



Government of the Republic of Malawi

Ministry of Water Development and Irrigation
National Water Development Programme

Independent Environmental Impact Assessment for the Upgraded
Kamuzu Barrage

Final Environmental and Social Management Plan



December 2013



Table of Contents	i
Abbreviations	iv
Acknowledgements	v
Executive Summary	vi
1 Introduction	1
1.1 Report Aim and Content	1
1.2 Project Setting	1
2 Project Description	4
2.1 Area of Project Impact	4
2.2 Project Details.....	4
2.2.1 Location and Justification	4
2.2.2 Description of Proposed Works.....	5
2.2.3 Operation and Maintenance Activities.....	6
2.2.4 Project Implementation.....	6
2.2.5 Project Cost.....	6
3 Summary of Social and Environmental Impacts	9
4 Description of Mitigation Measures	12
4.1 Summary of Environmental Management Measures	12
4.2 Physical Environment	12
4.3 Biological Environment	13
4.3.1 Environmental Flow Requirements	13
4.3.2 Mitigation of Impacts on Liwonde National Park	14
4.3.3 Mitigation of Fisheries Impacts.....	14
4.3.4 Construction Mitigation Measures.....	14
4.3.5 Summary of Water Release Boundary Conditions.....	15
4.3.6 Aquatic Weed Disposal	15
4.4 Socio-economic Environment.....	16
4.4.1 Preferential Employment Policy	16
4.4.2 Delivery of Entitlements.....	17
4.4.3 Establishment of an Early Warning System	17
4.4.4 Health and Safety.....	17
4.4.4.1 During the Construction Period	17
5 Monitoring Program	40
5.1 Compliance Monitoring	41
5.1.1 Physical Environment.....	41
5.1.1.1 Soils.....	41

5.1.1.2	Water Quality Monitoring.....	41
5.1.2	Socio-economic Environment.....	42
5.1.2.1	Monitoring of Resettlement / Compensation	42
5.1.2.2	Monitoring of Accidents / Health.....	42
5.1.2.3	Noise Level Monitoring.....	43
5.1.3	Monitoring ESMP Implementation.....	43
5.2	Outcome Monitoring	43
5.2.1	Physical Environment.....	43
5.2.1.1	Water Resources.....	43
5.2.2	Biological Environment.....	43
5.2.2.1	Vegetation	43
5.2.2.2	Terrestrial Wildlife.....	44
5.2.3	Monitoring the Operational Release Strategy	44
5.2.4	Monitoring Budget	46
6	Institutional Arrangement and Training.....	47
6.1	Institutional Arrangement.....	47
6.2	Environmental Training.....	47
7	Reporting Procedures and Implementation Schedule	49
7.1	Reporting System	49
7.1.1	Non-compliance Reporting.....	49
7.1.2	ESMP Audit Reporting	49
7.1.3	Reporting on In-voluntary Resettlement.....	49
7.2	Implementation Schedule	49
8	Cost Estimates.....	52
8.1	Environmental and Social Management Budget	52
9	Reference Material.....	53
9.1	Websites	53
9.2	Maps/Aerial Photos/Images.....	54
	Appendix 1: List of Consulting Staff	56
	Appendix 2: Environmental Best Practice Guidelines	57
	Appendix 3: Generic Management Plans for Project Construction Phase 68	
	Appendix 4: Examples of Reporting Forms.....	73

Table of Figures

Figure 1.	Project Location Map and Environmental Setting.....	3
Figure 2.	Area of Project impact.....	7

Figure 3.	Barrage construction and work sites and location of businesses impacted by the Project.....	8
Figure 4.	Shire River Hydrograph (World Bank 2010)	14
Figure 5.	ESMP Organisation Chart	47
Figure 6.	Floodplain grassland ecosystem, Liwonde National Park (Report cover).	55

Table of Tables

Table 1.	Summary of predicted impacts	9
Table 2.	Water release boundary conditions	15
Table 3.	Environmental and Social mitigation Measures.....	20
Table 4.	Mitigation Management	39
Table 5.	Monitoring Plan	45
Table 6.	Monitoring Budget	46
Table 7.	Training for MoWDI and contractor staff.....	48
Table 8.	ESMP implementation schedule.....	50
Table 9.	Environmental management costs	52

List of ESIA Documents

Volume 1: Main Report - ESIA

This is the “stand alone” main report addressing the environmental and social impact assessment of the Project and includes a summary of the Environmental and Social Management Plan (ESMP) which has been prepared as a separate document. The specialist reports in Volume 2 (Annexe to the ESIA) need only be consulted if a reader wishes to follow-up the specialist studies undertaken to complete the ESIA.

Volume 2: Annex to Main Report

1. Fisheries Report
2. Assessment of Wildlife Impacts
3. Vegetation Assessment
4. Water Quality Assessment

Environmental and Social Management Plan (this Report)

The ESMP is a stand-alone document which addresses mitigation measures, monitoring and institutional arrangements for the environmental management of the Project. One part of the ESMP is the environmental monitoring program which provides input to management decisions that may be taken during construction and operational phases. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes.

Resettlement Action Plan

The Resettlement Action Plan (RAP) is a separate report to support the ESIA. It identifies resettlement and compensation issues and provides compensation framework. The findings and recommendations have been included in the Main ESIA. It is in two volumes:

Volume 1: The main report addressing the legal and policy framework, entitlement framework, institutional and organisational framework, monitoring and evaluation, grievance procedures and costs related to Project resettlement / compensation.

Volume 2: Record of Consultation

Abbreviations

AIDS	Acquired Immuno-deficiency Syndrome
BOD	Biochemical Oxygen Demand
CEMP	Contractor Environmental Management Plan
CO	Carbon Monoxide
CO ²	Carbon Dioxide
dBA	Decibel – A weighting
DO	Dissolved Oxygen
EAD	Environmental Affairs Department (Malawi)
EC	Electrical Conductivity
EHS	Environment, Health and Safety
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESCOM	Electricity Supply Corporation of Malawi (Ltd)
Fe	Iron
GPS	Global Positioning System
HIV	Human Immuno-deficiency Virus
HRWL	Highest Regulated Water Level
IUCN	International Union for Conservation of Nature
LLC	Local Liaison Committee
LMLC	Lake Malawi Level Control
m	metres
masl	metres above sea level
MoWDI	Ministry of Water Development and Irrigation
NGO	Non-Governmental Organisation
NO ^x	Nitrous Oxides
NP	National Park
NWDP	National Water Development Project
PAP	Project Affected Person
PoE	Panel of Experts
PSC	Project Steering Committee
PSR	Project Steering Committee
RAP	Resettlement Action Plan
RPF	Resettlement Planning Framework
SADC	Southern African Development Community
SE	Supervising Engineer
SMEC	Snowy Mountains Engineering Corporation (Australia)
SRBMP	Shire River Basin Management Project
SS	Suspended Solids

