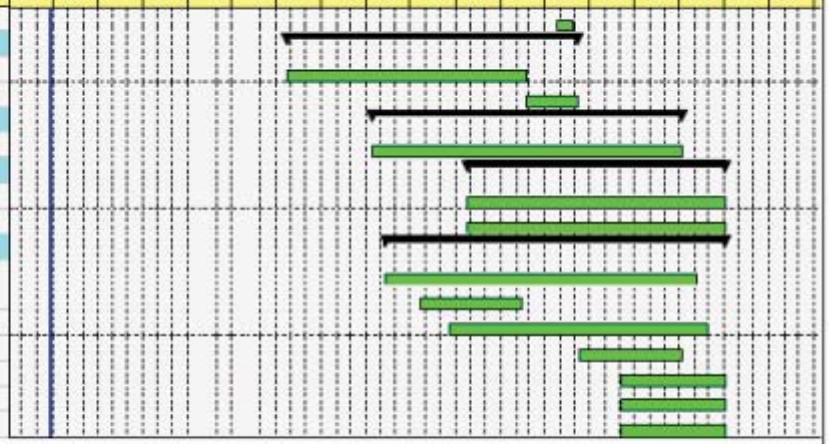
Primary Baseline | Critical Remaining Work | Summary
Actual Work | Milestone

15-Jun-2010

TENDER SCHEDULE OF MALE INTERNATIONAL AIRPORT LIMITED

PHASE I

Activity Name	Start	Finish
Markings	25-Apr-13	29-May-13
Fuel Farm	23-Oct-11	08-Jun-13
Fuel Farm	23-Oct-11	23-Feb-13
Dismantling of existing Fuel farm	24-Feb-13	08-Jun-13
Cargo Terminal Building works	14-Apr-12	04-Jan-14
Cargo Terminal Building	14-Apr-12	04-Jan-14
Utilities	25-Oct-12	03-Apr-14
STP	25-Oct-12	03-Apr-14
Desalination Upgrade/New Facility	25-Oct-12	03-Apr-14
Other Facilities	13-May-12	03-Apr-14
Seaplane/Boat Jetties	13-May-12	02-Feb-14
MNDF Facility	19-Jul-12	13-Feb-13
ForeCourt &Parking	20-Sep-12	27-Feb-14
ARFF	09-Jun-13	04-Jan-14
Stores	05-Sep-13	03-Apr-14
Ground Handling Base	05-Sep-13	03-Apr-14
Airport Maintenance facility	05-Sep-13	03-Apr-14

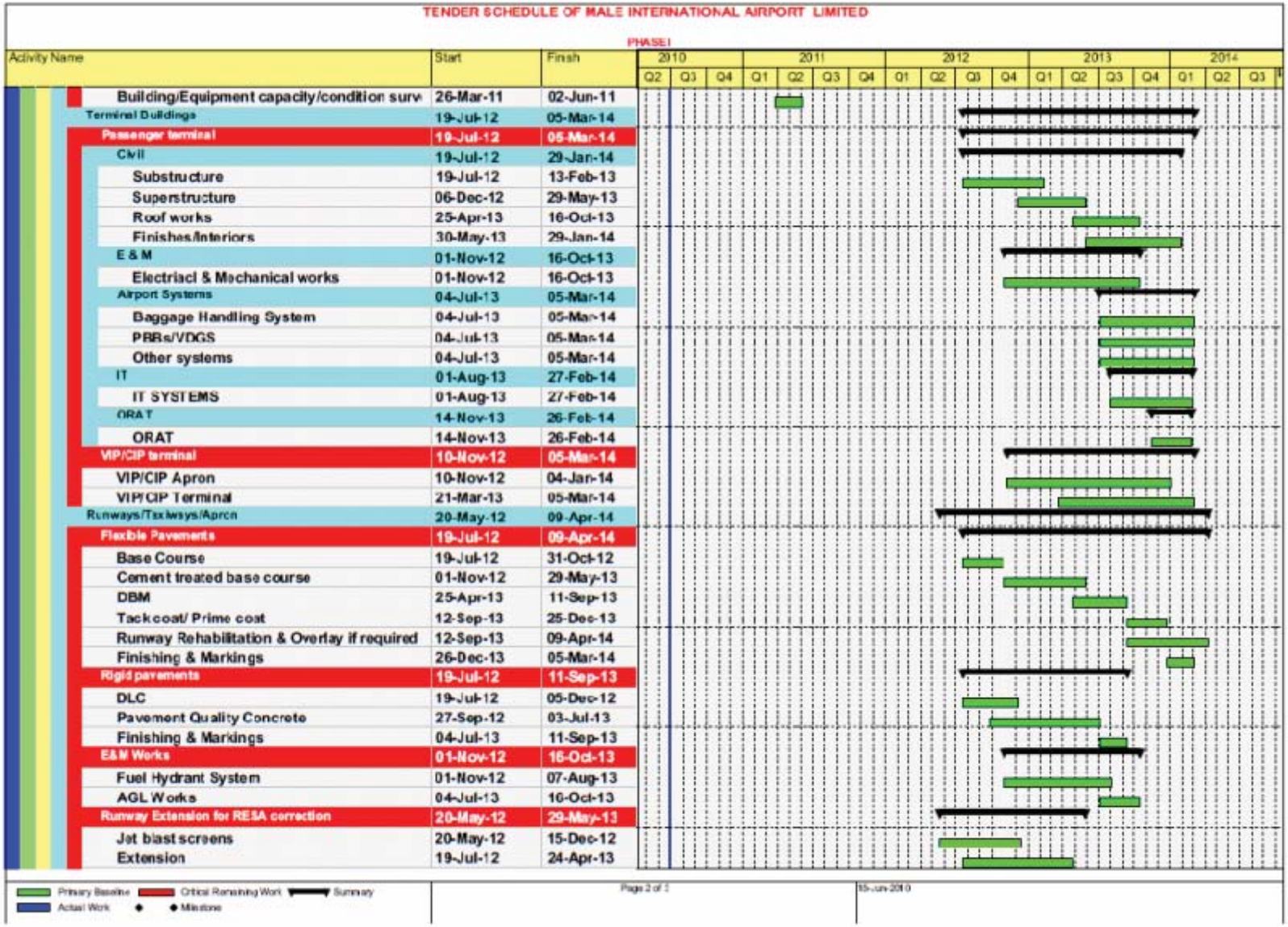


Primary Baseline Critical Remaining Work Summary
Actual Work Milestone

15-Jun-2010

TENDER SCHEDULE OF MALE INTERNATIONAL AIRPORT LIMITED

PHASE I



Activity Name	Start	Finish
Building/Equipment capacity/condition surv	26-Mar-11	02-Jun-11
Terminal Buildings	19-Jul-12	05-Mar-14
Passenger terminal	19-Jul-12	05-Mar-14
Civil	19-Jul-12	29-Jan-14
Substructure	19-Jul-12	13-Feb-13
Superstructure	06-Dec-12	29-May-13
Roof works	25-Apr-13	16-Oct-13
Finishes/Interiors	30-May-13	29-Jan-14
E & M	01-Nov-12	16-Oct-13
Electriacl & Mechanical works	01-Nov-12	16-Oct-13
Airport Systems	04-Jul-13	05-Mar-14
Baggage Handling System	04-Jul-13	05-Mar-14
PBBs/VDGS	04-Jul-13	05-Mar-14
Other systems	04-Jul-13	05-Mar-14
IT	01-Aug-13	27-Feb-14
IT SYSTEMS	01-Aug-13	27-Feb-14
ORAT	14-Nov-13	26-Feb-14
ORAT	14-Nov-13	26-Feb-14
VIP/CIP terminal	10-Nov-12	05-Mar-14
VIP/CIP Apron	10-Nov-12	04-Jan-14
VIP/CIP Terminal	21-Mar-13	05-Mar-14
Runways/Taxiways/Apron	20-May-12	09-Apr-14
Flexible Pavements	19-Jul-12	09-Apr-14
Base Course	19-Jul-12	31-Oct-12
Cement treated base course	01-Nov-12	29-May-13
DBM	25-Apr-13	11-Sep-13
Tackcoat/ Prime coat	12-Sep-13	25-Dec-13
Runway Rehabilitation & Overlay if required	12-Sep-13	09-Apr-14
Finishing & Markings	26-Dec-13	05-Mar-14
Rigid pavements	19-Jul-12	11-Sep-13
DLC	19-Jul-12	05-Dec-12
Pavement Quality Concrete	27-Sep-12	03-Jul-13
Finishing & Markings	04-Jul-13	11-Sep-13
E&M Works	01-Nov-12	16-Oct-13
Fuel Hydrant System	01-Nov-12	07-Aug-13
AGL Works	04-Jul-13	16-Oct-13
Runway Extension for RESA correction	20-May-12	29-May-13
Jet blast screens	20-May-12	15-Dec-12
Extension	19-Jul-12	24-Apr-13

15-Jun-2010

Appendix E: List of Respondents during Public Consultation

Respondents

. **Some respondents from Male' Vilingili and Hulhumale'**

Address	Name	Area of Work
M. Niumath	Mariyam Azeema	Civil Servant
M. Hanhaara	Mohamed Waheed	Private Sector
M. Hanhaara	Ali Adam	Civil Servant
M. Hanhaara	Shauna Hussain	Civil Servant
H. Manzil Rose	Ali Waheed	Civil Servant
M. Feeroazuge	Aishath Alya	Civil Servant
M. Feeroazuge	Fathimath Zehereen	Civil Servant
M. Feeroazuge	Raaman	Civil Servant
M. Nayagan	Mohamed Khaleem	Private Sector
M. Nayagan	Ahmed Khaleem	Not working
H. Naasthaa	Fathimath zeeshan Amir	Private Sector
G. Raskara	Mariyam Reesha Rasheed	Civil Servant
G. Freemans	Khadheeja Hussain	Civil Servant
Noonu Fehendhoo Ruvaage	Zeenath Waheed	Student
K. Maafushi Rozy	Alibe	Private Sector
Ma. Rozy side	Rassam Sattar	Private Sector
V. Finiroalhi	Hudhuna Ali	College Student
Ma. Aasthana	Ali Amir	Not working
Ma. Ruvage	Fazna Mohamed	Collage Student
Ma. Ali House	Hana Ali	Civil Servant
Ma. Black Hiuse	Ahmed Mohamed	Private Sector
V. Finikuraage	Hussain Amir	Private Sector
H Alif Ihavandhoo, Baazee	Rasheedube	Private Sector
H Alif Ihavandhool, Roashaneege	Hussain Fulhu	Private Sector
Vaavu. Felidhoo. Half Manzil	Hazrath Waheed	Private Sector
Vaavu. Feliidhoo. Half Road Vaadhee	Hussian Amru	Private Sector
Gaafu Dhaalu. Thnadhoo. Vaarey Manzil	Haseena Latheef	Civil Servant
Haa Dhaalu Kulhudhufushi. Hiyagaraagu	Fathimath Jeeza	Not working
Noonu Velidhoo. Youth House	Don Ali	Civil Servant
M. Bahaaruvilla	Shamila Adam	Civil Servant
Ma. Lunboage	Fathimath Adam	Not working
Ma. Iskandaruvilla	Musthfa Ali	Not working
Ma. Klhaoage	Aishath Naaz	Not working
Ma. Boakeyogasdhoshuge	Abdul Shukoor	Not working
Ma. Gulheege	Ali Azim	Private Sector
M, Red Rose	Hussian Waheedh	Private Sector
M. Red Rose	Mohamed Waheedh	Not working
M. Vaadhee villa	Samiya Ali	Civil Servant
G Dh. Thinadhoo. Vaarey Manzil	Fathimath Hassena	Civil Servant
G Dh Thinadhoo. Hikifinifenmaa	Hussain Hassan	Civil Servant
G Dh Thinadhoo. Hikifinifenmaa	Huseynu be	Not working
G Dh Thinadhoo. Manzil	Varudha Waheedh	Civil Servant
G Dh Thinadhoo. Ahi	Wheedha	Civil Servant
Dhallu kudahuvadhoo, Fenfiyaazuge	Fathimath Sumaiyya Ali	Civil Servant
Dhaalu Kudahuvadhoo. Hanafas	Zeenath Abbaa	Civil Servant
Dhaalu Meedhoo. Thankyou House	Mohammed Hussain	Not working
Dhaalu Meedhoo. Thankyou House	Fathimath Raheema Ali	Civil Servant
K. Maafushi. Honey	Aisha Shaheen Adam	Not working

K. Maafushi. Honey	Fathimath Smiya Adam	Private Sector
K. Gulhi. Fasmanzaru	Adam Hussain	Private Sector
K. Gulhi. Reynas	Nadheeha Waheedh	Not working
K. Gulhi. Roashanee	Fizanan waheedh	Private Sector
K. Gulhi. Roashanee	Fareedha Waheedh	Private Sector
K. Gilhi, Rose	Hisamath	Not working
M. Blue Diamond	Fathimaht Hussain	Private Sector
M. Jootflower	Thufeeq Ali	Private Sector
M. jootflower	Fathimath Naseera Ismail	Private Sector
Ma. Frenzy house	Ismail wahaab	Not working
Ma. Frenzy House	Mohamed Wahaab	Private Sector
M. Atha gasdhoshuge	Fathimath Suzan	Private Sector
M. Atha gasdhoshuge	Nahudha Ali	Civil Servant
H. Reed	Reeman thaufeeq	Civil Servant
G. AD villa	Hassan be	Private Sector
M. AD house	Ail Waheed	Private Sector
M. Rasheed fihaara	Mohamed Ali	Private Sector
G. Aabaadhee	Hasfsa Ali	Civil Servant
Ma .Aabaadhu	Hussain Nooraan	Civil Servant
M. Aabageechaa	Ali Ismail	Civil Servant
G. Aabidhaa manzil	Nabeen Ahmed	Civil Servant
G. Aabin	Fathimath Nashiya	Civil Servant
G. Aabuhavaa	Fathimath Zuhuraa	Civil Servant
M. Aadhaige	Ismail Fulhu	Not working
M. Aadhilleege	Qasim ibrahim'	Not working
M. Aadhuni	Ali Rameez	Private Sector
G.Faadu	Fathimath Fadhuva Hassan	Private Sector
G. Safalge	Aminath Nizam	Private Sector
V. Aafehi	Fazna Shalir	Private Sector
H. Fini vaijeheyge	Aiminath Amila Rasheed	Private Sector
M. Aagadhage	Irufan waheedh	College Student
H. Aagaraa house	Azha Mohamed	College Student
H. Aagaraage	Sajidha Adam	College Student
M. Noogas	Dhau Akram	Not working
H. Aagisaa manzil	Agisa Ali	Not working
M. Aagulshan	Zulaikha Adam	Not working
G. Aahama	Hmdhaan Noor	Not working
M. Nahethi	Fathimath Shiyana	Civil Servant
H. aahiyaa	Hussain Shamrooh Ali	Civil Servant
G. hiyaa gulshan	Gulfiashan Zahir	Civil Servant
M. Aahiyaa irumatheebai	Mariyam Noora	Civil Servant
H. Aashiyaa villa	Reesha Rasheed	Not working
G. Ishaa	Hytham	Not working
G. Jeenaa	Ahmed Suhail	Not working
M. Kaash	Waheedha Baaree	Not working
M. Aakaash villa	Fathimath Haleemath	Not working
M. Akakaage	Haneefa	Civil Servant
M. Aakakaage no 1	Ahmed Akram	Private Sector
H. Fenkuri	Fathimath Zuhuraa	Not working
G. Aala	Mohamed Ali	Private Sector
H. Aammu ufa	Fathimaht Zeehaan	Civil Servant
H. Aamuleege	Soffath Ali	Civil Servant
H. Aamuli	Aishath Nadhiya	Private Sector
H. Hikimuranga	Lalith	Private Sector
V. Dhandhu	Gasim Hassan	Private Sector
G. Nandhu	Ramziya Hussain	Private Sector

V. Hinmaiy	Reena Rameez	Private Sector
V. Maakuradhu	Farudheen Waheedh	Private Sector
V. Mustharee aabaadh	Reeshga Zubair	Student
V. Thiyara house	Hamid Huzaam	Student
V. White pearl	Vaahid	Student
V. Arifa manzil	Baasil Nasheed	Student
V. Erru hura	Mohamed Wajeeh	Civil Servant
V. Ever light	Ruwaidha Hameedh	Civil Servant
V. Farimaa hiya	Hamna Rasheed	Civil Servant
V. Five flowers	Hassan Waheedh	Cil Seevant
V. Progress	Jaisham Maleeh	Civil Servant
V. Iscreen aage	Zooshan Mohamed	Private Sector
V. Miares	Naushan Waheed	Private Sector
V. Ran thundi	Fathimath Reena	Private Sector
V. Elex	Reeman Haris	Private Sector
V. Hadhiya	Ali Mansoor	Not Working
V. Azlifa manzil	Hussain Waheedh	Private Sector
V. Babukeyo	Badheeu Ali	Private Sector
V. Chandellie	Buruhaan	Private Sector
V. Fas kani	Mohamed Hameedh	Private Sector
V. Florida house	Fatheena Ali	Civil Servant
V. Geveli	Fuireen Shafeeq	Civil Servant
V. Arankaa	Ameetha Ali	Civil Servant
V. Lucky offer	Badhoora Ali	Civil Servant
V. Reel manzil	Mariyam Salvaa	Civil Servant
V. Maamuthi	Aishath Shafeeq	Private Sector
V. Najuhiya	Fathimath Nihaya	Private Sector
V.Perismaa	Ramiza Ali	Private Sector
V. Rassaam	Aishath Leeza	Private Sector
V. Randy village	Fathimath Musthaq	Private Sector
V. Ranika manzil	Haaroon Ali	Private Sector
V. Shimaa	Ansaam Waheedh	Civil Servant
V. Suha	Fathimath Shuha	Civil Servant
V.Theeru	Zuhuraa Zareer	Civil Servant
Hulhumale'' 53308	Nazif	Pilot
Hulhumale'' 33003	Aafaaq	Airline Crew
Hulhumale'' 53209	Aishath Razeena	Not Working
Hulhumale' 37092	Azu	Private Sector
Hulhumale' 37092	Haleela	Private Sector
Hulhumale' 37092	Maahidh	Private Sector
Hulhumale'	Mohamed Anees	Private Sector
Hulhumale'	Rushdhee	Private Sector
Hulhumale'	Ibbe	Private Sector
Hulhumale'	Mariyam Shaeedha	College Student
Hulhumale'	Nisreen	Private Sector
Hulhumale'	Waheedha Ali	Not Working
Hulhumale'	Don Deen	Not Working
Hulhumale'	Fathimath Waheedha	Not working
Hulhumale'	Reenaa	Not Working
Hulhumale'	Mohamed Rasheed	Private Sector
Hulhumale'	Ali Waheed	Private Sector
Hulhumale'	Ali Mansoor	Private Sector
Hulhumale’	Ali Amir	MIA staff
Hulhumale’	Abdulla Shukoor	MIA Staff
Hulhumale’	Aleem	Student
Hulhumale’	Moosa Aboobakuru	Civil Servant

Hulhumale' visitor	Rasheed	Private sector
Hulhumale' visitor	Adam	not working
Hulhumale'	Abdulla Shimau	student
Hulhumale'	Mohamed Ali	HDC vessel
Hulhumale'	Ashfag Mohamed	private sector
Hulhumale'	Mohamed	private sector
Hulhumale'	Hussein Waheed	private sector
Hulhumale'	Ali Naeem	private sector
Hulhumale'	Imadulla	private sector
Hulhumale'	Khadeeja	housewife
Hulhumale'	Mh Yasin	Bangladesh carpenter
Hulhumale'	Abdulla Mufeed	
Hulhumale'	Jinna	HDC
Hulhumale'	Shizu	receptionist restaurant
Hulhumale'	Habeeb	guest house owner
Hulhumale'	Mufeed	private sector
Hulhumale' visitor	Ahmed Ali	private sector
Hulhumale' visitor	Ibrahim Shah	police
Hulhumale' visitor	Moosa Ismail	Businessman
Hulhumale'	Hawwa	housewife
Hulhumale'	Hussein Rasheed	businessman
Male'	Abdulla Rauf	tour agency
Male'	Ahmed Hafeez	Bandos employee
Hulhmale	Ibrahim Mohamed Nishan	
Male'	Fauzee	MIA shop manager
Male'	Haisham	Businesman
Hulhumale''	Muaz	MTCC ferry
Hulhumale'	Ibrahim Thoyib	Guest House owner
Hulhumale'	Abdulla	Guest House owner
Hulhumale'	Zaid Mohamed	Tour Agent

MALDIVES MIAS COMPANY LIMITED

Support Staff

Moosa Abubakuru - Support Staff
Suaib Mohamed - Support Staff
Abdul Latheef - Support Staff
Hassan Fathee - Assistant Maison
Hassan Rasheed - Support Staff Carpentry
Mohamed Rasheed - Support Staff
Abdul Samad - Support Staff
Abdulla Arif - Support Staff
Mohamed Afthab - Support Staff
Ahmed Lirar - Support Staff

Project Implementation Unit, Engineering Section

Mohamed Areef - Assistance Officer Administration
Abdul Shaheed Mohamed - Officer Maintenance
Ismail Anil - Officer Maintenance
Hussain Rasheed - Snior Officer accounts
Maumoon Majdheed - Senior Officer

Mohamed Nizam Ahmed - Janitor group head
Ismail Shiyam Mohamed - Electrical Engineer
Abdul Waleed - Assistance Officer
Abdul Majeedh - Assistance Officer
Akram Ramzee -Officer Maintenance

MIA Corporate section

1. Ali Huzam
2. Abdulla Amjad
3. Shiyama Ibrahim
4. Fathimath Fazeela
5. Rahumathulla Ashrah

HDC
Azleen- Senior Planning Officer
Fayaz
Mohamed Suhail – Member of Board of Directors

MTCC

Hawwa Huzeima	Executive
Mohamed Zameel	Chief Operating Officer

Island Aviation

Aishath Jenifer	Manager Loyalty Program

Hulhumale' Crime Prevention Committee

Abdulla Naseer	Police
Abdulla Rasheed	Vice Chairperson/ Hulhumale' Environment ,Youth and Development
Shama Mohamed	Hulhumale' Association for Women
Mohamed Shujau	Hulhumale' Preschool
Mohamed Hassan Fulhu	

Ferry services
Mohamed Gudhrath
Ahmed Shaid

TMA
Ahmed Latheef Deputy Managing Director

MATATO
Mohamed Maleeh Jameel- Secretary General

MATI
Sim Mohamed Ibrahim – Secretary General

MHE
Mohamed Zahir- Director General

EPA

Mohamed Zuhair – Director General

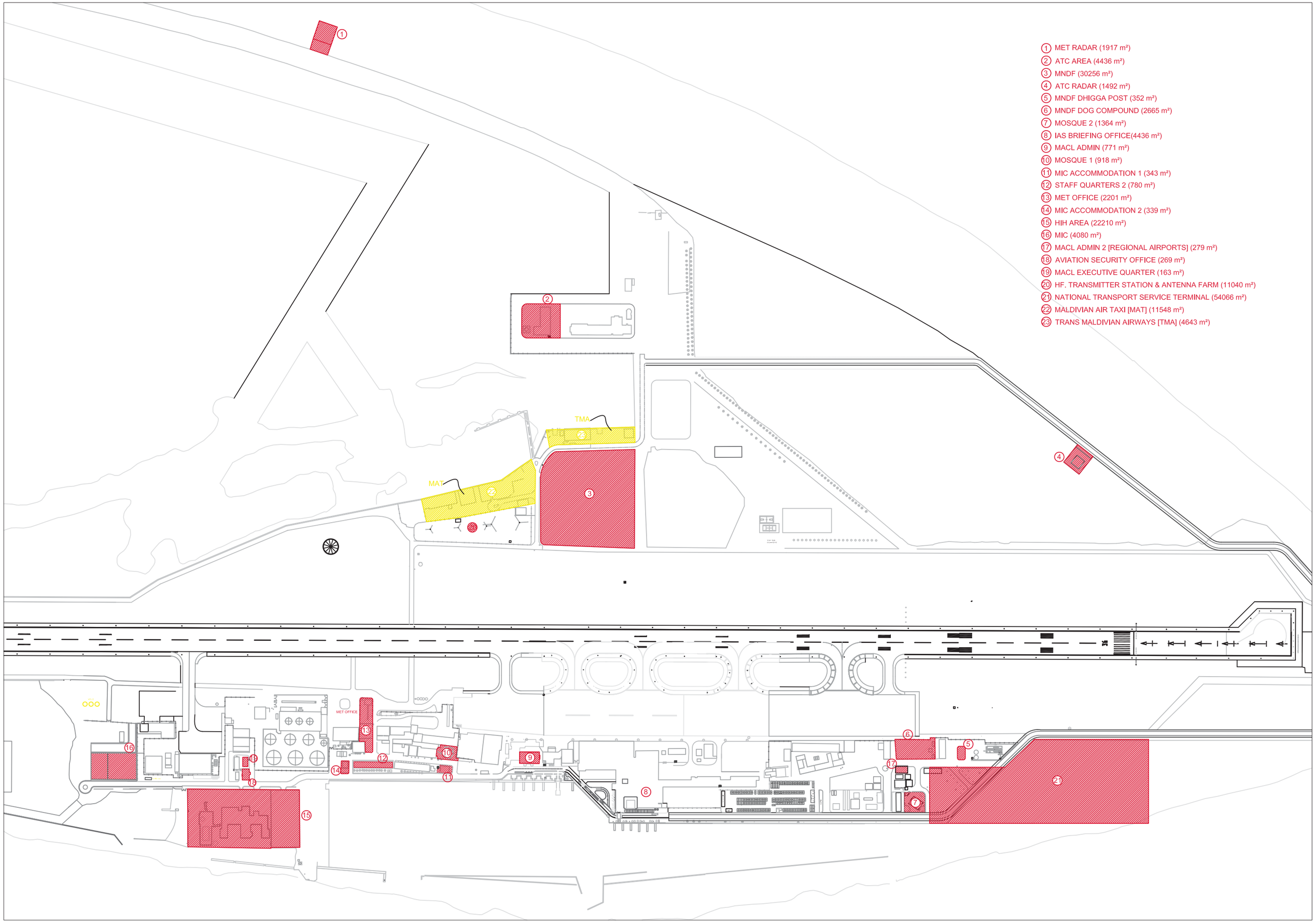
MTAC
Aishath Ali –Director General
Moosa zameer – Assistant Director
Izmeela
Fazla

MOFA
Adam Manik –Director

Resort Owner
Mohammed Waheedudheen

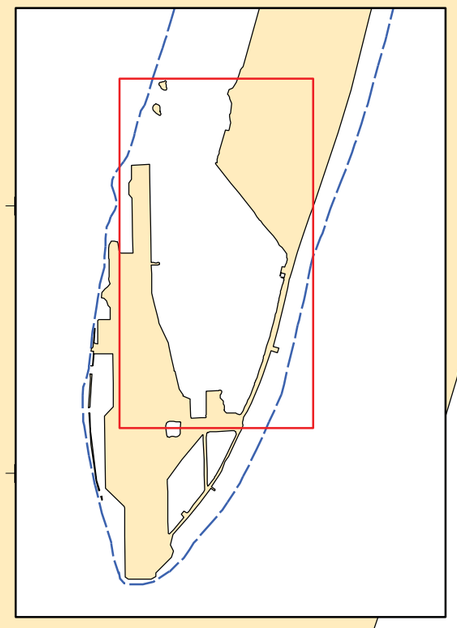
Privatisation Committee
Mahmood Razee

Appendix F: Airport Site Boundary Plan



1. MET RADAR (1917 m²)
2. ATC AREA (4436 m²)
3. MNDF (30256 m²)
4. ATC RADAR (1492 m²)
5. MNDF DHIGGA POST (352 m²)
6. MNDF DOG COMPOUND (2665 m²)
7. MOSQUE 2 (1364 m²)
8. IAS BRIEFING OFFICE(4436 m²)
9. MACL ADMIN (771 m²)
10. MOSQUE 1 (918 m²)
11. MIC ACCOMMODATION 1 (343 m²)
12. STAFF QUARTERS 2 (780 m²)
13. MET OFFICE (2201 m²)
14. MIC ACCOMMODATION 2 (339 m²)
15. HIH AREA (22210 m²)
16. MIC (4080 m²)
17. MACL ADMIN 2 [REGIONAL AIRPORTS] (279 m²)
18. AVIATION SECURITY OFFICE (269 m²)
19. MACL EXECUTIVE QUARTER (163 m²)
20. HF. TRANSMITTER STATION & ANTENNA FARM (11040 m²)
21. NATIONAL TRANSPORT SERVICE TERMINAL (54066 m²)
22. MALDIVIAN AIR TAXI [MAT] (11548 m²)
23. TRANS MALDIVIAN AIRWAYS [TMA] (4643 m²)

Appendix G: Bathymetric Plans



Hulhumale' Island

Male' International Airport

Hulhule Island Airport Bathy Chart

PROJECTION: Transverse Mercator (UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Mean Sea Level (2010) - Hulhule Airport Tide Gauge
All features based on GPS surveys (October 2010); satellite imagery (2007)
Map version 2 updated 27-10-2010.

0 120 240 480 720 960 Meters

N W E S

Surveyed and Prepared by: CDE Consulting, Maldives

Inner Lagoon 2

Reef

Hulhule Island Airport Bathy Chart
Inner Lagoon 1

PROJECTION: Transverse Mercator (UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Mean Sea Level (2010) - Hulhule Airport Tide Gauge
All features based on GPS surveys (October 2010); satellite imagery (2007)
Map version 2 updated 27-10-2010.

0 20 40 80 120 160 Meters

N W E S

Surveyed and Prepared by: CDE Consulting, Maldives

Male' International Airport

Reef Line

Hulhule Island Airport Bathy Chart
Inner Lagoon 2

PROJECTION: Transverse Mercator (UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Mean Sea Level (2010) - Hulhule Airport Tide Gauge
All features based on GPS surveys (October 2010); satellite imagery (2007)
Map version 2 updated 27-10-2010.

0 35 70 140 210 280 Meters

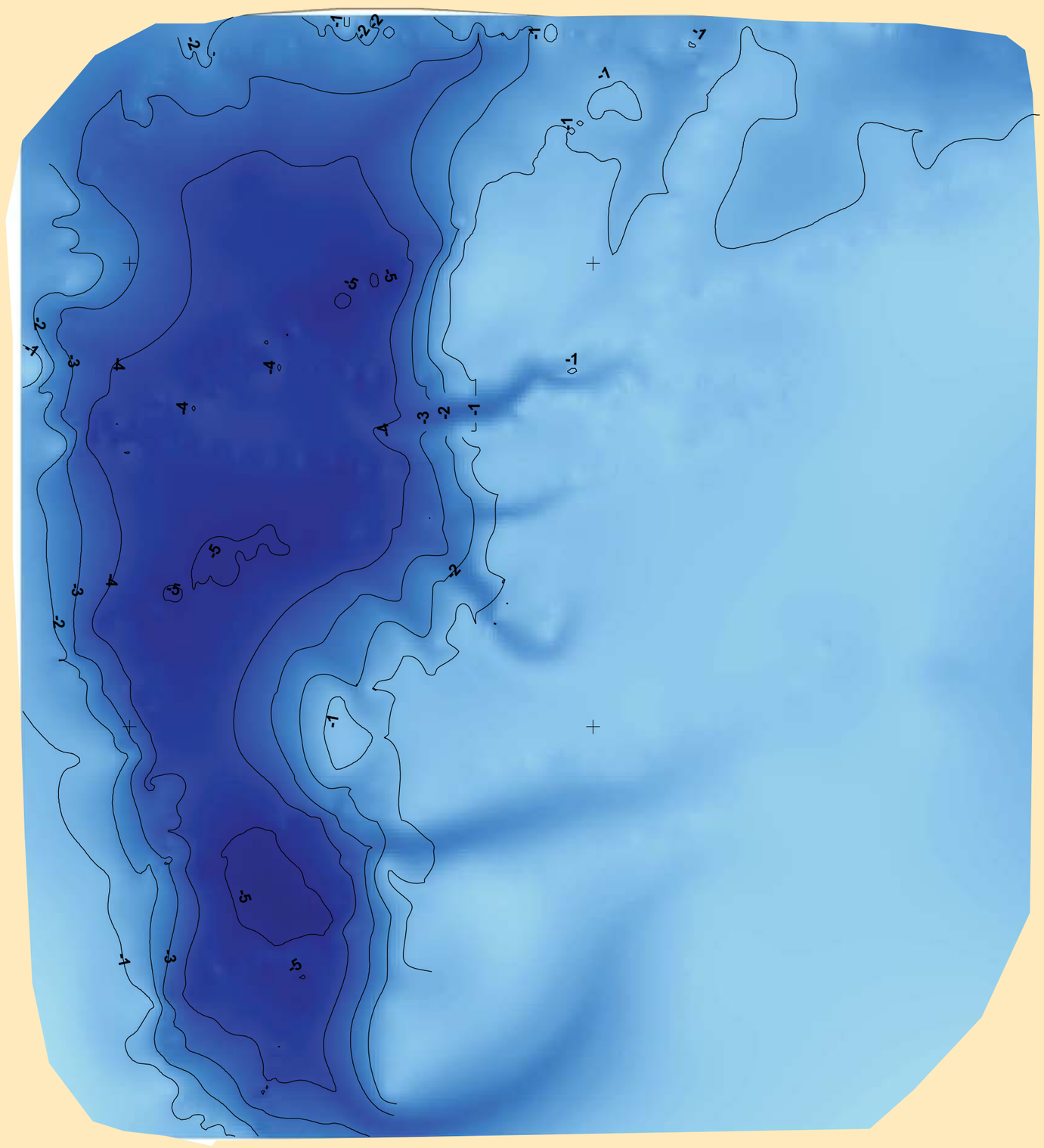
N W E S

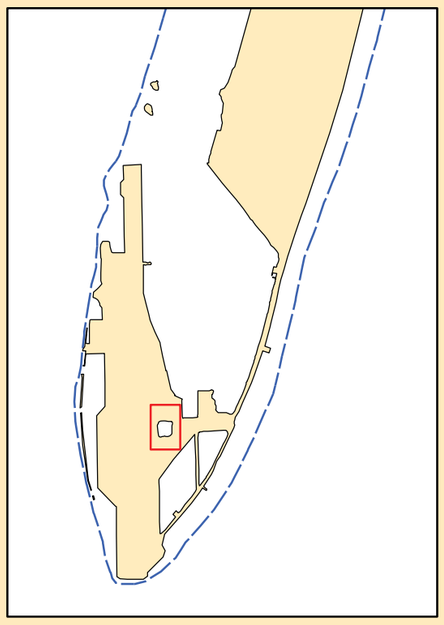
Surveyed and Prepared by: CDE Consulting, Maldives

336900.000000 336950.000000 337000.000000 337050.000000

463100.000000 463050.000000 463000.000000 462950.000000 462900.000000

Male' International Airport





Hulhule Island Airport Bathy Chart
Inner Lagoon 3

PROJECTION: Transverse Mercator (UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Mean Sea Level (2010) - Hulhule Airport Tide Gauge
All features based on GPS surveys (October 2010); satellite imagery (2007)
Map version 2 updated 27-10-2010.

0 10 20 40 60 80 Meters

N W E S

Surveyed and Prepared by: CDE Consulting, Maldives

337000.000000 337200.000000 337400.000000 337600.000000

463000.000000 462800.000000 462600.000000 462400.000000 462200.000000 462000.000000

Inner Lagoon 3

Inner Lagoon 1

Inner Lagoon 2

Reef

0.5 3 3.5 2 1 0.5

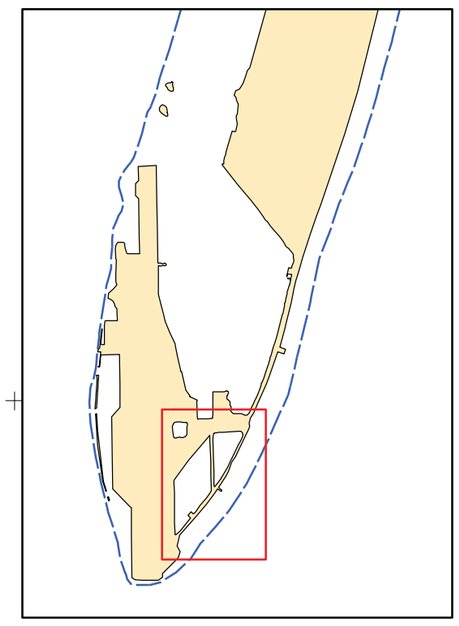
0.5 4 3 2 1

0.5

0.5

0.5

1 0.5 2 3 3.5



Hulhule Island Airport Bathy Chart Oceanward

PROJECTION: Transverse Mercator (UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Mean Sea Level (2010) - Hulhule Airport Tide Gauge
All features based on GPS surveys (October 2010); satellite imagery (2007)
Map version 2 updated 27-10-2010.

0 45 90 180 270 360 Meters

N W E S

Survyed and Prepared by: CDE Consulting, Maldives

Appendix H: Input Data for Air Modelling

EDMS 5.1.2 Model Inputs for BESAP Study

Study Created:	Tue Oct 26 07:20:05 2010
Report Date:	Sun Nov 07 18:50:35 2010
Study Pathname:	D:\BESAP\BESAP.edm

Study Setup

Unit System:	Metric
Dispersion Modeling:	Dispersion is enabled for this study
Speciated Organic Gas (OG) Modeling:	Speciated Organic Gas (OG) Emissions are excluded from this study.
Analysis Years:	2009

Scenarios

Scenario Name:	Description:	Add a description.
Baseline	Aircraft Times in Mode Basis:	Performance-Based
	Taxi Time Modeling:	Delay & Sequencing Model
	FOA3 Sulfur-to-Sulfate Conversion Rate:	2.400000 %
Scenario Name:	Description:	Add a description.
icao/usepa	Aircraft Times in Mode Basis:	Performance-Based
	Taxi Time Modeling:	Delay & Sequencing Model
	FOA3 Sulfur-to-Sulfate Conversion Rate:	2.400000 %

Airports

Airport Name:	Male Intl
IATA Code:	MLE
ICAO Code:	VRMM
FAA Code:	
Country:	MV
State:	
City:	Male
Airport Description:	Male Intl
Latitude:	4.192°
Longitude:	73.529°
Northing:	463484.98
Easting:	336745.83
UTM Zone:	43
Elevation:	6.00 feet
PM Modeling Methodology:	FOA3

Scenario-Airport: Baseline, Male Intl

Weather

Baseline, Male Intl

Mixing Height:	914.40 meters
Temperature:	28.53 °C
Daily High Temperature:	34.28 °C
Daily Low Temperature:	22.78 °C
Pressure:	101320.73 Pa
Sea Level Pressure:	101083.69 Pa
Relative Humidity:	79.66
Wind Speed:	18.02 kph
Wind Direction:	0.00 °
Ceiling:	30480.00 m
Visibility:	80.47 km

The user has used hourly meteorological data.

Base Elevation:	1.83 meters
Date Range:	Thursday, January 01, 2009 to Saturday, January 31, 2009
Source Data File Location:	D:\BESAP\INFORM~1\jansur.met
Upper Air Data File Location:	D:\BESAP\INFORM~1\janua.dat

Quarter-Hourly Operational Profiles

Baseline, Male Intl

Name: DEFAULT

Quarter-Hour	Weight	Quarter-Hour	Weight	Quarter-Hour	Weight	Quarter-Hour	Weight
12:00am to 12:14 am	1.000000	6:00am to 6:14am	1.000000	12:00pm to 12:14 pm	1.000000	6:00pm to 6:14pm	1.000000
12:15am to 12:29 am	1.000000	6:15am to 6:29am	1.000000	12:15pm to 12:29 pm	1.000000	6:15pm to 6:29pm	1.000000
12:30am to 12:44 am	1.000000	6:30am to 6:44am	1.000000	12:30pm to 12:44 pm	1.000000	6:30pm to 6:44pm	1.000000
12:45am to 12:59 am	1.000000	6:45am to 6:59am	1.000000	12:45pm to 12:59 pm	1.000000	6:45pm to 6:59pm	1.000000
1:00am to 1:14am	1.000000	7:00am to 7:14am	1.000000	1:00pm to 1:14pm	1.000000	7:00pm to 7:14pm	1.000000
1:15am to 1:29am	1.000000	7:15am to 7:29am	1.000000	1:15pm to 1:29pm	1.000000	7:15pm to 7:29pm	1.000000
1:30am to 1:44am	1.000000	7:30am to 7:44am	1.000000	1:30pm to 1:44pm	1.000000	7:30pm to 7:44pm	1.000000
1:45am to 1:59am	1.000000	7:45am to 7:59am	1.000000	1:45pm to 1:59pm	1.000000	7:45pm to 7:59pm	1.000000
2:00am to 2:14am	1.000000	8:00am to 8:14am	1.000000	2:00pm to 2:14pm	1.000000	8:00pm to 8:14pm	1.000000
2:15am to 2:29am	1.000000	8:15am to 8:29am	1.000000	2:15pm to 2:29pm	1.000000	8:15pm to 8:29pm	1.000000
2:30am to 2:44am	1.000000	8:30am to 8:44am	1.000000	2:30pm to 2:44pm	1.000000	8:30pm to 8:44pm	1.000000
2:45am to 2:59am	1.000000	8:45am to 8:59am	1.000000	2:45pm to 2:59pm	1.000000	8:45pm to 8:59pm	1.000000
3:00am to 3:14am	1.000000	9:00am to 9:14am	1.000000	3:00pm to 3:14pm	1.000000	9:00pm to 9:14pm	1.000000
3:15am to 3:29am	1.000000	9:15am to 9:29am	1.000000	3:15pm to 3:29pm	1.000000	9:15pm to 9:29pm	1.000000
3:30am to 3:44am	1.000000	9:30am to 9:44am	1.000000	3:30pm to 3:44pm	1.000000	9:30pm to 9:44pm	1.000000
3:45am to 3:59am	1.000000	9:45am to 9:59am	1.000000	3:45pm to 3:59pm	1.000000	9:45pm to 9:59pm	1.000000
4:00am to 4:14am	1.000000	10:00am to 10:14am	1.000000	4:00pm to 4:14pm	1.000000	10:00pm to 10:14pm	1.000000
4:15am to 4:29am	1.000000	10:15am to 10:29am	1.000000	4:15pm to 4:29pm	1.000000	10:15pm to 10:29pm	1.000000
4:30am to 4:44am	1.000000	10:30am to 10:44am	1.000000	4:30pm to 4:44pm	1.000000	10:30pm to 10:44pm	1.000000
4:45am to 4:59am	1.000000	10:45am to 10:59am	1.000000	4:45pm to 4:59pm	1.000000	10:45pm to 10:59pm	1.000000
5:00am to 5:14am	1.000000	11:00am to 11:14am	1.000000	5:00pm to 5:14pm	1.000000	11:00pm to 11:14pm	1.000000
5:15am to 5:29am	1.000000	11:15am to 11:29am	1.000000	5:15pm to 5:29pm	1.000000	11:15pm to 11:29pm	1.000000
5:30am to 5:44am	1.000000	11:30am to 11:44am	1.000000	5:30pm to 5:44pm	1.000000	11:30pm to 11:44pm	1.000000
5:45am to 5:59am	1.000000	11:45am to 11:59am	1.000000	5:45pm to 5:59pm	1.000000	11:45pm to 11:59pm	1.000000

Daily Operational Profiles

Baseline, Male Intl

Name: DEFAULT

Day	Weight	Day	Weight
Monday	1.000000	Friday	1.000000
Tuesday	1.000000	Saturday	1.000000
Wednesday	1.000000	Sunday	1.000000
Thursday	1.000000		

Monthly Operational Profiles

Baseline, Male Intl

Name: DEFAULT

Month	Weight	Month	Weight
January	1.000000	July	1.000000
February	1.000000	August	1.000000
March	1.000000	September	1.000000
April	1.000000	October	1.000000
May	1.000000	November	1.000000
June	1.000000	December	1.000000

Aircraft

Baseline, Male Intl

Default Taxi Out Time:	19.000000 min
Default Taxi In Time:	7.000000 min

Year:	Uses Schedule?	Schedule Filename:
2009	No	(None)

Aircraft Name:
Airbus A319-100 Series
Engine Type:
CFM56-5B6/P
Identification:
male mon5
Category:
LCJP

Take Off weight:	66270.00 Kgs
Approach Weight:	56250.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 36-300 (80HP)
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG GT-35, Douglas TBL-180)	Diesel	0.00	8.00	88.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	37.00	38.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	24.00	24.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Catering Truck (Hi-Way F650)	Diesel	7.00	8.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	12.00	235.00	70.00	
Lavatory Truck (TLD 1410)	Diesel	15.00	0.00	56.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	3
Annual Arrivals:	3
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Airbus A320-100 Series
Engine Type:
CFM56-5-A1
Identification:

Take Off weight:	70715.00 Kgs
Approach Weight:	58050.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 36-300 (80HP)

Male mon0
Category:
LCJP

APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG GT-35, Douglas TBL-180)	Diesel	0.00	8.00	88.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	37.00	38.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	24.00	24.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Catering Truck (Hi-Way F650)	Diesel	7.00	8.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	12.00	235.00	70.00	
Lavatory Truck (TLD 1410)	Diesel	15.00	0.00	56.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	7
Annual Arrivals:	7
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Airbus A330-200 Series
Engine Type:
CF6-80E1A4 Low emissions
Identification:
male mon1
Category:
HCJP

Take Off weight:	212780.00 Kgs
Approach Weight:	156600.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 331-350
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	

Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00

Year:
2009

Annual Departures:	9
Annual Arrivals:	9
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Airbus A330-300 Series
Engine Type:
CF6-80E1A4 Low emissions
Identification:
male mon2
Category:
HCJP

Take Off weight:	212780.00 Kgs
Approach Weight:	156600.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 331-350
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00	
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00	
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00	
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00	

Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00

Year:
2009

Annual Departures:	5
Annual Arrivals:	5
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Airbus A340-200 Series
Engine Type:
CFM56-5B1/2P DAC-II
Identification:
male mon3
Category:
HCJP

Take Off weight:	216636.00 Kgs
Approach Weight:	162900.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 331-350
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00	
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00	
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00	
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	8
Annual Arrivals:	8
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Boeing 747-100 Series
Engine Type:
JT9D-7A
Identification:
male mon8
Category:

HCJP

Take Off weight:	283495.00 Kgs
Approach Weight:	230243.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP 660 (300 HP)
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00	
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00	
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00	
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	1
Annual Arrivals:	1
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational	

Profile: DEFAULT

Aircraft Name:
Boeing 767-300 Series
Engine Type:
CF6-80A2
Identification:
male mon4
Category:
HCJP

Take Off weight:	161434.00 Kgs
Approach Weight:	130635.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP331-200ER (143 HP)
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 300/400)	Diesel	0.00	7.00	850.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00	
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00	
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00	
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	6
Annual Arrivals:	6
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

Aircraft Name:
Boeing 777-300 Series
Engine Type:
GE90-110B1 DAC
Identification:
male mon7
Category:
HCJP

Take Off weight:	256053.00 Kgs
Approach Weight:	213914.00 Kgs
Glide Slope:	3.00°
APU Assignment:	APU GTCP331-500 (143 HP)
APU Departure OP Time:	13.00 min
APU Arrival OP Time:	13.00 min
Gate Assignment:	Gate1

Assigned GSE/AGE:	FUEL	Arrival Op Time (mins)	Departure Op Time (mins)	Horsepower (hp)	Load Factor (%)	Manufactured Year
Air Conditioner (Generic)	Electric	7.00	23.00	0.00	75.00	
Air Start (ACE 180)	Diesel	0.00	7.00	425.00	90.00	
Aircraft Tractor (Stewart & Stevenson TUG T-750)	Diesel	0.00	8.00	475.00	80.00	
Baggage Tractor (Stewart & Stevenson TUG MA 50)	Gasoline	60.00	60.00	107.00	55.00	
Belt Loader (Stewart & Stevenson TUG 660)	Gasoline	17.00	18.00	107.00	50.00	
Cabin Service Truck (Hi-Way F650)	Diesel	17.00	18.00	210.00	53.00	
Cargo Loader (FMC Commander 15)	Diesel	40.00	40.00	80.00	50.00	
Catering Truck (Hi-Way F650)	Diesel	10.00	10.00	210.00	53.00	
Hydrant Truck (F250 / F350)	Diesel	0.00	20.00	235.00	70.00	
Lavatory Truck (Wollard TLS-770 / F350)	Diesel	25.00	0.00	235.00	25.00	
Service Truck (F250 / F350)	Diesel	7.00	8.00	235.00	20.00	
Water Service (Gate Service)	Electric	0.00	12.00	0.00	20.00	

Year:
2009

Annual Departures:	5
Annual Arrivals:	5
Annual TGOs:	0
Taxi Out Time:	Determined by Sequencing model
Taxi In Time:	Determined by Sequencing model

Departure Quarter-Hourly Operational profile:	DEFAULT
Departure Daily Operational Profile:	DEFAULT
Departure Monthly Operational Profile:	DEFAULT
Arrival Quarter-Hourly Operational profile:	DEFAULT
Arrival Daily Operational Profile:	DEFAULT
Arrival Monthly Operational Profile:	DEFAULT
Touch & Go Quarter-Hourly Operational profile:	DEFAULT
Touch & Go Daily Operational Profile:	DEFAULT
Touch & Go Monthly Operational Profile:	DEFAULT

GSE Population

Baseline, Male Intl

Type:	Fuel:	Ref. Model:	Identification:
Air Conditioner	Electric	ACE 802	ACE8021

Rated Power:	300.00 hp
Load Factor:	75.00%
The user has selected to use the default age distribution, and has not chosen a specific age.	
Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent
Gate1	25

Year:
2009

Population:	100 units
Yealry Operating Time:	8000.00 hours

Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Air Conditioner	Electric	ACE 804	ACE8041

Rated Power:	210.00 hp
Load Factor:	75.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	1000 units
Yealry Operating Time:	8000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Aircraft Tractor	Diesel	Douglas TBL-400	AT1

Rated Power:	617.00 hp
Load Factor:	80.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	200 units
Yealry Operating Time:	8760.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Fuel Truck	Gasoline	F750, Dukes Transportation Services, DART 3000 to 6000 gallon	FT1

Rated Power:	175.00 hp
Load Factor:	25.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A

Age:	N/A	
Gate:	Percent	

Year: 2009

Population:	20 units
Yealry Operating Time:	4000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Ground Power Unit	Electric	TLD, 28 VDC	GPU1

Rated Power:	71.00 hp
Load Factor:	75.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	200 units
Yealry Operating Time:	1600.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Ground Power Unit	Gasoline	TLD, 400 Hz AC	GPUG

Rated Power:	194.00 hp
Load Factor:	75.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	50 units
Yealry Operating Time:	1700.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Hydrant Cart	Electric	Dukes Transportation Services THS-400	HCE

Rated Power:	0.00 hp
Load Factor:	70.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	10 units
Yealry Operating Time:	1000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Hydrant Truck	Gasoline	F250 / F350	HTG

Rated Power:	235.00 hp
Load Factor:	70.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	20 units
Yealry Operating Time:	1527.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Lavatory Truck	Electric	TLD 1410	LT1

Rated Power:	56.00 hp
Load Factor:	25.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	0 units
Yealry Operating Time:	1492.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Lavatory Truck	Gasoline	Wollard TLS-770 / F350	LTG

Rated Power:	235.00 hp
Load Factor:	25.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	0 units
Yealry Operating Time:	1492.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Passenger Stand	Electric	Wollard CMPS170 / CMPS228	PSE

Rated Power:	65.00 hp
Load Factor:	57.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	500 units
Yealry Operating Time:	5000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Service Truck	Gasoline	F250 / F350	STG

Rated Power:	235.00 hp
Load Factor:	20.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	20 units

Yealry Operating Time:	3000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Service Truck	Electric	F250 / F350	ST1

Rated Power:	235.00 hp
Load Factor:	20.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	100 units
Yealry Operating Time:	5000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Sweeper	Gasoline	Tennant	SWG

Rated Power:	53.00 hp
Load Factor:	51.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	10 units
Yealry Operating Time:	6000.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Sweeper	Electric	Tennant	SW1

Rated Power:	53.00 hp
Load Factor:	51.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	25 units
Yealry Operating Time:	200.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Water Service	Gasoline	Gate Service	WSG

Rated Power:	0.00 hp
Load Factor:	20.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	10 units
Yealry Operating Time:	100.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Water Service	Gasoline	Wollard TWS-402 F250 / F350	WTG

Rated Power:	235.00 hp
Load Factor:	20.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent
Gate1	10

Year: 2009

Population:	25 units
Yealry Operating Time:	924.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Type:	Fuel:	Ref. Model:	Identification:
Water Service	Gasoline	Wollard TWS-402 F250 /	WTWSG

F350

Rated Power:	235.00 hp
Load Factor:	20.00%

The user has selected to use the default age distribution, and has not chosen a specific age.

Analysis Year:	2009
Year of Manufacture:	N/A
Age:	N/A

Gate:	Percent

Year: 2009

Population:	50 units
Yealry Operating Time:	924.00 hours
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

Parking Facilities

Baseline, Male Intl

Parking Facility Name: Parking

Vehicle Type:	Default Fleet Mix (all types, fuels & ages)
Fuel:	Gasoline
Manufactured Year:	2009
Average Speed	10 mph
Average Distance Traveled:	250.00 meters
Average Idle Time:	1.50 mins

Number of Levels:	1	
Release Height:	1.50 meters	
Level Spacing	3.00 meters	
Elevation:	1.83 meters	
Point:	X (meters)	Y (meters)
1	1700.00	100.00
2	2100.00	100.00
3	2100.00	300.00
4	1700.00	200.00

Year: 2009

Number of Vehicles per Year:	7.008e+006
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

The user has NOT edited the following emission factors:

CO (g/veh):	3.0987
THC (g/veh):	-1
NMHC (g/veh):	0.6004
VOC (g/veh):	0.6051
NOX (g/veh):	0.4359
SOX (g/veh):	0.0024
PM-10 (g/veh):	0.0097
PM-25 (g/veh):	0.0061
TOG (g/veh):	
BENZENE (g/veh):	0.01002
MTBE (g/veh):	0
1,3-BUTA (g/veh):	0.00142

FORMALDEHYDE (g/veh):	0.004264
ACETALDEHYDE (g/veh):	0.002867
ACROLEIN (g/veh):	0.000193

Roadways

Baseline, Male Intl

Roadway Name: Roadway

Vehicle Type:	Default Fleet Mix (all types, fuels & ages)
Fuel:	Gasoline
Manufactured Year:	2009
Average Speed:	20 mph
Roadway Length:	1.25 miles
Release Height:	

Width:	20.00 meters		
Point:	X (meters)	Y (meters)	Elevation (meters)
1	1.00	100.00	0
2	2000.00	-188.00	0

Year: 2009

Traffic Volume:	1752000
Quarter-Hourly Operational profile:	DEFAULT
Daily Operational profile:	DEFAULT
Monthly Operational Profile:	DEFAULT

The user has NOT edited the following emission factors:

CO (g/veh):	7.666
THC (g/veh):	-1
NMHC (g/veh):	0.915
VOC (g/veh):	0.926
NOX (g/veh):	1.432
SOX (g/veh):	0.0112
PM-10 (g/veh):	0.0443
PM-25 (g/veh):	0.0281
TOG (g/veh):	
BENZENE (g/veh):	0.023839
MTBE (g/veh):	0
1,3-BUTA (g/veh):	0.003402
FORMALDEHYDE (g/veh):	0.010488
ACETALDEHYDE (g/veh):	0.006951
ACROLEIN (g/veh):	0.000466

Stationary Sources

Baseline, Male Intl

Stationary Source Name: Air Craft Engine Tes

Stationary Category:	Aircraft Engine Testing
Stationary Type:	Engine of My Aircraft

This stationary source is modeled as a point

Elevation:	1.83 meters
Release Height:	20.00 meters
Gas Velocity:	15.00 m/s
Temperature:	400.00 °F
Time at 30Power :	0.00minutes/cycle
Time at 85Power :	0.00minutes/cycle
Time at 100Power :	0.00minutes/cycle
Time at 7Power :	0.00minutes/cycle

Point:	X (meters)	Y (meters)
1	1300.00	300.00

Year: 2009	Test Cycles	200
	Quarter-Hourly Operational profile:	DEFAULT
	Daily Operational profile:	DEFAULT
	Monthly Operational Profile:	DEFAULT

The user has edited the emission factors.

Stationary Source Name: Emergenecy Generator

Stationary Category:	Emergency Generator
Stationary Type:	Gasoline Fuel (EPA Methodology)

This stationary source is modeled as a point

Elevation:	1.83 meters	
Release Height:	20.00 meters	
Gas Velocity:	15.00 m/s	
Temperature:	400.00 °F	
CO EF :	199.0000grams/hp-hr	
TOC EF :	9.8000grams/hp-hr	
NOx EF :	5.0000grams/hp-hr	
SOx EF :	0.2680grams/hp-hr	
PM-10 EF :	0.3270grams/hp-hr	
CO Pollution Control Factor :	0.00 %	
TOC Pollution Control Factor :	0.00 %	
NOx Pollution Control Factor :	0.00 %	
SOx Pollution Control Factor :	0.00 %	
PM-10 Pollution Control Factor:	0.00 %	
Power Rating :	1340horsepower	
Point:	X (meters)	Y (meters)
1	2228.00	400.00

Year: 2009	Hours	8760
	Quarter-Hourly Operational profile:	DEFAULT
	Daily Operational profile:	DEFAULT
	Monthly Operational Profile:	DEFAULT

The user has NOT edited the emission factors.

Training Fires

Baseline, Male Intl

Training Fire Name: Training Fire

Fuel:	JP-4

Release Height:	4.00 meters
Diameter:	5.00 meters
Gas Velocity	10.00 m/s
Temperature:	400.00 °F
X:	1500.00 meters
Y:	500.00 meters
Elevation:	1.83 meters

Year: 2009	Gallons of Fuel Used (gal/year):	0
	Quarter-Hourly Operational profile:	DEFAULT
	Daily Operational profile:	DEFAULT

Monthly Operational Profile:	DEFAULT

The user has NOT edited the following emission factors:

CO (g/gallon):	1625.68
HC (g/gallon):	58.06
NOX (g/gallon):	12.19
SOX (g/gallon):	1.72
PM-10 (g/gallon):	435.44

Gates

Baseline, Male Intl

Gate Name: Gate1

Elevation:	1.83 meters	
Release Height:	1.50 meters	
Initial Sigma-Z:	3.00 meters	
Initial Sigma-Y:	16.00 meters	
Point:	X (meters)	Y (meters)
1	400.00	500.00
2	3400.00	500.00
3	3400.00	700.00
4	400.00	700.00

Taxiways

Baseline, Male Intl

Taxiway Name: Taxiway A

Width:	20.00 (meters)			
Point:	X (meters)	Y (meters)	Elevation (meters)	Speed (mph)
1	2050.00	500.00	1.83	17.26
2	2050.00	600.00	1.83	

Taxiway Name: Taxiway B

Width:	20.00 (meters)			
Point:	X (meters)	Y (meters)	Elevation (meters)	Speed (mph)
1	2150.00	500.00	1.83	17.26
2	2150.00	600.00	1.83	

Taxiway Name: Taxiway C

Width:	20.00 (meters)			
Point:	X (meters)	Y (meters)	Elevation (meters)	Speed (mph)
1	2350.00	500.00	1.83	17.26
2	2350.00	600.00	1.83	

Taxiway Name: Taxiway E

Width:	20.00 (meters)			
Point:	X (meters)	Y (meters)	Elevation (meters)	Speed (mph)
1	1350.00	500.00	1.83	17.26
2	1350.00	300.00	1.83	

Runways

Baseline, Male Intl

Runway Name: 18

Name:	X (meters)	Y (meters)	Elevation (meters)	Glide Slope (°)
18	400.00	500.00	1.83	3.00

Runway Name: 36

Name:	X (meters)	Y (meters)	Elevation (meters)	Glide Slope (°)
36	3400.00	500.00	1.83	3.00

Taxipaths

Baseline, Male Intl

Direction:	Gate:	Runway:	Runway Exit:	Taxiways:
Outbound	Gate1	36		Taxiway B

Direction:	Gate:	Runway:	Runway Exit:	Taxiways:

Inbound	Gate1	36	Taxiway A	Taxiway A Taxiway A

Direction:	Gate:	Runway:	Runway Exit:	Taxiways:
Inbound	Gate1	36	Taxiway C	Taxiway C

Direction:	Gate:	Runway:	Runway Exit:	Taxiways:
Inbound	Gate1	36	Taxiway E	Taxiway E

Configurations

Baseline, Male Intl

Configuration Name: Configuration
Time Used: 100 %

	From	To
Wind Direction:	0 (°)	180 (°)
Wind Speed:	no bound (knots)	no bound (knots)
Hour of Day:	no bound (hh:mm)	no bound (hh:mm)
Ceiling:	no bound (feet)	no bound (feet)
Visibility:	no bound (statute miles)	no bound (statute miles)
Temperature:	no bound (°F)	no bound (°F)

Point:	Arrivals Per Hour	Departures per Hour
1	35	55
2	55	35

Aicraft Size:	Runway	Arrivals (%)	Departures (%)	Touch & Gos (%)
Small	18	25 %	75 %	90 %
Small	36	75 %	25 %	10 %
Large	18	75 %	25 %	20 %
Large	36	25 %	75 %	80 %
Heavy	18	25 %	75 %	30 %
Heavy	36	75 %	25 %	70 %

Buildings

Baseline, Male Intl

None.

Discrete Cartesian Receptors

Baseline, Male Intl

Discrete Catersian Receptor Name: Cartesian_Receptor

X:	100.00 meters
Y:	1000.00 meters
Height:	1.80 meters
Elevation:	1.83 meters

Discrete Catersian Receptor Name: Cartesian_Receptor_(2)

X:	500.00 meters
Y:	1000.00 meters
Height:	1.80 meters
Elevation:	1.83 meters

Discrete Polar Receptors

Baseline, Male Intl

Discrete Polar Receptor Name: Polar_Receptor

Type:	Parking Facility
Name:	Parking
Direction:	0 °
Distance:	1000.00 meters
Height:	1.80 meters
Elevation:	1.83 meters

Cartesian Receptor Networks

Baseline, Male Intl

None.

Baseline, Male Intl

Polar Receptor Networks

None.

User-Created Aircraft

Baseline, Male Intl

None.

User-Created GSE

Baseline, Male Intl

None.

User-Created APU

Baseline, Male Intl

None.

Scenario-Airport: icao/usepa, Male Intl

Weather

icao/usepa, Male Intl

Mixing Height:	914.40 meters
Temperature:	28.53 °C
Daily High Temperature:	34.28 °C
Daily Low Temperature:	22.78 °C
Pressure:	101320.73 Pa
Sea Level Pressure:	101083.69 Pa
Relative Humidity:	79.66
Wind Speed:	18.02 kph
Wind Direction:	0.00 °
Ceiling:	30480.00 m
Visibility:	80.47 km
The user has used annual averages.	
Base Elevation:	1.83 meters
Date Range:	Thursday, January 01, 2004 to Friday, December 31, 2004
Source Data File Location:	
Upper Air Data File Location:	

Quarter-Hourly Operational Profiles

icao/usepa, Male Intl

Name: DEFAULT

Quarter-Hour	Weight	Quarter-Hour	Weight	Quarter-Hour	Weight	Quarter-Hour	Weight
12:00am to 12:14 am	1.000000	6:00am to 6:14am	1.000000	12:00pm to 12:14 pm	1.000000	6:00pm to 6:14pm	1.000000
12:15am to 12:29 am	1.000000	6:15am to 6:29am	1.000000	12:15pm to 12:29 pm	1.000000	6:15pm to 6:29pm	1.000000
12:30am to 12:44 am	1.000000	6:30am to 6:44am	1.000000	12:30pm to 12:44 pm	1.000000	6:30pm to 6:44pm	1.000000
12:45am to 12:59 am	1.000000	6:45am to 6:59am	1.000000	12:45pm to 12:59 pm	1.000000	6:45pm to 6:59pm	1.000000
1:00am to 1:14am	1.000000	7:00am to 7:14am	1.000000	1:00pm to 1:14pm	1.000000	7:00pm to 7:14pm	1.000000
1:15am to 1:29am	1.000000	7:15am to 7:29am	1.000000	1:15pm to 1:29pm	1.000000	7:15pm to 7:29pm	1.000000
1:30am to 1:44am	1.000000	7:30am to 7:44am	1.000000	1:30pm to 1:44pm	1.000000	7:30pm to 7:44pm	1.000000
1:45am to 1:59am	1.000000	7:45am to 7:59am	1.000000	1:45pm to 1:59pm	1.000000	7:45pm to 7:59pm	1.000000
2:00am to 2:14am	1.000000	8:00am to 8:14am	1.000000	2:00pm to 2:14pm	1.000000	8:00pm to 8:14pm	1.000000
2:15am to 2:29am	1.000000	8:15am to 8:29am	1.000000	2:15pm to 2:29pm	1.000000	8:15pm to 8:29pm	1.000000
2:30am to 2:44am	1.000000	8:30am to 8:44am	1.000000	2:30pm to 2:44pm	1.000000	8:30pm to 8:44pm	1.000000
2:45am to 2:59am	1.000000	8:45am to 8:59am	1.000000	2:45pm to 2:59pm	1.000000	8:45pm to 8:59pm	1.000000
3:00am to 3:14am	1.000000	9:00am to 9:14am	1.000000	3:00pm to 3:14pm	1.000000	9:00pm to 9:14pm	1.000000
3:15am to 3:29am	1.000000	9:15am to 9:29am	1.000000	3:15pm to 3:29pm	1.000000	9:15pm to 9:29pm	1.000000
3:30am to 3:44am	1.000000	9:30am to 9:44am	1.000000	3:30pm to 3:44pm	1.000000	9:30pm to 9:44pm	1.000000

3:45am to 3:59am	1.000000	9:45am to 9:59am	1.000000	3:45pm to 3:59pm	1.000000	9:45pm to 9:59pm	1.000000
4:00am to 4:14am	1.000000	10:00am to 10:14am	1.000000	4:00pm to 4:14pm	1.000000	10:00pm to 10:14pm	1.000000
4:15am to 4:29am	1.000000	10:15am to 10:29am	1.000000	4:15pm to 4:29pm	1.000000	10:15pm to 10:29pm	1.000000
4:30am to 4:44am	1.000000	10:30am to 10:44am	1.000000	4:30pm to 4:44pm	1.000000	10:30pm to 10:44pm	1.000000
4:45am to 4:59am	1.000000	10:45am to 10:59am	1.000000	4:45pm to 4:59pm	1.000000	10:45pm to 10:59pm	1.000000
5:00am to 5:14am	1.000000	11:00am to 11:14am	1.000000	5:00pm to 5:14pm	1.000000	11:00pm to 11:14pm	1.000000
5:15am to 5:29am	1.000000	11:15am to 11:29am	1.000000	5:15pm to 5:29pm	1.000000	11:15pm to 11:29pm	1.000000
5:30am to 5:44am	1.000000	11:30am to 11:44am	1.000000	5:30pm to 5:44pm	1.000000	11:30pm to 11:44pm	1.000000
5:45am to 5:59am	1.000000	11:45am to 11:59am	1.000000	5:45pm to 5:59pm	1.000000	11:45pm to 11:59pm	1.000000

Daily Operational Profiles

icao/usepa, Male Intl

Name: DEFAULT

Day	Weight	Day	Weight
Monday	1.000000	Friday	1.000000
Tuesday	1.000000	Saturday	1.000000
Wednesday	1.000000	Sunday	1.000000
Thursday	1.000000		

Monthly Operational Profiles

icao/usepa, Male Intl

Name: DEFAULT

Month	Weight	Month	Weight
January	1.000000	July	1.000000
February	1.000000	August	1.000000
March	1.000000	September	1.000000
April	1.000000	October	1.000000
May	1.000000	November	1.000000
June	1.000000	December	1.000000

Aircraft

icao/usepa, Male Intl

Default Taxi Out Time:	19.000000 min	
Default Taxi In Time:	7.000000 min	
Year:	Uses Schedule?	Schedule Filename:
2009	No	(None)

GSE Population

icao/usepa, Male Intl

None.

Parking Facilities

icao/usepa, Male Intl

None.

Roadways

icao/usepa, Male Intl

None.

Stationary Sources

icao/usepa, Male Intl

None.

Training Fires

icao/usepa, Male Intl

None.

Gates

icao/usepa, Male Intl

None.

Taxiways	icao/usepa, Male Intl
None.	
Runways	icao/usepa, Male Intl
None.	
Taxipaths	icao/usepa, Male Intl
None.	
Configurations	icao/usepa, Male Intl
None.	
Buildings	icao/usepa, Male Intl
None.	
Discrete Cartesian Receptors	icao/usepa, Male Intl
None.	
Discrete Polar Receptors	icao/usepa, Male Intl
None.	
Cartesian Receptor Networks	icao/usepa, Male Intl
None.	
Polar Receptor Networks	icao/usepa, Male Intl
None.	
User-Created Aircraft	icao/usepa, Male Intl
None.	

User-Created GSE	icao/usepa, Male Intl
None.	
User-Created APU	icao/usepa, Male Intl
None.	

Appendix I : Solid Waste Management Plan

1 SOLID WASTE MANAGEMENT

1.1 Introduction

Solid waste management is an integral part of any kind of infrastructural development. In case of airports, solid waste is generated by airport operations and other tentative activities, construction and demolition projects and ongoing airport improvement projects. The implementation of the Malé International Airport modernization project will also result in generation of huge quantities of solid waste including both municipal and hazardous waste. C&D debris will also be generated in large quantities during construction phase.

1.2 SWM Policies in Maldives

The Government of Maldives (GoM) has also established a company - Waste Management Corporation Limited (WMC) - a state owned enterprise, to handle all waste generated in the entire country in an environmentally sustainable manner and in accordance with applicable laws and standards. The Government intends to involve private sector participation in SWM in key regions of Maldives. The projects are being funded by International Finance Corporation (IFC).

There are no particular laws related to solid waste management in Maldives. The Ministry of Housing, Transport and Environment (MHTE) introduced the first draft of the Solid Waste Management Regulatory Framework (SWM Regulatory Framework) in August, 2009, inviting comments from various stakeholders. This has been formulated to implement the National Solid Waste Management Policy issued by the MHTE (SWM Policy) and to protect and preserve the environment. The framework will be finalized within a few months.

1.3 Current Scenario of SWM at Malé International Airport

The present solid waste generation at the airport is 18 tons per day (TPD). With a load of 2 million passengers everyday at the airport, the per capita waste generation computes to 3.285 kg/passenger/day.

Generally food items, plastic and glass bottles, cans, paper, grass, wood and Styrofoam boxes constitute the waste collected from airport. While the characteristic of waste generated at the airport reveals many different types of materials which can be recycled, all these are still going into the trash. As a practice towards sustainable development the challenge is to divert more recyclable materials from the waste stream into the recycling stream.

Waste management for the entire area under the Hulhulé airport is managed by “Building Services Unit” under the existing airport authority. The entire waste is collected from various billing areas and general areas in the airport. From these collection and storage points, waste is transported daily to Thilafushi Island in hired vessels. Thilafushi is the primary solid waste dumpsite located near Hulhulé. Thilafushi was originally a lagoon which has been reclaimed using both sand and waste as reclamation material.

1.4 Estimated Waste Generation for the Proposed Project

1.4.1 Construction Phase

The construction phase of the proposed project will primarily generate construction and demolition (C&D) waste and small quantities of general refuse in addition to the existing waste generation. It is estimated that nearly 20,000 metric tons (MT) of C&D waste will be generated over the 42 months construction period, which amounts to 15 TPD. Similarly the additional amount of general refuse or municipal solid

waste that would be generated during the construction period depends upon the number of labor involved. On an average, nearly 600 laborers per day will be engaged during this phase. Thus the additional municipal solid waste generation is estimated to be approximately 2.4 TPD[1].

1.4.2 Operation Phase

The estimated number of passengers and solid waste generation during the operation phase of the airport is as presented below:

Table 1.1: Estimated Waste Generation from Airport Project

Year	Number of Passengers per year	Estimated Waste (TPD)
2014	3 million	27
2035	5.2 million	47

1.5 Proposed SWM Strategy

An important first principle for this project is adoption of sustainable waste management practices. Waste will be managed to avoid adverse impacts on the life, amenity, health and wellbeing of people and the diversity of ecological processes and associated ecosystems. The primary objective will be to avoid or minimize waste generation. Hence the first component of waste prevention and minimization will be a green procurement policy. This policy will ensure that the project company procures goods and services that lessen the burden on the environment in their production, use and final disposition, wherever possible and economical.

A typical solid waste management plan generally includes the following components:

- Collection
- Segregation and Storage
- Transportation
- Treatment
- Disposal

The project developer along with the airport authority will be responsible for implementing sustainable waste management system at the airport.

1.5.1 Strategies for Construction Phase

The construction phase of the airport expansion project will primarily generate C&D debris and municipal solid waste. Following strategies may be adopted for effective waste management during construction phase.

- C&D waste will be segregated into recyclables and inert materials. Segregated metal and glass will be recycled and the remaining inert components will be sent to Thilafushi for use as landfill cover.
- General refuse will be segregated into recyclable and non-recyclable materials. The recyclables will be processed and reused. Remaining waste and inert will be sent to the disposal site at Thilafushi.
- All construction wastes, including packaging will be stored in covered bins in the waste management area.
- Waste collection bins will be placed along the construction sites so that they can be disposed at regular intervals and in an organized manner.

[1] Waste generation factor of 4 kg/capita/day has been assumed.

- Construction workers will be trained on how to dispose of food and drink containers emphasizing the need to protect the environment.
- Waste will be transported through hired vessels or *dhonis* to the dumpsite at Thilafushi.

1.5.2 Strategies for Operation Phase

Strategies that may be considered for different stages waste during operation phase have been described below.

Waste Collection, Segregation & Storage

Existing waste collection system at the airport needs to be upgraded. Since the quantity of waste generation will increase after expansion of the airport, the number of collection points also needs to be increased. Additional waste collection points will be identified.

Considering the type of waste likely to be generated from the operation of airport, it is recommended that 3 bin systems should be adopted so as to facilitate an organized and hierarchical system of waste collection and disposal. Use of plastic or metal containers with lid and capacity 10-15 liters is advised for the storage of food/biodegradable/wet waste. Similar size bins or plastic bags with or without lid may be used for storage of recyclable materials.

Figure 1.1: 3-bin System Containers

Storage of Hazardous Waste

Special care will be taken of the hazardous waste generated at the airport. Following strategies may be adopted for ensuring safe storage of hazardous waste:

- Chemicals, fuels, oils etc. will be stored appropriately in compliance with international standards to minimize the risk of environmental impact.
- Smaller quantities of chemicals, fuels and oils will be stored in self-bunded pallets, within a bunded area in the workshop, or in a bunded container on-site.
- Diesel and aviation fuel will be kept in bulk quantities in double skinned tanks allowing self-bunding, or other contained structures.
- All waste products (e.g. oil / water separator waste, sludges and residues) containment will be within weatherproof, sealed and bunded areas to ensure stability of the waste containment receptacles and prevent any leakages or spills. Regular inspections will be carried out of the tanks, bunds and storage areas to ensure integrity.
- A suitable area for the intermediary storage of hazardous waste will be provided. Dimension and location will be fixed after assessing the amount of hazardous waste.

- Hazardous waste will be transported to Thilafushi waste disposal site for further treatment & disposal.

Transportation

At present the waste is being transported to Thilafushi dumpsite in hired vessels. The waste transportation system for the operation phases is proposed to be similar to the existing system. Waste from collection points can be loaded in trolleys or mini trucks and carried to the vessels which will further transport it to the Thilafushi Island. In case manual loading of waste is practiced, hygiene of workers needs to be considered. It should be ensured that the workers are provided with gloves, boots and masks and their use should be strictly enforced.

Waste Processing

There are several solid waste management technologies, which are being followed in various parts of the world. Suitable technologies are chosen depending upon the type of waste and the area. Besides source reduction, reuse and recycling, broad categories of available technologies for processing solid waste are mentioned below:

Table 1.2: List of Identified Solid Waste Processing Technologies

Technology Group	Waste Processing Technology
Thermal Processing Technologies	Incineration
	Pyrolysis
	Pyrolysis / Gasification
	Plasma Arc Gasification
Biological Processing Technologies	Aerobic Digestion (Composting)
	Anaerobic Digestion (Biomethanation)
	Landfill as Bioreactor (Bioreactor Landfill)
Physical Processing Technologies	Refuse-Derived Fuel (RDF)
	Densification / Pelletisation
	Mechanical Separation
	Size reduction

Based on the type and quantity of waste that would be generated during operation phase of the airport and keeping in view the scarcity of land and the requirement to protect the fragile eco-system, biological processing technology of bio-methanation can be considered as a viable option. Majority of the waste generated consists of recyclable items such as plastic and glass bottles, cans, paper and Styrofoam boxes. These will be segregated, recycled and reused for certain airport activities. Remaining biodegradable waste will go to the bio-methanation plant that may be installed within the airport premises. Option

Bio-methanation

Bio-methanation is the production of CH_4 and CO_2 by biological processes that are carried out by methanogens. It can treat biodegradable organic waste to produce biogas that can be used to power electricity generators, provide heat and produce soil improving material. It enables reduction in land requirement for MSW disposal and produces stabilized sludge that can be used as soil conditioner in the agricultural field. The entire Bio-methanation process consists of the following unit operations –

- Feed preparation
- High Rate Anaerobic Digestion
- Water treatment
- Biogas Cleaning and Storage
- Digested products treatment and disposal

Proposed Capacity

Installation of Bio-methanation plant with power generation is being considered for the proposed project. It is assumed that 55% of the municipal solid waste generated at the airport will consist of organic matter. Thus 27 TPD of waste (till the year 2014) will have 14.85 TPD of organic matter. The capacity and economics of the bio-methanation plant for processing of waste till the year 2014 is presented below:

Table 1.3: Economics of Bio-methanation Plant

Particular	Unit	Value
Waste processing	TPD	15
Area	Acres	0.75
Capital Cost	USD millions	0.23
Operation & Maintenance Cost (per year)	USD millions	10% of capital cost
Biogas Generation	m3/day	660
Probable Power Generation @ 2.11 kwh/m^3	kwh/day	1390
Revenue from power @ INR 3.30/kwh	INR Lakhs/yr	15
Quantity of Manure @ 8% of capacity	kg/day	1200
Cost of Manure @ INR 2/kg	INR Lakhs/yr	7.8
Design life of plant	Years	20

It is also envisaged by the project developer that at the end of 2035, 5.2 million passengers will commute to the airport per year. Therefore an additional bio-methanation unit of 11 TPD capacity for processing the additional waste of 20 TPD will be installed at the airport.

Waste Disposal

Currently, there are three solid waste disposal sites operating in the following islands in Maldives.

- Thilafushi Island - It is the largest dump site in Maldives serving Malé and surrounding islands of Villingili, Hulhumalé and Hulhulé. Thilafushi is situated approximately 6.5 km west of Malé between Giraavaru and Gulhifalhu in the Vaadhoo channel. The existing airport disposes waste at this island.
- Hithadhoo Island - Hithadhoo dumpsite is located in the southernmost atoll of Maldives, the Seenu Atoll. It is more than 500 km from airport at Hulhulé.
- Kulhudhuffushi Island - Kulhudhuffushi is an inhabited island and atoll capital of Haa Dhaalu atoll in Upper North of Maldives. It is located at a distance of more than 250 km from Hulhulé.

Therefore the current practice of waste disposal at Thilafushi dumpsite will be continued even after implementation of the expansion project. However, care will be taken of minimizing the quantity of waste disposed at the dumpsite, after recycle, reuse and processing.

Appendix J: Maps/Aerial Pictures of Terrestrial Survey Area

Terrestrial Vegetation survey zone

The terrestrial survey was undertaken by dividing the island of Hulhule in to twelve (12) grids for easy management of data. The grids are shown in the above figure.Yellow lines indicate transect lines.

Survey date
October 2010

Company Name
Water Solutions

Surveyour / Section
WS Surveying

Image source
Digital Globe

PROJECT NO.:

Terrestrial Vegetation Map - Zone B3

Infrared image analysis indicating the vegetation in zone B3. Red colour indicates vegetation.
Yellow line indicates a 200 meter transect line in zone B3. Yellow arrow indicates the direction of the 2nd transect line overlapping area C3.

Survey date
October 2010

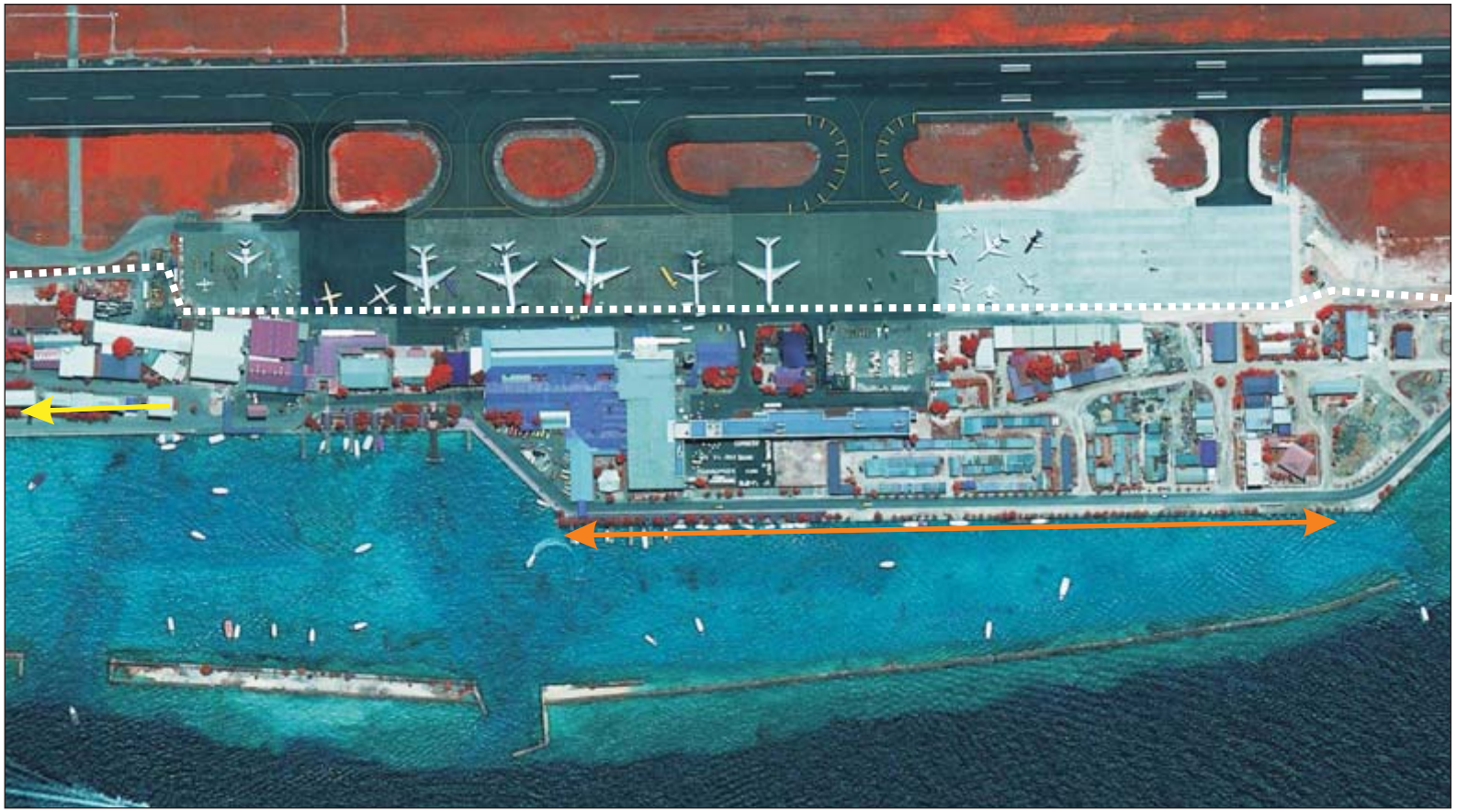
Company Name
Water Solutions

Surveyour / Section
WS Surveying

Image source
Digital Globe

PROJECT NO.:

Terrestrial Vegetation Map - Zone C3



Infrared image analysis indicating the vegetation in zone C3. Vegetation below the white line are mature trees sparsely spread across the this section of the island. None of these are natural and has been planted at some point in time.

Red colored areas above the yellow line indicates grass which is found on both east and western side of the runway. Since international airports must adhere to ICAO standards, 150 meters from the center line on each sides must be clear of trees or any objects.

Coconut trees (approximate height between 8 to 10m).

Survey date
October 2010

Company Name
Water Solutions

Surveyour / Section
WS Surveying

Image source
Digital Globe

PROJECT NO.:

Terrestrial Vegetation Map - Zone C2

Infrared image analysis indicating the vegetation in zone C2. Vegetation below the yellow line are mature trees sparsely spread across the this section of the island. Red colored areas above the yellow line indicates grass which is found on both east and western side of the runway.

Survey date
October 2010

Company Name
Water Solutions

Surveyour / Section
WS Surveying

Image source
Digital Globe

PROJECT NO.:

Groundwater sampling locations in Hulhule (November 2010)

Sample station ?	1	2	3	4	5	6	7	8
Parameter ?								
Date sampled	7-Nov-10 4°10'58.0"N, 73°31'38.5"E	7-Nov-10 4°11'10.299"N, 73°31'55.67"E	7-Nov-10 4°11'31.35"N, 73°31'49.18"E	7-Nov-10 4°10'58.9"N, 73°31'34.7"E	7-Nov-10 4°11'42.56"N, 73°31'41.11"E	7-Nov-10 4°11'31.95"N, 73°31'40.69"E	7-Nov-10 4°11'30.64"N, 73°31'41.5"E	7-Nov-10 4°11'29.27"N, 73°31'38.59"E
Type of water	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well	Shallow well
Physical appearance	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles	Clear with suspended particles
Odour	No	No	No	slight odour	slight pungent smell	No	No	No
Depth of Water table (m)	0.5	1	1.3	0.2	-	1	0.5	1.2
Sampling depth (m)	1	1	1	1		1	1	1
Temp. [°C]	28.7	28.5	29	28.7	29	29.7	29	29
pH	8	9	8	9	9	9	8	9
Salinity [ppt]	1	0.6	0.4	6.3	1.9	0.3	0.3	0.33
Electrical Conductivity- EC [uS/cm]	20600	1134	897	11150	3560	700	575	623
TDS [g/L]	10031	567	448	5570	1780	350	288	315
Turbidity [NTU]	0	0	0	0	0	0	0	0
Nitrites [mg/L]	-	-	0.001	-	0.001	0.001	0.014	0.014
Faecal Coliform (E.Coli)/100 ml	0	1	0	0	0	0	0	0

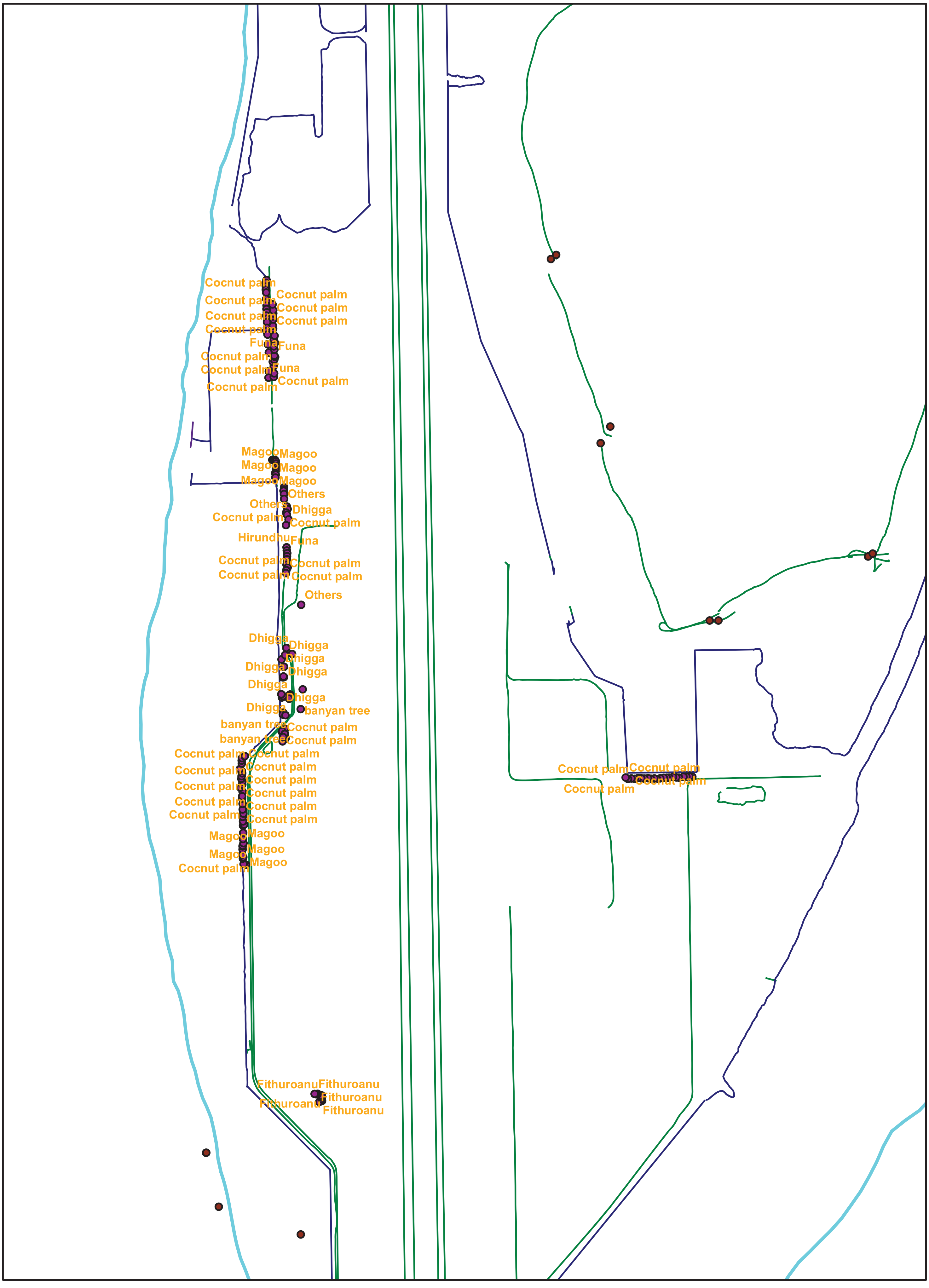
Survey date
November 2010

Company Name
Water Solutions

Surveyour / Section
WS Surveying

Image source
Digital Globe

PROJECT NO.:



Hulhule Iarport terrestrial vegetation survey map
Datum: WGS 1984

Appendix K: Health and Safety Plan

Safety Plan - Construction

Table of Contents

1. General

1.1 Introduction

1.1.1 This Safety Plan is prepared to

- ♦ Describe how to coordinate, manage and control the works in order to protect the safety, health and welfare of all personnel and the public engaged on the project.
- ♦ Ensures that all statutory and contractual requirements are observed.

1.1.2 For the effectiveness of the implementation of the Plan, our management and supervisory staff, the relevant suppliers and subcontractors have to well understand this Plan including their roles in accident prevention and their co-operation in safety.

1.1.3 We shall actively seek the support of the site management and all operatives engaged on the project to protect the safety and health of themselves and their colleagues.

1.1.4 Any person who patently disregards health and safety requirements of the Plan and safety regulations will be subject to disciplinary action which may result in his/her dismissal from the project.

1.2 Control

1.2.1 This Plan is a controlled document. All registered holders of controlled copy of this Safety Plan will be provided with all subsequent revisions, amendments and additions. They will modify their copy of the Plan according to our notification.

1.3 Implementing the Safety Plan

1.3.1 In order to eliminate and control the associated risks, the Project Manager is assigned by the Project Head to implement the Safety Plan to satisfy both contractual obligations and statutory requirements. He is also required to promote acceptable safety and health standards.

1.3.2 The Project Site Safety Manager is delegated to co-ordinate and advises the Project Manager of the implementation of this Safety Plan and prepares report to Project Manager of site safety situation.

1.4 Contractual Obligations

1.4.1 The Safety Plan is designed to describe how we can satisfy the contractual obligations and co-ordinate our operations and the operations of our subcontractors accordingly.

1.4.2 Every subcontractor is required to co-operate with us on all relevant safety and health matters to meet the contractual obligations.

1.5 Safety Organization Requirements

1.5.1 To fulfill relevant safety and health organization requirements, a Site Safety Committee is established to maintain a Safety Management System which includes the preparation of safety plan, risk assessment reports, safety inspections, and regular safety meetings, written safe working procedures, safety audits and communication systems.

1.5.2 The local safety and health statutory requirements to be complied with during the execution of this project.

2. Occupational Safety and Health Policy

2.1 Implementation

2.1.1 The attached Safety and Health Policy statement in English signed by the Head of projects is extracted from the existing Safety and Health Manual Project Company. We shall follow the procedures as laid down in the Safety and Health Manual to annually review the Safety and Health Policy.

2.1.2 This Policy statement is to demonstrate Project Company commitment to promote high standard of safety and health to prevent personal injury or ill health resulting from work activities for the duration of the project.

2.1.3 This project aims at zero dangerous occurrences.

2.1.4 The Chairman and the Board of Directors of this Project shall be In charge of overall co-ordination and implementation of the safety policy.

2.1.5 Monitoring and reviewing of the safety and health policy is one of the tasks of the Board of Directors. Members of the Board of Directors will meet at six months interval to discuss and review the safety performance of the overall situation of this project.

2.1.6 Procedures for reviewing of safety and health policy are as below:

- ♦ Review the existing safety and health policy whether it is up-to-date to meet newly issued statutory regulations and requirements by the Project Site Safety Manager of this Project.
- ♦ Prepare a draft Safety and Health Policy and disseminate to all departments to discuss. ♦ Departments shall discuss in their regular meetings and site safety committee meetings.
- ♦ Gather and return all feedback to Safety, Quality and Environment Department for any necessary amendment.
- ♦ Submit the draft revised Safety and Health Policy to the Board of Directors for approval. ♦ Endorse and announce the newly revised Safety and Health Policy by the Head of Projects.

2.1.7 The Safety Engineer or Project Site Safety Manager is in charge of keeping up-to-date health and safety information, including changes to regulations, new codes of practice, newly identified hazards and new work practices. Thereafter, the Safety Engineer or Project Site Safety Manager is also responsible to disseminate the above information to concerned parties and subcontractors.

2.1.8 The Health and Safety Policy or amended Policy shall be displayed on safety publication board, notice board, and conference room.

2.1.9 All workers and staff including those from sub-contractors & Nominated Sub-contractors, technical personnel, skilled, semi-skilled and unskilled labour will receive induction safety training within 2 working days.

2.2 Project Objectives

2.2.1 Our objective is to ensure the safety and health of our workforce and also members of the public affected by our operations.

2.2.2 Our target is to achieve zero fatal accident, eliminate serious accidents and legal actions.

3. Safety Organization, Structure and Responsibility

3.1 Objectives

3.1.1 This part is to describe the organizational structure for safety and health in the project and outlines the responsibilities of key staff that have significant contributions to make in the successful implementation of this Safety Plan.

3.1.2 Specific safety and health measures for different trades of subcontractors and various construction activities are defined and written in contract document for the relevant contractors, subcontractors and suppliers.

3.1.3 The Project Manager has the responsibility to implement the plan on site.

3.1.4 The Safety Engineer or Project Site Safety Manager is assigned to regularly review and monitor the implementation of the plan and make report to Project Manager and Head of Projects.

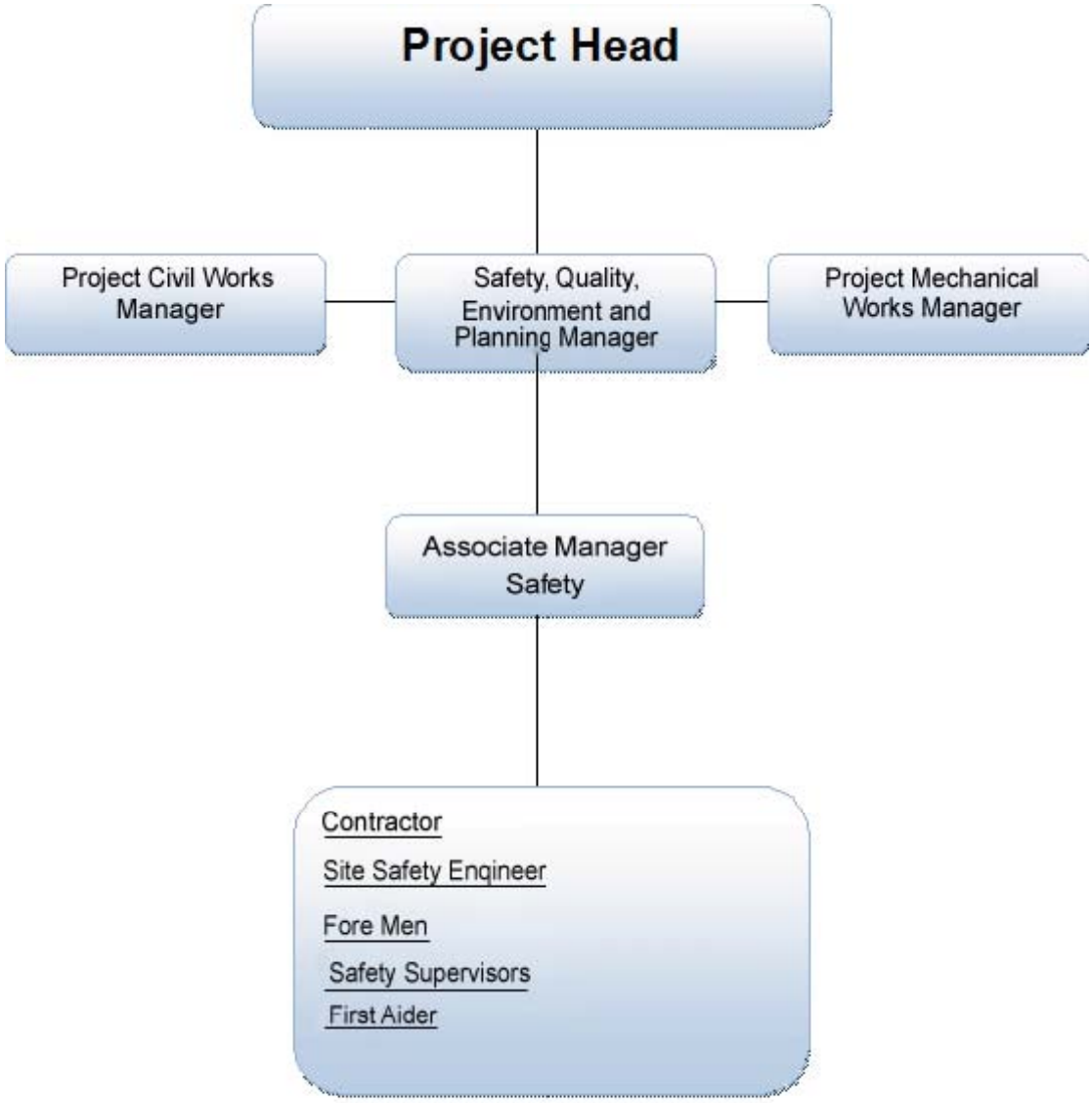
3.1.5 Site Management meeting is carried out monthly to discuss and review of safety matters, policy and performance.

3.1.6 Internal safety auditors shall carry out internal safety audit at 6 months interval to evaluate the effectiveness, efficiency and reliability of the safety management system.

3.1.7 Site inspection with written report by using the checklist is carried out by Project Site Safety Manager/Safety Engineer to ensure safety precautions had been taken in compliance with statutory requirements.

3.1.8 In order to ensure two-way communications between Main Contractor and Sub-contractors, site safety committee meeting and specified meeting shall be convened to discuss safety and health matters. Minutes of the meeting shall be displayed on site safety publication board. Representative of workers is invited to participate in the mentioned meetings to express their opinion and interest. Also, a suggestion box shall be placed in site office for any person to raise his recommendations in safety and health aspect.

3.2 Site Safety Organization Chart



4. Safety and Health Training

4.1 Resources and Training Plan

4.1.1 The Project Site Safety Manager will assist the Construction Manager to meet the training responsibilities and to help identify and evaluate the training needs and formulate safety training need analysis.

4.1.2 The Project Site Safety Manager will analyze the problem and the detailed need of training for the employees. The identification of training will separate into two parts.

- ♦ To perceive that a situation exists which merits need-analysis;
- ♦ To look closely at the situation to find out more precisely what the skill or knowledge or technology short fall is, and which operation will be made up by training arising from method statement/sequence of work.

4.1.3 The Project Site Safety Manager and the Safety Engineer shall prepare a health and safety training plan for the coming three months once the contract is awarded through the completion of the project.

4.1.4 The training plan shall be designed according to the construction activities for all levels of employees of human resources. The training plan shall include details of each course objectives, syllabus concerned, date and place, duration, frequency, targeted trainees, organizer, lecturer and refresher course required.

4.1.5 The training plan shall be reviewed by the Safety Engineer to suit the actual needs and control of the construction activities and to introduce new training program if available for site management levels, supervisors and workers. A copy of the safety training record will be maintained.

Fig : 2. Safety Training Plan

4.2 Induction Safety Training Contents

4.2.1 The contents of the Induction safety training are as follows:

♦ The attitude of employees towards safety ♦

Safety-related Regulations

♦ Safety Practices

♦ Personal Protective Equipment

♦ Company Safety Policy and Program ♦

Site Environment

♦ Potential hazards associated with the site activities ♦

Emergency Procedures and First Aid Procedures

♦ Accident reporting and employees' compensation procedures

4.3 Tool Box Talks

Fig : 3. Tool Box Talks

Workers will receive toolbox talks conducted by the respective front line Supervisors, Safety Engineer. The toolbox talks will focus on different trade and activities and enhance safety and health awareness amongst operatives.

4.4 Specified Safety Training Topics

♦ Use of Fire Fighting Equipment and Fire Prevention ♦

Manual Handling

♦ Electricity Safety

♦ Safe Use of Lifting Appliances and Lifting Gears

♦ Introduction to General Duties of Employers and Employees ♦

Work in Confined Space

♦ Dangerous Substance Handling ♦

Cartridge-operated fixing tools ♦

Passengers Hoist

♦ Suspended Working Platform

♦ Other suitable training courses for local workers

Fig : 4. Safety Training Topics

4.5 Safety Training on High Risk Activities

Topics of the high risk safety training include, but are not limited to:

♦ Working at height

♦ Erection or up-raising of tower crane ♦

Erection of scaffolding

♦ Working on slope

♦ Lifting & installation of steel formwork ♦

Heavy lifting

♦ Hot works etc.

4.6 Management Training

Appropriate safety management training will be provided to the project management team.

5. Occupational Safety and Health Programs - Safety Rules

5.1 General Safety Rules

The general Safety Rules related to legal and other requirements of this project to be displayed at entrance and standard notice board include:

5.1.1 All persons must wear safety helmet when entering or working within site boundary, use safety belt when working at height.

5.1.2 Scaffolds/working platform must be secured and stabilized. Scaffolds/working platform when higher than 1.9m must be provided with guardrails, toe-boards to prevent fall of person. All electrical tools must be properly connected / earthed.

5.1.3 To take care of self & co-workers when operating machine. Safety equipment must be used to protect person on site. Safety installations must not be interfered by falling objects.

5.1.4 Unauthorized entry is prohibited while construction work is in progress.

5.1.5 No alcohol is allowed during working hours, no gambling is permitted within this site boundary at any time.

5.1.6 Everybody within the site boundary must wear their worker's I.D., otherwise entry will be prohibited. Security in charge of this site is authorized to expel those people without I.D.'s.

5.1.7 Illegal workers are prohibited within site boundary; offenders will be subjected to prosecution.

5.1.8 To be aware of trucks at site entrance, all vehicles are not allowed to enter this site without permission, and the company will not be responsible for any damage so caused.

5.1.9 Everybody who enters the site must be over age of 18 and show their I.D. upon request of the security in charge of the site, admission in thoroughfare.

5.2 Specific Safety Rules

5.2.1 Specific safety rules and regulations have been formulated and listed in the Company Safety Manual. All subcontractors, suppliers and workers shall follow the requirements to carry out construction works. Specific rules and regulations are as listed below.

♦ Powered Hand Tools Operational Rules ♦

Flame Cutting Operational Rules

♦ Abrasive Wheel Operational Rules ♦

Welding Operational Rules

♦ Circular Saw Operational Rules ♦

Work at Height Safety Rules

♦ Use at Height Safety Rules ♦

Excavation Safety Rules

♦ Manual Handling Safety Rules ♦

Material Hoist Operational Rules

♦ Installing, Raising, and Dismantling of Tower Crane ♦

Precast Façade Erection

♦ Steel Formwork Erection

♦ Work-at-Height and the associated Risks ♦

Work in Confined Spaces

♦ The Designing, Erection, Loading, Unloading And Dismantling Of Temporary Works ♦

Handling, Use, Storage and Transportation Of Materials And Substances

♦ Operations involving Grinding, Chipping, Cutting, Welding, Burning, etc. ♦

Exposure to Hazardous Substances

♦ Exposure to Environmental or Health Risks associated with Dusts, Fumes, Vapors, etc. ♦

Exposure to Excessive Noise Levels

♦ Other relevant rules required by the local authorities

Fig : 5. Specific Safety Rules

5.2.2 All safety rules and regulations must be distributed to and endorsed in any format by all staff. Specific safety rules of hazardous activities must be posted in the nearby area or operation such as welding, lifting operation, woodworking, etc.

5.3 Foreseeable Hazards of the Project

Prior to the commencement of the project activities, a hazard identification survey will be conducted by the Safety Engineer and the members of the project team to associate with the work activities.

5.3.1 For any hazardous operations to be carried out by or under the immediate control of sub-contractors who shall prepare the written safe working procedure which will be incorporated into a method statement, and then submitted to Construction Manager /Construction Manager for vetting and comment. The Project Site Safety Manager shall be consulted prior to acceptance of the said documents.

5.3.2 All written safe working procedures and method statements shall clearly identify the objective, the sequence of operations, foreseeable hazards, precautionary and control measures. Specific safety training shall be provided to those personnel who are assigned to carry out high risk task.

5.3.3 During the course of hazardous operations on different site situation, the written safe system of work shall require re-assessment and revision, then the said document will be revised by the Engineer and the Safety Engineer accordingly.

5.3.4 Any revision of the said documents will be submitted to the Deputy Project Manager and distributed to relevant parties such as Clients, sub-contractors, etc. For the application of the permit-to-work procedures in site activities, its operation will be strictly controlled by the relevant sub-contractors and all expired permits shall be retained in a dedicated file. All such procedures and files will be inspected by the Project Site Safety Manager.

5.4 Monitoring for Compliance of Safety Rules and Control Measures

5.4.1 The Safety Engineer is responsible to review and revise such in-house safety rules and regulations when it is no longer to meet the statutory requirements for the site to which he is responsible.

5.4.2 The Project Site Safety Manager is responsible for ensuring that construction activities follow the sequence and criteria of method statement to proceed.

5.4.3 Workers who perform their duty in relation to such rules and regulations are required to attend specific training.

5.4.4 The determined in-house safety rules and regulations display in the entrance notice board or in the site office area.

5.4.5 The Safety Engineer, Safety Supervisor and General Foreman are responsible to monitor the status of compliance with determined in-house safety rules and regulations during weekly site inspection.

5.4.6 Monetary penalty steps laid down in the sub-contract document impose to workers or subcontractors who disregard the formulated rules and regulations.

5.4.7 The Project Manager would take appropriate penalty measures to ensure the implementation of Safety Plan and relative safety rules or regulations of the Government and the employer, which includes but not limited to:

- ♦ Dismissal any person from site.
- ♦ Handling charge of any violation of relevant rules and regulations made by any contractor or person.
- ♦ In case breaches are repeated, issuing instructions, written warnings or disciplinary action to the offenders.

5.4.8 The disciplinary actions will include levying an administration fee from subcontractor's interim payment. The procedures include:

- ♦ The Safety Engineer will identify the breaches found, take evidence photographs and submit to the Construction Manager.
- ♦ The Construction Manager will review the breaches found and pass it to Quantity Surveying Department Head for necessary action.
- ♦ The Safety Engineer will notify the offenders in writing and charge the administration fees.
- ♦ One copy of the memo regarding penalty warning applied will be submitted to the Project Manager.

5.5 Preparation for Hazard Identification and Hazard Control

- ♦ A hazard identification survey will be conducted by the Safety Engineer and relevant project team within one month after commencement of works, according to the construction activities on site. The Safety Engineer will base on the hazard results to indicate whether or not risk assessment or method statement shall be developed any further.
- ♦ When high risk tasks have been defined in the hazard identification, a risk assessment to lay down all job activities of the high risk tasks will be proceeded.
- ♦ Hazard identification survey will be reviewed by the Safety Engineer, at least once for every 3 months or when there is any change on site condition.
- ♦ Risk assessment sheets for recording the activities, hazards, likelihood, severity, risk rating, control measures and responsible persons for implementation will be prepared by the Safety Engineer and relevant project team members for each high risk task.
- ♦ Safety and Health problems and control measures in each risk assessment sheet will be considered in the re-preparation of the method statement. The potential hazards and respective control measures will be identified in proper order to ensure that the activities are properly controlled and executed safely.
- ♦ Written specifications of the control measures including safe systems of work, protective clothing/equipment and training, etc., and persons responsible for ensuring the

implementation for each hazard, will be recorded in risk assessment sheet. These specifications will be distributed to those responsible persons for checking if actual site condition compiles with the control measures.

5.6 Permits to Work for Specific Site Activities

- ♦ Permit-to-work system is established to control person entering or working in the restricted area.
- ♦ Prior to the commencement of the work, the subcontractors and workers must obtain a permit issued by the immediate supervisor.
- ♦ The subcontractors and workers have to follow the precautionary measures laid down in the permit.
- ♦ The working period has to be approved by the supervisor.
- ♦ When permit expired, no one is allowed to enter or remain in the restricted area.
- ♦ Prominent notice and a copy of the Permit have to be posted outside the Restricted Working Area for inspection identifying the number of workers inside and the time of their entry and out.

6. Communication - Site Safety Committee

6.1 Type of Safety Committee

6.1.1 The Site Safety Committee is established to monitor safety and health at work, for full cooperation and commitment of the supervisory staff and workers.

6.1.2 The establishment of the Site Safety Committee will influence site management, supervisors, workers and subcontractors to involve and commitment on site safety and health aspects.

6.1.3 The Deputy Project Manager assigned by the Project Manager in writing will chair the Site Safety Committee Meeting regularly.

6.2 Terms of Reference and Monitoring for Site Safety Committee

The Site Safety Committee will implement this Site Safety Plan with the following terms of reference:

6.2.1 To promote safety and health training and safety publicity.

6.2.2 To identify and discuss hazards associated with daily site operations, consider and take necessary safety precautions to prevent such hazards.

6.2.3 To review past accidents record to identify causes, unsafe practices and/or conditions.

6.2.4 To review the accident statistics of different trade of subcontractors.

6.2.5 To provide a forum of two way communication for the site management and working level to discuss and solve site safety and health matters.

6.2.6 To conduct site safety inspections before or after the committee meeting and take follow up actions.

6.2.7 To discuss and take precautionary actions on the results of Internal and External Safety Audits.

6.2.8 To suggest and make recommendations to the senior management of safety measures.

6.2.9 To ensure that the site management makes quick decisions on the suggestions and recommendations made by the Committee for preventing accidents.

6.2.10 To promote safety and health for the Project, monitor the implementation of the Site Safety Plan, review accidents record and trends, accident and incident reports, plan safety and health activities associated with preventive measures.

6.2.11 To carry out the management review for site safety and occupational health aspects during the Site Safety Committee meeting when the site operate for one year in yearly interval.

7. Program for Inspection and Performance Monitoring

7.1 Safety Inspections Program

7.1.1 The Safety Supervisors shall carry out safety inspections on daily basis and complete the weekly inspection report. The Deputy Project Manager/Construction Manager shall discuss with the safety supervisors about their submitted reports and countersign the reports.

7.1.2 The Safety Engineer shall carry out weekly formal site safety inspections to identify defects, unsafe conditions and practices, and breaching of statutory or safety plan requirements accompanied by the Construction Manager, Safety Supervisor and sub-contractors' safety representatives.

7.1.3 The Safety Engineer shall complete and forward a written inspection report with a comprehensive checklist and results to the Project Manager and the subcontractors for corrective action and improvement to ensure risk controls are effective.

7.1.4 The Safety Engineer will complete and submit a monthly report to the Project Manager. He will discuss the report with the Safety Engineer.

7.1.5 A detailed monthly safety report which is prepared by the Safety Engineer concerning the accident statistic, safety training record, safety audit, risk assessment report and amendment of the Site Safety Plan shall be submitted to the Chairman of the Site Safety Committee, and Site Safety Management Committee where appropriate.

7.1.6 The Safety Engineer shall collate and analyze the results of hazard identification survey and weekly safety reports to the Project Manager notify and monitor the subcontractors and suppliers of the results and safety standards.

7.1.7 The Safety Engineer shall take action and report to the Project Manager and Site Safety Committee, and Site Safety Management Committee where appropriate of any further result of action.

7.1.8 The Safety Engineer, Safety Supervisor, Project Manager and Construction Manager of the Site Safety Committee have received safety education and safety management training respectively for inspection and implementation of safety measures.

7.2 Follow-up Action on Hazard Findings

7.2.1 After conducting the safety inspection, the daily inspection report should be submitted to the Construction Manager within 24 hours of the inspection. Follow-up action will be taken within 24 hours from date of the report.

7.2.2 For those items in inspection reports that require the subcontractors to take immediate action, the Safety Engineer and the Construction Manager shall issue a verbal or written warning to related subcontractors for rectification. The Safety Engineer and Safety Supervisor will follow up to check that the items are improved.

7.2.3 If irregularities are found on the sub-contractors repeatedly, an administrative fee will be levied to them in accordance with sub-contractor-safety rules to the related sub-contractors and a record will be filed in the site office.

7.2.4 The Safety Engineer shall prepare a monthly summary from safety inspection report and present it in monthly safety report. All the items shall be discussed in Site Safety Management Committee Meeting.

7.2.5 The monthly safety report should be kept on site and signed by the Project Manager.

7.2.6 All the recommendations from government department or safety audit report should be taken action to rectify within 7 days from the date of receipt of the report is received. The recommendations should also be discussed in Site Safety Management Committee Meeting.

Fig : 6. Hazand Findings for Safety Management Committee

8. Job Hazard Analysis - Hazard Identification, Risk Assessment and Control

8.1 Arrangement

8.1.1 The Construction Manager, Engineering Manager, the Safety Engineer, the Foreman and Subcontractors are responsible to carry out risk assessment on occupational health and safety matters in connection with the project. The above responsible persons are competent and capable of performing hazard identification risk assessment and risk control because of their education, training and construction experience.

8.1.2 The criteria laid down in the Annex D of BS 8800: 1996 Occupational Health and Safety Management Systems are the standard to be followed in carrying out risk assessment. The methodology of risk assessment includes identification, determination of risk, rating, prevention measures, safe working procedures and will be reviewed every six months or a process is changed. The Safety Engineer is to conduct the risk assessment review.

8.1.3 The representative of related trade subcontractors is invited to participate on the process of risk assessment.

8.1.4 The Construction Manager and the Engineer shall give the method statements to the Safety Engineer within 2 weeks before commencement of construction work.

8.1.5 After hazard identification survey, the Safety Engineer, the project team and related subcontractors shall carry out risk assessment of site activities which have high risk, using the risk assessment form. The activities will be broken down into jobs/tasks for hazard identification and evaluation. The risk assessment process will include the normal activities and non-normal activities that may include plant maintenance and cleaning.

Fig : 7 (a). Hazand Identification Survey

Fig : 7 (b). Hazand Identification Survey

8.2 Risk Assessment Procedures

8.2.1 The Construction Manager, Engineering Manager, the Safety Engineer and the General Foreman will carry out risk assessment in respect of the forthcoming normal activities monthly before the activities start.

8.2.2 Assessment, which includes details of the necessary precautions, shall be used and recorded to formulate clear instructions for the personnel supervising and undertaking the work.

8.2.3 Risk assessment sheets shall be recorded with the activities, hazards, likelihood, severity, risk rating, control measures, responsible persons, time for completion.

8.2.4 The risk control measures will be accounted in the risk assessment report. Detailed description such as type of PPE and training course, will be classified in the risk assessment report.

8.2.5 The risk assessment results will be used to develop safe working procedures, a rewritten method statement and permit to work. All the results should be accounted in a part of the rewritten method statement.

8.2.6 The Results of the assessment shall be submitted to the Construction Manager for implementation and be discussed in the Site Safety Committee meeting and, if appropriate, the Site Safety Management Committee Meeting.

8.2.7 The Project Manager shall be notified the preventive and protective measures recommended in the risk assessment report for follow-up.

8.2.8 All risk assessments will be continuously reviewed and where circumstances have changed such that the original assessment is invalid, a new assessment will be carried out. The Safety Engineer is responsible for this review and monitoring work.

8.2.9 In order to ensure plant, personal protective equipment and training provided are in accordance with safety procedures/method statements/permit to work, internal safety audit shall be taken.

8.2.10 Number of risk assessments will be done for the period of commencement of work until completion of site activities.

8.2.11 Detailed risk assessment reports will be maintained.

8.3 Specification for Control Measures and its Implementation

8.3.1 The Project Manager is responsible for overall administration of control measures for each hazard including safe systems of work, protective clothing and/or equipment, etc.

8.3.2 The safe working procedure, rewritten method statement, permit to work system and training as laid down in the risk assessment report will bring to the Site Safety Committee to discuss and implement. The Safety Engineer disseminates risk assessment report in Local Language and English to workers during specific safety training.

8.3.3 The Safety Engineer distributes the developed safe working procedure, rewritten method statement, permit to work system to the operatives during training for actual operation such as erection of tower crane.

9. Provision of Personal Protective Equipment (PPE)

9.1 Statutory Requirement

Various personal protective equipment will be provided to and worn by the workforce in accordance with the relevant work activities being conducted. The standards of will be strictly in line with the local requirements, if specified and if not, the acceptable international standards.

9.2 Personal Protective Equipment (PPE) - Arrangement

9.2.1 Adequate and suitable PPE will be kept available on site.

9.2.2 The Safety Engineer or the Safety Supervisor is responsible to individually issue workers and visitors with suitable PPE before entering the site.

9.2.3 Workers and visitors who receive each item of PPE are required to sign a receipt which will be kept in site office by the Safety Engineer.

9.2.4 A warning notice shall be issued to workers who fail to use the PPE provided. Any Person frequently disregard the warning notice will be subject to disciplinary action which results in their dismissal from the site.

9.2.5 The Safety Engineer or the Safety Supervisor checks the stock of PPE regularly ensuring the subcontractors and workers can use them.

9.2.6 If any defects found to the PPE, the user, after visual inspection, shall contact the Safety Engineer or Safety Supervisor for replacement.

9.2.7 The Sub-contractors shall carry out their workers' PPE inspection regularly to ensure them using appropriate PPE.

9.2.8 Concerned departments and construction sites shall be notified in writing at the end of each year for the selected PPE.

9.2.9 The storekeeper shall follow the notification to purchase PPE.

9.2.10 The need of any type of protective clothing/equipment will be identified in the risk assessment report.

Fig : 8. Personal Protective Equipment

10. Accident/Incident Investigation: Corrective and Preventive Action

10.1 Accident/Incident Reporting Procedures

10.1.1 All accidents/incidents occurred shall be investigated by the immediate supervisor of the injured person and the Safety Engineer. The Safety Engineer records in a summary sheet of the incidents including near misses of causes and consequence. The result of the incidents or near-misses has made no damage, and then no further action is required. If any damage is involved, then the Safety Engineer brings the incident or near-miss to discuss in the Site Safety Committee Meeting.

10.1.2 In the event of an accident, the injured person shall immediately report to CSCHK's site staff and his direct employer.

10.1.3 The employer of the injured person shall complete a report form and submit to CSCHK site office within 24 hours after the accident.

10.1.4 Upon receipt of written accident report from the employer of the injured person or notified by Site Management, the Safety Engineer or Assistant Safety Engineer will carry out investigation to all accidents/incidents.

10.1.5 A written report shall be completed with recommendations by Site Safety Engineer and be discussed in Site Safety Committee Meeting with all subcontractors for prevention of the recurrence. Before discussion in the Site Safety Committee Meeting, the Safety Engineer, Construction Manager and General Foreman evaluate the practicality of proposed corrective and preventive actions or recommendations on risk assessment format before implementation. This report will be copied to the Project Manager for reference.

10.1.6 In the event of a person sustain a serious of fatality injury arising from an accident; the Safety Engineer shall immediately report the accident to the local authority. In such case, senior management will carry our investigation together with Safety Engineer.

10.2 Investigation Procedure

10.2.1 Investigations are to be conducted in an open atmosphere so as to encourage the witness and the injured person to speak freely. The main objective is to obtain the whole truth regarding the accident.

10.2.2 The investigation should be conducted in the following manner :

- ♦ Take photographs and make sketches
- ♦ Examine the equipment/tool/material involved in the accident
- ♦ Note the environment of the accident scene
- ♦ Interview the injured person, eye-witness and any other parties involved
- ♦ Consult expert opinion where necessaryand
- ♦ Identify the specific employer of those involved.

10.2.3 After looking closely into the accident, the Safety Engineer shall complete an Accident Investigation Report in the prescribed Project Company format covering the following key findings and recommendations as a minimum :

♦ The work in action at the same of the accident

♦ The circumstances under which the accident occurs ♦
The possible causes of the accident

♦ Any negligence on the part of any person and the person(s) to be held responsible, if any ♦
The particulars of the injured person(s)

♦ The nature of the bodily injury

♦ The remedial and preventive actions/measures to be taken.

10.2.4 The Accident Investigation Report should be distributed to Safety and Environmental Protection Department, Project Manager, Construction Manager and displayed on site notice board.

10.2.5 The Accident Investigation Report will be submitted to the client in accordance with the contractual requirement and relevant party in the prescribed format.

10.2.6 Also, Site Safety Committee and Site Safety Management Committee will study accidents and prompt actions are taken on the recommendation of the investigation so that a similar nature will hopefully be prevented in the future.

10.2.7 The investigation findings and recommendations will be a part of information of toolbox talks. The corrective or preventive action shall be reviewed as part of the control measures of a risk assessment process.

10.3 Accident Statistics and Analysis

10.3.1 The company overall accident statistics and analysis will cover at least the following aspects :

♦ The total number and accident in a certain month.

♦ The type/nature and cause of each individual accident. ♦
The seriousness of each accident.

♦ Government prosecution.

♦ The accumulated number of accidents since the commencement of the project. ♦ For any accident involving property damage, type and amount of property damage.

10.3.2 The Safety Engineer should prepare a safety monthly report including accident statistics and analysis and report to the Project Manager.

10.3.3 The computed and classified results of the accident statistics, analysis and investigation results should be analyzed by both the Site Safety Management Committee and the Site Safety Committee

for the sake of identifying problematic areas, and subsequently devising remedial-actions and possibly proactive safety measures to prevent the recurrence of similar accidents in the future.

10.3.4 The accident statistics and investigation results should be noticed on the safety bulletin boards for the attention of all employees on

- ♦ No injury records
- ♦ Frequent causes of accidents
- ♦ Simple tables comparing other site records ♦

Unusual accidents

- ♦ Charts showing reduction in accidents
- ♦ Chemicals or hazardous materials, if related to ill health, indicating accident trend ♦

Workload conditions (increased or unchanged)

- ♦ Worker's attendance or absence from work
- ♦ Non-conformance register that includes the assessment of corrective and preventive actions to be effective or not
- ♦ Length of time delay

11. Emergency Preparendness and Response

11.1 Emergency Plan

11.1.1 In the event of emergency, emergency team members will rescue any injured person and minimize influence to the public and property loss.

11.1.2 Designation of a central gathering point and means of fire escape shall be described on emergency plan. Safety Engineer and General Foreman carry out the drills and practices as scheduled.

11.1.3 Emergency and rescue equipment such as portable first-aid kit with sufficient content and stretcher shall be readily available on site. Emergency lighting and power sources will be available too.

11.1.4 The Safety Engineer should review and document post incident or drill of the emergency, the plan and the participants' performance and identify areas for improvement in the plan or the performance against site risk assessment results.

11.2 Emergency Procedures

11.2.1 An emergency team shall be established to deal with emergency situation such as outbreak of fire, flooding and accident to meet legal requirements.

11.2.2 The Safety Engineer shall prepare a draft Fire Preparedness Plan (hose reels, extinguishers etc) which shall be adopted following approval by the DGM, PM and the Employer's Representative.

11.2.3 The name list of the emergency team members including team leader as emergency coordinator shall be displayed on site notice board.

11.2.4 The emergency team members shall receive training on the use of firefighting equipment and relevant rescue equipment.

11.2.5 A fire evacuation procedure shall be displayed on notice board in site office.

11.2.6 Fire drills including rescue operation will be conducted in every six months.

11.2.7 The emergency team shall comprise Deputy Project Manager, Construction Manager, General Foreman, First-aider, Safety Engineer and Safety Supervisor. They are assigned to rescue life, protect property and stop fire.

12. Communication - Safety Promotion

12.1 Safety and Health Information

12.1.1 Erect a safety publication board to display and update company safety policies, emergency telephone list, organizational structure of Site Safety Committee, agenda and minutes of SiteSafety Committee Meeting, emergency and rescue procedures, excavation route plan, safety rules, safety guidelines or code of practice, newsletter, and safety promotion activities.

12.1.2 Erect an accident statistic and analysis board at the site entrance showing the current number of accumulates reportable accidents.

12.1.3 Provide and maintain safety and health guidebooks.

12.1.4 Display and update appropriate Safety Signs/Posters at the site entrances and relative work areas.

12.2 Procedures for Selection and Regular Update Information

12.2.1 The Assistant Safety Engineer is responsible to monthly update the information displayed on the safety publication board.

12.2.2 The Construction Manager to discuss with the Safety Engineer to select which item to be displayed.

12.3 Safety Incentive Scheme

12.3.1 Safety promotion & safety award scheme would be provided on site.

12.3.2 Safety worker award will be held every month during the joint site safety inspection. The inspection team consists of Project Manager, Construction Manager, safety Engineer and contractor's representatives. The assessment criteria will be base on observation and area foremen report.

12.3.3 Best Safety Performance of Subcontractor Scheme will be carried out every month.

13. Occupational Health Assurance Program

13.1 Health Assessment

13.1.1 Risk assessment of hazards to health shall be carried out by the main contractor and subcontractors and afterwards discussed in the Site Safety meeting.

13.1.2 All subcontractors and suppliers are reminded to submit sample and material safety data sheet (MSDS) for all dangerous substances and chemicals used on site to the main contractor and the Architect for approval.

13.1.3 Information on dangerous and hazardous substances shall be clearly identified.

13.2 First Aid Facilities

At every work place there shall be provided and maintained, so as to be easily accessible during working hours, first-aid boxes at the rate of not less than one box per 150 (one hundred and fifty) labour or part thereof ordinarily employed.

The first-aid box shall be distinctly marked with a red cross on white back ground and shall contain the following equipment:

♦ For work places in which the number of contract labour exceed 50:

12 small sterilized dressings.

6 medium size sterilized dressings.

6 large size sterilized dressings.

6 large size sterilized burn dressings.

6 (15 gms.) packets sterilized cotton wool.

1 (60 ml.) bottle containing two per cent alcoholic solution iodine.

1 (60 ml.) bottle containing salvolatile having the dose and made of administration indicated on the label.

1 roll of adhesive plaster.

1 snake bite lancet.

1 (30 gms.) bottle of potassium permanganate crystals.

1 pair scissors.

1 copy of the first-aid leaflet issued by the Director General Factory Advice Service and Labour Institutes / Government of India.

A bottle containing 100 tablets (each of 5 gms.) of

aspirin. Ointment for burns.

A bottle of suitable surgical antiseptic solution.

Adequate arrangements shall be made for immediate recoupment of the used items of the First-aid Box necessary.

Nothing except the prescribed contents shall be kept in the First-aid box.

The First-aid box shall be kept under the charge of a responsible person who shall always be readily available during the working hours of the work place.

A person in charge of the First-aid box shall be a person trained in First-aid treatment, in the work places where the number of contract labour employed is 150 or more.

In work places where the number of contract labour employed is 500 or more and hospital facilities are not available within easy distance from the works, first-aid posts shall be established and run by a trained compounder. The compounder shall be on duty and shall be available at all hours when the workers are at work.

A suitable ambulance shall be maintained on site at all times to carry injured persons or persons suddenly taken ill to the nearest hospital.

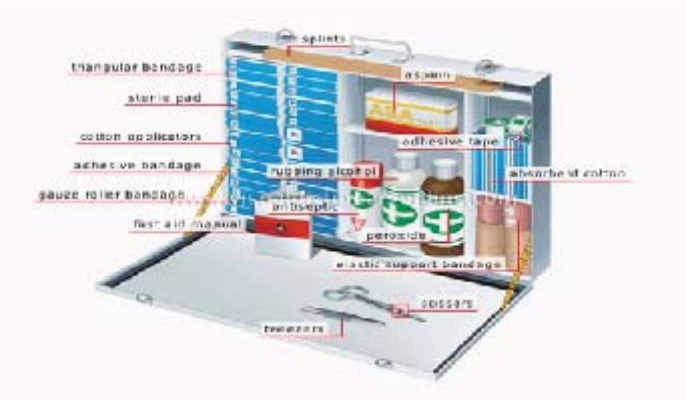


Fig : 8. First Aid Box

13.3 Welfare

13.3.1 Drinking Water

In every work place, there shall be provided and maintained at suitable places, easily accessible to labour, a sufficient supply of cold water fit for drinking.

Where drinking water is obtained from an intermittent public water supply, each work place shall be provided with storage, where such drinking water shall be stored.

13.3.2 Washing Facilities

In every work place adequate and suitable facilities for washing shall be provided and maintained for the use of labour employed therein. Separate and adequate cleaning facilities shall be provided Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition.

13.3.3 Latrines and Urinals

Latrines shall be provided in every work place on the following scale namely:

♦ Where female are employed there shall be at least one latrine for every 25 females. ♦ Where males are employed, there shall be at least one latrine for every 25 males.

Provided that where the number of males or females exceeds 100, it shall be sufficient if there is one latrine for 25 males or females as the case may be unto the first 100, and one for every 50 thereafter.

13.3.4 Provision of shelter during rest

At every place there shall be provided, free of cost, four suitable sheds, two for meals and the other two for rest, separately for the use of men and women labour. The height of each shelter shall not be less than 3 meters (10 ft.) from the floor level to the lowest part of the roof. These shall be kept clean and the space provided shall be on the basis of 0.6 sq. m. (6 sq. ft) per head.

Provided that the Employers Representative may permit, subject to his satisfaction, a portion of the building under construction or other alternative accommodation can be used for the purpose.

13.3.5 Creches

At every work place, at which 20 or more women workers are ordinarily employed, there shall be provided two rooms of reasonable dimensions for the use of their children under the age of six years. One room shall be used as a play room for the children and the other as their bedroom.

The rooms shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean.

13.3.6 Canteens

In every work place where the work regarding the employment of contract labour is likely to continue for six months and wherein contract labour numbering one hundred or more are ordinarily employed, an adequate canteen shall be provided by the Contractor for the use of such contract labour.

The canteen shall be maintained by the Contractor in an efficient manner.

The canteen shall consist of at least a dining hall, kitchen, and storeroom, pantry and washing places separately for workers and utensils.

The canteen shall be sufficiently lit at all times when any person has access to it.

13.3.7 Anti-malarial precautions

The Contractor shall at his own expense, conform to all anti-malarial instructions given to him by the Employers Representative including the filling up of any borrow pits which may have been dug by him.

13.4 Noise

- ♦ Noise survey shall be conducted for noisy activities.
- ♦ Noise survey shall be carried out by a competent person with approved type sound level meter and an assessment report shall be prepared.
- ♦ Safety signs shall be displayed to distinguish the hearing protection zone.
- ♦ Hearing protectors shall be made available on site and provided to workers exposed to noise level of 85dB (A) or more according to the result of the noise assessment.
- ♦ Label shall be attached to noisy machines on tools within the specified distance and suitable approved ear protectors shall be worn by any employee who operates the machine or tool.
- ♦ Hearing protectors shall be worn by other workers who are performing duties within the hearing protection zone.
- ♦ All subcontractors were instructed to choose low noise equipment for preceding their works.
- ♦ The Construction Manager and the Engineer plans to use silent type machineries or isolate people to work in high noise level of machineries due to the result of noise assessment.
- ♦ The following machines will be used with noise assessment :

  Generator

  Operation of backhoe with breaker

  Operation of air receiver

  Concrete breaking with hand-held pneumatic breaker

  Concrete breaking with hand-held electric breaker

  Operation of circular saw

  Use of saw bench

  Use of vibrating poke of concreting

13.5 Public Nuisance and Pollution

- ♦ All combustion engines shall be frequently maintained to prevent air pollution, and 8km/h is the speed limit within the site area.
- ♦ Site accesses, entrances and temporary haul roads shall be frequently sprayed with water to control dust dispersion.
- ♦ Washing facilities would be provided at site access point for removing mud from site vehicles.
- ♦ Sedimentation tank shall be provided prior to discharge wastewater. ♦

Low noise level generator / compressor shall be used.

- ♦ Lighting shall be provided along temporary sidewalk on traffic way. All lighting equipment shall be installed with earthing device.

14. Evaluation, Selection and Control of Subcontractor

14.1 Evaluation and Selection of Subcontractors

14.1.1 Any report of unsafe record by the subcontractors or suppliers will reduce the chance from selection by Project Company.

14.1.2 When selecting subcontractors or suppliers, Project Company will consider the sub-contractor's past safety performance for reference as stated in the Operation Procedures.

14.2 Control of Subcontractors

14.2.1 The Project Manager shall monitor the subcontractor's performance to ensure that they carry out their safety responsibilities of their Safety Policy.

14.2.2 The Safety Engineer shall regularly monitor the subcontractors for the implementation of Safety Plan and method statements and report to the Project Manager.

14.2.3 A pre-meeting will be held by the Safety Engineer with the subcontractors to discuss safety aspect before commencement of works to ensure that the subcontractors are aware of safety policy, safety plan, in-house safety rules and regulations, and emergency plan and the client's safety rules and procedures, if any.

14.2.4 Apart from safety message in the monthly site safety meeting, letters, memo and circular will also be issued to subcontractors concerned safety matters, hazards created by all parties and workers attending safety trainings.

14.2.5 All subcontractors are requested to submit their Safety Policy and Safety Plan.

14.2.6 Subcontractor will provide a responsible person to ensure the safety of the works. He must be present at the site all the time during the working period and attend all Site Safety meetings.

14.2.7 The subcontractor will provide each workman with a suitable safety helmet and other necessary protective clothing and equipment.

14.2.8 The subcontractor will be assured that all electrical wiring in use will be in good working condition and all machinery in use will be properly guarded around their dangerous parts against accidents touching by human bodies.

14.2.9 All of the materials, tools and equipment on site will be controlled by the following :

The security guard should inform the Safety Engineer, Assistant Safety Engineer or Safety Supervisor to check the operator license and valid certificate before any crane, heavy trucks entering into the site.

The subcontractor shall register all of the equipment and hand tools by the security guard when they enter this construction site. Only registered equipment & hand tools can be carried out of the site. One copy of above record will be submitted to the Safety Engineer.

The subcontractor shall inform Safety Engineer on any chemical substance they use. All of the dangerous and hazardous substances should be stored in a way recommended by manufacturer.

14.2.10 Design and submission of all method statements and risk assessments for construction works will be done by the main contractor after discussion with relevant subcontractor.

14.2.11 In order to ensure the subcontractors obey the safety regulations. A penalty system will be applied to offended subcontractor by deducting administration charge from interim payment.

14.2.12 All Suppliers are required to submit evidence, to confirm and undertake their goods comply with relevant statutory requirement. They shall comply with the site material delivery system.

14.2.13 The subcontractors will execute their works in compliance with all statutory safety regulations and ordinance and the requirements of this Safety Plan.

Appendix L: Disaster Risk Assessment Plan

1 NATURAL HAZARDS RISK ASSESSMENT

1.1 Introduction

Maldives is an island nation located in the north of the Indian Ocean. Its vulnerability can be attributed to a number of factors such as its geographical location, topographical features, probable effects of climate change, nature of its economy and associated trends of population concentration. Due to their location, the chain of islands that comprise Maldives are regularly exposed to multiple natural hazards such as storms, droughts, heavy rains and high waves caused by cyclones in the southern Indian Ocean.

This chapter maps out a detailed natural hazards risk assessment for the project area including Male, Hulhulé and Hulhumalé. A risk assessment is analytically based on documenting and assessing the hazard, followed by an evaluation of the vulnerability of a population or region to this hazard. The assessment has the following objectives:

- To determine the probability of natural hazards occurring across the project area based on historical data and future projections.
- To identify the potential impacts of such hazards on the project.
- To develop a disaster risk management plan based on the physical vulnerability of the project area.

Data and information related to physical vulnerability have been gathered from various secondary sources.

1.2 Physical Environment of Hulhulé

1.2.1 Rainfall

Monitoring of rainfall data is significant for predicting the occurrence of floods in a region. The islands of Maldives are particularly vulnerable to flooding due to heavy rainfall since the average elevation of Maldivian islands is only 1.5 m above mean sea level.

National Meteorological Center of Maldives records 3-hourly/ 6-hourly rainfall data for meteorological station located at Hulhulé. From the hourly rainfall data, monthly and yearly rainfall at Hulhulé for the period 2007 - 09 has been computed. The table below shows the average monthly rainfall for the period.

Table 1.1: Average Monthly Rainfall at Hulhulé (in mm), 2007 - 09

Year / Month	2007	2008	2009
January	14.7	69.6	85.2
February	0.3	51.3	12.8
March	22	176.7	36.8
April	199.6	136.5	86.6
May	181.9	243.9	168.9
June	180.6	240	213.7
July	178.2	156.6	275.9

August	136.3	236.8	416.9
September	268.3	40.5	193.3
October	328.4	254.6	97.4
November	31.1	156.3	400.2
December	243.2	222.5	189.4
Total	**1784.6**	**1985.3**	**2177.1**
Source: National Meteorological Station of Maldives			

Maldives generally experiences heavy rainfall from the month of April to August. The above data for Hulhulé shows that the monsoon period extends up to the month of December. The trend of rainfall over the last three years shows that the annual average rainfall has increased by 10% as compared to the previous year. Hence it's likely that the annual average rainfall at Hulhulé and nearby areas may gradually increase over the coming years.

Return periods for heavy rainfall is also taken into account while assessing heavy flood occurrence pattern. A UNDP study has calculated the probable maximum precipitation (PMP) for 24 hours for various return periods.

Table 1.2: Probable Maximum Precipitation for 24 hours for various Return Periods (mm)

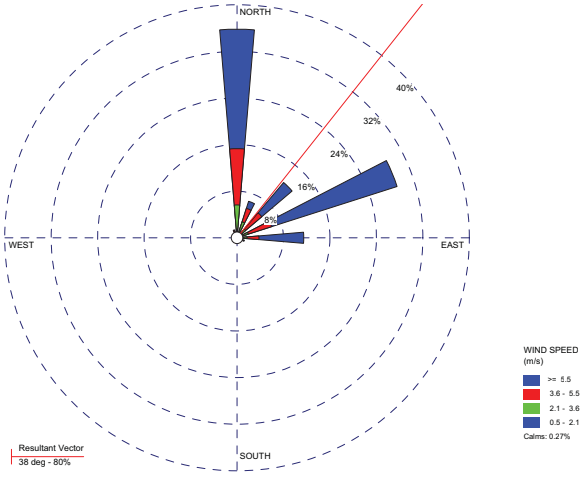
Station name	Return Period			
	50 years	**100 years**	**200 years**	**500 years**
Hulhulé	187.4	203.6	219.8	241.1
Source: UNDP Report "Developing a Disaster Risk Profile for Maldives"				

1.2.2 Wind

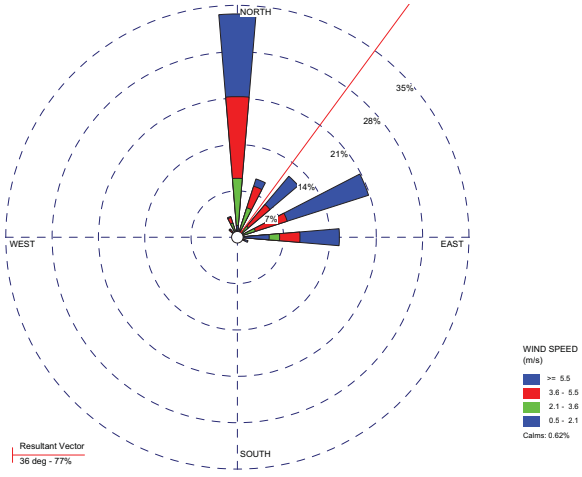
Wind speed and direction play significant roles in the occurrence of storms and cyclones. The National Meteorological Center for Maldives provides data for wind speed as recorded at Hulhulé meteorological station, for the period 1990-2010.

Figure 1.1: Monthly Wind Rose Diagrams for Hulhulé Station, 1990-2010

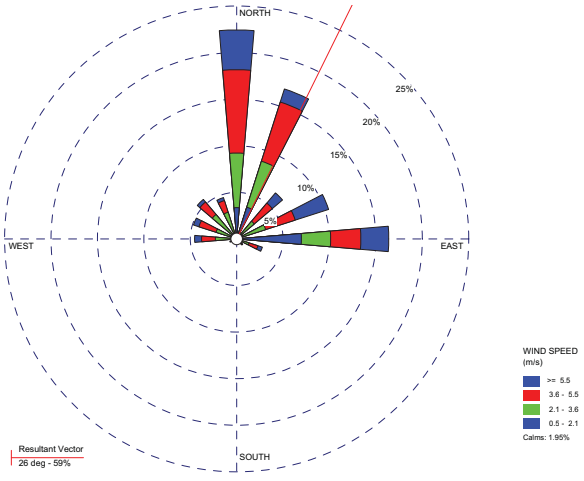
January **February**



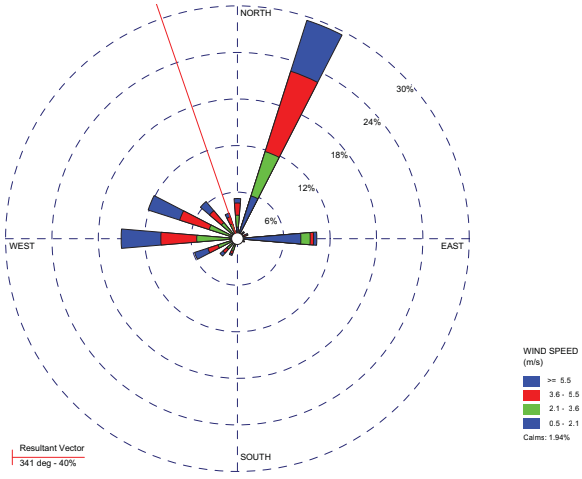
March



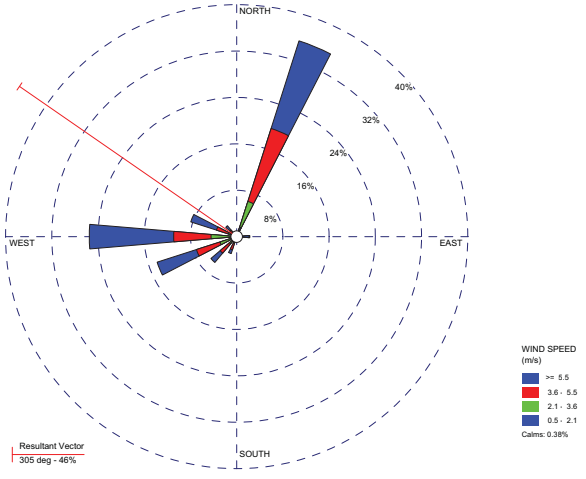
April



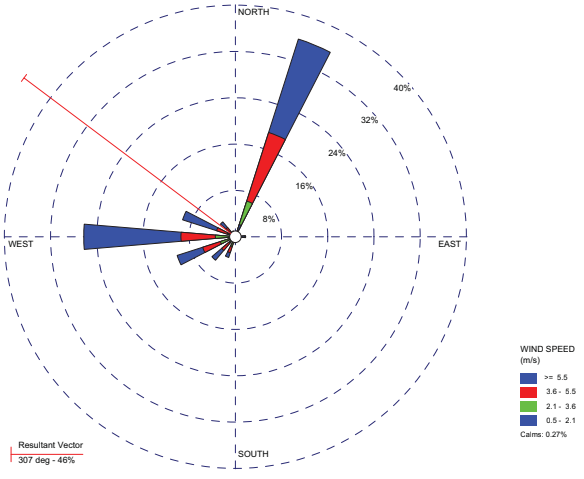
May



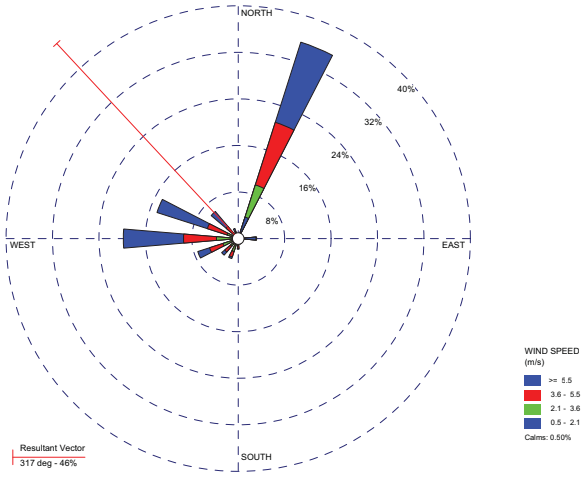
June

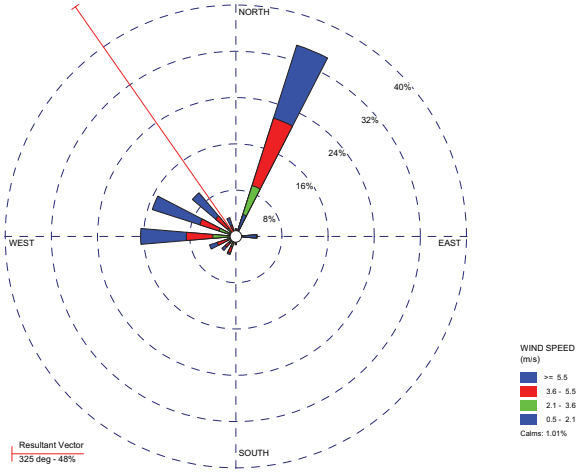


July

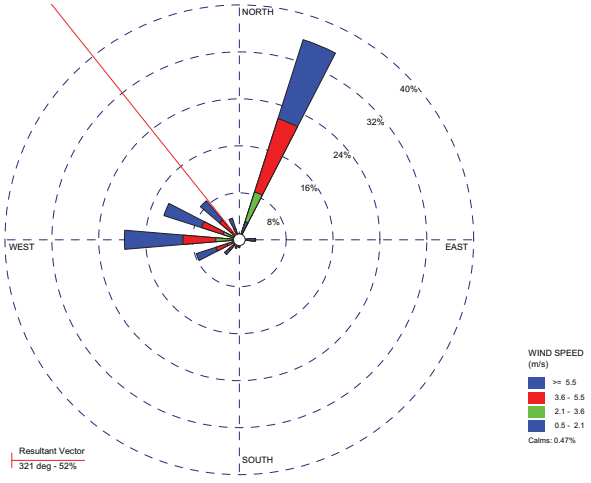


August

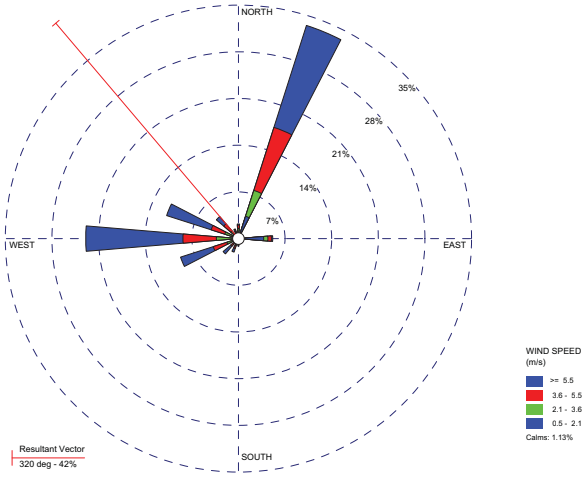




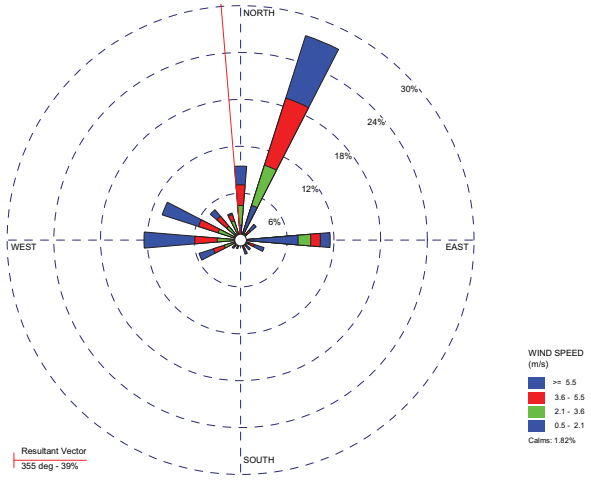
September



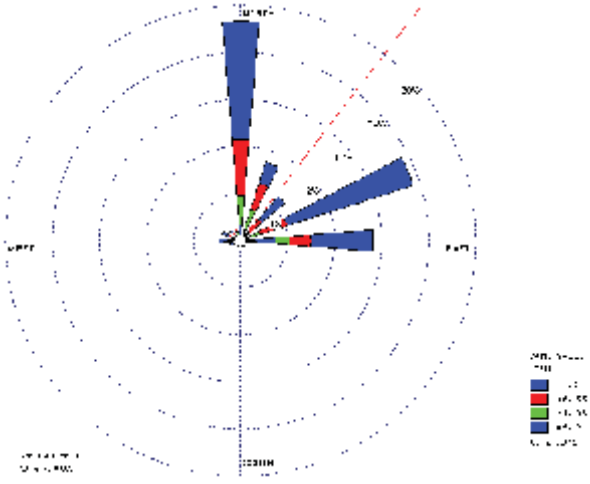
October



November



December



Source: National Meteorological Center, Maldives

The average monthly wind speed over last 10 years at Hulhulé has been derived from the above windrose diagrams and presented in table below. The maximum average wind speed has been observed in the month of January and lowest in March.

Table 1.3: Average Monthly Wind Speed of Hulhulé (1990-2010)

Month	Average Wind Speed (m/s)
January	6.02
February	4.99
March	3.88
April	4.04
May	5.54
June	5.72
July	5.23
August	5.04
September	5.25
October	5.52
November	4.58
December	5.51

1.2.3 Current

An ocean current is a continuous, directed movement of ocean water generated by several forces such as waves, wind tides etc. acting upon this mean flow. Ocean currents affect weather, food chains, human activity and can cause natural disasters. Changing ocean currents can result in changes of water temperature which could result in a global food shortage by killing fish and ocean plant life. The currents could also adversely affect the intensity and frequency of storms. Ocean currents also play an important role in climate change. Vice versa, climate change can also adversely affect the ocean current circulation.

Secondary data for ocean currents has been gathered from the database of NASA. The database provides data on ocean current speed, direction and convergence for the region covering Malé, Hulhulé and Hulhumalé islands (71.8E-73.8E, 2.2N-4.2N), which has been presented in table below. The direction of the ocean currents is predominantly towards east.

Table 1.4: Surface Current Speed and Convergence[1] for Malé Region

Surface Current Mean Speed (m/s)				
Year	**2007**	**2008**	**2009**	**2010**
January	0.51	0.35	0.48	0.45
February	0.40	0.34	0.50	0.53
March	0.33	0.22	0.31	0.37
April	0.20	0.24	0.21	0.30
May	0.30	0.24	0.28	0.35

[1] Current speed measures how far the water surface moves in one second. Current convergence measures how strongly the current flows towards or flows away from a location. A positive convergence of water indicates flow inwards to a location. A negative convergence (known as divergence) indicates flow outwards.

June	0.27	0.33	0.24	-
July	0.34	0.39	0.25	-
August	0.34	0.27	0.33	-
September	0.50	0.29	0.38	-
October	0.60	0.25	0.30	-
November	0.43	0.23	0.32	-
December	0.35	0.35	0.17	-
Surface Current Mean Convergence x 10^6				
Year	**2007**	**2008**	**2009**	**2010**
January	-1.31	2.07	6.51	0.77
February	-5.47	-0.91	0.25	0.15
March	-0.58	-1.23	4.13	3.42
April	-1.88	-6.58	-6.92	-6.33
May	0.59	7.76	1.79	-1.09
June	9.74	12.75	9.21	-
July	4.86	-11.88	11.87	-
August	-5.03	-6.01	1.95	-
September	-3.21	1.23	-2.24	-
October	-5.42	1.90	-2.88	-
November	1.68	0.65	-0.53	-
December	8.34	2.38	3.14	-
Source: http://oceanmotion.org/html/resources/oscar.htm				

1.3 Major Natural Hazards

The OFDA/CRED International Disaster Database provides information on major historical disasters worldwide. List of major natural hazards that have occurred in Maldives over the last 100 years has also been sourced from the same database, as indicated below:

Table 1.5: Major Natural Hazards of Maldives (1900-2010)

Natural Hazard	Date	Total Affected	Total Killed
Flood	11 Apr 1987	300	-
Storm Surge	27 Mar 1991	1649	-
Local Storm	15 Mar 2007	23849	-
Tsunami	26 Dec 2004	27214	102
Source: "EM-DAT: The OFDA/CRED International Disaster Database"			

Based on the historical records and several studies on natural hazards in Maldives, the following natural hazards, that can prove disastrous for the project under consideration, have been identified for the project areas including Hulhulé, Male and Hulhumalé.

- Floods/ Droughts
- Storms/ Cyclones
- Earthquakes
- Tsunami
- Sea Level Rise

1.3.1 Floods/Droughts

Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water. However, floods are not always caused by heavy rainfall. They can result from other phenomenon, particularly in coastal areas where inundation can be caused by a storm surge associated with a tropical cyclone, a tsunami or a high tide coinciding with higher than normal river levels.

In the last 40 years, Hulhulé has experienced flood and drought occurrences five to six times. The year 1978 was an extreme flood year for the island while extreme drought condition took place in 1995. However, as compared to other islands of Maldives, the frequency of floods and droughts in Hulhulé is considered to be medium.

1.3.2 Storms and Cyclones

Besides heavy rains and strong winds during monsoons, Hulhulé is also affected by tropical storms or 'tropical cyclones', (hereafter called 'cyclones') and severe local storms (thunder storms/ thunder squalls). Strong winds can damage vegetation, houses, communication systems, roads and bridges. Cyclonic winds sometimes can cause a sudden rise in sea-level along the coast, leading to a storm surge. The combined effect of surge and tide is known as 'storm tide'. Storm tides can cause catastrophe in low-lying areas.

Tropical Cyclones

According to the study carried out by UNDP, the islands of Maldives are less prone to tropical cyclones. The number of cyclones directly crossing Maldives is small. Only 11 cyclones crossed the islands over the entire span of 128 years. Most of the cyclones crossed Maldives north of 6.0^{o} N and none of them crossed south of 2.7^{o} N during the period. All the cyclones that affected Maldives were formed during the months of October to January except one, which formed in April. Maldives has not been affected by cyclones after 1993. The concerned project area (Malé atoll) lies within 3.7 ^{o} N to 4.8 ^{o} N. Hence the vulnerability of the project area to cyclones and tropical storms is considered to be moderate. The return period for cyclonic wind speeds with 65 knots are expected to recur once in 135 years in Maldives.

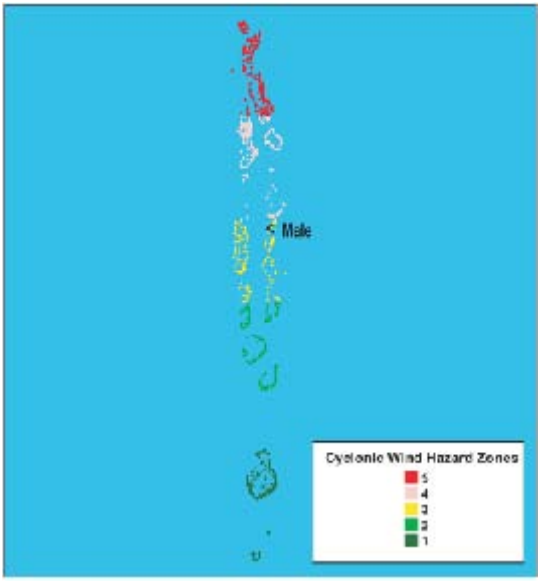
The following figure shows the tracks of cyclones affecting Maldives during the period 1877 - 2004.

Figure 1.2: Tracks of Cyclones affecting Maldives, 1877-2004

Source: UNDP Report "Developing a Disaster Risk Profile for Maldives"

The cyclone hazard zones of Maldives have been classified into five regions according to the 500 year return period wind speed of each region. According to the figure below, Hulhulé (Male) falls in Zone 3 of with moderate cyclone hazard and maximum wind speed of 69.6 knots.

Figure 1.3: Cyclonic Wind Hazard Map of Maldives



Source: UNDP Report "Developing a Disaster Risk Profile for Maldives"

Local Storms

Historical data shows that Male was affected by seven 'freak storms' in the period from 1958 to 1988 with peak seasons during May - July. However adequate reliable data is not available for local freak storms for the region. It is based more on observations by the local residents rather on recorded data.

Storm Surge

A storm surge is an offshore rise of water that occurs typically during a tropical cyclone. They are caused primarily by high winds pushing on the ocean's surface. The wind causes the water to pile up higher than the ordinary sea level. Hence storm surge can cause severe flooding in coastal areas. Storm surge is more of a threat when the storm strikes land from seaward, rather than approaching from landwards.

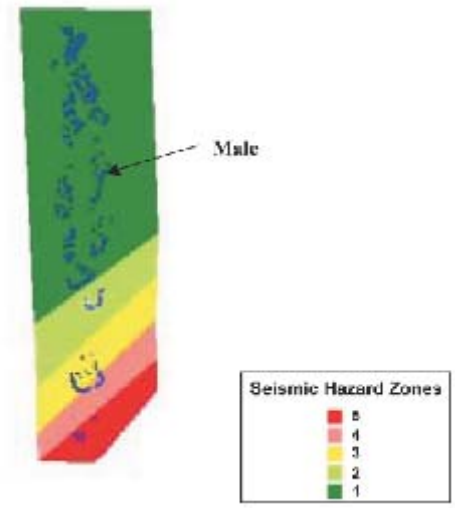
1.3.3 Earthquakes

Earthquakes can prove to be potentially disastrous for islands since they trigger tsunamis which are one of the most destructible natural hazards.

Studies show that only the southern region of Maldives is prone to earthquake hazards. Malé and surrounding islands of Hulhulé and Hulhumalé fall in the lowest seismic hazard zone, as seen in the figure below. The peak ground acceleration (PGA) value[2] for this zone for 475 years return period is less than 0.04. Hence risk from earthquakes is minimal for the project area.

[2] Peak ground acceleration (PGA) is a measure of earthquake acceleration on the ground. It measures how hard the earth shakes in a given geographic area.

Figure 1.4: Maldives Seismic Hazard Zones



Source: UNDP Report "Developing a Disaster Risk Profile for Maldives"

1.3.4 Tsunamis

Tsunamis are disastrous shock waves that are triggered by earthquakes, volcanic eruption or landslide originating below the ocean floor. They generate tremendous upwelling of waves that cause severe beach erosion and inundation of land. Tsunamis can destroy small islands completely, as was the case during the tsunami of 26 December 2004. It is the only reported tsunami in the last 100 years that affected Maldives on such a large scale. The height of the tidal waves ranged between 1 to 5 m high. It caused widespread devastation of infrastructure in most of the atolls.

According to sources, any tsunami impacting Maldives with a 2 m wave height has a return period of 50 years, 4 m wave height has a return period of 100 years and so on. The return period of the 2004 event is computed at 219 years. Studies conducted after the 2004 tsunami show that Maldives is most prone to tsunamis generating from the eastern side since the Sumatra Subduction Zone (maximum tsunami-producing zone worldwide) is on the eastern side of Maldives. Hence the project areas of Male, Hulhulé and Hulhumalé are most vulnerable to tsunami related hazards.

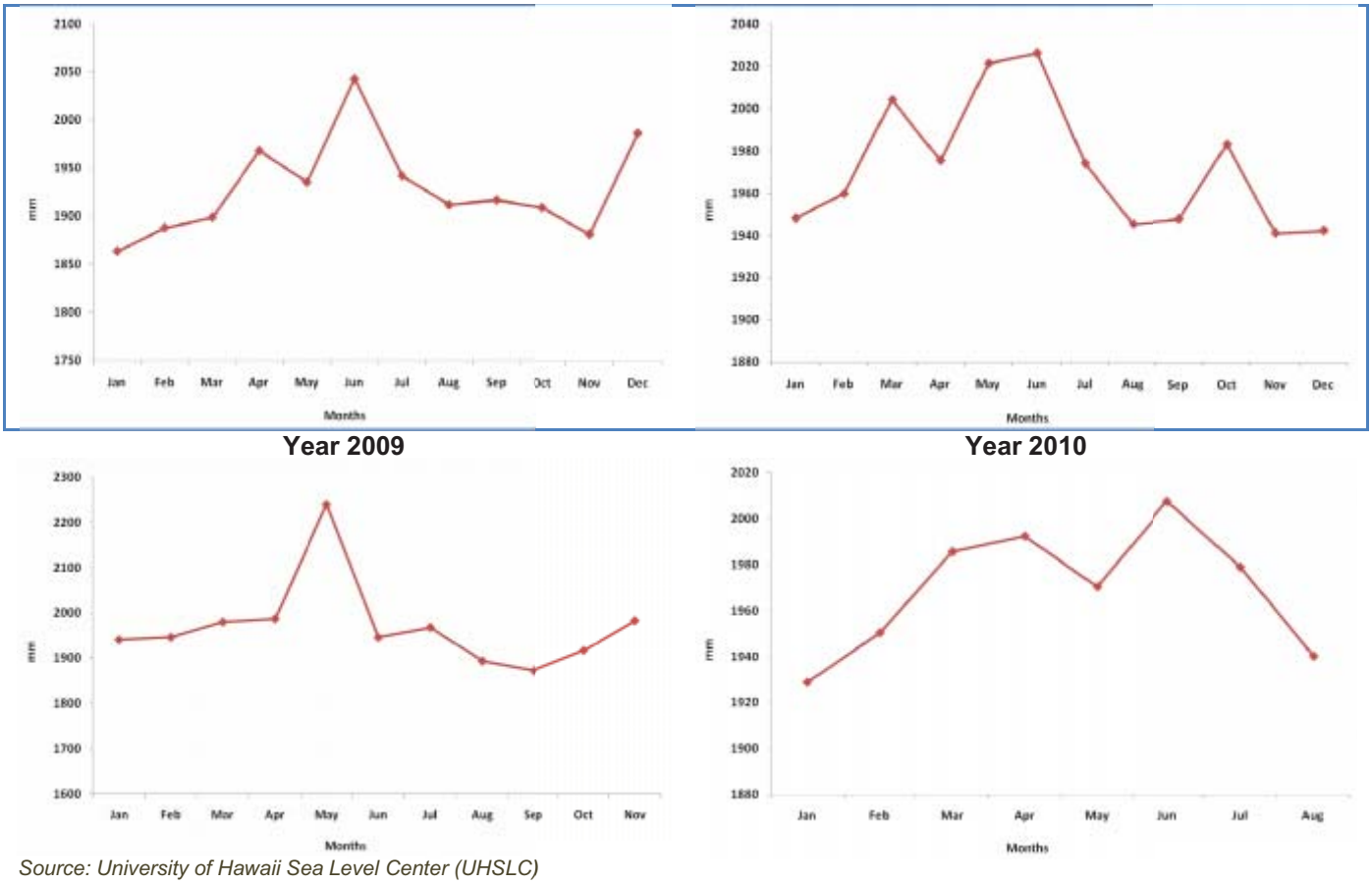
1.3.5 Sea Level Rise

The Maldives, being a low lying small island state, is very vulnerable to climate change and its associated impacts, especially sea level rise. Although the country contributes only 0.001% of global GHGs, it is one of the most susceptible to climate change impacts. The average elevation of Maldivian islands is 1.5 m above mean sea level (MSL). More than 80% of the land area of Maldives is less than 1 m above MSL. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report predicts that sea-level rise of up to 0.88m by 2100 will submerge the Maldives completely.

Malé International Airport on Hulhulé Island is the only gateway to the Maldives. The height of the runway is only 2 m above MSL and is extremely vulnerable to climate change related sea level rise. The University of Hawaii Sea Level Center (UHSLC) monitors and gathers data on mean sea level for several stations including Hulhulé. The following graphs show the trend of monthly mean sea level as monitored at Hulhulé station for the period 2007 to 2010.

Figure 1.5: Mean Sea Level (in mm) from University of Hawaii Sea Level Center

Year 2007 **Year 2008**



Source: University of Hawaii Sea Level Center (UHSLC)

1.4 Potential Environmental Impacts due to Natural Hazards

Natural hazards can have several impacts on the environment, most of them being short term. Since return periods of potentially disastrous natural hazards are usually near to 100 years, islands gradually recover from such impacts. Given below are the potential major environmental impacts due to natural hazards that may affect the project area.

Table 1.6: Potential Major Environmental Impacts on Hulhulé Island

Natural Hazard	Probability	Impacts
Floods	High	– Submergence of runway resulting in minor damage – Loss of life and airport infrastructure damage – Temporary termination of airlines/airport services
Cyclones	Medium/ Low	– Loss of life, vegetation and airport infrastructure damage – Temporary termination of airlines/airport services
Earthquake	Low	– Loss of life and airport infrastructure damage – Earthquakes of higher scale can damage the runway (e.g. runway may develop cracks) – May trigger tsunamis that have high damage potential – Temporary termination of airlines/airport services – Minor to moderate geomorphologic changes in the island
Tsunami	High	– Flooding of the airport premises, including runway resulting in widespread damage to airport infrastructure, coastal protection

		and island access infrastructure – Moderate damage to coral reefs – Disruption of air services for long duration of time
Sea level rise	High	*Short term impacts* – Result in widespread flooding during high tides and storm surges. – Loss of coastal vegetation and land due to erosion. *Long term impacts* – Gradual rise in sea level due to climate change will result in complete submergence of Hulhulé and adjacent Hulhumalé islands over the next 100 years.

1.5 Natural Disaster Management Plan

Natural hazards are low-probability events that are largely unstoppable. Natural disasters are the unfortunately common consequences of these extreme events. Humanity has become more and more vulnerable to natural hazard related disasters over the past few years. Anthropogenic activities have further deteriorated the situation by increasing the frequency of climate change induced natural hazards. Therefore, although occurrence of natural hazards cannot be prevented, adequate measures need to be adopted in order to minimize the impacts and mitigate the post hazard disasters.

Islands such as Malé, Hulhulé and Hulhumalé are particularly susceptible to various natural hazards as described in the above sections. Following measures can be adopted for minimizing the impacts of natural disasters at the airport.

Table 1.7: Natural Hazard Disaster Management Plan for Male International Airport at Hulhulé

Natural Hazard	Pre Hazard Measures	Responsibility
Floods	– Periodic monitoring of rainfall data monitored at Hulhulé meteorological station in order to track the frequency of occurrence of floods due to heavy rainfall. – Construction of coastal protection structures around the airport premises, such as sea walls. – Adequate storm water drainage system should be present to get rid of the accumulated water. – Preparation of an emergency evacuation plan for the passengers and airport staff. – Evacuate all persons as soon as flood warning signals are received at the airport. – Training and periodic safety drills for airport staff should be conducted from time to time.	–
Cyclones	– Early cyclone warning signals of the Meteorological department should be taken into account. – Construction of coastal protection structures around the airport premises, such as sea walls, in order to prevent the cyclone induced sea water surges into the island. – Emergency evacuation plan needs to be devised for the airport and should be followed as soon as warning signals are received. – Adequate relief supplies should be stored within the airport for emergency situations. – All warning signals should be released and made public, for preventing passengers from coming to the airport (THIS WILL ALSO BE DONE BY THE GOVT) – The airport personnel should work in close coordination with the Disaster Management Centre, GoM for keeping track of any natural hazards likely to occur in the region. – Necessary number of emergency exits should be present in all the buildings within the airport so people can reach to safety. – Training and periodic safety drills for airport staff should be conducted from time to time.	–
Earthquake	– Although probability of earthquakes is low for Hulhule, precautionary measures should be taken to avoid any kind of seismic related disasters. – All new construction such as terminal buildings, cargo building, maintenance building, power house etc. should be designed taking seismic safety into consideration. – Signage and posters highlighting safety measures that need to be taken during earthquakes should be demonstrated for passengers at significant points in the airport. – All airport personnel should be trained for handling earthquake hazard situation.	–

	– Emergency evacuation plan should be devised for earthquake related disasters in order to ensure safety of human life.	
Tsunami	– Airport personnel to work in close coordination with the Disaster Management Center, GoM in order to receive early warnings related to tsunamis. – Construction of coastal protection structures around the airport premises, such as sea walls to prevent sudden gushing of water into the island. – Emergency response plan should be developed for adopting on receipt of tsunami warnings. – Standard Operating Procedures (SOPs) should be devised and followed by each airport personnel during hazard emergency. – The airport management should ensure provision of human resources for search and rescue, medical aid, evacuation, relief supply storage and emergency shelters as part of the hazard emergency response plan. – Safety drills for airport staff should be carried out at frequent intervals in order to train them for all kinds of emergency situations.	–
Sea level rise	– Since this is related to fossil fuel induced climate change and has more of long term impacts, the airport management should contribute to greenhouse gas reduction on a global scale. – Reducing the use of fossil fuels during construction and operation of the airport. – Airport management should adopt sustainable practices. – Detailed carbon footprint of the airport construction and operation should be carried out – Airport authorities should aim at becoming carbon neutral, in view of the government's goal of 100% carbon neutrality for Maldives by the end of 2020.	–
Natural Hazard	**Post Hazard Measures**	**Responsibility**
Floods/ Cyclones/ Earthquakes/ Tsunami/ Sea Level Rise	– Thorough review of the damage caused to infrastructure, including terminal buildings, power houses, ATC tower, fuel farm and runway. – Ensure safety of human life by conducting thorough check of the entire airport premises after the hazard. – Provide necessary relief to passengers/staff affected due to the hazard. – Disrupt airline services until the situation is completely under control of the airport management.	–

Appendix M: Climate Change Impact

1 CLIMATE CHANGE IMPACTS

1.1 Introduction

Climate change may be defined as the long-term change in the global weather patterns over periods of time that range from decades to millions of years. It is a slow natural process that has been occurring ever since the formation of earth and depends upon a number of factors. However, anthropogenic activities have fastened the process of climate change and the situation has aggravated since the last few years. Climate change and its adverse effects are now the cause of global concern.

Maldives is one of the small island developing states (SIDS), that have long been recognized by the international community on climate change as a special case whose needs and concerns have to be addressed. Although these countries are among the least responsible for climate change, they are likely to suffer most from its adverse effects and could in some cases even become uninhabitable.

Maldives is among the 41 SIDS that are Parties to the United Nations Framework Convention on Climate Change (UNFCCC). Maldives is also the first country to become signatory to the Kyoto Protocol and ratified to it in 2002. Likewise, it is also member of the Alliance of Small Island States (AOSIS), and listed as one of the 11 least developed countries (LDCs). It has been actively participating in all climate change related negotiations.

Thus, in view of the vulnerability of the nation to climate change impacts, several strategies and initiatives being taken up by the Government of Maldives (GoM):

- Aim to achieve 100% carbon neutrality by the year 2020[1]
- Phase out hydro-chloro-fluoro-carbons (HCFC) by year 2020[2]

1.2 Greenhouse Gas Emissions Inventory for Maldives

Maldives depends largely on fossil fuels. Diesel is the main source of fossil fuel for generation of electricity in Maldives. The land and sea transportation system mainly uses diesel and to some extent gasoline, while air transport is dependent on jet kerosene. Firewood, LPG and kerosene are the main sources of energy used for cooking in the country.

The first GHG inventory for the Republic of Maldives was undertaken in 2001 by the Ministry of Home Affairs, Housing and Environment. It was published in the form of the ***"First National Communication of the Republic of Maldives"*** for submission to UNFCCC. The baseline year was 1994 and the methodology used was the IPCC Reference Approach.

According to estimations provided in the report, the energy sector contributed **129 Gg** of CO_2. Diesel is the primary contributor of CO_2 emissions, responsible for 80% of the total CO2 emissions. Disposal of municipal solid waste (MSW) resulted in release of **1.142 Gg** CH_4 emissions into the atmosphere.

Table below shows the amount and type of fuels consumed within Maldives and respective CO_2 emissions from each fuel type.

[1] As per the announcement of the President of Maldives in March 2009

[2] HCFCs, used as refrigerants, deplete the ozone layer and contribute to global warming. In 2007 the international community took an important step towards phasing out these refrigerant gases.

Table 1.1: Emission of CO_2 from Energy Sector of Maldives

Fuel Type	Fuel Consumed (Mt)	CO_2 Emission (Gg)
Gasoline	3.127	10.182
Jet Kerosene	3.541	11.175
Other Kerosene	0.013	0.043
Gas/Diesel	65.556	103.465
LPG	1.107	3.033
Bitumen	0.006	0.009
Lubricants	0.719	1.048
Total	**115.246**	**128.995**

Source: First National Communication of Maldives to UNFCCC, 2001

The below table presents the summary of GHG emissions from various sectors for Maldives.

Table 1.2: Sectoral GHG Emissions for Maldives

Fuel Type	CO_2	CH_4	N_2O
Energy	129.0	-	-
Industrial Processes	-	-	-
Agriculture	-	-	-
Land Use Change and Forestry	-	-	-
Landfills	-	1.1	-
Total (net) National emissions (Gg)	**129.0**	**1.1**	**-**

Source: First National Communication of Maldives to UNFCCC, 2001

1.3 Impacts of Climate Change

The Maldives, being a low lying small island state, is very vulnerable to climate change and its associated impacts, especially sea level rise. Although the country contributes only 0.001% of global GHGs, it is one of the most susceptible to climate change impacts. Malé International Airport on Hulhulé Island is the only gateway to the Maldives. The height of the runway is only marginally above mean sea level (MSL) which makes it extremely vulnerable to climate change related sea level rise.

Some of the critical issues being faced by Maldives due to climate change are as described below:

1.3.1 Sea Level Rise and Land Loss

The average elevation of Maldivian islands is 1.5 m above MSL. More than 80% of the land area of Maldives is less than 1 m above MSL. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report predicts that sea-level rise of up to 0.88m by 2100 will submerge the Maldives completely. The following table gives past and projected sea level changes for Hulhulé station.

Table 1.3: Past and projected sea level changes for Hulhulé Station for the period 1989 - 2000

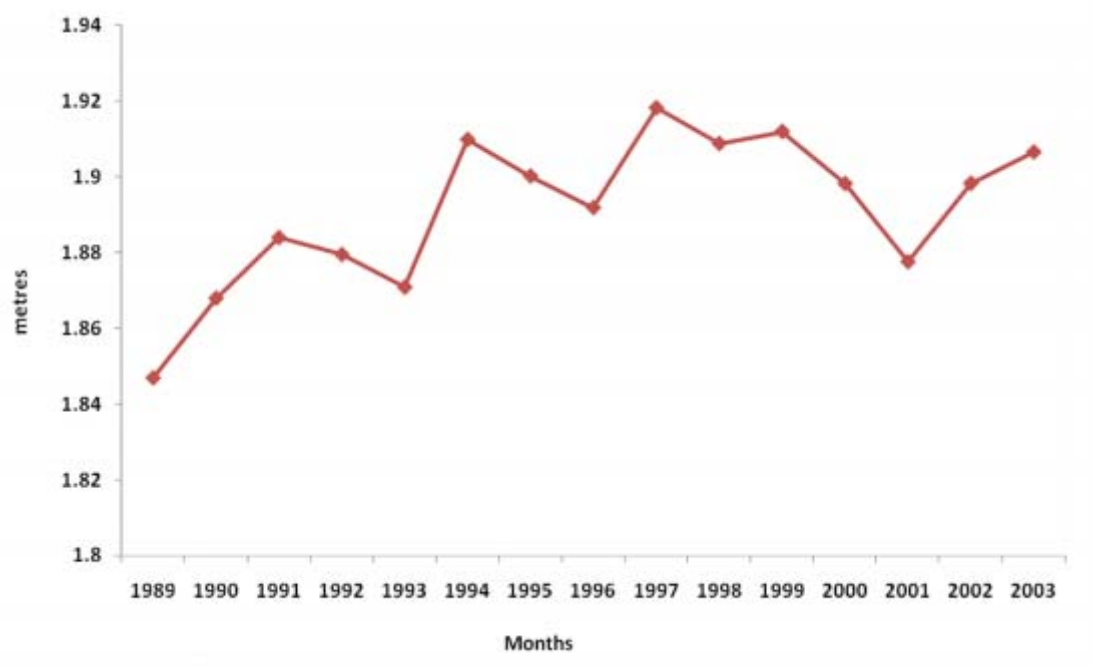
Estimated Historical Relative Sea Level Rise	Estimated Global Sea level Rise During This Period*	Calculated Island Subsidence	Absolute Sea Level Rise During 21st Century (mean case)	Relative Sea Level Rise During 21st Century (mean case)	Absolute Sea Level Rise During 21st Century (more extreme case)	Relative Sea Level Rise During 21st Century (more extreme case)
45 mm/ 14 yr	20 mm/ 11 yr	+25 mm/ 11yr	500 mm	+730 mm	900 mm	+ 1130 mm

** Based on 1.8 mm/yr*
Source: Small Island States in Indian and Atlantic Oceans: Vulnerability to Climate Change and Strategies for Adaptation, Mills and Hancock

The data shows that Maldives would be majorly impacted by relative sea level rise during the 21st century. Relative sea level is predicted to increase by 730 mm to 1130 mm for the nation.

The University of Hawaii Sea Level Center (UHSLC) also monitors and gathers real time data on mean sea level for several stations of Maldives, including Hulhulé. The following figure shows the yearly mean sea level as monitored at Hulhulé station for the period 1989 to 2003.

Figure 1.1: Monitored Mean Sea Levels for Hulhulé Station, 1989-2003



Source: University of Hawaii Sea Level Center (UHSLC)

Being so low-lying, the airport island of Hulhule is extremely vulnerable to sea level rise. From the above data it is evident that the mean sea level is gradually increasing; 0.06 m increase in 14 years. Hence the slightest rise in sea level will result in submergence of the airport island over the next 100 years.

1.3.2 Flooding and Beach Erosion

Floods have become quite frequent in several islands of the Maldives. As discussed in earlier chapters, the islands of Male, Hulhulé and Hulhumalé are also quite vulnerable to flood related disasters. Although these floods are mainly due to heavy rainfall and storm surges, the gradual increase in mean sea levels will further aggravate the situation. If the level of sea water is high, moderate rainfall can also result in flooding of the islands. This will cause severe beach erosion in the islands, since they are very low lying and vulnerable to inundation.

1.3.3 Coral Reef Damage

Coral reef ecosystems of the Maldives are significant at both national and international level. The two major economic activities of tourism and fisheries are reef based and provide more than 80% of the total revenues to the nation. Corals are highly sensitive to the changes in temperature and bleaching of corals take place at high temperatures. The El Niño of 1997 had caused severe coral bleaching. Hence global warming and higher sea temperatures will damage the corals severely. Moreover, the Maldives will disappear entirely if the rate of sea-level rise exceeds the rate of coral growth and sand generation.

1.3.4 Fresh Water Shortages

Majority of the population of Maldives depend on groundwater and fresh water resources. Intrusion of salt water and reduction in the fresh water lens is seen as a major impact of climate change and sea level rise. Some of the fresh water resources in the low lying atolls may be degraded severely and become un-exploitable in the short term. Also, the change in rainfall pattern is gradually affecting the replenishment of these fresh water resources.

1.3.5 Human Health

Changes in temperature and rainfall regimes are causing higher incidences of vector-borne diseases. Climate change related water borne diseases are becoming more frequent. Increase in flooding and surface air temperature will cause higher incidence of vector borne diseases.

1.4 Government Initiatives

UNFCCC recommends two types of measures that can be adopted by governments throughout the world for combating climate change – mitigation and adaptation. Hence the Government of Maldives (GoM) has identified several options for mitigating and adapting to climate change impacts in its' First National Communication to UNFCCC.

1.4.1 Mitigation of GHG Emissions

The First National Communication suggests measures that can be adopted by the government as well as private project developers for mitigating GHG emissions. The measures include sectors such as energy, transport, waste management and ecological improvement. These will aid the GoM in achieving 100% carbon neutrality by 2020.

- Use of high efficiency diesel generators for electricity generation
- Use of high energy efficient appliances in residential, commercial and industrial sectors
- Increase the use of renewable energy sources for replacing role of DG sets in power generation
- Use of solar energy for desalination of sea water
- Banning import of old reconditioned vehicles (such as cars more than 5 years old) into the country and levying high import duty on vehicles
- Developing an integrated transport system combining land, sea and air transport systems
- Development of integrated solid waste management system and sewage treatment facilities
- Increasing the vegetation cover and improving the health of coral reefs

1.4.2 Adaptation to Climate Change Impacts

Adaptation options are limited and the response measures are costly. But with available funding options, the GoM aims at adapting to the severe impacts of climate change and implementing following adaptation measures.

- Coastal protection in the form of seawalls and similar protective structures
- Population consolidation
- Imposing ban on coral mining activities
- Protection of the Male International Airport by construction of proper seawall and up gradation of existing domestic airports
- Increase the elevation of islands in future
- Reduction of human impacts on corals reefs and assigning protection status for the reefs
- Coastal protection of resort islands
- Protection of groundwater and increasing rainwater harvesting and storage capacity
- Public awareness and education

1.5 Role of the Project in Climate Change Impact Mitigation

As per climate change related reports and studies, Male International Airport on Hulhule Island is quite susceptible to sea level rise since the runway is just 2 m above MSL. The GoM has recommended construction of proper seawall around the airport for its protection in the First National Communication.

The project under consideration, i.e Male International Airport Expansion and Modernization Project, can contribute to achieving the target set by Maldives government of becoming 100% carbon neutral by 2020. The following options may be considered by the client in this regard.

- Undertaking ***Carbon Foot-print*** of the project, including both construction and operation phases. This would involve preparation of GHG emissions inventory for construction and operation phases and identification of strategies for mitigating them.
- Identifying potential ***Clean Development Mechanism (CDM)*** opportunities in the project, which would generate substantial revenue for the airport, thereby providing funds for climate change mitigation/adaptation measures.