ASIAN DEVELOPMENT BANK
TSUNAMI EMERGENCY ASSISTANCE PROJECT

☐ **IEE REPORT**

INITIAL ENVIRONMENTAL EXAMINATION FOR SH.MAROSHI ELECTRICITY UPGRATION

POWER PROJECT

Prepared by:

Hussein Zahir
Environmental Consultant

Prepared for:

Project Consultant
Zaahi Engineering Services Pvt. Ltd, Maldives

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Introduction

Tsunami of 26th December 2004 has caused significant damage of the infrastructure of Maldives including electricity in all the impacted islands. Upgrading of the replacement of electricity generating and supply systems in several islands is currently underway through government and international donor assistance. Sh. Maroshi has been identified as one of the 7 islands for upgrading electrical supply systems funded by Asian Development Bank (ADB).

This Initial Environmental Evaluation (IEE) report thus fulfils the requirements specified in the terms of reference prepared for this project specific to the environmental specialist. In preparing the report consideration has been given to cover the environmental requirements by ADB for these kinds of projects as well as the environmental requirements by the government of Maldives.

This IEE was carried out between 8th and 10th February 2006 during the field visit made to the project site by the by the environmental consultant and other relevant consultants for the project.

Terms of Reference

The 26 December 2004 tsunami inflicted widespread damage to the infrastructure and severely affected the living conditions of the population on the outer islands of the Maldives. The rehabilitation and reconstruction efforts on several areas are currently underway through assistance by several international organizations including Asian development Bank (ADB)

ADB's assistance as Tsunami Emergency Assistance Project (TEAP) is to provide the Government of the Maldives with the equipment, civil works, goods and other related services required for the rehabilitation and reconstruction of the tsunami-damaged infrastructure facilities. The Ministry of Environment, Energy, and Water (MEEW), in association with Maldives Electricity Bureau (MEB) has selected 7 islands for rehabilitation/reconstruction of the power stations under the Project. The designs for the 7 power stations have been completed under a separate contract awarded by MEB and financed by the Government of Maldives and are currently in the process of preparation of tenders for submission to the Tender Evaluation Board (TEB). In order to thoroughly examine each of the 7 power stations, additional studies are necessary to be carried out that include: (i) an initial environmental evaluation (IEE) and if required an EIA, (ii) a socio-economic assessment, and (iii) an economic and financial analysis for each power station. In order to carry out the additional studies, consulting services are required to assist the Government and ADB. During the study period, the consultant will be administered by ADB HQ and assisted, as required, by ADB's Extended Mission in the Maldives (EMM).

Detailed Tasks and specific activities carried out by the environmental specialist specific activities to be carried out during the project include, but are not limited to:

1. Preparation of the initial environmental examination (IEE), and if required an EIA, for the 7 power stations; This will include a description and location of each station (maps, aerial photographs, satellite imagery), description of the environment, screening of potential environmental impacts and mitigation measures, institutional requirements, public consultation and information disclosure, findings and recommendations, and conclusions.

2. Preparation of the environmental monitoring and management plans for each power station;

3. Inclusion of clauses in the tender documents that are directly related to the environment and mitigation measures required of the contractor and to be followed explicitly by the contractor, or others, in order to monitor the environmental aspects during construction.

Project description

This project involves construction of a new powerhouse for the island community as a replacement of the existing powerhouse which provides electricity to the island which is managed by Island Development Committee.

As part of the new facility three diesel generator sets with total capacity of 105KW, a control room with automatic switching control panel, an office and billing area and an accommodation facility will be provide. In addition fuel and water storage tanks will also be constructed as part of the project (figure 1).

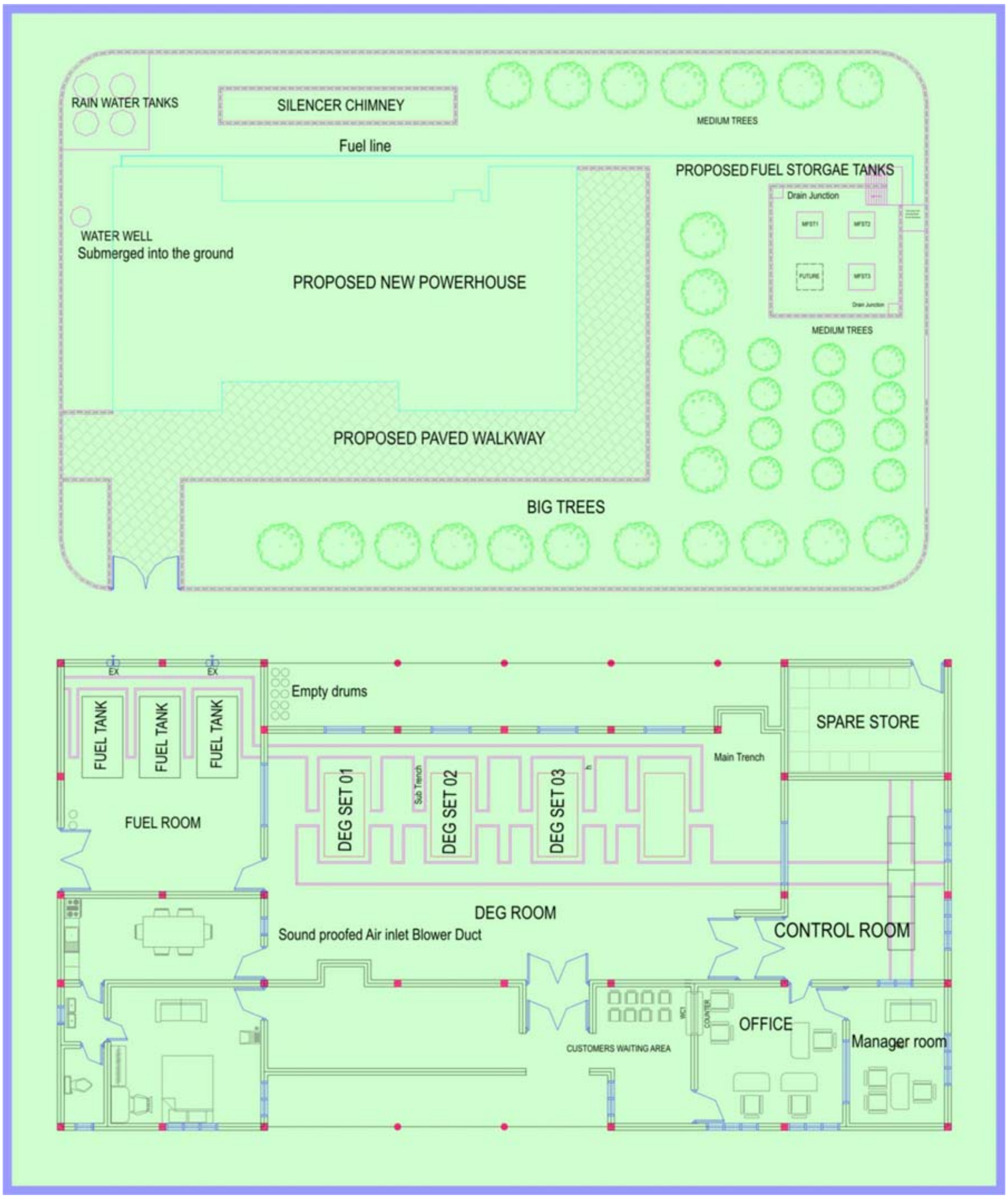

Figure 1 General layout of the powerhouse

Description of the environment

General setting: Project location

Geographically distinct, each community or village is physically separated from each other by sea where the islands are part of the atoll archipelago of Maldives in the north and central part of Indian Ocean. As such the island of Maroshi is located on the north western side of Shaviyani atoll, an administrative atoll with in Ha Alif to Noonu atoll complex (not a distinct geographic atoll) in the country. The island is relatively large in Maldivian standards (majority of the islands are less than 50 hectares in area) with dense vegetation fringed mainly by coconut palms. The eastern side of the island is exposed to the ocean side where as the western side is facing the atoll lagoon. Maroshi is a fairly small island which is more or less circular in shape with a length and width of 690m and 600m respectively. The island has an area of approximately 26 hectares with a population density of 32 persons per hectare. The village is located on the eastern side of the island near the coast (figure 2).

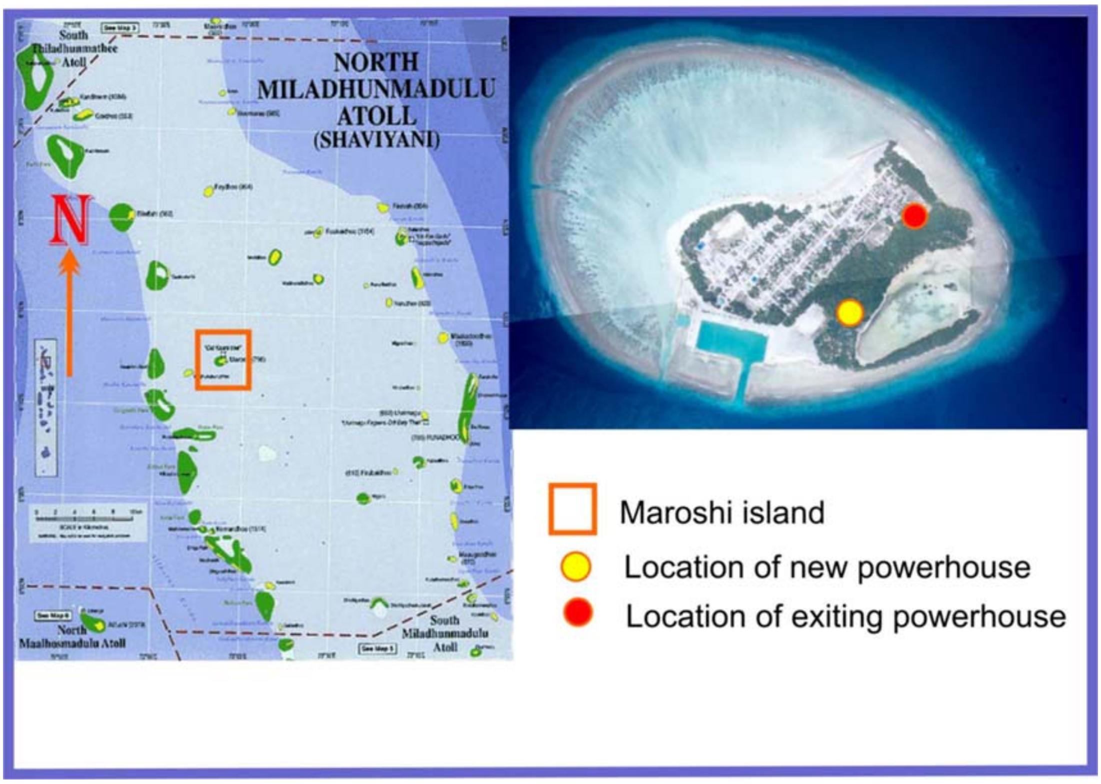

Figure 2 General location of Maroshi and proposed location of the new powerhouse

Physical environment

Air quality

Air quality is generally good at the project site. There are few point source emissions or engine exhausts that would cause a significant impact to the environment. Among these include few mechanized fishing vessels, other sea transport vessels, a few motor cycles and the existing powerhouse, and the powerhouse is the only source which emits exhaust fumes continuously all year around. The tropical climate with monsoonal winds provides an environment with good flushing and mixing of air and leaves little or virtually negligible traces of foul air in the immediate environment from the current sources of exhaust emissions.

Although emissions from the motor vehicles are not a significant concern in outer islands such as Maroshi it is already a significant issue and a concern in the capital Male. There are few regulatory measures to minimize the impacts on air quality. A road worthiness certification is imposed by the Ministry of Transport and Communication on motor vehicles every two years however, these routine checks are mostly on the physical aspects of the vehicle rather than the checks on limiting the exhaust fumes.

The powerhouse exhaust is currently not equipped with appropriate exhaust chimney. Chimneys are small bore pipes without a hood and emissions are directly discharged to the open air. As a result soot and other particulate matter are accumulated on the boundary wall of the powerhouse and on some of the plants in the vicinity of the chimneys.

Noise

In general, noise pollution is not a significant human health issue in the Maldives as there are no large motorized industries. The most significant source of noise in the islands including the project site is from the electric power house which is powered by diesel generators (DEG). These generators are generally operated in compliance with the regulations imposed by the Maldives Electricity Bureau (MEB) of Maldives.

The existing powerhouse compound is in the vicinity of housing plots which is only separated by narrow streets from two sides. None of the generators (except one) are sound proof and the building is not equipped with sound attenuators. As such sound levels from the powerhouse are in excess of 85 dB (A) in the immediate vicinity of the powerhouse (60m radius). Furthermore, the powerhouse is located close to the school which may cause some level of nuisance depending on the prevailing wind condition. As such, currently the powerhouse is not in compliance with MEB regulation which specifies all diesel power generating systems should have a minimum distance of 60m from the residential areas (articles no. 8.4 of MEB Regulation Handbook, 1995).

Soil and groundwater

Soil in these small tropical islands are poor and highly alkaline in nature as result of the sediments been saturated by calcium carbonate (100% coral sand). Only the top thin layer of the soil contains humus which varies depending on the vegetation and canopy. As the soil is highly sandy the water retaining capacity of the soil is poor. Maroshi soil can be categorized as fair compared to majority of the islands in the Maldives. There are no large agricultural activities that can be considered a significant economic activity. However, there is small scale agricultural gardening at the backyard of the residential plots mainly for home consumption.

Groundwater is the only source of water for cooking and sanitation purpose and is reported saline and not appropriate for drinking. Sewage disposal is generally through septic tank systems where the effluents are disposed to the ground which may eventually mix with the freshwater lens through drainage and precipitation and have the potential to contaminate the groundwater. As a result the community uses rainwater as the main source of drinking water. Many households have rainwater tanks to collect rainwater during the rainy season. There are also communal rainwater collecting facilities on the island with public finance.

Maroshi Island was significantly flooded with sea water during the tsunami of December 2004. Groundwater of all the islands inundated by the tsunami has been affected through contamination and saline intrusion. As a result the groundwaters in many islands are slightly saline, however significantly improved over the 12 months since the tsunami. Groundwater was tested for salinity, electrical conductivity and Total Dissolved Solids (TDS) from the well in the premises of the power house and a reference location about within 100 meter radius of the powerhouse. The primary intention of the tests for the water are to find out whether there is any trace of fuel in the groundwater as there is good indication of substantial spill of diesel in the area of fuel refueling. However, the Public Health Laboratory (PHL) in the Male does not have the reagents for testing trace levels of hydrocarbons at the time of the surveys. The salinity from both the powerhouse and the reference station was more than 2ppt (2.1ppt in the powerhouse well and 2.4ppt in the reference station). Similarly TDS and electrical conductivity (EC) was much higher in both the reference station and the powerhouse water sample. The EC of the powerhouse well water were higher than WHO reference standards for drinking water (less than 1500 μs/cm) and are 4340 μs/cm and 5010 μs/cm respectively. These results indicate that the groundwater, though slightly saline has high levels of dissolved solids (2010 mg/l for the powerhouse well-water and 2340 mg/l for the reference station well-water sample). For comparative purpose the groundwater of Male was also tested for salinity and electrical conductivity. The sample of water tested from Male has a salinity of 10.3ppt and electrical conductivity of over 19000 μs/cm.

Climate and oceanography

Maldives is affected by the Southwest monsoon (SW) (May – September) and the Northeast monsoon (NE) (December – February). The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the Hulhangu Halha, while the transition period from SW monsoon to NE monsoon known as Iruvai Halha is from October to November. The SW monsoon is generally rough and wetter (locally known as the rainy season) than the NE monsoon. Storms and gales are infrequent in this part of the Indian Ocean and cyclones do not reach the Maldivian archipelago.

The average temperature of Maldives is around 28 °C with little variation across the latitudes it spans close to the equator. The average daily temperature which can be applied to the project area is from Hanimaadhoo is between 31°C and 25°C. Rainfall records for the area shows about 1780mm of rain annually.

Tides

Tides experienced in Maldives are mixed semi-diurnal and diurnal with a strong diurnal inequality. There are few tidal record stations in Maldives. The nearest tide station to Maroshi is at Hanimaadhoo in Ha Dhaal atoll. Tidal estimates for the year 2005 indicate that the maximum tidal range at Hanimaadhoo is approximately 1.34m (tide calculations based on the tide data available for Hanimaadhoo at www.iikai.soest.hawaii.edu/uhslsc.woce.html). The highest astronomical tide level is +0.56m (MSL) and the lowest astronomical tide level are -0.78m (MSL). These tide measures can be applied to Maroshi because of the insignificant tidal variations in tide levels throughout the Maldives. Tidal variation reported from National Meteorological Centre (NMC) reports about 0.15m north to south variation where the tidal range is slightly larger in the southern atolls of Maldives. Site specific records and calculations for the tide were not taken at the project site because these parameters are not directly relevant to the proposed project activities.

Waves

The swell and wind waves experienced at Maroshi are conditioned by the monsoons and the swells generated by the storms in the Indian Ocean. The waves approaching the shoreline of Maroshi are conditioned by the two monsoons the NE and SW monsoon. However, since Maroshi is located within the atoll complex of Haa Alif, Haa Dhaal, Shaviyani and Noon the influence of oceanic swells and wind generated waves are somewhat dissipated before it reaches the shoreline of the island. The waves that reach the shoreline of the island would be waves that would have been regenerated on the reef flat after the original wave have broken on the reef slope/crest. The south and the east side of the reef more exposed to the wind and wave generated waves compared to the north and east side because of the narrow width of the reef on the south and east side compared to the north and west side The western side of the island occupies a wide reef flat occupied by a shallow lagoon. Although this side of the island is exposed to the SW monsoon the width and reef and shallow peripheral reef flat significantly reduces the wave energy before it reaches the shoreline.

Currents

Generally oceanic current flow through the Maldives is driven by the monsoon winds. Westward flowing currents are dominated from January to March (NE monsoon) and eastwardly from May to November (SW monsoon). The change in current flow patterns occurs in April and December (roughly the beginning of monsoon change). In April the westward currents are weak and eastward currents flow will slowly take place. Similarly in December eastward currents are weak and westward currents will take over slowly. Near shore currents are slightly different from the oceanic currents and are largely influenced by the location, orientation and morphology of the reef s around the islands.

Ecological resources

Terrestrial environment

Due to the high population density there is little dense vegetation on Maroshi. The vegetation structure in addition to coconut palms include Kuredhi (*Pemphis acidula*), Magoo (*Scaevola taccada*) and Halavel (*Suriana maritima*) dominate the nearshore or coastal area in tropical coral islands such as in Maldives. Timber size trees such as Nika (*Ficus bengalensis*), Funa (*Caloplyllum inophyllum*), Kaani (*Cordia subcordata*), Dhiggaa (*Hibiscus tiliaceus*) and Hirundhu (*Thespesia populnea*) are also common but not abundant. The southern side of the island harbours a natural bay which is fringed by few species of mangroves and mangrove associated species.

The area designated to construct the new powerhouse is located on the south eastern side of the island. This location is in the vicinity of the enclosed bay as far back it can be located away from the residential area to fulfill the minimum compliance distance required by MEB. The vegetation here is wild and several trees have to be felled in order to clear the land for the new powerhouse. These include approximately 40 coconut palms, few Dhigga, some screw pines and several species of bushes and shrubs as undergrowth.

Soil here is generally good composed of thin layer of humus and plant litter. Land clearing would lessen the richness of the soil with almost full exposure to the sun and rain. However this is directed to a small area and would have little residual effects to the surrounding areas.

Marine environment

Marine environment of Maldives is highly diverse in context of coral reef environment in which the whole Maldivian island ecology is dependent. The coastal marine environment is comprised of several coral reef related marine organisms many of which are ecologically important in addition to the myriad species in the ecosystem. Currently there are over 1200 species of fish, 250 species of corals, 13 species of mangroves, several species of sea grasses, 25 species of whales and dolphins, five species of sea turtles among many other several animal groups from the coastal environment. Reef environment is highly important to the economy of Maldives both from a fishery and tourism perspective.

This project and its impacts are not directly related to the marine environment and its associated components. Therefore little effort is made to describe marine environment in detail.

Ecologically important habitats

The marine environment, the island environment and associated habitats are all ecologically important ecological entities in a national context. Some of the more significant habitats are reefs, sea-grass beds, mangroves and inter-tidal area which have more of an ecological value than economic value. There are no major habitats associated with the project site (island) except the coral reef and the mangroves fringing the bay on the southern side which would have no or negligible impact from the proposed project activities. There are no seagrass beds associated with the project.

Rare and endangered species

There are no rare or endangered species associated or would be directly impacted as a result of this project. Rare and endangered species in the Maldives are more confined to the marine environment. Not rare but endangered species that are of highly significant even at global level are all the 5 species of sea turtles found in Maldivian waters. In addition to sea turtles several other marine species are protected. There are several species with an export ban and few species with ban on exploitation

Protected areas

Protected areas are few in the country which is mostly confined to marine protected dive sites. There are 25 protected dive sites in the Maldives but none in the vicinity of the project site. In addition to these protected dive sites a protected area has been recently declared in Addu atoll, known as Eidhegili kilhi area on of the first protected area that encompass both marine and terrestrial habitats.

There are no protected areas associated with this project. However there is a social and cultural monument on the northern side of the island which has a historical significance. This is a large tree which is boasted to be over 400 years old which has some relevance to the national hero who fought against the Portuguese who occupied and ruled the Maldives for over 15 years some 400 years back. This tree (monumental tree) is protected by law due to its historical significance. This site is however well away for the proposed powerhouse.

Potential impacts and mitigation measures

The existing powerhouse at Maroshi is located in vicinity but at the outer bounds of residential plots on the east side of the island. It has a boundary wall all around the powerhouse. The power house is equipped with three generator sets which are partially damaged but repaired after the tsunami and the condition of the generator sets are bad and the electricity provided is scanty and unreliable.

The existing building is not constructed to minimize the sound generated by the powerhouse apart from the lack of sound attenuators. The exhaust is open (without a chimney) so that all the particulate matter from the exhaust is widely dispersed to the vicinity. Accumulation of soot from some surfaces of the powerhouse compound indicates deposition of these materials in the vicinity. No attempts were made to quantify the amount of soot which may have been accumulating over the past several months.

Fuel storage at the existing powerhouse is not adequate with evidence of lot of spill around the pumping area.

The potential environmental impacts associated with the project activities and their likely magnitudes are described in table 1. These impacts were based on key environmental components and specific parameters within each component which is associated with the project. Considerations were also given taking to account the magnitude of the project and project activities in assessing these impacts.

Table 1 Potential areas of environmental impacts from the proposed project

KEY COMPONENTS		NO	YES		
			MINOR	MODERATE	MAJOR
Atmospheric	Air Quality		√		
Terrestrial	Vegetation Loss		√		
	Soil		√		
	Habitat		√		
	Waste management		√		
Water Resources	Groundwater	√			
	Freshwater Lens	√			
Coastal & Marine	Damage to Reef	√			
	Damage to sea grass	√			
	Marine Pollution	√			
	Beach Erosion	√			
	Fisheries	√			
Socio-Economic	Noise		√		
	Public Safety	√			
	Public Health		√		

	Employment		√		
	Land/Seascape		√		

As described in the table 2, many of the environmental components are identified to have a minor impact. These minor impacts are from activities either during the construction and operation phase of the project. As outlined earlier the magnitude of the proposed project and its components are not large, therefore the likely impacts associated with various activities are also not highly significant. The mitigation measures for the various impacts identified are given in table 2. In addition the magnitude and duration of the impacts, mitigation costs and responsible agencies are also identified.

Even though some of the impacts associated with the project are minor, the major components that may cause these impacts are outlined below. Description of these are based on the finding of field visit to the project site, consultations with the project engineer, published information and reports and consultants own knowledge through several references in this field.

Table 2 Potential environmental impact mitigation measures

PHASE	POSSIBLE IMPACTS	MITIGATION MEASURES	LOCATION	TIME FRAME	MITIGATION COSTS	INSTITUTIONAL RESPONSIBILITY
CONSTRUCTION – temporary impacts	**Air quality** • Dust and construction related dust from site clearing and structural construction	Follow and adhere to code of conduct followed inn the local construction industry. Such practices may include; • Cover loose and dry material with canvas or other appropriate method. • Wet the construction area if it becomes dry to minimize potential dust issues.	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant
	Noise and vibration • from construction works and machinery	Limit all work between 0600hrs and 1800 hrs Adherence of motor-vehicle noise standards	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant

	Vegetation loss • site clearing at the powerhouse construction site • site clearing for construction material storage and workforce camp	Minimize land clearing to absolute necessary level by • avoid cutting trees where possible • transplant and relocate large trees where possible • planting and landscaping works carried out in the final stages of construction	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant
	Pollution • waste generated from construction work force • construction waste • sewage disposal related to construction workforce	• Good code of conduct adhered by the workforce • Aggregate and segregate waste and dispose it according to the local waste management practice or to a higher standard (e.g. make arrangements to transport hazardous waste to municipal waste disposal site in Thilafushi, Male atoll. • Avoid if possible setting up construction workforce away from the community	Powerhouse plot and the vicinity Residential area	During the construction	Covered by the contractor	Contractor Project management consultant

OPERATION – permanent impacts	**Air quality** • Smoke from engine exhaust • Particulate matter in the exhaust fumes	• Good engine maintenance and adherence to repair and maintenance schedule specified by the manufacturers • Design and construction of silencers so that exhaust emissions dispose through the chimney	Powerhouse plot and atmosphere in the vicinity of the powerhouse	During the operation of the powerhouse	Covered by the contractor	PMU, project design engineer
	Noise and vibration • Engine operation (continuous sound)	• Powerhouse constructed to design specifications, away from residential area (minimum 200 feet radius from residential plots) • Install sound attenuators • Powerhouse operated to design specifications (proper use of double doors, door closers	Powerhouse plot and atmosphere in the vicinity of the powerhouse	During the operation of the powerhouse	Covered by the contractor	PMU, project design engineer
	Waste • Waste oil generated from the engines • Radiator waste • Waste rugs or cloths	• Good house keeping • Drain empty container before they are disposed burn waste clothes if they are in small quantities.	Powerhouse	During the operation of the power house but more during repair and maintenance	Powerhouse manager/ management unit	Powerhouse manager/ management unit

	Oil pollution • Oil and fuel is designed to be stored in the powerhouse premises. Accidental spill and leakages are likely during fuel transfer and transport	• Fuel storage tanks constructed by reinforced steel • Fuel storage area bunded to contain accidental leakages coated with impermeable material • Adhere to the code of conduct for engine repair and maintenance followed by MEB	Powerhouse and fuel storage area	Operation of the powerhouse ; during fuel transfer and refueling times.	Powerhouse manager/ management unit	Powerhouse manager/ management unit

New Powerhouse

Location and land clearing

The powerhouse is located in the vicinity of the football field (figure 3). An area of 60x50 meter plot has been selected near the football field after consultation with the community leaders. The consultants advised on the MEB powerhouse site regulation to IDC which specifies that there has to be a minimum distance of 60 meters from a residential area. This location for the new powerhouse complies to the MEB regulations.

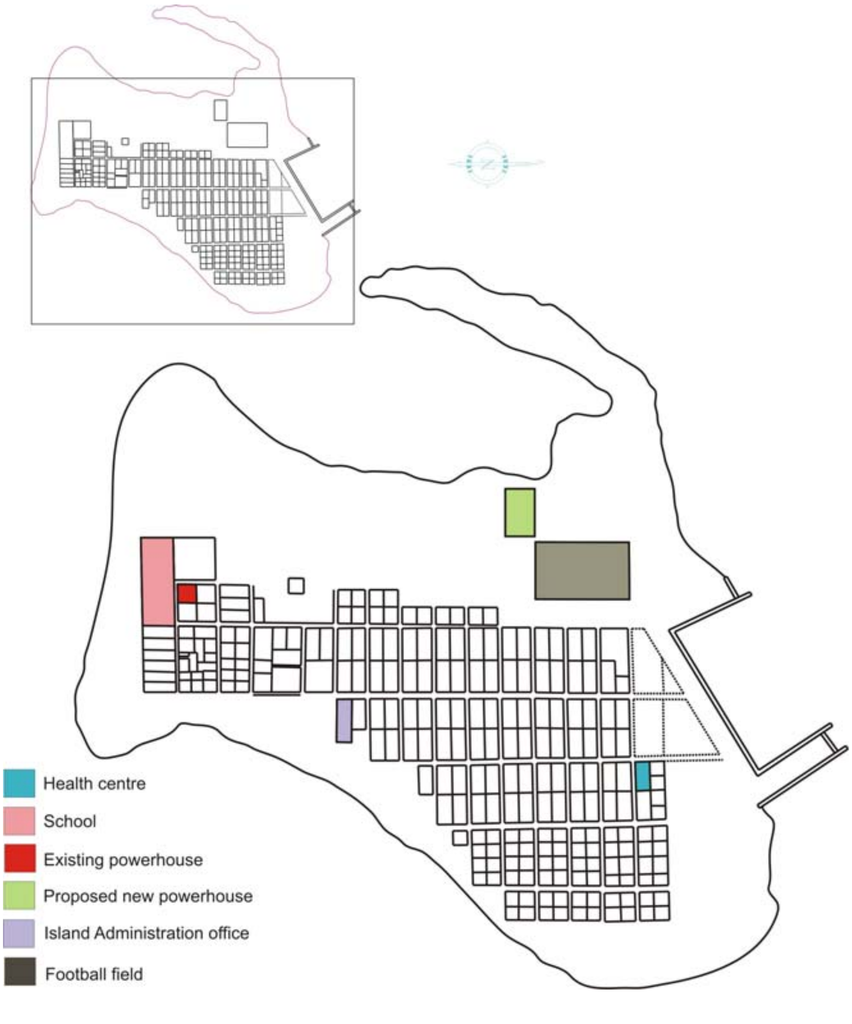

Figure 3 Location of the new powerhouse with respect to significant infrastructures

There are fair amount of vegetation in the designated area for the new powerhouse. They are mainly coconut palms; few small sized wood plants but mainly small bushes and shrubs as undergrowth. There are also few breadfruit trees (all are more or less dead) affected by the saline flooding during the tsunami.

The damage to the terrestrial environment is anticipated to be minor as a result of the project. This is outlined in table 1. Only few trees have to be cut down to accommodate the powerhouse building. As some of the larger trees belong to the residents arrangement has been made to pay the compensation for the trees through the contractor.

There isn't also any major land clearance involved in the project, less than (3000 square meters). Therefore, no major soil erosion or soil run off is anticipated as a result of this project.

Construction of powerhouse

The new powerhouse consists of DEG set room, control room, office/billing area, fuel room, fuel storage tanks and water storage facility (figure 1).

The construction works involve largely civil masonry works and commissioning and installment of new generator sets. Civil and masonry that may have impact if any would come from mainly sand and cement

Coral sand would be used for construction. Sand would be mined locally as it could be collected from approved designated areas within an atoll. Thus almost negligible impact is anticipated on the marine environment as a result of the project especially due to the small scale of the project. Cement for the project would be brought from Male in bulk quantities and stored in the construction site.

Dust from the cement has the potential to cause negative health impacts to the work force. However, with health conscious work practice followed by the construction workforce such as wearing simple masks in the immediate cement handling areas such negative impacts would be minimized.

In addition to the masonry works the project includes commissioning of three DEG sets, installment of associated equipment and partial repair and installment of underground power distribution cables.

All cables would be buried along the earthen (unpaved coral sand) streets. The trenches are narrow (0.3 meters) with an approximate depth of 1 meter (more or less above the groundwater lens). All cables would be covered with an inert polyvinyl chloride (PVC) sheath. The trenches will be open for only a short while and will be buried immediately after the cables are laid. Therefore disturbance to the soil structure is anticipated. Some level of discomfort to the community is anticipated as the cables would be buried in the existing streets. This is only for the duration of the cable distribution and is temporary.

Waste generation and waste management

The waste generated from the construction workforce is anticipated low given the scale and number of the workforce. Approximately 30 people are estimated to be involved during the construction of the project. The best option for accommodating the construction workforce is to find suitable accommodation within the community (temporary) so that a separate camp for them is not needed. Additionally, unskilled and semi skilled worker can be recruited from the local community so that some economic return from the project is provided to the community even at the construction stage.

Construction related waste from the project can disposed following sound environmental practices followed in the country. It is proposed that organic and non hazardous waste is burned (common local practice as the land is scarce. Harmful waste has to be separately managed by the contractor and disposed to Thilafushi.

Noise and vibration

The new powerhouse, although close to the residential areas would have improved noise control measures as compared to the old powerhouse. The building is designed to equip double doors into the generator room. There is no sound attenuators considered as part of the new design neither in the old design. However the double door concept together with the engine silencer emitting the exhaust through a chimney. The chimney also has sound absorbing capacity. In addition the powerhouse compound would be planted with tress to further mitigate the noise levels outside the powerhouse

The generator sets are allocated for the powerhouse is all high speed light diesel engines and ground vibrations are not a significant issue. In addition anti-vibration mounts will be used when the DEG sets are installed, which comes with the DEG sets.

Emissions

Currently the exhaust fumes from the engines are dispersed without a chimney. However the new powerhouse would be equipped with residential class primary silencers emitting exhaust through a chimney. This action would reduce exhaust emission as compared to the old powerhouse which would have a positive impact on the air quality. The chimney in addition facilitate the sound reduction would also facilitate to reduce the particulate matter emitted through the exhaust. It is believed high level of carbon would be accumulated inside the chimney which has to be removed periodically by scraping the chimney floor. The carbon collected would be disposed to the local disposal site.

Diesel oil and other chemicals

The most significant environmental impact associated with the powerhouse would be related to the running and operation of the DEG sets. 3 generator sets with a total capacity of 105 KW would be installed and operational at the powerhouse. Assuming approximately 60% operation of the DEG sets (45 KW) the estimated annual fuel consumption is 114,000 liters. The total fuel storage capacity of the powerhouse is 18,000 liters, 3 tanks each with a capacity of 6000 liters. Diesel tanks would be constructed with steel with an outer bund-wall made from reinforced sand/cement structures. The purpose of this bund-wall is to contain accidental spill during fuel transfer and also to accommodate leakages. The main fuel storage tanks would be connected to the fuel day tank which feeds fuel to the engines through a fuel line.

Waste oil generated from the DEG sets would produce a substantial amounting to over 325 liters annually. Presently waste oil is stored in 200 liter polyethylene containers or metal drum in the powerhouse premises. Waste oil has some demand for treating timber and timber based small fishing vessels. Although this is commonly practiced care has to be taken in handling waste oil as it contains low levels of carcinogens which may cause skin irritations and it is important to notify the buyers of the waste oil the risk involved.

Reuse of waste oil mixed with diesel fuel has been considered as an option for optimal usage of the waste oil. Although such mixing methods are available it has not been widely practiced as the viscosity of the mixed fuel doe not meet the specifications required by for the smooth operation of the engines. Such options may not be favored as it may reduce the life of the engines.

The best practical method for disposal of the waste oil would be to transport it to a site designated by MEEW to dispose waste oil and other hazardous material. However, such a place does not exist within the atoll. The nearest waste disposal site is located in Kulhudhuffushi which had a regional waste management site. The other option is to transport the waste oil to Thilafushi, the main municipal and hazardous waste disposal site in the country.

Fire and other safety aspects

Work safety aspects required by MEB have been incorporated in the design of the powerhouse. Suitable fire extinguishers will be installed. Sound level in the generator room is anticipated to be higher than required by MEB, therefore employees would be provided with ear protection devices such as ear plugs or headphones. Safety shoes would also be provided to the employees.

Institutional requirements and environmental monitoring plan

The environmental impacts associated with this project are viewed in context of the fragile tropical environment of Maldives where some of the impacts can be regarded significant given the small size of the islands and sensitivity to adverse environmental impacts. The environmental impacts discussed will be systematically monitored and reported during construction and operation of the powerhouse in accordance with arrangements specified in the . The Project is designed to comply with the local construction standards, powerhouse/electricity operation and supply standards. With the design and operational specifications included in the contract document the project is expected to meet good environmental standards. Table 3 summarizes the mitigating measures, the monitoring requirements (e.g., parameters monitored), frequency of monitoring, and the parties responsible for compliance and implementation.

Table 3 Environmental Monitoring and Management Plan.

ENVIRONMENTAL COMPONENT	PROJECT STAGE	PARAMETERS	LOCATION	FREQUENCY	STANDARDS	COSTS	RESPONSIBLITIES	
							IMPLEMENTATION	SUPERVISION
Terrestrial Vegetation loss	Construction phase	Felling of trees for constructing the powerhouse	Powerhouse plot	once	Identified in consultation with MEEW	Approx. USD 150.00	Contractor	Consultant in association with MEEW
Air quality	Operation phase	Exhaust particulate matter	In the vicinity of the powerhouse	Twice a year	Identified in consultation with MEEW	Approx. USD 200.00	environmental officer/consultant	Consultant in association with MEEW
Noise	Operation phase	Noise levels from the powerhouse	Vicinity of the powerhouse	Twice a year	Identified in consultation with MEEW and MEB	Approx. USD 200.00	environmental consultant	Consultant in association with MEEW
Oil spillage/pollution	Operation phase	General housekeeping audits, Oil in groundwater/ soil	Powerhouse, fuel storage area, workshop	Twice a year	Identified in consultation with MEEW	Included in operation and maintenance costs, USD 200.00	environmental consultant	IDC Powerhouse mamagemennt

MEB/MEEW pay close attention at all stages of the project, to monitor and control environmental performance and to consult regularly with the responsible authorities and the community (e.g. powerhouse manager or relevant representative in IDC). The plant operations organization will include a specific person responsible for environmental management and monitoring, and training. Programs will include appropriate environmental management activities for all operational staff.

The institutional arrangement for environmental management and monitoring of the powerhouse is shown in figure 4.

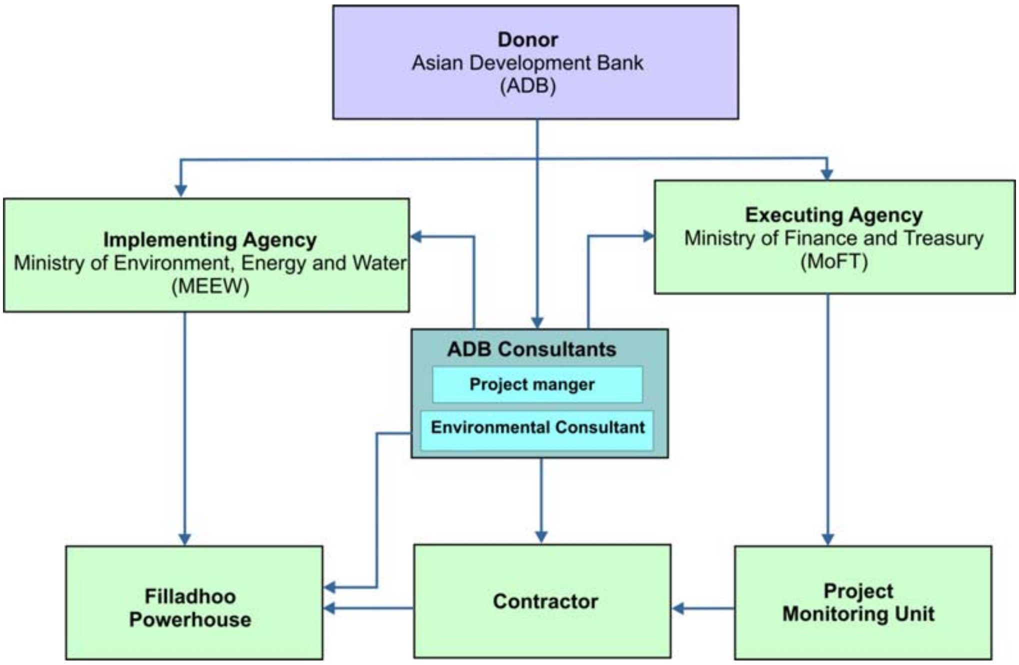

Figure 4 Institutional arrangements for the implementation of the proposed project

Public consultation and information disclosure

The design for the powerhouse, equipment and services provided under the project has been consulted and approved by Maldives Electricity Bureau (MEB) and MEEW. Environmental consultations during for the IEE were carried out with the relevant stake holders including island communities and other relevant agencies. The main purpose of these consultations were to discuss the ADB requirement for IEEs and its objectives of setting the baseline for the project sites and confirming which environmental category the project belongs to with respect to both the Governments and ADB regulations. The full list of those met and consulted is in Appendix 1.

The Island Development Committee (IDC) and key senior citizens including Women Development Committee representatives from the island has been briefed on the environmental consideration required by the project. Detailed description of the each component of the project was presented to the community to get their feedback and perception on the overall project. In addition, the group was asked their environmental concerns in general as well as any related to the project.

Among the issues which were raised in consultations, apart from the state of the electricity and the need for improved electric supply system, those that aroused the most concern were state of the groundwater and waste management. Groundwater has been contaminated with sewage effluents from the septic tanks and seawater during the tsunami flooding which was substantial. Many feel that the groundwater is becoming less saline which is slow but steady. Good precipitation is likely to improve the quality of the groundwater, at least the salinity.

Waste was highlighted by the IDC as the second serious problem. There is currently no waste management site designated to dispose the waste. As the island is relatively small and there is scarcity of land the community disposes the waste into the woods including the bay fringed with mangroves. As this is a shallow area the idea is to fill this area with waste and eventually use it for development. Sewage disposal is through septic tank systems where each household has a system. The effluents from the sewage system slowly drain to the groundwater. In small quantities the groundwater or the soil has the ability to purify the effluents from the contaminants. The extent of contaminants in the groundwater from the sewage disposal is unknown. Some of the key informants feel that groundwater is contaminated in some area. However, in general the groundwater is reported free from sewage related contaminants.

These concerns and other points of view of the community and the environmental issues associated with the project and its components have formed the basis of this IEE, supplemented as necessary by the consultants' own observations and knowledge on the environmental issues in the Maldives.

Public consultation would be made as part of the public information and disclosure process as required by MEEW. As soon as the report is approved by the relevant authorities ADB and MEEW, it would be available to the key stakeholders involved in the project for comments.

The report would be published in ADB website: www.adb.org
It would also be made available at MEEW website; www.environment.gov.mv
Also it would be provided, at least for perusal, to those who request it.

Findings and recommendations

This IEE report confirms that all the significant adverse environmental impacts associated with the new powerhouse with fuel storage facility and its operations in Maroshi can be satisfactorily mitigated.

Then project will an overall positive impact on the environment as the efficiency of the diesel powered electricity supply would be improved through decommissioning of the old engines and installment of the 3 new DEG sets with renovation of the distribution network. This new improved power generating system with its efficiency would also reduce the fuel and other electricity related losses.

Noise levels would be reduced through the installment of the chimney in the new powerhouse. In addition to the noise, emissions would also be reduced and controlled by the settlement of carbon in the chimney walls and floor as as the exhaust fumes pass though the chimney.

Fuel storage and handling efficiency would be improved through the implementation of the project. Accidental fuel spill can be retained and safely handled through the installment of the fuel retainer wall around the fuel tanks.

In addition to these mitigation measures powerhouse staff would be trained to safely operate the engines and electric system according to the specifications of the systems and powerhouse operation procedures outlined by MEB. Moreover the powerhouse manager would be trained by the contractor/consultant to follow and monitor the environmental monitoring and mitigation measures discussed in the environmental monitoring plan.

Conclusions

The finding of this IEE, after the assessment of the existing environmental conditions at the project site, environmental impacts associated with the proposed activities confirms that the impacts identified can be controlled provided all the environmental measures and monitoring procedures are followed.

Appendices

Appendix 1 List of people met

1.	Mr.Zahid Jameel	Team Leader/ADB
2.	Mr.Hussain Zahir	Environmentalist/ADB
3.	Mr.Adhnan Ibrahim	Socio Economist/ADB
4.	Mr.Ahmed Rasheed	Engineer
5.	Mr.Ahmed Abdul Rahmaan	IDC President
6.	Mr.Iqbal Mohamed	Asst. Island chief
7.	Mr.Ismail Nafiu	Senior Figure of the island.
8.	Mr.Ahmed Naseer	IDC Member
9.	Mr.Mohamed Hameed	IDC Member
10.	Mr.Abdul Razzaq	IDC Member
11.	Mr.Mohamed Thaufeeq	IDC Member
12.	Mr.Abdul Hakeem	IDC Member
13.	Mr.Mohamed Naseem	Society General Secretary
14.	Mr.Ali Naseer	Senior Figure of the island.
15.	Mr.Mohamed Waheed	School Teacher
16.	MrMohamed Slaeem	IDC Member
17.	Mr.Abdul Raheem Ali	IDC Member
18.	Mr.Abdulla Adam	Senior Figure of the island