STIs	Sexually Transmitted Infections
ToR	Terms of Reference
USD	United States Dollar
VOC	Volatile Organic Compound
WB	World Bank
WHO	World Health Organisation

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 - Principal Hydrologist, MoWDI
 - Chief Water Resources Development Officer, MoWDI
 - Principal Environmental Officer, EAD
 - Chief Hydrologist Technician, Hydrology Department, MoWDI
 - Mangochi District Commissioner
 - Zone Manager, Mangochi District
 - Health and Sanitation Expert, Mangochi District
 - Water Resources Board, MoWDI
 - Officer-in-charge of Kamuzu Barrage, ESCOM
 - Mr. Mbye; Operation Manager, Kamuzu Barrage
 - Navigator of Boats, Kamuzu Barrage
 - Operation Manager, Nkula Power Station, ESCOM
 - Senior Power Station Manager, Nkula Power Station, ESCOM
 - Blantyre Water Pumping Station, Blantyre Water Board
- NORPLAN Design Consultant for Kamuzu Barrage upgrading

Executive Summary

Background Information

The Government of Malawi, through the Ministry of Water Development and Irrigation (MoWDI), is implementing the National Water Development Project (NWDP) Phase II. Under Phase I of the NWDP, a number of studies were undertaken including: i) Water Resources Development Plan Study to identify future potential sources of water supply, ii) Catchment Rehabilitation and Protection Study, iii) Integrated Water Resources Management Plan for the Lake Malawi and Shire River Study, iv) Songwe River Stabilization Study and v) Strengthening of the Water Resources Board Study.

The upgrading of Kamuzu Barrage at Liwonde was selected as the best option of a number of alternatives considered under the Integrated Water Resources Management Plan for the Lake Malawi and Shire River Study (also known as the Lake Malawi Level Control - LMLC) to further regulate flows in the Shire River. Upgrading of the Barrage will be undertaken as a sub-project of the Shire River Basin Management Project (SRBMP) financed through the World Bank (WB). The overall program development objective of the SRBMP is to make significant progress in achieving socially, environmentally and economically sustainable development in the Shire Basin.

The major intended functions of the upgraded Barrage are i) to regulate water flow in the Shire River to meet demands from downstream water users, most importantly water supply, energy and irrigation, ii) improve weed management and reduce handling cost; iii) regulate water levels upstream to meet environmental and socio-economic conditions; iv) influence, to a certain degree, the water level in Lake Malawi; and v) improve safety and traffic circulation by physically separating road traffic from areas needed for gate operation (operation and weed handling currently takes place on the road, which is a major north-south corridor. The Barrage can only regulate Lake levels within a certain range which does not cover the historical variations. The refurbished Barrage will improve flow regulation by increasing the highest regulated water level at the Barrage (up to 40 cm, still within the natural range); and by operational measures based on improved hydrological observations, hydraulic modelling, decision support on water demand and ability to operate the Barrage in real time.

Project Description

The Project proponent is the Ministry of Water Development and Irrigation. The project involves upgrading the existing Kamuzu Barrage which is located on the Shire River at the town of Liwonde. The preferred design option for the Upgraded Kamuzu Barrage involves: refurbishment of the existing Kamuzu Barrage Structure with new gates and raising the maximum regulating capacity of the Barrage by 40 cm corresponding to a Lake Malawi water level of 475.72 masl; construction of a new road bridge on the downstream side of the existing Barrage (as part of the same structure); and construction of a floating steel boom upstream of the Barrage to control floating weeds. Erosion protection works will also be constructed downstream of the Barrage. Construction time is estimated at 34 months.

Summary of Impacts

The beneficial and adverse Project impacts have been assessed based on five impact criteria and a summary of the impacts is provided in the Table below.

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Physical Environment								
Changes to micro-climate upstream	O	L	LT	L	L	P	N	N
Soils (floodplain, erosion; soil removal from construction activities)	C, O	L	LT	L	HL	N	L	Y

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Inundation of commercial mineral resources	C, O	L	LT	L	P	N	N	N
Water resources								
Modified flows in Shire River	O	R	LT	L	HL	N	L/M	Y
Erosion of downstream river banks	O	L/R	LT	M	D	N	M	Y
Raising groundwater levels	C, O	L	LT	L	L	N	L	N
Water quality changes								
Lake Malawi	O	L	LT	L	P	N	N	N
Lake Malombe	O	L	LT	M	L	N	M	Y
Shire River upstream of Barrage	O	L	LT	L	P	N	N	Y
Shire River downstream of Barrage	O	R	LT	L	L	N	L	Y
Biological Environment								
Loss of riparian vegetation (inundate floodplain areas of Liwonde NP)	C, O	R	LT	M	D	N	M	Y
Removal of floating aquatic weeds	O	R/N	LT	M	D	P	H	Y
Disposal of aquatic weeds	O	L	LT	M	D	N	M	Y
Wildlife (loss of habitat)	C, O	R	LT	M	D	N	M	Y
Inundate emergent boulders in Shire River (Rock Pratincole)	O	N	LT	L	P	N	M	Y
Inundate sand banks along Shire River and Lake foreshores (crocodiles, turtles)	O	R	LT	L	P	N	M	Y
Inundate sand bars within Shire River channel (African Skimmer)	O	I	LT	L	P	N	M	Y
Fish	O	R	LT	L/M	L	N	L/M	Y
Habitat loss in Lake Malawi (Cichlids)	O	I	LT	L	P	N	L	N
Loss of habitat in Lake Malombe	O	L	LT	L	P	N	M	Y
Barrier to fish movement upstream	O	R	LT	L	D	N	L	N
Socio-Economic Environment								
Increased regulated flows for more reliable hydropower generation	O	N	LT	M	D	P	H	N
National economy – more reliable power	O	N	LT	M	D	P	H	N
Local economic benefits (Project employment, increased trading)	C,O	L	LT	M	L	P	M	Y
Land Resources								
Temporary loss of access/use of Temporary Contractor Site (affects ESCOM+2 private landowners)	C	M	S	M	D	N	M	Y
Permanent loss through inundation (cultivation/grazing land)	O	L	LT	L	D	N	L	Y
Livelihoods (small businesses near Barrage)	C, O	L	S	H	D	N	H	Y
Livestock farming (loss of pasture land)	C, O	L	LT	M	L	N	M	Y

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Lake Malawi transport – flooding of jetties	O	L	LT	L	P	P	L	N
Pedestrian / vehicle access across Barrage	C, O	R	LT	H	D	P	H	Y
Vulnerable groups – impact on livelihood	O	L	LT	L	P	N	L	Y
Downstream irrigators along Shire River	C	R	LT	M	HL	P	M	Y
More reliable town water supplies	O	R	LT	M	P	P	M	Y
Tourist facilities								
Inundation of infrastructure upstream	O	N	LT	L	P	N	L	N
Construction site (Barrage) – affects Shiri Lodge, Shire Camp and NP boat landing	C, O	L	LT	H	D	N	H	Y
Health								
Air pollution at construction sites	C	L	S	L	L	N	L	Y
Improved potable water supply	O	R	LT	M	P	P	M	Y
Pollution from waste disposal work sites	C, O	L	LT	L	L	N	L	Y
Noise pollution (close to work sites, 2.5 year construction period)	C, O	L	S	L	D	N	L	Y
Increased communicable diseases (HIV/Aids, etc.) from influx of workers	C	L	LT	M	P	N	L/M	Y
Community safety – increased traffic	C	L	S	L	P	N	L	Y
Increase in water born / vector diseases	C, O	R	LT	M	HL	N	M	Y
Technical disaster scenarios								
Barrage failure	O	R	S	H	P	N	M	Y
Downstream flooding	C, O	R	S	M	P	N	M	Y
Fire, explosion, chemical spill	C,	L	S	M	P	N	N	Y
Waste management from existing Barrage gates and existing weed boom	C	L	S	M	D	N	L	Y
Inundation of cultural resources	C, O	L	LT	L	P	N	N	Y

Legend:

Project Phase: Pre-construction, Construction or Operation

Scale: Physical scale / area over which the impact will be felt: Local, Regional, National or International

Duration: The length of time the impact is likely to occur: Short, Medium or Long Term

Severity: The intensity of the impact: Low, Medium or High

Certainty: The probability of the impact occurring: Possible, Likely, Highly Likely or Definite

Direction: Whether the impact is Positive (beneficial) or Negative (adverse)

Significance: Based on the above criteria, an overall rating of significance of the impact: Nil or Negligible, Low, Medium, High or Very High

Mitigation/Enhancement: Whether mitigation or enhancement is required (Y) or not (N)

The significance of the impacts on the issues mentioned range from low to very high according to level of operations. However, most of the construction impacts are localized and of temporary nature. For these issues, precautionary measures and quick response are necessary to contain negative impacts.

Mitigation Measures

Physical Environment

Provide River stabilisation works immediately downstream of the Barrage to prevent erosion of the River bed and banks during high flow releases. Monitor upstream river banks and lake foreshores to ensure releases from the Barrage are not causing further erosion.

Biological Environment

Ecological environmental flow requirements:

- For Lake Malawi: Limit increased (above Baseline) frequency and duration of high flood events and extreme flooding events to conserve important floodplain ecosystems and biota; to protect dimba and reduce loss of property;
- For the Upper Shire – Section from Lake Malawi to Liwonde: Limit flooding along the river to a minimum above Baseline, prevent out of season flooding and ensure some seasonal variation in fluctuation;
- For Upper Shire – Section from Liwonde to Kholombidzo: Ensure that regulation results in flooding taking place annually during March/April, even when water levels are low and flooding can be prevented, for flood plain maintenance for conservation of biota and flood plain agriculture;
- For Middle Shire : No specific requirements;
- Lower Shire: Annual flood releases should coincide with downstream flooding for wetland and flood plain maintenance. This also discourages encroachment on to the flood plain thus reducing the risk of catastrophic flooding events.

Mitigation of Impacts on Liwonde National Park

It is critical that management of the upgraded Barrage takes into account how their actions affect the National Park. Rapid opening and closure of the Barrage gates, high flood levels and dampening of the natural rise and fall of seasonal water levels all have short and long-term implications for the Park. Park management should be integrated into the institutional structures responsible for management and monitoring of the Barrage.

Mitigation/Benefit Enhancement for Elephant Marsh

Annual simulation of natural flood events down the Shire River will help maintain terrestrial and aquatic processes within the Marsh. The simulation of a natural flood will significantly improve the situation over the baseline (there were no adequate flood releases from Liwonde during the period 1993 – 2002, apart from 1997).

Mitigation Measures During Construction

- Removal of the informal solid waste dump alongside the Barrage approach on the right bank (west side) of the Shire River prior to commencement of main civil works.
- Progressive rehabilitation for all cut and fill areas as earth works progress.
- All alien vegetation in new temporary / permanent work sites, borrow and quarry areas will be removed and disposed of properly before construction takes place.
- Contractors will take appropriate measures to ensure invasive species of plants are not introduced into the area through vehicle movements.
- For all work areas, after the topsoil has been replaced and worked, appropriate grass mixtures will be planted to initially stabilise the areas before they are landscaped with native plants common to the area.

- Clearing of vegetation will be restricted to only those areas necessary for construction/access activities.
- Workers will not be allowed to harvest natural resources unless approved by local communities and the Project's environmental inspectors.
- Laws and regulations on the protection of plants and animals will be enforced.
- Disposal of all waste in an environmentally acceptable manner including re-use or re-cycling where possible. This will apply to waste from removing the existing Barrage gates and the existing weed boom.

Socio-economic Environment

Compensation Program

The refurbishment (and heightening) of Kamuzu Barrage will involve the involuntary acquisition of land resulting in loss of assets or access to assets, and/or loss of means of livelihood of those affected. Such acquisition can adversely affect the well-being of the people whose assets are acquired, as well as the communities in which they live. Implementation of the Project's Resettlement Action Plan by the MoWDI will assist in mitigating the adverse social impacts. Affected people should be meaningfully consulted and should have opportunities to participate in planning and implementing of the compensation program.

Health and Safety during Construction

Dust

- Frequent watering of access roads
- Respiratory protective equipment for workers

Combustion gases from construction machinery and vehicles

- Time limitation of work / exposure
- CO: combustion control
- CO₂: reduction of use of fossil fuels
- NO_x: antipollution systems (catalytic reduction)
- VOCs: increase in combustion performance
- Safeguarding combustion performance of machinery and vehicles.

Emissions to soil / Waste management

- Recovery of waste materials, restoration of site
- Workplaces regularly cleaned, with proper management of garbage disposal (liquid, solid and recyclable waste) according to health standards.

Biological wastes

- Establish adequate sanitary facilities and removal of solid waste and waste water with no contamination of water and the environment
- Sufficient toilets for both men and women with complete sanitary fixtures
- Safe and clean potable water for drinking and hand washing, with sanitary detergents
- Adequate amount of water for washing facilities and sanitation

Biological contaminants of drinking-water (viruses, bacteria, protozoa, toxins)

- Physical maintenance of water distribution (prevent leakages and recontamination of treated water)

- Ongoing monitoring of physical characteristics of drinking-water including concentration of chemicals and biological contaminants
- Epidemiological surveillance

Noise

- Distance from crushing sites to households at least 1,000m
- Hearing protection equipment for workers
- Limitation of working hours and the movement of trucks between 07:00hr and 19:00hr and no work during weekends without notifying local residents in advance
- Ongoing monitoring (standards or recommendations: Leq 45 dBA (night) and 55 dBA (day)).

High volume, heavy traffic

- Speed limits depending on location and distance to village
- Strict control of adherence to speed limits
- Road signs in place
- Heavy traffic restricted to daylight hours
- Consultation with for communities especially children on traffic risks
- Driving with lights on
- Bright colours of tracks and vehicles
- Increased presence of the police

Indirect effect of construction and presence of construction workers

- HIV/AIDS and STI education campaign among the local population, targeting not only youth but adults as well, before the start of the construction phase and be complemented by increased access to condoms, as well as to voluntary counselling and testing.
- Ongoing HIV/AIDS and STI education campaign targeting all workers employed on the Project, both national and international, complemented by easy access to condoms at the workplace as well as to voluntary counselling and testing.
- HIV/AIDS and STI education campaign among sex workers, initiated before the arrival of the workers, pursued throughout the construction phase and complemented by increased access to condoms specifically targeted for this group as well as voluntary counselling and testing, together with improved access to medical services.
- Inclusion specifically also of the diagnosis and treatment of STI and HIV/AIDS in upgrading of the health facilities, as well as the uninterrupted availability of rapid HIV testing and of AIDS counsellors, complementary laboratory tests provided by central laboratories, as well as periodical consultations by qualified physicians. These measures should encompass both the public and private health sector.

Fire, explosion and chemical spill

- Installation of automatic fire control devices in chemical storage areas, preparation of emergency plan, containment and collection measures.

Health and Safety

The safety of communities in the Barrage area may be compromised by construction activities (e.g. increased vehicular traffic, drilling / blasting and excavations) and project operation (e.g. risk of drowning). Construction and operation plans will include procedures for the management of these security risks, as well as for flooding and operational releases from the Barrage. These will entail:

- Regular liaison with local authorities and community representatives to discuss security and safety risks and management plans;

- Fencing of high risk construction sites to prevent accidents;
- An early warning system at blasting areas; and
- Preparation of an emergency preparedness plan for Barrage releases under normal operating and flood conditions.

Construction Workforce Impacts

The following measures will be introduced to minimise adverse workforce-induced impacts, and enhance potential benefits:

- The MoWDI will ensure that acceptable facilities are provided at construction camps (e.g. health services, and water and sanitation facilities).
- A structured consultation programme will be implemented to ensure that there is regular liaison and interaction with community representatives, local authorities and NGOs. The consultation structure will be used to discuss workforce issues and community concerns, to agree on any corrective measures and to discuss ways to enhance the provision of basic services by local entrepreneurs.

Monitoring Program

The following Table provides a summary of monitoring based on the proposed social and environmental mitigation measures.

Environment Component	Project Stage	Parameter	Standard	Location	Frequency	Duration	Implementation	Monitoring
Compliance (Construction) Monitoring								
Land Acquisition and Compensation	Pre-construction / operation	Compensation payments	RAP	All work sites	Monthly until complete	As per RAP	MoWDI	EAD
Water Quality	Construction	pH, EC, SS, turbidity, colour, NH4+, NO3-, total P, Fe, DO, BOD, grease & oil, E-coli	WHO guidelines	Construction Camps	Monthly during operation of camps		Contractor	EAD
Noise Levels	Construction	Noise levels on dB (A) scale	WHO guidelines	All work sites	Monthly as required by Supervision Consultant		Contractor	EAD
		Noise levels on dB (A) scale	WHO guidelines	Noise level readings taken at nearest residential house to work site	As directed by the Supervision Consultant	Readings to be taken at 15 second interval for 15 min every hr and then averaged	Contractor	EAD
Soil Erosion	Construction	Turbidity in storm water	ESIA guidelines	As identified by MoWDI	As required		Contractor	EAD
Vegetation Clearing	Construction	Area cleared (ha)	ESMP	All work sites	As required		Contractor	EAD
Rehabilitation of Work Sites	Construction	Monitoring to ensure all work sites are progressively rehabilitated	ESMP	Work camps, material storage sites, borrow areas, quarry	As required		Contractor	EAD
Health	Construction	Signs, posters displayed, health awareness lectures, health checks for workers	ESMP	All work sites, work camps and surrounding areas	Monthly		Contractor	EAD
Accidents	Construction	Number workers trained, accident reports,	ESMP	All work sites	Monthly		Contractor	EAD

Environment Component	Project Stage	Parameter	Standard	Location	Frequency	Duration	Implementation	Monitoring
		community consultation						
Implementation of EMP	All stages	All	ESIA	Project impact area	Monthly	Life of Project	MoWDI	EAD
Outcome (Operation) Monitoring								
Downstream hydrology	Construction / operation	River levels, bank erosion	ESMP	Shire River channel	Daily River levels; monthly bank erosion	Ongoing with annual review	MoWDI	EAD
Operation release strategy	Operation	Operational discharge	ESIA	Downstream of Barrage	Daily	Project life	MoWDI	EAD
Vegetation	Operation	Vegetation communities	ESIA	Liwonde NP	Every 2 years	Review after 10 years	MoWDI	EAD
Wildlife	Operation	Key species	ESIA	Upstream / downstream	Every 2 years	Review after 10 years	MoWDI	EAD

Institutional Arrangements

The ESMP is based on MoWDI having the overall responsibility for the coordination, planning and implementation of the Project as well as the actual implementation of the environmental monitoring and management and land acquisition components. It is also based on the appointment of a construction Supervision (Management) Consultant with responsibilities under the direction of MoWDI of directly supervising the Contractor implementing the works. EAD has the role of approving the Project from an environmental perspective and monitoring compliance with any environmental licence conditions it has set for the Project to proceed. This may include auditing of the Project's ESMP and its implementation.

Reporting Procedures and Implementation Schedule

The MoWDI shall be responsible for the implementation of the ESMP and for compliance auditing. The Supervising Engineer (SE) will be responsible for the day to day monitoring of environmental performance of the Construction Contractor and for monthly reporting of environmental performance which is to be submitted to the MoWDI.

The implementation schedule covers pre-construction, 34 months construction and operation periods of the Project. Some monitoring will be required to continue for the life of the Project.

Monitoring and Management Budget

Estimated item costs for all mitigation and enhancement measures and monitoring to be implemented under the ESMP, ESIA and RAP for the Project are provided in the Table below. Certain good practices in engineering act as environmental mitigation and the costs of these are reflected in the Civil Works Contract for the Project rather than under environmental management in this Report.

Item	Cost (USD)
Resettlement Action Plan Implementation (refer to RAP)	777,482
Environmental Monitoring (including environmental training / capacity building) from this ESMP	614,500
Total	1,391,982

It should be noted that the costs outlined above cover the two and half year construction period and provision will need to be made for some monitoring to continue beyond this time and in some instances for the life of the Project. The extent of ongoing monitoring will be dependent on the outcomes of the review of the monitoring program after construction has been completed.

1 Introduction

1.1 Report Aim and Content

This Environmental and Social Management Plan (ESMP) forms part of the environmental and social impact assessment (ESIA) studies undertaken for the upgrading of Kamuzu Barrage which is located on the Shire River at Liwonde (Figure 1). The ESMP is based on the ESIA report and Resettlement Action Plan (RAP) prepared for the Project and should be read in conjunction with those reports.

The ESMP is a standalone document which addresses mitigation measures, monitoring and institutional arrangements for the environmental management of the Project. The environmental monitoring program provides information on which management decisions may be taken during construction and operational phases. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes.

The objective of the ESMP is to:

- Describe in detail mitigation measures to be carried out, including costing, scheduling and assigning responsibility for such measures.
- Provide a detailed monitoring process and schedule and a description of any training support that may be required.

The ESMP is organised as follows:

Section 1 outlines the aims and objectives of the ESMP and its contents;

Section 2 provides a brief Project description;

Section 3 summarises the social and environmental impacts identified in the ESIA Report and RAP;

Section 4 describes the mitigation measures during pre-construction, construction and post-construction (operation) stages of the Project to prevent or reduce significant negative impacts to acceptable levels. It also lists the location, timing and responsibility for implementation and monitoring of each mitigation measure.

Section 5 describes the detailed arrangements for monitoring the mitigation measures and the impacts of the project during construction and operation;

Section 6 defines the responsibilities for mitigation and monitoring i.e. the institutional arrangements to implement the ESIA recommendations;

Section 7 specifies an implementation schedule for mitigation measures and recommends reporting procedures to provide information on progress and results of mitigation and monitoring measures;

Section 8 summarises the costs related to the implementation and management of the ESMP including institutional development, capacity building and training.

Appendices to the Report include Environmental Best Practice Guidelines and examples of environmental reporting forms. Appendix 1 lists consulting staff for the environmental study.

1.2 Project Setting

The Shire Basin has a unique resource base as it is the outflow of one of the largest Lakes in the World; with very complex climate response dynamics; and at the same time virtually the entire economy of the country is based on this resource making improvements to water resources management a priority for Malawi's development.

The upgrading of Kamuzu Barrage at Liwonde was selected as the best option of a number of alternatives considered under the Integrated Water Resources Management Plan for the Lake Malawi and Shire River Study (also known as the Lake Malawi Level Control - LMLC) to further regulate flows in the Shire River. Upgrading of the Barrage will be undertaken as a sub-project of the Shire River Basin Management Project (SRBMP) financed through the World Bank (WB). The overall program development objective of the SRBMP is to make significant progress in achieving socially, environmentally and economically sustainable development in the Shire Basin. The program has a planned duration of 12-15 years. The first phase project

will establish coordinated inter-sectoral development planning and coordination mechanisms, undertake the most urgent water related infrastructure investments (including upgrading of Kamuzu Barrage), prepare additional infrastructure investments, and develop up-scalable systems and methods to rehabilitate sub-catchments and protect existing natural forests, wetlands and biodiversity. Future phases will consolidate Basin planning and development mechanisms and institutions, undertake further infrastructure investments, and up-scale catchment rehabilitation for sustainable natural resource management and livelihoods.

The major intended functions of the upgraded Barrage are i) to regulate water flow in the Shire River to meet demands from downstream water users, most importantly water supply, energy and irrigation, ii) improve weed management and reduce handling cost; iii) regulate water levels upstream to meet environmental and socio-economic conditions; iv) influence, to a certain degree, the water level in Lake Malawi; and v) improve safety and traffic circulation by physically separating road traffic from areas needed for gate operation (operation and weed handling currently takes place on the road, which is a major north-south corridor).

The Barrage can only regulate Lake levels within a certain range which does not cover the historical variations. The refurbished Barrage will improve flow regulation by increasing the highest regulated water level at the Barrage from 475.32 masl to 475.72 masl (corresponding to a 40 cm rise which is still within the natural range of water level fluctuations within Lake Malawi); and by operational measures based on improved hydrological observations, hydraulic modelling, decision support on water demand and ability to operate the Barrage in real time.

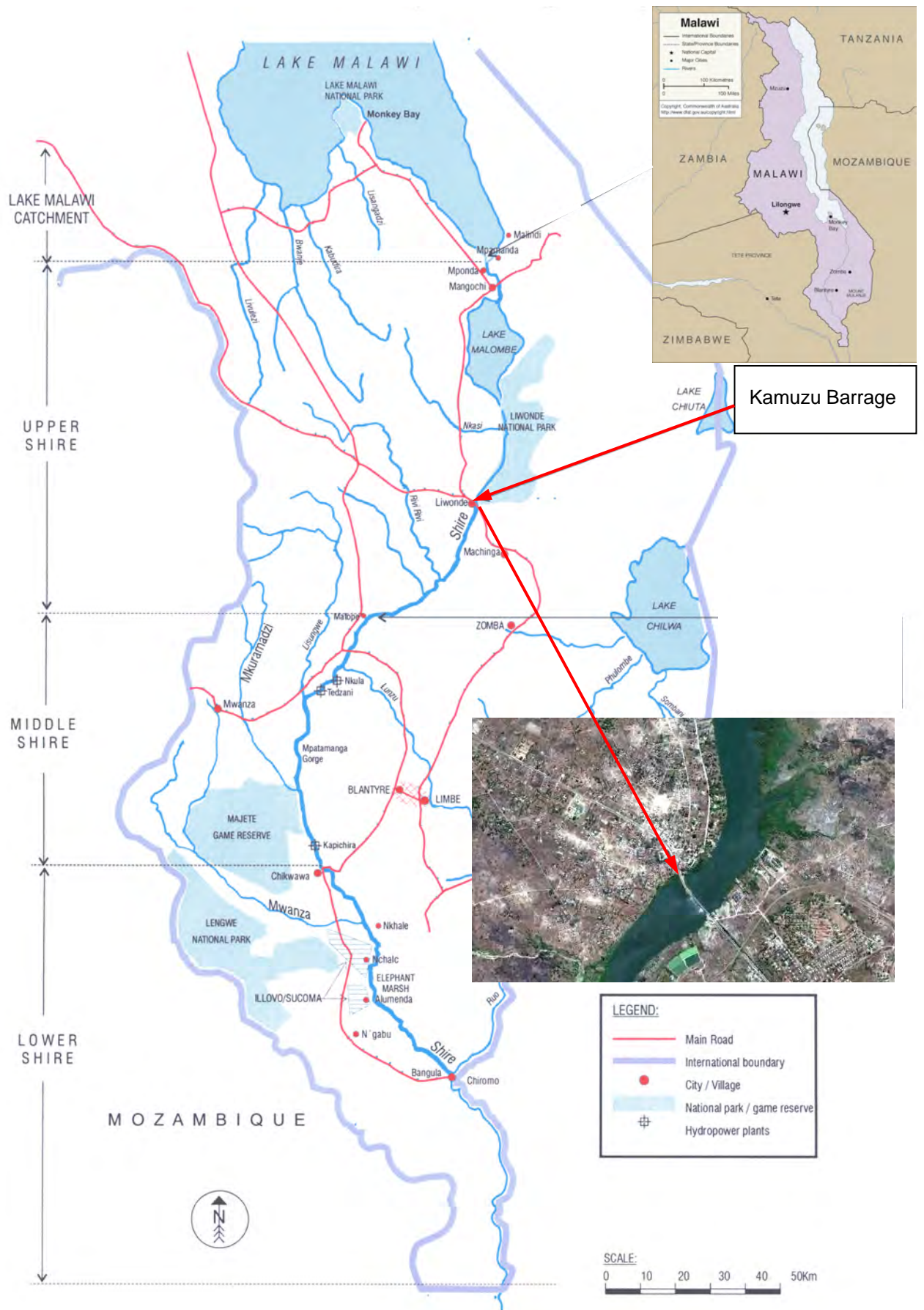


Figure 1. Project Location Map and Environmental Setting

2 Project Description

2.1 Area of Project Impact

In general the environmental and social study area will include the following areas which will benefit from the Project, or which may be directly affected in a negative way, by any of the components of the Project (see Figure 2). Specifically, the study area will include:

- The upstream environment as far as Lake Malawi and its foreshores which will be affected by the operation of the upgraded Kamuzu Barrage;

It has been empirically established the Barrage only influences a small range of Lake Malawi water levels within the natural variation of the Lake (approximately 1m annually and 7m over the recorded history of Lake levels) and hence the variations that would be caused due to raising the height of the Barrage by 40cm would be much less than the natural variations. Impacts on Lake Malawi are therefore expected to be minimal. There will however be more frequent inundation of land upstream of the Barrage (especially during the dry season) as a result of the 40cm increase in water level at times within Lake Malawi.

Although people living along the shoreline of Lake Malombe experience variations in water levels more than for Lake Malawi, increasing the regulating capacity of Kamuzu Barrage is not expected to have a significant impact. However, operation of the Barrage could cause a significant impact. Because of the relative shallowness of Lake Malombe's foreshores, a sudden drawdown could strand irrigation pumps, make foreshore access difficult and impact on fisheries (especially during the breeding season), which would impact on the livelihoods dependent on the Lake's fishery.

- The land resources and the people who may be affected by construction activities as these relate to the refurbishment of the Barrage, new temporary and permanent roads, and other ancillary work sites including material storage and handling sites, worker camp etc.;
- Farmers, hydropower stations and other water users downstream of Kamuzu Barrage dependent on regulated flow releases from the Barrage.

The Barrage influence is mainly dependent on a selected flow regime rather than the elevation of the Barrage. Different release strategies will have differential environmental and social impacts, although given the River profile and the fact that many tributaries with much more pronounced hydrographs enter the system downstream, the impact of the main stem is negligible (this also why the Barrage cannot be used to a great extent for flood control), and hence minimal adverse impact is expected downstream of the Barrage.

2.2 Project Details

2.2.1 Location and Justification

Kamuzu Barrage was constructed across the Shire River at Liwonde on the Zomba to Lilongwe road in the Southern Region of Malawi. It is located on the upper Shire River downstream from Lakes Malawi and Malombe (Figure 2).

The Barrage was originally constructed in response to low rainfall in the catchment areas of Lake Malawi and the Shire River resulting in lowered lake levels and lack of flow in the Shire River which in turn adversely affected livelihood activities including dimba cultivation, transport and the fisheries industry for those living adjacent to the two water bodies and the nation as a whole.

Kamuzu Barrage which became operational in 1965 is reported to have outlived its life span by about 25 years and some of its gates are no longer full operational. Different ways of securing and regulating the water flow have been suggested and studied. The most recent of these studies is the Lake Malawi Level Control Study – Phase I and II which analysed different types of interventions to further regulate the flow in the Shire

River, including the no-action alternative. One alternative deals with the option of upgrading the existing Barrage at Liwonde.

The purpose of upgrading Kamuzu Barrage is to increase water storage capacity upstream (particularly within Lake Malawi) and thereby to help ensure adequate downstream flows in the Shire River during the dry season to sustain key economic activities. These include hydropower generation (most of Malawi's electricity comes from Shire River hydroelectric plants), water supply (including for the city of Blantyre), existing and proposed irrigation systems, fisheries, traditional flood-recession agriculture, and other human uses. Important ecosystems (such as the Elephant Marsh) and fish and wildlife downstream of the Barrage also depend upon Shire River flows. In previous years of especially low water levels in Lake Malawi, the Shire River has run dry. The Kamuzu Barrage is intended to help prevent (to a certain extent) a recurrence of these low flow situations, which would be economically disastrous because so many people and businesses now depend upon adequate year-round flows within the River.

2.2.2 Description of Proposed Works

The preferred design option for the Upgraded Kamuzu Barrage involves: refurbishment of the existing Kamuzu Barrage Structure including replacement of the existing 14 radial gates with new ones; raising the height of the maximum regulating level of the Barrage by up to 40 cm (corresponding to a Lake Malawi level of 475.72 masl); construction of a new road bridge immediately downstream of the existing Barrage (connected to the existing structure); and construction of a floating steel boom and weed collector upstream of the Barrage to control floating weeds (NORPLAN 2013). Project layout is shown in Figure 3. The proposed works and activities which will be carried out in phases include:

Erosion protection / energy dissipation – erosion protection works (mainly concrete slab) will be constructed downstream to reduce water velocities and erosion.

Excavations/extraction - Borrow areas and a quarry will be required where the contractor will source construction materials including sand and quarry stone, weathered rock and gravel for the Project. Four potential sites have been identified: Naliswe River, 6-8km west of Liwonde towards Balaka (river sand); the existing Naliswe quarry, 14km west of Liwonde towards Balaka (quarry stone); Molipa borrow area, 24km east of Liwonde towards Nsanama (an existing source of weathered rock / coarse gravel); and, Chabwera borrow areas, 2-4km east of Liwonde (also an existing source of weathered rock / gravel material).

Work camp and plant area - the contractor will establish a temporary camp for project administration and workers residence. The proposed site is located upstream of the Barrage on the left (east) bank of the Shire River (Figure 3).

Transportation of equipment, materials and work force - There will be increased traffic in the project area as the contractor transports equipment and materials (including new weeds boom and Barrage gates) to and from the site during the upgrading work.

Construction of drainage structures - A number of structures will be constructed to direct water away from construction / works areas.

Drilling riverbed - for pillars for the new road bridge including 130 bored piles.

Excavation and concrete works – for foundation, erosion protection, pillars and bridge structure involving 25,000m³ of excavation/fill and 5,000m³ of concrete.

Compaction - Heavy road compacting machines will be used to strengthen/compact the ends of the Barrage.

Road works – upgrading and adjustments of the existing approaches to the Barrage, asphalt work.

Coffer dams – There will be phased construction of temporary earth / rock-fill coffer dams (6 in total requiring 11,000m² of steel sheeting and 80,000 m³ of fill) upstream and downstream of the existing Barrage to facilitate refurbishment of the Barrage including construction of the new road deck and the weeds boom.

Dismantling of the existing gates and installation of 14 new gates.

Construction of a new weed boom, jib crane for collection of weeds and a permanent store, workshop and office building with provision to house the Marine Police premises.

Removal of the existing weed boom and the east and west anchors after the new boom is installed.

Construction of a new permanent control and administration building near the Barrage.

Installation of a new hydraulic monitoring system for lake level monitoring, discharge monitoring and downstream flow monitoring.

Emergency power supply – a diesel generator will be installed to provide an emergency power supply during operation of the Barrage.

With regard to the construction workforce it is envisaged that there will be between 200 and 250 workers on the project depending on the various stages of construction. Out of these about 100 will be unskilled workers who will most likely come from the local area, another 100 will be skilled workers (technicians and artisans, drivers, plant operators etc.) who will be Malawian and may come from other areas of the country while about 50 will be expatriate from elsewhere (i.e. the region or abroad) whose special skills will be required from time to time so they will all not be there during the whole construction period. However up to 10 expatriate employees (for the consultant and the contractor) will be on site for almost all the time.

2.2.3 Operation and Maintenance Activities

Only a small permanent workforce is expected to be employed to undertake the operation and maintenance activities once the Barrage has been refurbished. They will be located in a permanent administration building located on the left bank of the Shire River just upstream of the Barrage (Figure 3).

2.2.4 Project Implementation

Construction time is estimated at 34 months with the bidding and contract phase to take approximately 6 months. Construction will be sequenced to minimise disruption to transport across the Barrage. The proposed work schedule is shown in detail in Chapter 15 of the detailed design report (NORPLAN and Associate, 2013).

It is proposed that construction management and construction supervision will be undertaken by a Consultant appointed through a tendering process.

2.2.5 Project Cost

Cost estimates for all construction activities, materials and construction supervision is USD 45.4 million based on the final design and the Bill of Quantities and the Price Schedules included in the Bid Documents prepared by the Design Consultant in July 2012.

This excludes environmental and social management costs (including RAP implementation) totalling USD 1,391,982 as detailed in the ESIA and RAP.

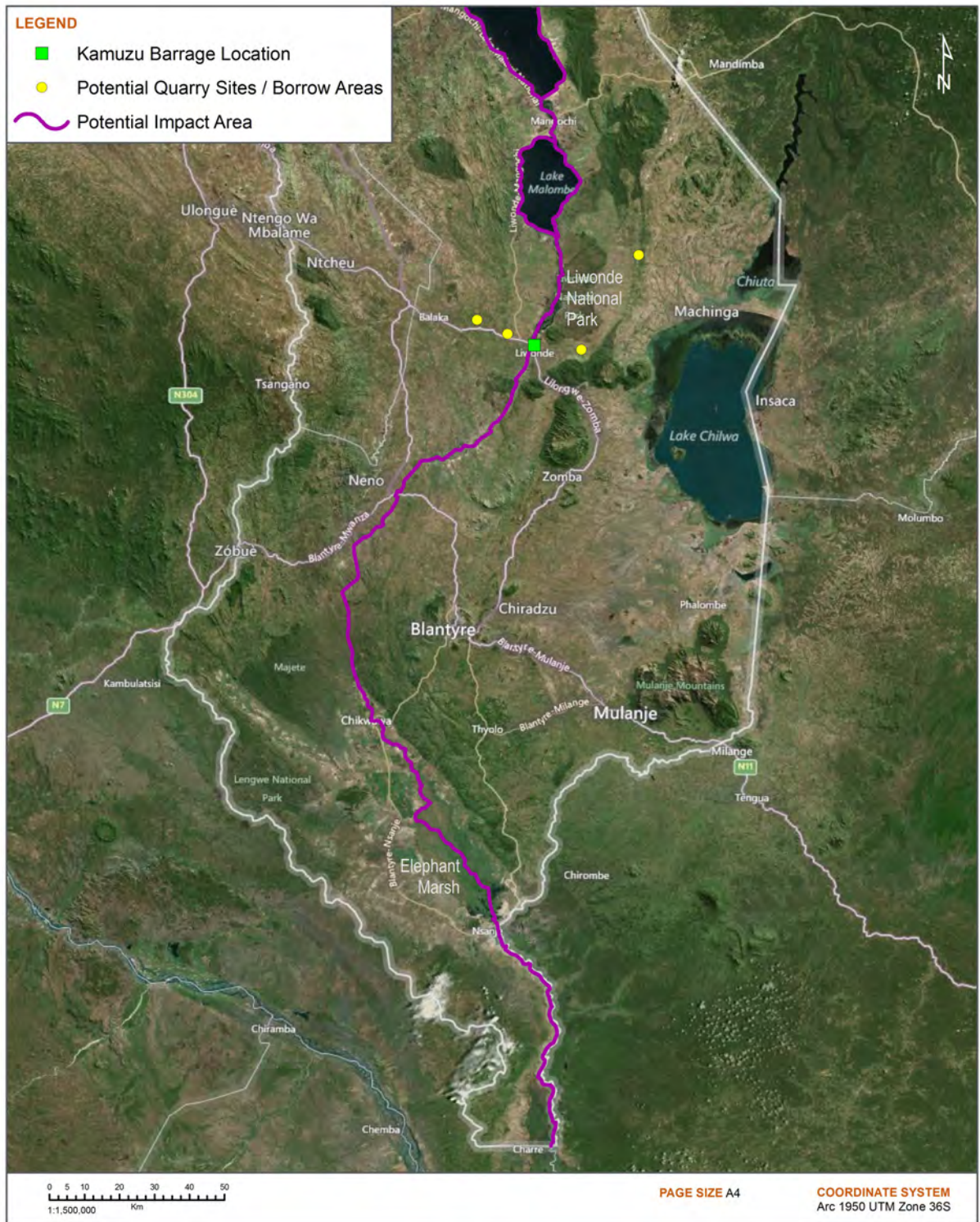


Figure 2. Area of Project impact



Source of map: Design Report (Norplan and Associate, 2012a) and SMEC.

Figure 3. Barrage construction and work sites and location of businesses impacted by the Project.

3 Summary of Social and Environmental Impacts

Table 1 provides a summary of the impacts which are described in the ESIA Report for the Project. Project impacts have been assessed based on five impact criteria, namely: scale; duration; severity; certainty and direction (refer to the Legend at the end of Table 1). Since the current Project involves upgrading (refurbishing) the existing Kamuzu Barrage (which has existed since 1966) resulting in increased water level regulation capacity, the impacts from the refurbished Barrage will be incremental in nature and less significant than if a new Barrage were built. Nevertheless, the refurbished Barrage will result in potentially significant impacts on the aquatic and adjacent terrestrial environments both upstream and downstream of the Barrage if appropriate mitigation measures are not implemented. Social impacts will also result from construction activities associated with refurbishment of the Barrage and operation of the new weed boom.

TABLE 1. SUMMARY OF PREDICTED IMPACTS

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Physical Environment								
Changes to micro-climate upstream	O	L	LT	L	L	P	N	N
Soils (floodplain, erosion; soil removal from construction activities)	C, O	L	LT	L	HL	N	L	Y
Inundation of commercial mineral resources	C, O	L	LT	L	P	N	N	N
Water resources								
Modified flows in Shire River	O	R	LT	L	HL	N	L/M	Y
Erosion of downstream river banks	O	L/R	LT	M	D	N	M	Y
Raising groundwater levels	C, O	L	LT	L	L	N	L	N
Water quality changes								
Lake Malawi	O	L	LT	L	P	N	N	N
Lake Malombe	O	L	LT	M	L	N	M	Y
Shire River upstream of Barrage	O	L	LT	L	P	N	N	Y
Shire River downstream of Barrage	O	R	LT	L	L	N	L	Y
Biological Environment								
Loss of riparian vegetation (inundate floodplain areas of Liwonde NP)	C, O	R	LT	M	D	N	M	Y
Removal of floating aquatic weeds	O	R/N	LT	M	D	P	H	Y
Disposal of aquatic weeds	O	L	LT	M	D	N	M	Y
Wildlife (loss of habitat)	C, O	R	LT	M	D	N	M	Y
Inundate emergent boulders in Shire River (Rock Pratincole)	O	N	LT	L	P	N	M	Y
Inundate sand banks along Shire River and Lake foreshores (crocodiles, turtles)	O	R	LT	L	P	N	M	Y
Inundate sand bars within Shire River channel (African Skimmer)	O	I	LT	L	P	N	M	Y
Fish	O	R	LT	L/M	L	N	L/M	Y
Habitat loss in Lake Malawi (Cichlids)	O	I	LT	L	P	N	L	N

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Loss of habitat in Lake Malombe	O	L	LT	L	P	N	M	Y
Barrier to fish movement upstream	O	R	LT	L	D	N	L	N
Socio-Economic Environment								
Increased regulated flows for more reliable hydropower generation	O	N	LT	M	D	P	H	N
National economy – more reliable power	O	N	LT	M	D	P	H	N
Local economic benefits (Project employment, increased trading)	C,O	L	LT	M	L	P	M	Y
Land Resources								
Temporary loss of access/use of Temporary Contractor Site (affects ESCOM+2 private landowners)	C	M	S	M	D	N	M	Y
Permanent loss through inundation (cultivation/grazing land)	O	L	LT	L	D	N	L	Y
Livelihoods (small businesses near Barrage)	C, O	L	S	H	D	N	H	Y
Livestock farming (loss of pasture land)	C, O	L	LT	M	L	N	M	Y
Lake Malawi transport – flooding of jetties	O	L	LT	L	P	P	L	N
Pedestrian / vehicle access across Barrage	C, O	R	LT	H	D	P	H	Y
Vulnerable groups – impact on livelihood	O	L	LT	L	P	N	L	Y
Downstream irrigators along Shire River	C	R	LT	M	HL	P	M	Y
More reliable town water supplies	O	R	LT	M	P	P	M	Y
Tourist facilities								
Inundation of infrastructure upstream	O	N	LT	L	P	N	L	N
Construction site (Barrage) – affects Shiri Lodge, Shire Camp and NP boat landing	C, O	L	LT	H	D	N	H	Y
Health								
Air pollution at construction sites	C	L	S	L	L	N	L	Y
Improved potable water supply	O	R	LT	M	P	P	M	Y
Pollution from waste disposal work sites	C, O	L	LT	L	L	N	L	Y
Noise pollution (close to work sites, 2.5 year construction period)	C, O	L	S	L	D	N	L	Y
Increased communicable diseases (HIV/Aids, etc.) from influx of workers)	C	L	LT	M	P	N	L/M	Y
Community safety – increased traffic	C	L	S	L	P	N	L	Y
Increase in water born / vector diseases	C, O	R	LT	M	HL	N	M	Y
Technical disaster scenarios								
Barrage failure	O	R	S	H	P	N	M	Y
Downstream flooding	C, O	R	S	M	P	N	M	Y
Fire, explosion, chemical spill	C,	L	S	M	P	N	N	Y

Environmental Impact / Issue	Project Phase	Impact Criteria					Significance	Mitigation / Enhancement
		Scale	Duration	Severity	Certainty	Direction		
Waste management from existing Barrage gates and existing weed boom	C	L	S	M	D	N	L	Y
Inundation of cultural resources	C, O	L	LT	L	P	N	N	Y

Legend:

Project Phase: Pre-construction, Construction or Operation

Scale: Physical scale / area over which the impact will be felt: Local, Regional, National or International

Duration: The length of time the impact is likely to occur: Short, Medium or Long Term

Severity: The intensity of the impact: Low, Medium or High

Certainty: The probability of the impact occurring: Possible, Likely, Highly Likely or Definite

Direction: Whether the impact is Positive (beneficial) or Negative (adverse)

Significance: Based on the above criteria, an overall rating of significance of the impact: Nil or Negligible, Low, