

6. Presentation Materials

(1) Inception Report

Tedzani Hydropower Extension Project

A Preparatory Survey by
JICA(TEPSCO)
July 2013



1

I. Purposes of the Preparatory Survey

1. To understand the background of the Project
2. To evaluate appropriateness of the Project to be implemented in terms of technical and economical point of view under the Japanese Grant Aid
3. To propose undertaking by Malawi Government of implementation plan, and operation and maintenance.



2

II. Implementation Policy of Preparatory Survey

- Policy-1: Preparatory Survey for Japanese Grant Aid
- Policy-2: Data collection for Survey
- Policy-3: Japanese expert to be appointed
- Policy-4: Environmental study , IEE and EIA
- Policy-5: Optimum development plan
- Policy-6: Technical standards to be applied



3

Policy-1. Japanese Grant Aid Procedure

1. Preparatory Survey for study by JICA
2. Appraisal by GOJ and JICA, and approval by Japanese Cabinet
3. Authority for Determining Implementation, Exchange of Note (E/N) between Malawi and GOJ
4. Grant Agreement (G/A) between Malawi and JICA
5. Implementation of the Project on the basis of the Grant Agreement



4

Policy-2 Data Collection

Survey Team prepared the Questionnaire for:

1. General information about Malawi and power industry
2. Electro-mechanical Works for turbine and generator
3. Civil Works for design and construction planning
4. Transmission line and substation
5. Procurement for Civil works
6. Economic and financial analysis
7. Environmental and social considerations
8. Topography and Geology of the site
9. Hydrology of the Tedzani Reservoir



5

Policy-3 Assigned Engineers



6

Policy -4: Environmental and Social Consideration

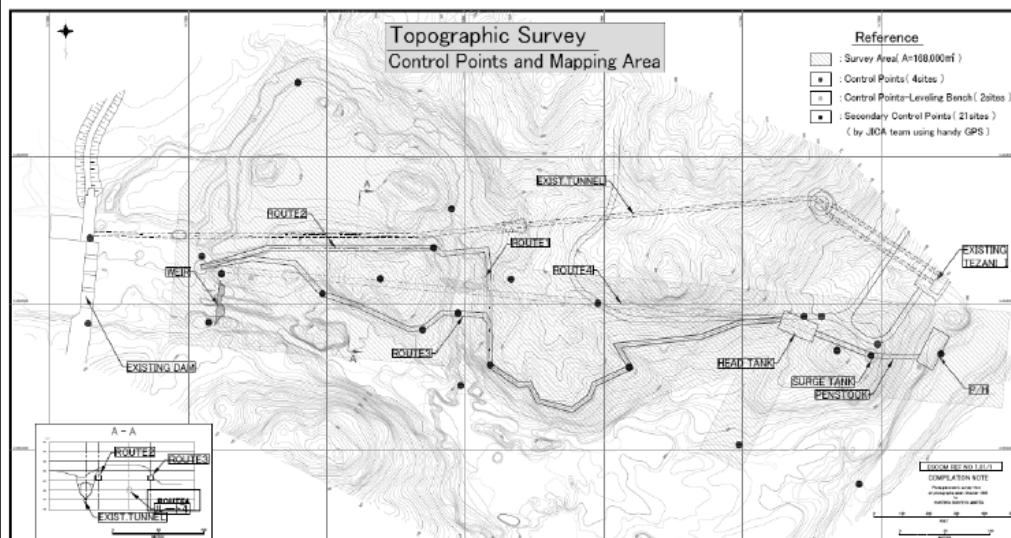
1. Confirmation of EIA procedure in accordance with EMA-1996

- Requirement of EIA for the Tedzani Project
- 2. Initial Environmental Examination (IEE)
- JICA team will carry out the IEE level survey for the Project.



7

Policy -5: Optimum power development



8

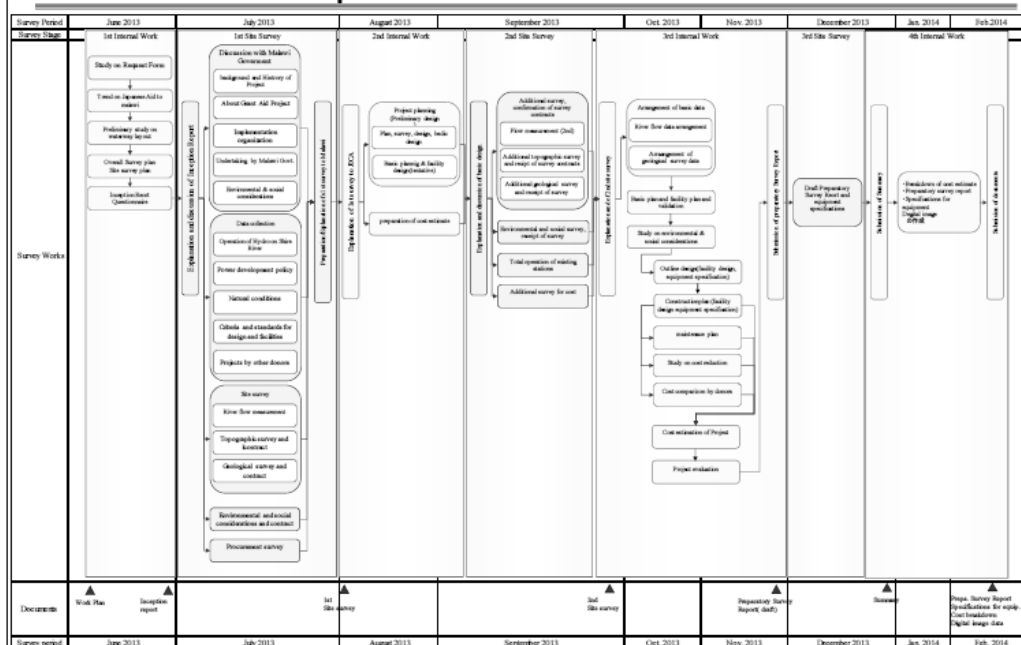
Policy -6: Standards to be adopted

Title	Publisher	Remarks
Technical Standards for Hydropower Facilities	METI	
Technical Standards for Electrical facilities	METI	
Technical Criteria for River Works	MILT	
Standard Specification for Concrete Structure	JSCE	
Technical Standards for Gate and penstock	JHGPA	
Criteria for Transmission and Substation	JESC	
Technical Requirement Guideline for Transmission Line Interconnection	METI	
Technical guideline for Interconnection by Distributed Generation	JESC	
Technical Guideline for Design of Steel Structures, Mini-Hydropower edition	Ministry of Agriculture	
The Institute of Electrical Engineers of Japan	JEC	
Standard Criteria of JEMA	JEMA	
Electric Technology Research Association	ETRA	
Standard for Cost Estimation on Civil Works	MILT	
Estimation Table for machinery Ownership Rate Government Rate for Depreciation of Construction Equipment	MILT	
Standard Yardstick for Civil Works	CRI	
Guideline and manual for Hydropower Development	JICA	Technical manual for rural electrification on mini-hydro under 500kW



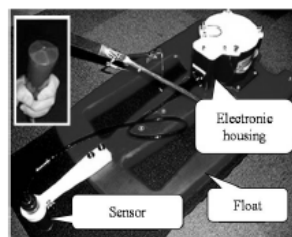
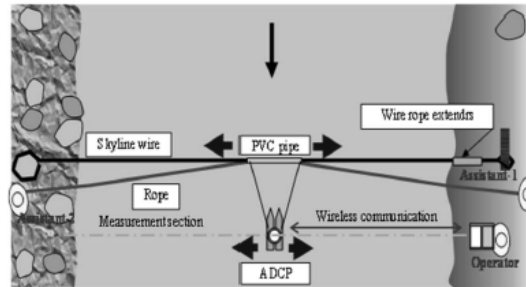
9

III. Implementation Method



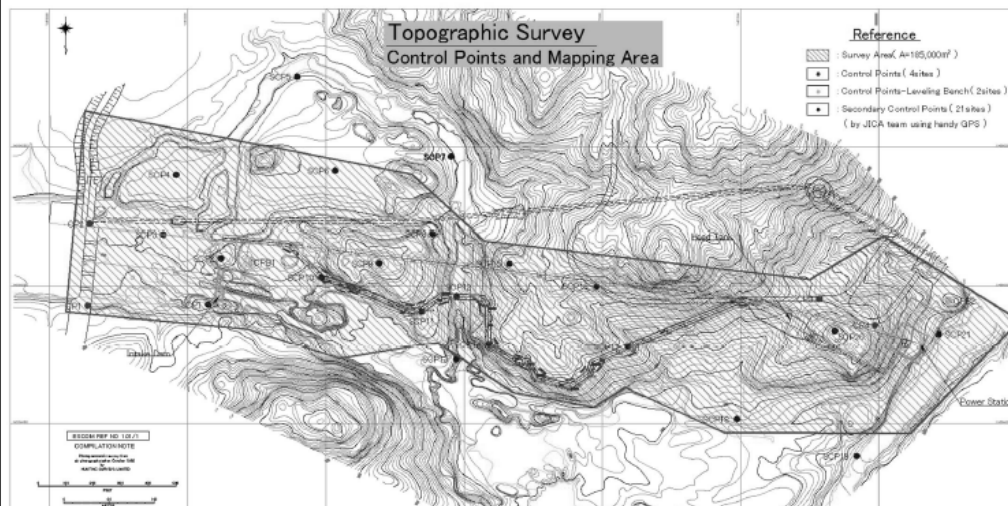
10

IV. River Flow Measurement



11

V. Topographic and Geological Surveys



12

VI. Other Surveys

1. Electro-mechanical Works
:Check Tedzani III power station.
2. Civil Works : Data collection from the existing Tedzani I,II and III projects.
3. Transmission Line and Sub-station
Check T/L, the existing switchyard and substation.
4. Procurement for Civil Works: cost estimation
5. Environmental and Social Considerations



13

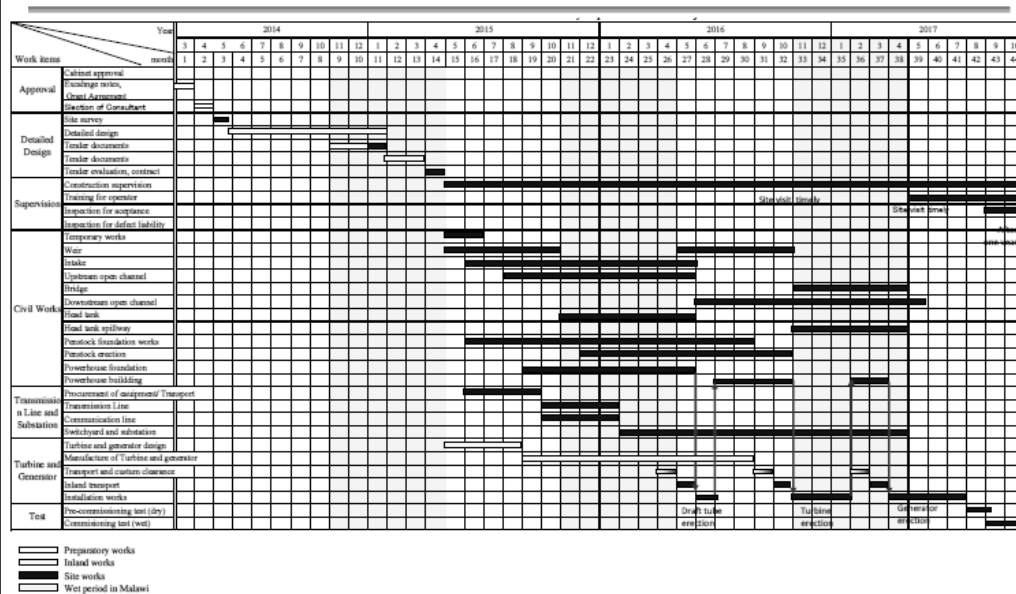
VII. Overall Schedule

- 2nd Site Survey in September 2013
- 3rd Site Survey: Submission of Draft Final Report in December 2013
- Cabinet Approval in February 2014
- Exchange of Notes (E/N): March 2014
- Grant Agreement: (G/A): March 2014
- Selection of Consultant : April 2014
- Commencement of Detailed Design: April 2014



14

VIII. Construction Schedule



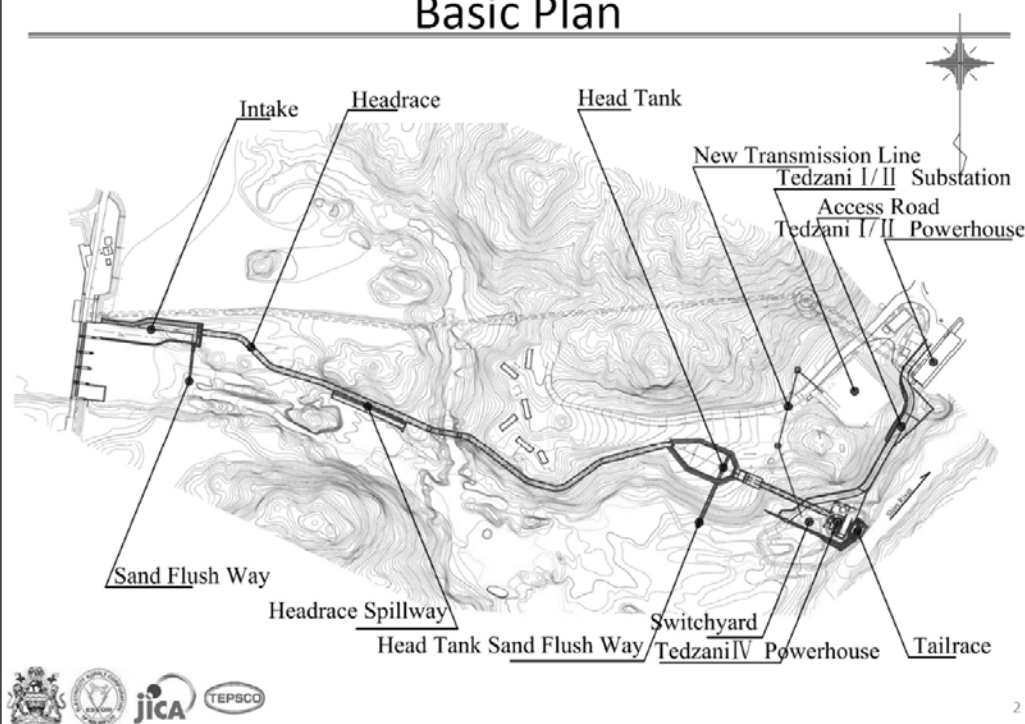
Tedzani Hydropower Extension Project

Draft Final Report Prepared by
JICA(TEPSCO)
December 2013



1

Basic Plan



2

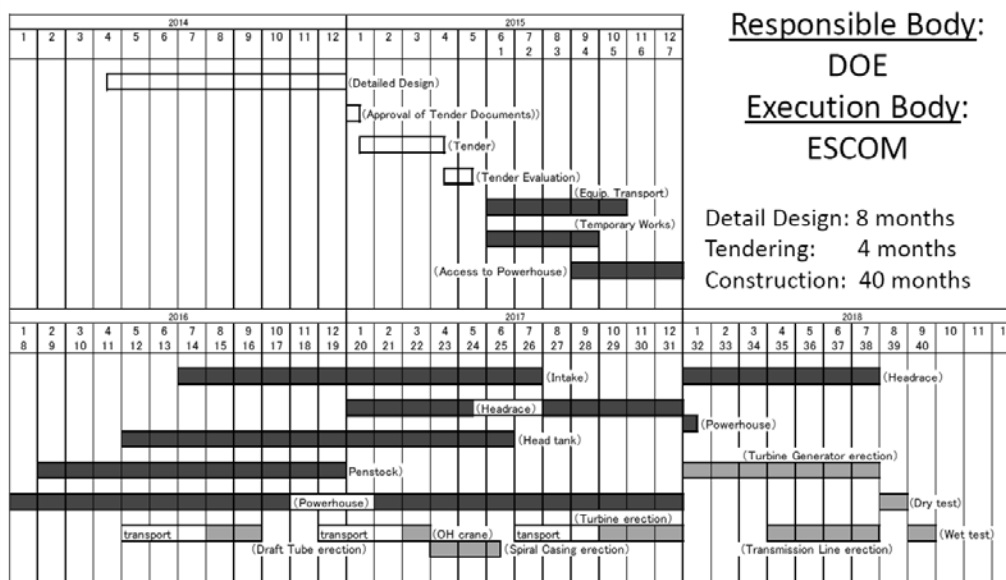
Basic Plan

Works	Items	Features
Civil Works	Generation method	Run of river
	Gross head	40.760m
	Effective head	37.0m
	Maximum discharge	70 m ³ /s
	Installed capacity	21,800 kW (1unit)
	Annual generated energy	170 GWh
Electro-mechanical and Transmission Line Works	Turbine	Vertical Francis turbine
	Generator	Synchronous generator
	66kV transmission line	260m
	11kV/66kV main transformer	1 unit



3

Implementation Policy and Schedule



4

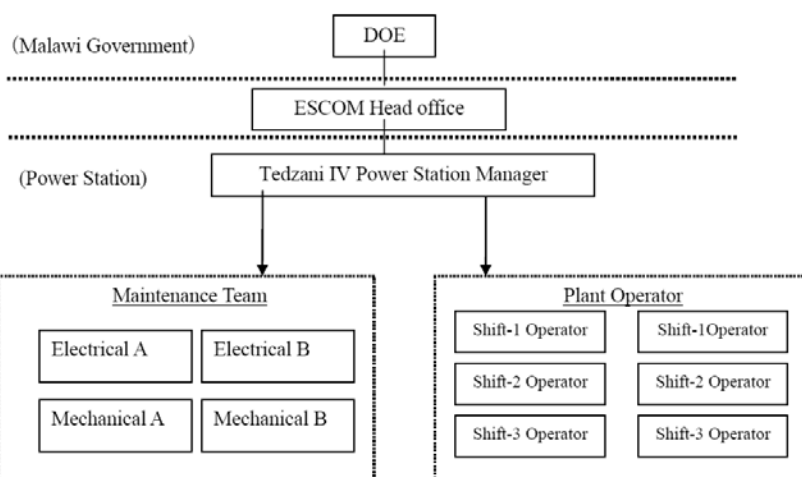
Undertakings by Malawi Government

1. License procedure for construction of hydropower station
2. License for hydropower development
3. Environmental and social considerations
 - Environmental Management Plan (EMP)
 - Environmental Management Monitoring Plan (EMMP)
4. Establishment of operation and maintenance organization
5. Exemption of tax and duty
6. Banking arrangement (B/A) and authorization to pay (A/P)



5

Operation and Maintenance Plan



Item	Annual Expense (US\$)
Maintenance	280,000
Other Cost (20% of maintenance)	56,000
Total	336,000



6

Environmental and Social Consideration

1. Results on Environmental and Social Survey

- No protection areas in and near the project
- No involuntary resettlement
- No issues about poverty groups, ethnic minorities groups and indigenous
- Prepared Initial Environmental Evaluation (IEE) Report

2. Unnecessary: Environmental Impact Assessment (EIA)

- "Certificate of Exemption of EIA" issued by the Director of Environmental Affairs Department (EAD) of Ministry of Environment and Climate Change Management (MOECM) on 25th July, 2013

3. Necessary:

- Environmental Management Plan (EMP)
- Environmental Management Monitoring Plan (EMMP)

Final Report proposes scope of EMP&EMMP



7

Environmental and Social Consideration

Item		Project Name	Hydropower Station and Transmission line (including Sub-Station)
Implementation Cost for Environmental Management Plan (EMP)			US\$8,500
Implementation Cost for Environmental Monitoring Plan (EMMP)	Construction phase		
	Operation phase		



8

7. IEE : Initial Environmental Examination



Japan International Cooperation Agency

THE GOVERNMENT OF MALAWI

TOKYO ELECTRIC POWER SERVICES CO., LTD (TEPSCO)

INITIAL ENVIRONMENTAL EXAMINATION (IEE) FOR TEDZANI HYDROPOWER STATION



FINAL REPORT

NOVEMBER, 2013



Post.NetX114, Crossroads, Lilongwe, Malawi.
Tel. (265) 1 754 090/ 01 978 189
E-mail hfukiza@hendersonpartners.org

EXECUTIVE SUMMARY

This report highlights the main findings of an Initial Environmental Examination (IEE) which was undertaken to develop an Environmental Management Plan for the extension of Tedzani Hydropower plant. The proposed project will improve ESCOM's generation capacity of hydropower by 20 Megawatts thereby improving the availability of power in Malawi and consequently reducing outages. The extension will improve the reliability of the existing power plant which comprises of three Power Stations: Tedzani I, Tedzani II and Tedzani III Hydro Power Stations located on Shire River In line with Malawi's existing legal and policy framework and JICA's Guidelines for Environmental and Social Considerations (April 2010) the IEE also undertaken to assess any positive and negative impacts of the project the environmental and socioeconomic conditions of the area. Malawi parliament passed the Environmental Management Act (EMA), (Act NO, 23, 1996) on 28 June 1996. This Act governs all matters related to the protection and management of the environment, conservation and sustainable utilization of natural resources. Following the enactment of EMA, the Environmental Affairs Department (EAD) was created and charged with the responsibility to oversee, coordinate and supervise the operationalisation of Environmental Assessments in Malawi. The EAD recommended that there was need to prepare a comprehensive Environmental Management Plan (EMP) for the project based on the Terms of Reference (ToRs) which have been attached to this report.

The report is based on site visits, laboratory analyses, desktop studies and public consultation and it includes description of the project, analysis of alternative sites, environmental baseline of the project area, policy and legal framework, audit findings, impacts, enhancement and mitigation measures, and environmental management and monitoring plans.

The IEE found that the extension of Tedzani Hydropower station positively impacts on the socio-economic status of Malawians and the Malawi government in the following major ways:

- a) Employment opportunities for the people of Malawi: This will be enhanced by offering realistic wages to employees, ensuring gender balance in the composition of employees at all levels, giving a fair chance of job opportunities to people from the area surrounding the project site, and being transparent in the bidding process of any outsourced services.
- b) Provision of Energy (Electricity): The developer will enhance the impact by ensuring that there is improved energy supply to industries and the people of Malawi.

However the extension of Tedzani Hydropwer station has negative impacts in several respects which include:

- a) Road Safety: The developer will mitigate the impact by properly regulating traffic at the entrance gates of the two access roads, raise awareness on road safety, and observing and enforcing a speed limit of 40km/hr.
- b) Risks associated with occupational health and safety: The developer will, among many other measures, provide appropriate personal protective equipment (PPE) to all workers, orient visitors on occupational health and safety before entry into the project site, train workers on occupational health and safety measures, and subject the project site to occupational safety and health inspection by government officials.
- c) Generation of waste: The impact will be minimized by providing proper liquid and solid waste storage, collection and disposal services.
- d) Soil erosion: The developer will install slope protection structures such as terraces and gabion baskets and stockpile soils away from the drainage channels.
- e) Risk of changes in the river flow: The project proponent will ensure the use of minimum flow turbines.
- f) Air Quality (Ambience): This impact will be minimized by regularly spraying bare ground with water to minimize dust, covering stockpiles of soil and sand, screening off the project site, and limiting the working period to daytime.
- g) Loss of vegetation and animal habitat (ecosystem disturbance): The developer will limit site clearing to designated area for construction and re-vegetate the cleared land.
- h) Risk of increased cases of Sexually Transmitted Infections (STIs) including HIV & AIDS: The developer intends to raise awareness among the workforce on the dangers of STIs and HIV& AIDS, provide condoms to workers, introduce and promote HIV&AIDS workplace policy, and employ people from the surrounding area to maintain the existing sexual relationships.

Overall, it is the consultant's view that the project should be allowed to proceed on condition that the developer strictly adheres to and fully implements the Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP) that have been proposed in this report.

CONTENTS	Page
EXECUTIVE SUMMARY	i
TABLE OF CONTENTS	iii
LIST OF ACRONYMS	vi
LIST OF FIGURES	vii
LIST OF TABLES	vii
LIST OF APPENDICES	vii
ACKNOWLEDGEMENTS	viii
1.0 INTRODUCTION	1
1.1 Background of the Study	1
1.2 Objectives and Scope of the IEE	1
1.3 Methodology and Challenges of the Study	3
1.3.1 Public Consultations	3
1.3.2 Desktop Study	4
1.3.3 Laboratory Analyses	4
1.3.4 Site Visits	4
2.0 LEGAL, POLICY AND ADMININISTRATIVE REQUIREMENTS	5
2.1 National Policy Framework	5
2.1.1 National Environmental Policy	5
2.1.2 National Land Policy	5
2.1.3 National Forestry Policy	6
2.1.4 National Water Policy	6
2.1.5 National Fisheries and Aquaculture Policy	6
2.2 National Legal Framework	7
2.2.1 The constitution of the Republic of Malawi	7
2.2.2 Environmental Management Act and EIA Guidelines	7
2.2.3 Malawi Forestry Act	8
2.2.4 Water Resources Act	8
2.2.5 Occupational Safety, Health and welfare Act	9
2.2.6 Land Act	9
2.2.7 National Local Government Act	10
2.2.8 Fisheries Conservation and Management Act	10
2.2.9 Forestry Act	10

2.2.10	Employment Act	11
2.2.11	Electricity Act	11
2.2.12	Malawi Growth and Development Strategy II	11
2.2.13	International Agreements	12
3.0	DESCRIPTION OF THE PROJECT	13
3.1	Project Category and Project Location	13
3.2	Features of the Extension of Tedzani Hydropower Plant	14
3.3	Site Development and Construction	15
4.0	DESCRIPTION OF ENVIRONMENTAL BASELINE	16
4.1	Physical Environment	16
4.1.1	Climate	16
4.1.2	Topography, Geology and Landforms	17
4.1.3	Water Resources	18
4.2	Biological Environment	20
4.2.1	Flora	20
4.2.2	Fauna	20
4.3	Economic, Cultural and Social Environment	22
4.3.1	Socioeconomic characteristics of Communities	22
4.3.2	Traffic Circulation	23
4.3.3	Health and Education Facilities /Infrastructure	23
5.0	ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	24
5.1	Impacts and Mitigation Measures during pre-construction phase	24
5.1.1	Flora and Fauna	24
5.1.2	Erosion and Sedimentation	24
5.1.3	Waste	25
5.1.4	Socioeconomic aspects	25
5.2	Impacts during construction phase	25
5.2.1	Waste	25
5.2.2	Noise and vibration	26
5.2.3	Dust (Air quality)	26
5.2.4	Water resources	26
5.2.5	Health and Safety	27

5.2.6	Traffic	27
5.2.7	Socio-economic impacts	27
5.3	Impacts during Project Operation	27
5.3.1	Power Plant Operation and Maintenance	27
5.3.2	Flora and Fauna	28
5.3.3	Air quality	28
5.4	Overall assessment of impacts	28
6.0	ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND ENVIRONMENTAL MONITORING PLAN (EMoP)	31
6.1	Government and Community Level Institutional Arrangements	31
7.0	CONCLUSIONS AND RECOMMENDATIONS	43
8.0	REFERENCES	44
9.0	APPENDICES	45

LIST OF ACRONYMS

EMA	:	Environmental Management Act
EIA	:	Environmental Impact Assessment
TORs	:	Terms of Reference
COD	:	Chemical Oxygen Demand
BOD	:	Biochemical Oxygen Demand
EAD	:	Environmental Affairs Department
MGDS	:	Malawi Growth and Development Strategy
PPE	:	Personal Protective Equipment
EMP	:	Environmental Management Plan
EMoP	:	Environmental Monitoring Plan
ESCOM	:	Electricity Supply Commission of Malawi
DoE	:	Department of Energy
IDA	:	Infrastructure Development Activity
IEE	:	Initial Environmental Examination
MoECCM	:	Ministry of Environment and Climate Change Management
MERA	:	Malawi Energy Regulatory Authority
MoL	:	Ministry of Labour
MoH	:	Ministry of Health
MoWI	:	Ministry of Water Development and Irrigation
ODPP	:	Office of Director of Public Procurement
OSHWA	:	Occupational Safety, Health and Welfare Act
PDP	:	Power Development Plan
STIs	:	Sexually Transmitted Infections
HIV	:	Human Immunodeficiency Virus
AIDS	:	Acquired Immunodeficiency Syndrome
IUCN	:	International Union for Conservation of Nature
CITES	:	Convention on International Trade in Endangered Species
NCE	:	National Council for the Environment
TCE	:	Technical Committee on the Environment

List of Figures	Page Number
Figure 1: The EIA process in Malawi	2
Figure 2: Public consultations with the affected community	3
Figure 3: Location map of Tedzani hydropower station	13
Figure 4: Aerial view of hydropower station	14
Figure 5: Typical vegetation in the area	21
Figure 6: A cotton garden in the surrounding community	23
 List of Tables	
Table 1: Existing features at Tedzani I, II and III	14
Table 2: Mean monthly relative humidity for a10 year period	16
Table 3: Mean monthly minimum temperature for a10 year period	16
Table 4: Mean monthly maximum temperature for a10 year period	17
Table 5: Mean monthly rainfall for a10 year period	17
Table 6: Water quality results at the proposed site	18
Table 7: Water quality results at the intake	19
Table 8: Most common vegetation around the proposed site	20
Table 9: Terrestrial and aquatic fauna at Tedzani	21
Table 10: Matrix for the project activities	29
Table 11: Assessment of impact significance	30
Table 12: Environmental Management Plan	33
Table 13: Environmental Monitoring Plan	38
 List of Appendices	
Appendix 1: List of Stakeholders Consulted	45
Appendix 2: Terms of Reference (TORs) for the IEE	46

ACKNOWLEDGEMENTS

Henderson & Partners Consulting Civil Engineers would like to thank all persons, especially the management and staff of ESCOM for providing the information that supported the preparation of this IEE Report. Thanks are also due to Environmental Affairs Department and other government departments for their support in various ways.

Henderson & Partners Consulting Civil Engineers
Lilongwe, Malawi.

November, 2013.

1 INTRODUCTION

1.1 Background of the Study

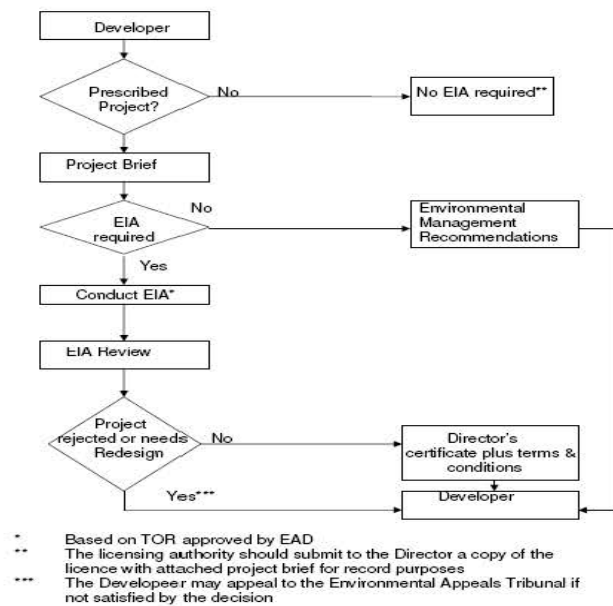
The government of Malawi would like to extend Tedzani Hydropower Plant from the current capacity of 92.7 Megawatts to approximately 112.7 Megawatts representing a total increase of 22%. This intended Infrastructure Development Activity (IDA) will improve ESCOM's generation capacity of hydropower thereby improving the availability of power in Malawi thereby reducing outages. The extension will improve the reliability of the existing power plant which comprises of three Power Stations: Tedzani I, Tedzani II and Tedzani III Hydro Power Stations located on Shire River, sharing a common Intake Dam but with separate Bell Mouths. The combined generation capacity for the three hydropower stations (Tedxani I, Tedzani II and Tedzani III) is 91 MW. The total potential for hydropower generation on Shire River is estimated at 300- 685 MW. The nationwide installed capacity is about 302 MW and the available power is only around 285MW against a power demand of 350MW. Malawi's economy is growing at an annual rate of 7.5%; a scenario that results in a corresponding increase in energy demand and subsequent load shedding during the peak hours (06:00 – 09:00 hrs and 18:00 – 20:00 hrs).

Realizing the growing challenge of inadequate power supply, the Malawi Government requested the Japanese Government to implement the extension of Tedzani Hydropower station. The Tedzani Extension Project is regarded as one of the midterm solutions according to the Power Development Plan (PDP) of Malawi's Department of Energy (DOE). It is expected that the project will greatly improve and stabilize the energy supply in Malawi.

1.2 Objectives and Scope of the Initial Environmental Examination (IEE)

The aim of this IEE is to assess the positive and negative impacts of the proposed project based on construction works and its subsequent operation. The IEE has been prepared by JICA Study Team to verify compliance with JICA's Guidelines for Environmental and Social Considerations (April 2010) which aim at minimising negative impacts on the environmental and socioeconomic conditions of the area. It is also important that the IEE should be done in line with Malawi's Environmental Impact Assessment (EIA) process. Figure 1 highlights the major steps that need to be followed in Malawi's EIA process.

Figure 1: The EIA process in Malawi.



Projects of the magnitude and type such as the expansion of Tedzani hydropower extension project fall under list A6.1 of Malawi's Guidelines for Environmental Impact Assessment of 1997 which stipulate that "Construction or expansion of electrical generating facilities designed to operate at greater than 4 MW or, in the case of hydro-electric generating facilities, where the total head is greater than 20 m or where there is a firm flow of 100 cubic metres per second " are subject to screening and approval by the Director of Environmental Affairs. In this respect, the first step in the Tedzani hydropower extension project was to develop a project brief which was sent to the Department of Environmental Affairs for screening to determine if a full EIA was required or not. After screening, the Department of Environmental Affairs, in its communication of 25th July 2013 (Appendix 2), recommended that the project does not require a full EIA but rather a comprehensive Environmental Management Plan in addition to an Initial Environmental Examination (IEE). The terms of reference (TORs) for this IEE and the comprehensive Environmental Management Plan (EMP) are presented in the Appendix. Specifically, the objectives of the IEE are:

- To assess the environmental and socioeconomic conditions of the project area.
- To identify the potential positive and negative impacts of the project and their significance.

- c) To develop an Environmental Management Plan (EMP) based on the identified impacts.
- d) To develop an Environmental Monitoring Plan (EMoP) for the project.

1.3 Methodology and challenges of the study

This IEE report is based on both primary and secondary data sources which mainly comprised a desktop study, direct observations during the two site visits, public consultations, interviews, laboratory analyses as well as assessments of land use, flora and fauna. There were no major challenges in the study except for lack of some secondary data such as air quality over the past few years.

1.3.1 Public Consultations

Two focus-group discussions were held as a means of obtaining information. The focus-group discussions provided an opportunity to observe and get important information from the respondents. This particularly worked well for the illiterate population.

The use of direct observations helped in getting first hand information on the issues that the people were talking about. In addition, interviews were held with people from the surrounding areas. These interviews were conducted in both English and the local language (Chewa) depending on the respondent. Figure 2 shows a public consultation session on 20th August 2013 at Nzigala Village which is at the boundary of the main fence for Tedzani hydropower station. The population of Nzigala village is about 1100 people (according to the village register kept by the chief) and their major livelihood sources are small scale businesses and subsistence farming.

Figure 2: Public consultations with representatives of the affected community



1.3.2 Desktop Study

Several documents pertaining to land development issues, such as policies and laws, books, journals and Internet articles, were reviewed. For some existing conditions the team referred to some documents of studies previously done in the area. Documents reviewed include the Environmental Management Act, the National Land Policy, the Malawi Housing Act, the National Environmental Action Plan, the National Environmental Policy, the Electricity Act, the Public Street Act, the Water Works Act, the Water Resources Act, the Town and Country Planning Act, the Public Health Act, Guidelines for Environmental impact Assessment, EIA and the Geology of the Shire Highlands (1965). IEE reports on similar projects that were also reviewed.

1.3.3 Laboratory Analyses

Water samples were collected and analysed in a laboratory to determine their quality and hence the level of pollution before implementation of the project. The water samples from Shire River were analysed for turbidity, suspended solids, total dissolved solids and biochemical oxygen demand.

1.3.4 Site Visits

Two visits were made to the site and surrounding environment in order to establish the physical characteristics of the areas, and to obtain information on land uses, as well as the existing flora and fauna.

2 LEGAL, POLICY AND ADMINISTRATIVE REQUIREMENTS IN MALAWI

The contractor is committed to conduct its activities with full compliance to the requirements of national regulations and its obligations under international conventions and treaties, giving due consideration to international best practices and policies. This IEE report has been developed taking into consideration the laws and decrees of the Republic of Malawi and International Standard Policies.

2.1 NATIONAL POLICY FRAMEWORK

2.1.1 THE NATIONAL ENVIRONMENTAL POLICY, 2004

The Government of Malawi first adopted the National Environmental Policy in 1996 to provide guidance and set standards for development of sector policies in environment and natural resources. It was as a result of its increasingly concerned about the deterioration of the country's natural resources and the environment. The overall policy goal of the National Environmental policy (NEP) 2004 is to promote sustainable social and economic development through the sound management of the environment and natural resources. The specific policy goals addresses issues of environmental security for healthy and well being of the people, utilization and management of the country's natural resources and encourage, where appropriate, long term self-sufficiency in food, fuel wood and other energy requirements, to facilitate the rehabilitation and management of essential ecosystems and ecological processes. Enhance public awareness of the importance of sound environmental management; and Tradeoffs between economic development and environmental degradation will be minimized through use of environmental impact assessment and natural resource monitoring. The road construction project will integrate the principles of the environmental policy into the project so that rehabilitation is done in an environmentally responsible manner with the participation of all stakeholders using EIA as a tool.

2.1.2 THE NATIONAL LAND POLICY, 2002

The goal of the National Land Policy in Malawi is to ensure tenure security and equitable access to land, to facilitate the attainment of social harmony and broad based social and economic development through optimum and ecologically balanced use of land and land based resources. The Land Policy has the definite objective of ensuring equal opportunities for the acquisition, use and enjoyment of land for all citizens. This also guarantees security and instills confidence and fairness in all land transactions without being bias. In establishing stable land tenure system to protect investments and production factors tied to land it is important to respect the law and protection of the integrity of accrued property rights. Taking

the agreement between Government and Public lands into consideration, the Government will ensure that: any private land acquired to be used for the benefit of the general public or for national development purposes will be valued and compensation based on the open market value paid to the owner for both the land and improvements. The policy will then guide the constructor in making important decisions regarding compensation of land and protection of natural resources.

2.1.3 NATIONAL FORESTRY POLICY, 1997

The main goal of the National Forest Policy, 1997 is to sustain the contribution of the national forest resources to the quality of life in the country by conserving the resources for the benefit of the nation. This was as a result that the National acknowledge the need to protect natural environment such as trees from deforestation and improper land use that would endanger the forest. The contractor will then have to take full advantage of provisions under this act to prevent unnecessary destruction of forest and related resources.

2.1.4 NATIONAL WATER POLICY, 2004

The National water policy, 2004 was developed to achieve the UN millennium goals and the world Summit on sustainable development target of 2015. Their common problems include degradation of water resources, inadequate service coverage, inadequate financing, and increasing water demand as a result of increasing population. The overall Policy goal is sustainable management and utilization of water resources, in order to provide water of acceptable quality and of sufficient quantities, and ensure availability of efficient and effective water and sanitation services that satisfy the basic requirements of every Malawian and for the enhancement of the country's natural ecosystems. The specific policy goals addresses issues of achieving a sustainable and integrate water resources management and development that make water readily available and equitably accessible to all. Ensuring acceptable water quality to all and controlling pollution. This policy is important in a way that it will guide in the construction of the road to prevent polluting water resources within the area of development

2.1.5 NATIONAL FISHERIES AND AQUACULTURE POLICY, 2001

The National fisheries and aquaculture policy aims at maximizing the sustainable yield from the national waters of Lakes, Shire River, other smaller river systems and from small natural and man-made water bodies. Secondary objectives are to improve the efficiency of exploitation, processing and marketing, promote investment in the fishing industry, rural fish farming units and exploit all opportunities to expand existing and develop new aquatic

resources. The policy also recognizes the impact of pollution on fisheries and its resources. A consideration will therefore be taken on the impact of the construction to prevent polluting water bodies existing within the construction area.

2.2 NATIONAL LEGAL FRAMEWORK

2.2.1 THE CONSTITUTION OF THE REPUBLIC OF MALAWI, 1995

Environmental management is provided for within Section 13(d) of the National Constitution of Malawi. The constitution provides for the prevention of the degradation of the environment, the provision of healthy living and working environment for the people of Malawi. Further, it accords a full recognition of the rights of future generation by means of environmental protection and the sustainable development of natural resources, and the conservation and enhancement of the biodiversity of Malawi. The constitution therefore promulgates the attainment of any human rights to the general population without compromising on the conservation of the country's environment. Hence, in this case, the construction or upgrading of the road must consider the associated environmental implications - i.e. cost and benefits - of the project.

2.2.2. THE ENVIRONMENT MANAGEMENT ACT (1996) AND EIA GUIDELINES, (1997)

The Malawi Parliament passed the Environmental Management Act (EMA), (Act NO, 23, 1996) on 28 June 1996. This Act governs all matters related to the protection and management of the environment, conservation and sustainable utilization of natural resources. Following the enactment of EMA, the Department of Environmental Affairs (DEA) was created and charged with the responsibility to oversee, coordinate and supervise the operationalisation of the EIA process in Malawi. In compliance with the provisions of the Act (section 29) and Guidelines for Environmental Impact Assessment of 1997 (List A10), the Director of Environmental Affairs is empowered to require changes to a project of this magnitude to reduce its environmental impact and to reject the project if, in his view, significant and irreparable injury to the environment are anticipated. The Environment Management Act has given every Malawian a right to a clean and healthy environment but this cannot be achieved if there is no supporting mechanism in place. The act recognizes that a central authority is crucial in coordination and advisory roles on all environmental issues in the country including EIA procedures and requirements. In Malawi, the Environmental Affairs Department (EAD) under the Ministry of Environment and Climate Change Management (MoECCM) is such an authority. The Act sets out the powers, functions and duties of the Director of Environmental

Affairs in administering the Environmental Impact Assessment (EIA) process. The Act provides for the establishment of the National Council for the Environment (NCE) and the Technical Committee on the Environment (TCE) under Sections 10 and 16 respectively. The NCE is a policy making body which advises EAD and the government in general on environmental matters including making recommendations to the Minister on decisions to be undertaken on EIA submissions. The TCE provides technical advice to the Department on environmental matters including EIA. In line with these powers and duties, EAD published an EIA guideline document (1997) which provides details of the EIA processes and requirements. Under the EMA, as provided for in section 26, a prescribed project cannot receive the required authorization to proceed from the relevant licensing authorities unless and until the Director of Environmental Affairs has issued a certificate stating that an EIA is not required or, on the basis of an EIA report the Director has approved the project. The EAD has further published sector specific EIA guidelines in the fields of Energy and other sectors to provide details of EIA requirements under those sectors. The contractor will have to understand the hierarchy of information flow and decision making for proper execution of the project.

2.2.3 MALAWI FORESTRY ACT, 1997

Section 3 (a – l) states the general principles governing the Malawi Forestry Act. Specific to the environment and in relation to EIA are Subsections (a), (b), (c) and (i) of the aforementioned section. The aforesaid stipulate the maintenance of environmental stability through the prevention of natural resource degradation, the conservation of soil and water, and the protection of fragile areas such as steep slopes, river banks, water catchment in order to conserve and enhance biodiversity. Further, the Act stipulates the promotion of community involvement in the conservation of trees and forests. Hence, the Act aims at upholding the environment while maximising the associated social and economic benefits.

2.2.4 WATER RESOURCES ACT, 1969

The Water Resources Act focuses on the ownership and right to water, and thus provides for the control, conservation, apportionment and use of water resources of Malawi. According to Section 3(1) and 3(2), the ownership of all water resources in Malawi rests in the President whose prerogative is sometimes delegated to the Ministry of Water Development. And the Ministry, under Section 4(1) and 4(2) may further delegate such responsibilities to Water Resources Boards. Hence the minister has the authority over granting of water rights; revision, variation, determination and diminution of water rights, pollution of public water; miscellaneous powers to declare controlled areas; and schedules for the establishment,

composition and modus operandi of the Water Resources Boards. Section 16(1) and 16(2) stipulate modes of public water pollution - i.e. the discharge into, or in the vicinity of public water, or in a place where public water is likely to flow, of any matter or substance likely to cause injury whether directly or indirectly to public health, livestock, animal life, fish, crops, orchards or gardens which are irrigated by such water or any product in the processing of which such water is used or which occasions, or which is likely to occasion, a nuisance. And the Act categorises the aforementioned elements as offences liable to penalties under Section 25. Further, the Water Resources Boards have the powers to inspect any project in regard to water abstraction and anticipated or experienced pollution as proclaimed in Section 19(1), 19(2) and 19(3).

2.2.5 OCCUPATIONAL SAFETY, HEALTH AND WELFARE ACT, 1997

The Occupational Safety, Health and Welfare Act covers the following in relation to EIA of road construction projects: health and welfare, machinery safety, health and safety, dangerous occurrences and industrial diseases, offences, penalties and legal proceedings. The Act makes provision for the regulation of the conditions of employment in workplaces as regards the safety, health and welfare of persons employed therein; for the inspection of certain plant and machinery, and the prevention and regulation of accidents occurring to persons employed or to go into the workplaces; and to provide for matters connected with or incidental to the abovementioned. In road construction projects employees are prone to accidents, and chemical and biological hazards including disease epidemics. Such hazards may have an effect on the workforce – the anticipated composition being substantially local - and in turn have negative impacts on the social and economic environment of the areas affected by the project. Hence the evaluation of the different technologies that may be used during the project is imperative in order to identify the mitigating factors for the provision of meaningful occupational health safety to all employees and the general public

2.2.6 LAND ACT, 1965

The Land Act, 1965 (Cap 57.01) mainly deals with land tenure and land use issues. It recognizes that every person has a natural dependence on land and that it is therefore important that government provides for secure and equitable access to land as a multi-purpose resource and an economic asset by clearly defining issues of security of tenure. Further, the land Acquisition Act (Cap 57.04) outlines procedures to be followed for land acquisition by individuals or government. The procedures include the steps to be undertaken for government

to acquire land starting from issuance of formal notices to persons with existing land interests to the payment of compensations.

2.2.7 NATIONAL LOCAL GOVERNMENT ACT, 1998

Section 3 of the National Local Government Act prescribes furthering of the constitutional order based on democratic principles, accountability, objectives of local transparency and participation of the people in decision-making government and development processes, as the main objective of the local government. And, Section 6 stipulates the functions of local governments within areas of their jurisdiction. In relation with EIA guiding principles are functions prescribed in Sections 6(a), 6(b) and 6(c) and these relate to making policy and decisions on local governance and development, consolidation and promotion of democratic institutions and participation, and the promotion of infrastructural and economic development through the formulation, approval and execution of district development plans. Further, Section 2 of the second schedule of the National Local Government Act entrusts local governments with environment protection against biological and chemical pollution of areas within their jurisdiction. The project falls within two areas of jurisdiction i.e. Blantyre and Neno district assemblies. The project intends to involve the aforementioned district assemblies to uphold democratic principles put down within the Act and this IEE intends to uphold the same through public engagement and participation.

2.2.8 FISHERIES CONSERVATION AND MANAGEMENT ACT, 1997

The Fisheries Conservation and Management Act focuses on the regulation, conservation and management of fisheries in Malawi. The Act under Section 43 prohibits pollution of rivers, streams and lakes. Pollution may affect fish, fish spawning grounds and other aquatic life. Aquatics in Shire River may be affected by the technology employed by the project and the associated pollution. In regard to the aforementioned the IEE intends to evaluate possible effects of the project on the rivers and suggest mitigating factors to minimise negative project impacts on the aquatic life along the road project and the areas covered by the rivers and streams.

2.2.9 FORESTRY ACT, 1997

The Act deals with the management of indigenous forests on customary and private land; forest reserves and protected forest areas; woodlots and plantation forestry and also crosscutting issues including law enforcement and fire management. The Act among other things seeks to protect trees and other resources in forest reserves, conserve and enhance biodiversity, protect and facilitate management of trees on customary land, promote

community involvement in the conservation of trees, promote sustainable utilization of timber and other forest produce and protect fragile areas such as river banks and water catchment. Construction of extended hydropower plant at Tedzani will result in destruction of riverine vegetation on the river banks and in the water due to alternative crossing of the watercourse during construction.

Construction of diversions will have to undertake measures to protect riverine vegetation on the river banks and in the water, trees within the diversions and limit the cutting down of trees to where it is absolutely necessary in consultation with relevant authorities and communities.

2.2.10 THE EMPLOYMENT ACT, CAP 55:02 AND LABOUR RELATIONS ACT, CAP 54:01

The two Acts regulates employment matters i.e. minimum wage, fair labour practices, non discrimination, prohibition (in some cases) of employment of children. When employing people for the implementation of the project activities, the developer should ensure that provisions of this Act are taken care of.

2.2. 11 ELECTRICITY ACT (2004)

Electricity generation in Malawi is governed by the Electricity Act of 2004. The Act has liberalized the energy sector by introducing separate licensing for generation, transmission and distribution permitting private sector participation. The Malawi Energy Regulatory Authority (MERA) is mandated to approve tariffs and prices of energy sales and services as provided for in sections 16 and 17 of the Act.

2.2.12 THE MALAWI GROWTH AND DEVELOPMENT STRATEGY II

The Malawi Growth and Development Strategy (MGDS II) is the overarching strategy for Malawi for 5 years from 2006/02 to 2010/17. The overriding philosophy is poverty reduction through sustainable economic growth and infrastructural development. The MGDS identifies six key priority areas for the country to achieve economic development. The areas are agriculture and food security; irrigation and water development; transport infrastructure development; energy generation and supply; integrated rural development; prevention and management of nutrition disorders, HIV and AIDS.

The MGDS II will accelerate the attainment of the Millennium Development Goals. The MGDS therefore aims at maintaining a balance between the economic and social sectors of the economy. The MGDS II is built around five thematic areas namely sustainable economic growth; social protection; social development; infrastructure development, and improved governance. In translating the Millennium Development Goals, the MGDS recognizes that

managing natural resources is an essential aspect of environmental sustainability. Further, on subtheme four of theme one (sustainable economic growth), the MGDS recognizes that sustainable use of natural resources contributes to many of the goals in the MGDS. This includes fisheries, wildlife, forestry, and environmental protection. Efforts in environmental protection will focus on improving compliance with environmental and natural resource management laws. The developer has to comply with the strategies in the MGDS II on the conservation of the environment during the project.

2.3 INTERNATIONAL AGREEMENTS

Malawi is party to a number of internationally acceptable policies, conventions, treaties and protocols in order to augment the national policies and laws. International laws and probably their institutions serve as the principal framework for international co-operation and collaboration between members of the international community in their efforts to protect the local, regional and global environment. This is due to the fact that most environmental problems have a trans-boundary effect hence require a concerted effort to manage them.

It is therefore apparent from the foregoing, that international environmental laws assist in capturing and building consensus between nations on goals for environmental protection, resource conservation and sustainable use.

Malawi, just like other States will become bound to the provisions of an international agreement/law, only if it signs and submits instruments of ratification in respect of a particular agreement. Some of the international environmental instruments relevant to the study which Malawi signed or ratified include the following:

- Millennium Development Goals especially number 7: Ensure environmental sustainability
- Convention of Biological Diversity;
- Basel Convention
- African Convention on Conservation of Nature and Natural Resources Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora
- The United Nations Framework Convention on Climate Change
- Convention on Fishing and Conservation of Fishing Resources of the High Seas
- SADC Protocol on Fisheries
- SADC Protocol on Forestry
- Kyoto Protocol
- Convention to Combat Desertification
- Ramsar Convention.

3.0 DESCRIPTION OF THE PROJECT

3.1 Project Category and Project Location

Tedzani Hydroelectric Power Plant Malawi is located at Tedzani Falls on the Shire River, which borders the administrative districts of Blantyre and Neno in Southern Malawi. The location coordinates for the proposed site are: Latitude of -15.427 and Longitude of 34.467. This infrastructure is a Hydro Power Plant with a design capacity of 20 MW and located approximately 7km off the Mwanza to Blantyre Road and some 80 km from Blantyre City. It will be operated by Electricity Supply Corporation of Malawi (ESCOM) Limited. Figure 3 shows the location map of Tedzani in Southern Malawi and figure 4 shows the aerial view of the existing site plan of the hydropower plant.

Figure 3: Location map of Tedzani hydropower station in Southern Malawi



Figure 4: Aerial view of Tedzani hydropower scheme



3.2 Features of the Extension of Tedzani Hydropower Plant

The main feature in the proposed project is to extend the generation capacity by 20 MW. The conditions for the existing three stations are as follows:

Table 1: Existing features for Tedzani I, II and III

No.	Station Name	Total Capacity (MW)	Head (H)	Discharge (Q)	Year Commissioned
1	Tedzani I	20	37m	30.1m ³ /s	1973
2	Tedzani II	20	37m	30.1m ³ /s	1977
3	Tedzani II	52.7	37m	78.8m ³ /s	1995

Source: <http://www.escom.mw/station-tedzani.php>

3.3 Site Development and construction

The work is scheduled to complete in three phases comprising detailed designs, construction works and operation and maintenance of the extended power plant. Standard technology will be used during construction and operation of this project. Once project activities come to an end, there will be need to systematically decommission the civil works by implementing a comprehensive rehabilitation and monitoring programme. Tedzani hydropower extension project will utilize the existing power generation scheme to harness energy from Shire River (run-of river power generation). The major activities will constitute construction of a waterway, a power house, a spillway, and an additional switch yard.

4.0 DESCRIPTION OF THE ENVIRONMENTAL BASELINE

4.1 PHYSICAL ENVIRONMENT

4.1.1 Climate

The area is located in the subtropical climate zone affected by Indian Ocean cyclones. Temperatures range from an average of 14° C in the cold dry season (June/July) to 31° C in the hot season (October/November). The average rainfall is 865 mm per annum and the relative humidity is 64%. There is no weather station at Tedzani and the climatic data for the area is extrapolated from the nearest station which is located at Chileka International Airport. The tables below highlight the climatic characteristics of the area over a 10 year period.

Table 2: Mean monthly relative humidity (%) for a 10 year period

Year / Month	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	83	78	69	75	75	66	58	59	55	47	55	64
2001	87	52	81	73	47	65	42	38	34	55	41	49
2002	77	75	77	73	59	62	54	59	55	54	56	70
2003	79	82	83	72	56	60	68	54	51	48	54	66
2004	71	77	74	79	74	70	63	56	54	56	67	79
2005	80	71	64	60	65	60	61	49	49	51	56	72
2006	81	79	84	77	68	68	62	54	47	52	63	78
2007	80	63	77	76	70	64	66	55	48	52	63	80
2008	83	74	77	67	63	59	62	59	51	50	57	79
2009	79	78	77	69	67	59	67	55	49	54	56	71
2010	70	81	76	78	68	69	69	60	46	48	50	72
Mean	79	73.6	76.4	72.7	64.8	63.7	61.2	54.4	49	51.5	56.2	70.9

Table 3: Mean monthly minimum temperature (°C) for a 10 year period

Year /Month	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	21.1	20.5	20.3	18.6	16.3	15.0	14.5	14.6	18.1	19.5	20.2	21.1
2001	21.2	20.4	19.9	18.1	15.8	14.6	14.3	14.7	17.3	19.0	22.0	20.9
2002	20.3	19.4	19.9	18.1	16.1	14.7	15.2	16.6	17.7	20.1	19.9	20.7
2003	20.9	20.1	20.0	17.9	17.4	14.6	13.8	14.8	18.6	20.9	21.7	21.7
2004	21.1	20.6	20.5	17.7	14.9	14.0	13.7	15.7	17.8	19.9	20.5	20.8
2005	20.9	20.6	20.0	18.6	16.2	15.9	14.7	16.6	18.6	21.2	21.8	21.1
2006	20.6	19.4	19.9	18.2	15.1	14.5	14.7	15.9	18.3	20.5	21.1	22.2
2007	20.5	20.2	20.0	18.8	16.4	15.4	14.2	15.4	18.4	20.0	21.5	21.0
2008	20.8	19.1	18.6	17.2	16.1	14.6	13.8	13.7	17.8	20.7	22.0	21.5
2009	20.5	19.9	19.5	17.7	16.6	15.3	14.2	15.2	18.9	20.4	20.3	21.4
2010	21.4	21.1	20.5	19.9	16.7	14.3	14.4	13.8	17.8	20.7	22.3	21.0
Mean	20.9	20.1	19.9	18.3	16.1	14.8	14.3	15.2	18.1	20.3	21.2	21.2

Table 4: Mean monthly maximum temperature (°C) for a 10 year period

Year /Month	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	28.8	28.7	28.5	27.2	25.2	24.1	24.5	24.1	28.8	31.3	29.0	29.3
2001	29.0	28.1	28.1	27.7	25.9	24.2	24.3	27.9	29.9	28.7	33.1	31.4
2002	28.5	28.5	28.3	27.2	26.1	24.1	26.9	26.6	29.1	31.5	30.8	29.7
2003	28.7	28.4	28.6	27.0	27.4	23.6	22.8	26.0	29.5	33.0	32.6	31.2
2004	29.6	27.5	28.8	26.3	24.2	23.1	23.7	27.2	29.2	31.0	30.5	28.7
2005	28.7	29.1	30.5	29.5	27.5	26.1	24.6	28.6	29.3	31.8	32.4	30.0
2006	28.5	28.9	27.3	26.9	26.1	24.5	24.5	27.1	30.3	32.3	29.8	28.9
2007	27.1	28.5	28.6	27.6	26.0	25.3	23.9	26.7	30.4	31.3	31.6	28.5
2008	27.3	28.4	27.0	27.6	27.2	24.3	24.6	26.2	30.0	32.5	32.9	29.2
2009	29.5	28.8	27.4	26.1	26.1	26.2	23.2	26.3	29.3	31.0	31.6	30.7
2010	30.2	28.3	28.6	27.7	26.8	23.7	23.8	24.6	30.2	33.2	33.3	29.3
Mean	28.7	28.5	28.3	27.3	26.2	24.5	24.3	26.5	29.6	31.6	31.6	29.7

Table 5: Mean monthly rainfall (mm) for a 10 year period

Year/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999/00	239.8	234.0	109.1	86.1	0.0	0.0	8.1	0.0	9.0	0.0	98.5	78.4
2000/01	267.8	213.2	84.6	16.4	0.2	0.0	0.7	0.0	0.0	18.7	197.1	227.0
2001/02	41.5	258.8	214.8	19.3	25.7	0.0	0.0	1.1	3.1	12.2	78.3	205.0
2002/03	219.0	103.5	134.0	100.2	0.0	0.5	0.0	39.2	8.2	37.1	19.2	110.9
2003/04	183.8	149.0	215.0	1.2	30.7	0.7	0.7	0.0	0.0	4.2	22.4	46.0
2004/05	299.8	46.5	106.8	73.4	0.0	7.0	0.0	7.5	0.0	23.6	106.1	180.1
2005/06	173.0	12.4	5.4	0.9	13.0	0.0	0.0	0.0	40.6	0.0	162.5	145.0
2006/07	263.0	257.7	192.2	20.6	0.0	0.4	0.0	0.0	1.9	17.0	129.2	172.9
2007/08	309.0	188.1	111.5	39.8	0.2	0.4	1.2	0.0	2.7	15.2	71.7	172.5
2008/09	277.8	110.5	140.7	3.8	0.0	0.8	6.1	4.4	0.0	0.9	74.0	219.3
2009/10	276.7	85.3	167.0	1.7	1.6	0.0	0.2	0.0	3.8	10.7	107.0	204.1
Mean	231.9	150.8	134.6	33.0	6.5	0.9	1.5	4.7	6.3	12.7	96.9	160.1

Source of data: Department of Meteorological Services and Climate Change

4.1.2 Topography, Geology and Landforms

Tedzani, at altitudes of between 800 and 1000 m above sea level (asl), has an undulating or rolling topography, with one ridge cutting through the land. The general landform of Tedzani can be described as dissected uplands with the dominant slope class ranging from 3 -13%. The intake point of Tedzani Hydropower scheme is found at an altitude of 323.78 m asl while the power house is at an elevation of 294.395 m asl. This indicates an average slope of approximately 3.2% from the intake point to the power generating plant.

The top soil (0-30cm) varies from sandy loam to sandy clay loam and the subsoil (>30cm) ranges from sandy clay loam to sandy clay. The soils can be said to be deep, well-drained, medium textured, reddish brown soils with low chemical fertility. Intermediate metamorphic rocks (gneissess) underlie the land.

4.1.3 Water Resources

Shire River is the main water body that passes through the area. There are other streams (the most important being Lisungwe, Mwanza and Mkurumadzi Rivers) which make the area to have a good supply of both surface and ground water. Laboratory analyses of water from Shire River indicated an average turbidity of <2 NTU, a total dissolved solids (TDS) value of 132 mg/L, a pH of 6.82 and a total hardness of 109 mg/L as CaCO₃. A full detail of the laboratory analysis and results is highlighted in Tables 6 and 7 below. The sampling was done on 20th August, 2013 at the location of the proposed site.

Table 6: Tedzani Proposed Site Water Quality Test Results

Parameter	Malawi Standards (MS 733:2005) for Borehole Water (untreated)	World Health Organisation Guideline Standards for Drinking Water	Tedzani Proposed Site Values
pH Value	6.00 – 9.5	6.5-8.5	8.62
CONDUCTIVITY (µs/cm at 25°C)	3500	-	260
TOTAL DISSOLVED SOLIDS	2000	1000	132
CARBONATE		-	7.0
BICARBONATE (as HCO ₃ ⁻)		-	123
CHLORIDE (as Cl ⁻)	0 – 750	600	10
SULPHATE (as SO ₄ ²⁻)	0 – 800	400	4.3
NITRATE	0 – 100	45	0.04
FLUORIDE (as F)	0 – 3.0	1.5	ND
SODIUM	0 – 500	200	9
POTASSIUM		-	1.1
CALCIUM	0 – 250	200	28.7
MAGNESIUM	0 – 200	150	9.1
IRON	0 – 3.0	1.0	0.48
MANGANESE	0 – 1.5	0.50	<0.001
TOTAL HARDNESS (as CaCO ₃ in mg/l)	0 – 800	500	109
BOD	400	-	360
COD	1000	-	740

TURBIDITY (NTU)	0 – 25	5	<2
SUSPENDED SOLIDS	0 – 20	-	1.2
COLOR, TCU	15	15	<1
TASTE	Not Unpleasant	Not Unpleasant	Not Unpleasant
ODOUR	Not Unpleasant	Not Unpleasant	Not Unpleasant
FAECAL COLIFORM Count/100ml	0 – 50	0	10
FAECAL STREPTOCOCCI Count/100ml	0 – 50	0	6

Table 7: Tedzani Intake Water Quality Test Results

Parameter	Malawi Standards (MS 733:2005) for Borehole Water (untreated)	World Health Organisation Guideline Standards for Drinking Water	Tedzani Intake Values
pH Value	6.00 – 9.5	6.5-8.5	8.54
CONDUCTIVITY (µs/cm at 25°C)	3500	-	257
TOTAL DISSOLVED SOLIDS	2000	1000	130
CARBONATE		-	6
BICARBONATE (as HCO ₃ ⁻)		-	122
CHLORIDE (as Cl ⁻)	0 – 750	600	10
SULPHATE (as SO ₄ ²⁻)	0 – 800	400	3.8
NITRATE	0 – 100	45	0.05
FLUORIDE (as F ⁻)	0 – 3.0	1.5	ND
SODIUM	0 – 500	200	9
POTASSIUM		-	0.9
CALCIUM	0 – 250	200	28.7
MAGNESIUM	0 – 200	150	8.8
IRON	0 – 3.0	1.0	0.43
MANGANESE	0 – 1.5	0.50	<0.001
TOTAL HARDNESS (as CaCO ₃ in mg/L)	0 – 800	500	108
BOD	400	-	220
COD	1000	-	580
TURBIDITY (NTU)	0 – 25	5	<1
SUSPENDED SOLIDS	0 – 20	-	<1
COLOR, TCU	15	15	<1
TASTE	Not Unpleasant	Not Unpleasant	Not Unpleasant
ODOUR	Not Unpleasant	Not Unpleasant	Not Unpleasant
FAECAL COLIFORM Count/100mL	0 – 50	0	3
FAECAL STREPTOCOCCI Count/100mL	0 – 50	0	0

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Flora

The vegetation around intake of existing reservoir where construction of the open channel is proposed is predominantly miombo with *Leguminosae* and *Bignoniaceae* species planted as a second generation of flora after land clearances for Tedzani No.1 Hydropower station in the early 1970s. The whole area is however, secondary in nature with tall grass savanna and other tree species dominating vegetation of under trees (see figure 5). Table 8 highlights the major species found at the proposed project site.

Table 8: A summary the most common vegetation around the proposed site.

No.	Scientific Name	English Name	Local Name
1	<i>Brachystegia boehmii</i>	Miombo or "Prince of Wales Feathers"	Mfendaluzi
2	<i>Diploxynechus condylocarpon</i>	Horn-pod tree	Thombozi
3	<i>Adansonia digitata</i>	Baobab	Mlambe
4	<i>Acacia nilotica</i>	Egyptian Mimosa	Chiwiri
5	<i>Dichrostachys cinerea</i>	Sicklebush	Mpangala
6	<i>Acacia xanthophloea</i>	Fever tree	Nchezime
7	<i>Combretum zeyheri</i>	African Bushwillow	Kalamafupa
8	<i>Acacia erioloba</i>	Camel Thorn	Mkunkhu
9	<i>Kigelia africana</i>	Sausage tree	Mvunguti
10	<i>Anacardiaceae Sclerocarya birrea</i>	Amalula	Mfula
11	<i>Anisophyllea boehmii</i>	-	Mfungo
12	<i>Cordyla africana</i>	Bush mango	Mtondo
13	<i>Colophospermum mopane</i>	Butterfly tree	Tsanya
14	<i>Combretum molle</i>	Velvet Bushwillow	Kalama
15	<i>Acacia tortilis</i>	Umbrella thorn acacia	Nsangu
16	<i>Dalbergia melanoxylon</i>	African Blackwood	Phingo
17	<i>Euphorbia ingens</i>	Naboom	Mbilima / mviro

None of the 17 tree species found at Tedzani appear on the IUCN Red List of threatened species but two of these species; *Cordyla africana* (Bush mango) and *Colophospermum mopane* (Butterfly tree) are protected under the Forestry Act of Malawi (1997).

Figure 5: Typical vegetation near the existing reservoir



The vegetation around Hydro-Power Plant and edge of channel facing power house is mainly lianous woody plants with *Euphorbia ingens* creeping between thin sandy residual rocks of escarpment areas.

The grass types in the area vary quite remarkably according to habitat but are generally of savanana type with medium height and low ground cover. The aquatic plant species found at Tedzani includes *Nymphaea odorata* (water lily), *Neptunia oleracea* (water mimosa), *Eichhornia crassipes* (water hyacinth), *Phragmites australis* (common reed), and *Vossia cuspidata* (hippo grass).

4.2.2 Fauna

There are about 192 species of mammals and 664 species of birds in Malawi. These are differentially located depending on the type of vegetation, climate, topography, and other existing ecosystem attributes. Tedzani has been used for power generation in Malawi since 1973 and a wire fence encloses the 36 square kilometre piece of land. The fence therefore limits the number of animals which can enter into the Tedzani area. Table 9 indicates the fauna found at the site and the aquatic species in Shire River.

Table 9: Terrestrial and aquatic fauna at Tedzani

No.	Scientific Name	English Name	Local Name
1	<i>Rynchops flavirostris</i>	African Skimmer	-
2	<i>Crocodylus niloticus</i>	Nile Crocodile	Ng'ona
3	<i>Lupus saxatilis</i>	Scrub hare	Kalulu
4	<i>Hemidactylus mabouia</i>	Agama lizard	dududu

5	<i>Gekkonidae</i>	Gecko	Gulo
6	<i>Bitis arietans</i>	Puff adder	Mphiri
7	<i>Dendroaspis polylepis</i>	Black mamba	Mamba
8	<i>Ploceus cucullatus</i>	Village Weaver	-
9	<i>Bubulcus ibis</i>	Cattle Egret	Kakowa
10	<i>Clarias gariepinus</i>	catfish	Mlamba
11	<i>Barbus ssp.</i>	-	Matemba
12	<i>Oreochromis mossambicus</i>	cichlids	Chambo
13	<i>Merops boehmi</i>	Boehm's Bee-eater	-
14	<i>Estrilda astrild</i>	Common Waxbill	-
15	<i>Actitis hypoleucos</i>	Common Sandpiper	-
16	<i>Corvus albus</i>	The Pied Crow	Khwangwala
17	<i>Chlorocebus pygerythrus</i>	Vervet Monkey	Nyani

The International Union for Conservation of Nature (IUCN) red list identifies *Rynchops flavirostris* (African skimmer) and *Oreochromis mossambicus* (chambo) as species under threat while the Convention on International Trade in Endangered Species (CITES) list includes *Crocodylus niloticus* (Nile crocodile). A few insects such as grasshoppers and butterflies were also identified in the area.

4.3 ECONOMIC, CULTURAL AND SOCIAL ENVIRONMENT

4.3.1 Socio-economic characteristics of the community surrounding Tedzani

There are 7 houses belonging to ESOM employees close to the project site with each household having about 5 people. These people will be temporarily shifted during construction of the site. ESCOM will find alternative housing for these affected staff members.

People in the surrounding areas (outside ESCOM premises) are mostly subsistence farmers, small-scale businessmen, unskilled workers and semi-skilled workers. They have some open land crop fields where crops such as maize (*Zea mays*), cotton (*Gossypium hirsutum*) and cowpeas (*Vigna sinensis*) are grown. The figure below shows a cotton field in the surrounding area of the project site.

Figure 6: A cotton garden



4.3.3 Traffic Circulation

Tedzani hydropower station is fringed by two access roads. One is 7 km from the Mwanza to Blantyre main road while the other one is about 1 km from Nkula hydropower station. There is currently no problem with traffic circulation in the area.

4.3.4 Educational and Health Facilities

Tedzani has a free primary (elementary) school with classes 1 to 8. As at October 11, 2013, the school had 425 enrolled pupils (192 boys and 233 girls). The school enrolls pupils from both within Tedzani premises and surrounding villages.

There is also an outpatient dispensary which was constructed by ESCOM in 1998 as part of its corporate social responsibility. The surrounding communities benefit from the dispensary by paying a fee of roughly 5 US\$ (about 2,000 Malawi Kwacha) for an average ailment such as diarrhoea.

5 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Malawi faces an acute shortage of energy supply. Projects that increase the availability of housing alleviate this problem. Nevertheless hydropower generation has the ability to negatively impact the environment and other quality life issues.

To identify potential impacts, consultations, site visits, literature review, professional judgment, laboratory analyses, and an impact matrix have been used. Several assessment parameters including significance, extent, duration, and magnitude have been incorporated in the analysis to fully characterize each impact. The impact matrix qualitatively depicts the impacts whether positive or negative, short term or long term, local, regional or confined, and high, moderate or low.

5.1 Impacts and mitigation measures during pre-construction phase

Pre-construction activities can lead to the loss of wildlife habitats, erosion and sedimentation associated with the use of heavy machinery, loss of native plant life, and contamination of soils and surface and groundwater. On the other hand, pre-construction activities will provide opportunities for employment most especially for semi-skilled and unskilled labour.

5.1.1 Flora and fauna

The project area has two species of Malawi's protected tree species. In addition there are a few animals in the area, which are mainly birds and reptiles.

As a mitigation measure, individual trees or stands of old growth that would otherwise be destroyed will be preserved. In addition, the project includes the re-vegetation of areas disturbed by land clearing. This activity will be done by ESCOM.

5.1.2 Erosion and sedimentation

Soil erosion may arise from exposure of land to wind and rain after cutting down trees and grass. This may be aggravated by the use of heavy machinery on open land. When the soil is eroded to water bodies, especially through surface runoff, sedimentation may occur.

Care will be taken to disturb the land as little as possible. For example heavy machinery will not be used during land clearing. In addition, the land clearing stage will be done during the dry season to avoid excessive runoff on bare ground.

5.1.3 Waste

Trees and grass cut from the area may affect other segments of the environment especially water bodies. This may decrease the amount of oxygen dissolved in the water i.e. it may increase the biochemical oxygen demand (BOD).

Local community groups or individual homeowners may be interested in reusing such materials as trees and grass cut down during land clearing. Other waste generated during land clearing will be properly disposed of in landfills.

5.1.4 Socio-economic aspects

During land clearing, the company will employ people through the construction contractor. It is the intention of developer to employ the labour force from surrounding area. This will be the major positive impact to the community surrounding Tedzani.

Employing the natives of the area will reduce the likelihood of squatting during the project.

5.2 Impacts during construction phase

Construction activities may produce a lot of waste, noise and vibration, and dust in addition to increasing water demand and traffic volumes. Construction activities in this project will be minimal and therefore not result in intensive negative impacts. On the other hand, construction will provide opportunities for employment for both skilled and unskilled labour.

5.2.1 Waste

Construction activities may produce waste in form of unused and excess material generated during site excavation and construction. These wastes will include soils, rubble (concrete, bricks, and asphalt), oils, wood and wood products, plaster, metals, plastics, and insulation.

These materials will be properly disposed of in landfills. During disposal, consideration will be taken into account that some of these waste products may contain constituents that pose a risk to human health and the environment. The project includes the use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time. Soil excavated from the construction site will be re-spread in areas to be landscaped to enhance plant health.

5.2.2 Noise and vibration

The use of equipment such as graders, concrete mixers, drills, and compaction equipment can produce a lot of noise and vibrations. An increase in the number of trucks and lorries bringing in construction materials may also increase the noise.

The working hours will be limited to daytime. However, there are no surrounding communities close to the project site so the impact will be negligible. There will also be regular maintenance of the construction plant and equipment to reduce noise generated during friction of moving parts. The workers will also be provided with ear protectors (muffs) to reduce the impact of the noise on their ears.

5.2.3 Dust (Air quality)

Construction activities may generate a lot of dust which may be a nuisance to surrounding communities and a potential harm to the environment. Dust from construction areas is easily transported into occupied zones by air currents, people and vehicles moving to and from the project site. The dust during construction will be localised and generated due to the opening of access roads and excavation of foundations.

As a mitigation measure to reduce dust emissions into the atmosphere, dust suppression will be undertaken by sprinkling water on access roads and covering stockpiles of soil and sand. Wherever necessary, dust screens will be erected to minimize the effect on adjacent facilities

5.2.4 Water resources

A limited amount of water will be used during construction. This will increase the water withdrawal. The used water released into the environment will also increase the chances of polluting the water resources. Improper planning may even result in blockage/closure of rivers or watercourses.

Only small amounts of water will be required so there is minimal need for a corrective action. In addition, vegetative cover will be planted and maintained within the non-paved areas to minimize the amount of evaporation and therefore enhance stream recharge. Water used during construction will be recycled wherever possible. Providing appropriate liquid and solid management will minimize contamination of surface water entering streams. Proper care will be taken to avoid blockage/ stoppage of the Shire

River.

5.2.5 Health and safety

Workers in construction are required, under standard occupational health and safety, to be provided with appropriate gear to protect the health of construction workers.

Therefore employees in construction will be provided with protective clothing that includes overalls, gloves, boots, hard hats, earmuffs, and gas masks wherever necessary.

5.2.6 Traffic

It is generally accepted that coordinated development of an area depends crucially on the availability of an efficient transport system. Nevertheless, lorries and trucks that will be bringing construction materials to the site may cause traffic jams or route blockage.

This is less likely in this project because a good access road franks the area. Proper routing will minimize this even further. Warning signs will be erected to avoid risks from moving vehicles

5.2.7 Socio-economic impacts

It is anticipated that a good number of people from the area will be employed at all levels (skilled, semi-skilled and unskilled) during the extension of Tedzani Hydropower Plant. However, during consultations with local communities, it there were fears that some contractors like to have marital affairs with women in a project area hence spreading HIV/AIDS and other sexually transmitted infections.

The contractor, in collaboration with the Ministry of Health, will promote and intensify HIV/AIDS campaigns in the area in order to militate against sexually transmitted infections (STIs). Local AIDS committees already established will be empowered to promote voluntary counselling and testing and to distribute and encourage the use of free condoms sourced by the company and other stakeholders.

5.3 Impacts during Project Operation

5.3.1 Operation and Maintenance

The extension of Tedzani Hydropower Plant will provide more reliable generation of electricity and provide direct employment. There is also a high likelihood of people in the area benefiting economically from the project through establishment of small scale businesses such

as groceries, restaurants, houses for rentals, sale of agricultural produce and fish at the local market and by the road side is high. Significant economic benefits will be enjoyed in the project area. The direct cash income from employment by the project and money realized from sale of agricultural produce and other commodities will enable people in the project area and beyond to meet their basic needs and afford essentials such as food, clothing and good houses which will raise their living standards.

One other important aspect to consider in hydropower plants is the surge tank which act as water reservoirs as well as pressure and flow regulators.

5.3.2 Flora and fauna

During operation, it is very unlikely that tree vegetation and will be lost. Only a small percentage of grass cover and secondary growth will be affected as the ESCOM clear the surroundings of the new premises for aesthetic quality.

The area will be rehabilitated through landscaping and re-afforested to preserve the environment. This will avoid the heat-island effect and, of course, reduce surface runoff.

5.3.3 Air quality

New employees, especially managers, are likely to own cars which may contribute to the emission of smoke and other green house gases that are responsible for global warming. These gases include nitrogen oxides, sulphur oxides and carbon dioxide.

The overall increase in the number of new cars will be small so that the impact will be insignificant.

5.4 OVERALL ASSESSMENT OF IMPACTS

An analysis of the matrix (Table 3) and using professional judgment, the results of the IEE study indicate that if all the mitigation measures are put in place, extension of Tedzani Hydropower Plant will have an overall positive impact on the environment. Nationally, the project will reduce the problem power shortage; hence improve livelihoods for many citizens of Malawi.

Table 10: An impact matrix for the project activities

Environmental components	Climate	Geology and Soils	Water resources	Topography	Fauna	Flora	Air quality	Noise and	Land use	Economy	Infrastructure	Health & safety	Employment	Aesthetic values
Project activities														
Land Clearing	-L +L L EL	-M +L S EL	-M +L L EL	-L +L S EL	-L +L L EL	-H +L L EL	-M +L L EL	-L +L L EL	-M +H L EL	-L +H L ER	-L +L S EL	-M +M L EL	+H S EL	-M +L S EL
Land excavation	-L +L S EL	-M +L L EL	-M +L S EL	-M +L S EL	-M +L L EL	-L +L L EL	-M +L S EL	-M +L S EL	-L +L L EL	-L M S EL	-L +L S EL	-L +L S EL	+H DS L EL	-M +L S EL
Construction	-L +L S EL	-H +L L EL	-M +L S EL	-M +M L EL	-L +L L EL	-H +L L EL	-M +L L EL	-M +L S EL	-M +L L EL	-L +H L EL	-L +H L EL	-L +L S EL	+H DS L EL	-L +H L EL
Transportation	-L +L S EL						-M +L S EL	-M +L S EL				-L +L S EL	+H S EL	
Operation			-M +H L EL						-L +H L EL	-L +H L ER	-L +H L EL		+M L EL	-L +H L EL

Significance of negative impact: -H = High

-M = Moderate

-L = Low

Significance of positive impact: +H = High

+M = Moderate

+L = Low

Duration of impact : L = Long term

S = Short term

Extent of impact : ER = Regional

EL = Localised

A more general approach to assess impacts is by identifying the different characteristics of a potential impact. To do this it is useful to ask the following questions: What is the effect of the impact? What is the magnitude of the effect? What is the receiving environment? What is the occurrence and duration? Answering each of the preceding questions, even in a qualitative manner, provides an indication of the severity of the impact and provide an initial basis for assessing impacts. The significance of impacts, in this respect, has been assessed on a scale of 1 to 5, with 1 being the least and 5 being the highest. A positive sign means that the situation is favourable and a negative sign means unfavourable consequences.

Table 11: Assessment of impact significance

Environmental Impact	Existing	Proposed
Loss of flora and fauna	0	-1
Erosion and sedimentation	-2	-3
Generation of waste	0	-4
Water resources	-1	-3
Air quality	-1	-2
Noise and vibration	0	-2
Employment	+1	+5
Energy (Power)	0	+5
Traffic circulation	0	+2
Occupational health and safety	-1	-2
Reduction in crime	-2	+4
Provision of Electricity	0	+5
Economy	+1	+5
Cumulative significance of impacts	-5	+9

The cumulative significance of impacts shows that the extension of Tedzani Hydropower has an overall positive significance (+9) whereas the existing situation has a negative overall significance of -5.

6 ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND THE ENVIRONMENTAL MONITORING PLAN (EMoP)

The environmental sustainability of any major development project depends on proper planning. This is highlighted in the Environmental Management Act of 1996 and the Guidelines for Environmental Impact Assessment of 1997. To that effect, an Environmental Management Plan (EMP) for this project has been designed and is summarized in table 12. This plan indicates the predicted impacts, mitigation measures/enhancement measures, schedule for implementation of measures, estimated costs to implement the measures, and also highlights the responsible authorities for effective implementation of the plan.

It is also essential that an Environmental Monitoring Plan (EMoP) is put in place to ensure that the project activities are in line with the EMP and that the project proponent is indeed implementing the proposed mitigation measures. The EMoP includes parameters to be monitored, location and monitoring equipment, methods of monitoring, frequency, estimated costs and responsible institutions

6.1 Government and Community Level Institutional Arrangements

The implementation of the EMP is the direct responsibility of ESCOM. The Environmental Planning Office is responsible for technical planning and the implementation of all environmental mitigation measures outlined in the EMP. ESCOM through the project contractor and other stakeholders will be responsible for implementing measures to avoid or minimize environmental, social and health impacts during construction. The contractor will also be required to apply international standard quality assurance procedures and an environmental management system in full compliance with International Organization of Standardization. ESCOM is also responsible for ensuring that the contractor fully meets its contractual and environmental management obligations. The other key organizations responsible for ensuring the successful implementation of the EMP are MERA and the Departments of Environmental Affairs. The Environmental Planning Office of the ESCOM will report to EAD on issues of EMP, respectively and work in close cooperation with them as necessary. The key role of the EAD will be to provide technical advice on the implementation of the EMP where possible and ensure its full compliance with the Environment Management Act on all legally binding issues. The key role of the MERA will be to give advisory support for the full implementation of the EMP. In addition it is recommendable for the ESCOM to hire services of either a professional firm or NGOs that would directly monitor performance

and associated impacts on environment and affected persons. This could be considered as a technical audit built into the consultant's contract. TORs would be developed in collaboration with DEA and the relevant stakeholders. Monitoring reports would therefore be discussed by key stakeholders and lessons learnt incorporated into the ongoing project activities. At community Level implementation will be done through the existing local structures. Tables 12 and 13 present the EMP and EMoP for the extension of Tedzani Hydropower station.

Table 12: Environmental Management Plan (EMP) for the Extension of Tedzani Hydropower Station

No.	Environmental Component	Predicted Impact	Mitigation/Enhancement Measures	Schedule of Implementation (Timeframe)	Estimated Cost (MWK)	Responsible Personnel/ Institution
1	Road Safety	Traffic Hazard	Properly regulate traffic at the entrance gates of the two access roads	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
			Raise awareness on road safety	During construction and operation	Under Operation Cost	ESCOM & Contractor
			Put warning signs and humps on roads within the premises of the project site	Prior to commencement of construction activities	Under Operation Cost	ESCOM
			Observe and enforce a speed limit of 40km/hr	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
2	Occupational Health, Hazards and Safety	Compromise on Occupational Health, Hazards and Safety (through accidents, diseases, noise and vibration)	Provide appropriate Personal Protective Equipment (PPE) to all workers	Continuous throughout the project lifespan	800,000.00	Contractor
			Orient visitors on occupational Health and safety before entry into the project site.	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor

No.	Environmental Component	Predicted Impact	Mitigation/Enhancement Measures	Schedule of Implementation (Timeframe)	Estimated Cost (MWK)	Responsible Personnel/ Institution
2	Occupational Health, Hazards and Safety	Compromise on Occupational Health, Hazards and Safety (through accidents, diseases, noise and vibration)	Subject the Site to Occupational Safety and Health Inspection by government officials	Once a year	200,000.00	ESCOM, MoL, MoH & Contractor
			Organize routine medical checkups for employees	Once a year	300,000.00	ESCOM
			Train workers on occupational health and safety measures	Continuous throughout the project lifespan	350,000.00	ESCOM
			Provide well stocked first aid kits	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
			Clearly display an abstract of Occupational Health, Safety and Welfare Act (1997) on notice boards	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
			Provide toilets and other welfare facilities such as showers	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
3	Soil Quality	Soil Erosion	Install slope protection structures such as terraces and gabion baskets	At the start of construction activities	Under Operation Cost	ESCOM
			Stockpile soils away from the drainage channels.	During construction	Under Operation Cost	Contractor

No.	Environmental Component	Predicted Impact	Mitigation/Enhancement Measures	Schedule of Implementation (Timeframe)	Estimated Cost (MWK)	Responsible Personnel/ Institution
3	Water Quality	Water pollution from construction activities and sedimentation	Install sediment traps (detention ponds) on natural drainage paths at site	During construction	Under Operation Cost	Contractor
			Properly manage liquid and solid waste to avoid water contamination	Continuous throughout the project lifespan	Under Operation Cost	ESCOM
			Use well serviced machinery (equipment) and vehicles to minimize oils spills and leakages	Continuous throughout the project lifespan	Under Operation Cost	Contractor
			Locate storage areas for fuels and lubricants away from natural drainage courses	During construction	Under Operation Cost	Contractor
			Bund storage areas and line the floor with concrete	During construction	500,000.00	Contractor
4	Air Quality (Ambience)	Air pollution	Regularly spray bare ground with water to minimize dust	Continuous throughout the project lifespan	150,000.00	ESCOM
			Limit working period to daytime.	During construction	Under Operation Cost	Contractor
			Cover stockpiles of soil and sand	Continuous throughout the project lifespan	Under Operation Cost	Contractor
			Screen off the project site	During construction	Under Operation Cost	Contractor
5	Flora and fauna	Loss of vegetation and animal habitat (ecosystem disturbance)	Limit site clearing to designated area for construction	During construction	Under Operation Cost	Contractor
			Re-vegetation of the cleared land	At the end of the construction	100,000.00	ESCOM

No.	Environmental Component	Predicted Impact	Mitigation/Enhancement Measures	Schedule of Implementation (Timeframe)	Estimated Cost (MWK)	Responsible Personnel/ Institution
6	Waste Management	Waste generation from project related activities	Provide proper liquid and solid waste storage, collection and disposal services	Continuous throughout the project lifespan	Under Construction Cost	ESCOM & Blantyre District Council
			Segregate waste according to hazard category	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
			Regularly maintain and empty the existing septic tanks	Continuous throughout the project lifespan	500,000.00	ESCOM & Blantyre District Council
			Regularly maintain and clean toilets	Continuous throughout the project lifespan	300,000.00	ESCOM
7	National Economic Development	Employment Opportunities	Ensure gender balance in the composition of employees at all levels	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
			Offer realistic wages to employees	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
			Give a fair chance of job opportunities to people from the area surrounding the project site	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
			Be transparent in the bidding process of any outsourced services	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
		Provision of Energy (Electricity)	Ensure improved energy supply to industries and the people of Malawi.	During Operation	Under Operation Cost	MERA, DoE, & ESCOM

No.	Environmental Component	Predicted Impact	Mitigation/Enhancement Measures	Schedule of Implementation (Timeframe)	Estimated Cost (MWK)	Responsible Personnel/ Institution
8	Health Risk	Prevalence of increased cases of Sexually Transmitted Infections (STIs) including HIV & AIDS	Raise awareness among the workforce on the dangers of STIs and HIV& AIDS	Continuous throughout the project lifespan	300,000.00	ESCOM
			Provide condoms to workers	Continuous throughout the project lifespan	150,000.00	ESCOM
			Introduce and promote HIV&AIDS workplace policy	During operation	Under Operation Cost	ESCOM
			Employ people from the surrounding area	Continuous throughout the project lifespan	Under Operation Cost	ESCOM & Contractor
9	River Hydrology	Changes in the river flow	Use of minimum flow turbines	During Operation	Under Operation Cost	ESCOM & Contractor

Table 13: Environmental Management Plan (EMoP) for the Extension of Tedzani Hydropower Station

No.	Parameter/Issue	Monitoring Location	Method	Indicators	Frequency (in a year)	Estimated Cost (MWK)	Responsible Personnel/ Institution
1	Traffic Hazard	At the entrance gates of the access roads and on the project site	Site observation	Presence of speed limit signage, traffic control personnel, and other road safety measures such as humps	Twice a month	100,000.00	ESCOM & EAD
2	Occupational Health, Hazards and Safety	Project site	Site observation	Behaviour of visitors within premises	Biannually	30,000.00	ESCOM, MoL & EAD
				Number of employees wearing PPE	Quarterly	50,000.00	ESCOM & MoL
				Workplace inspection reports	Annually	120,000.00	ESCOM, MoL & EAD
				Medical reports	Annually	50,000.00	ESCOM, MoL & EAD
				Availability of first aid kits and their level of adequacy	Annually	100,000.00	ESCOM, MoL & EAD
				Presence of abstracts of the OSHWA (1997) on notice boards	Annually	70,000.00	ESCOM, MoL & EAD
				Availability of toilets	Annually	30,000.00	ESCOM, MoL & EAD

No.	Parameter/Issue	Monitoring Location	Method	Indicators	Frequency (in a year)	Estimated Cost (MWK)	Responsible Personnel/ Institution
2	Occupational Health, Hazards and Safety	Project site	Spot checks	Presence of abstracts on notice boards	Quarterly	70,000.00	ESCOM, MoL & EAD
			Direct Observation and review of training records	Health and safety conscious behaviour of employees and the number of workers trained.	Quarterly	100,000.00	ESCOM, MoL & EAD
3	Soil erosion	At the project site and unstable slope areas around the site (especially at the intake and powerhouse)	Site observation, Local information, photographs	Occurrence of landslides and soil erosion; presence, number of the installed sediment traps and slope stability	Quarterly	200,000.00	ESCOM & EAD
4	Water pollution	Headworks and powerhouse	Water sampling, analysis and comparison with standards	Water quality results within acceptable limits for surface water	Bi-monthly	400,000.00	ESCOM, MoWI & EAD
		Project site	Site Observation	Location and status of floors and storage areas for fuels and lubricants	Bi-monthly	100,000.00	EAD

No.	Parameter/Issue	Monitoring Location	Method	Indicators	Frequency (in a year)	Estimated Cost (MWK)	Responsible Personnel/ Institution
5	Air pollution	In the proximity of project site, weir, powerhouse and along access roads	Low volume sampling and analysis of air quality	Dust levels within acceptable ambient limits (preferably less than 50mg/m ³).	Bi-monthly during construction	400,000.00	ESCOM, MoWI & EAD
			Site observation	Project site spread with water	Bi-monthly during construction	100,000.00	Ministry of Transport
				Area screened off	Bi-monthly during construction	100,000.00	Blantyre District Council, EAD
6	Generated waste	Project site	Spot checks	Number of skips and bins provided & Frequency of refuse collection	Bi-monthly	100,000.00	Blantyre District Council, EAD.
				Number of bins provided for different types of waste	Bi-monthly	50,000.00	Blantyre District Council, EAD
				Functional septic tanks and frequency of emptying	Bi-monthly	100,000.00	Blantyre District Council, EAD
				Functional and clean toilets	Bi-monthly	100,000.00	Blantyre District Council, MoL

No.	Parameter/Issue	Monitoring Location	Method	Indicators	Frequency (in a year)	Estimated Cost (MWK)	Responsible Personnel/ Institution
7	Prevalence of increased cases of Sexually Transmitted Infections (STIs) including HIV & AIDS	Project Site	Medical records	Number of civic education meetings conducted on STIs and HIV&AIDS	Biannually	100,000.00	MoH
			Medical records	Number of condoms distributed	Quarterly	50,000.00	MoH
			Site observation	Availability of HIV&AIDS workplace policy document	Annually	100,000.00	MoH
			Wages payroll	Number of people employed from the surrounding area	Annually	100,000.00	MoL
8	Creation of employment opportunities	Project site	Wages payroll	Number of women against men	Annually	100,000.00	MoL
			Wages payroll	Realistic wages to employees	Annually	100,000.00	MoL
			Procurement records	Fair and transparent award of contracts	Annually	100,000.00	ESCOM, ODPP
9	River hydrology	Gauging station	River flow	Changes in the flow rate of Shire River	Weekly (especially during the dry season)	None (System is already available)	ESCOM

No.	Parameter/Issue	Monitoring Location	Method	Indicators	Frequency (in a year)	Estimated Cost (MWK)	Responsible Personnel/ Institution
10	Fisheries	Upstream of the project site and downstream the power house	Fish sampling and discussions with local fishermen	Fish species and populations, and migratory habits	Monthly	200,000.00	ESCOM, Fisheries Department
11	Provision of Energy (Electricity)	Power house	Spot checks & customer complaints	Frequency of load shedding and customer complaints	Weekly	None (System already available)	ESCOM, DoE & MERA
12	Flora and fauna	Project site	Site observation	Changes in availability	Quarterly for fauna and Biannually for flora.	200,000.00	ESCOM, EAD

7.0 CONCLUSIONS AND RECOMMENDATIONS

Results of the IEE study indicate that Tedzani Hydropower Extension Project will have both negative and positive impacts on the environment. However, an overall assessment of impacts shows that the positive impacts of the project significantly outweigh the negative impacts. The project will considerably alleviate the current electricity shortage in Malawi. It is imperative and, therefore, recommended that ESCOM and its partners should strictly adhere to and implement the Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP) that have been recommended has been in this report. Full commitment to the EMP should be done during design, construction, and operational phases of the project.

8.0 REFERENCES

1. **Fabreck, M.N. and O'Rourke, J.J. (1998).** Environment Project Planning for Design and Construction, New York: John Wiley .
2. **Government of Malawi (1996).** National Environmental Management Act. Environmental Affairs Department, Lilongwe, Malawi.
3. **Government of Malawi (2004).** National Environmental Policy. Environmental Affairs Department, Lilongwe, Malawi.
4. **Japan International Cooperation Agency (2010).** Guidelines for environmental and social considerations. Tokyo, Japan.
5. **National Statistical Office (2008).** Malawi Population and Housing Census: Report of final Census Results, Zomba, Malawi.
6. **Government of Malawi (1997).** Malawi Guidelines for Environmental Impact Assessment
7. **Government of Malawi (1994).** National Environmental Action Plan, Lilongwe.
8. **Government of Malawi (2010).** National State of the Environment Report, Lilongwe
9. **Government of Malawi (1998).** Customary Land Utilization Study Repository GIS Data. Compass II Project. Blantyre.
10. **Government of Malawi, (2011).** Malawi Economic Growth and Development Strategy II. Lilongwe

APPENDIX 1: LIST OF STAKEHOLDERS CONSULTED

LOCATION	PERSONS CONSULTED
Tedzani Power House (ESCOM Employees)	<ol style="list-style-type: none"> 1. Harrison Jere 2. Aubrey Ngulube 3. Madalitso Malefula 4. Oscar Gondwe 5. Patrick Gondwe 6. Jonathan Lambiki 7. Wadson Zimbambo 8. Edmund Kamoto 9. Master Sambisa 10. Evance Phiri 11. Biston Chathamanga
Nzigala Village, T/A Kunthembwe (Villagers)	<ol style="list-style-type: none"> 1. Peter Jose 2. Gladess Mapinda 3. Thomson Maxwell 4. Oliver Phazi 5. Sellina Mofolo 6. Luzita Nandolo 7. Stefano Elias 8. Elizabeth Jose 9. Symon Chatsalira 10. Fletcher Matemba 11. Village Headman Nzigala

APPENDIX 2: TERMS OF REFERENCE FOR THE IEE



**TERMS OF REFERENCE FOR THE ENVIRONMENTAL MANAGEMENT PLAN FOR THE
PROPOSED EXTENSION OF TEDZANI HYDROPOWER STATION**

1. Provide a **brief description of the nature and location** of the project with respect to the name of the proponent, postal and physical address, the spatial location of the site for the project, the duration of the project, estimated cost of the project, the project design, the activities to be undertaken, number of people to be employed (provide a breakdown for males and females, locals and non-local); the size of the land, expected inputs and outputs.
2. Provide a **brief description of the existing environment** in terms of its biophysical characteristics and social conditions of the proposed area.
3. In **brief identify and assess** the likely environmental impacts associated with the project as a result of the activities that will be carried out.
4. Propose an Environmental Management Plan (EMP) for the project. The EMP should be in tabular form which should specify the predicted impacts, mitigation measures/enhancement measures, schedule of these measures, costs to undertake these measures, and responsible persons and institutions.
5. Propose the Environmental Monitoring Plan for the project. The monitoring plan should outline all the main indicators to be used for monitoring the impacts, the frequency of monitoring and the estimated costs.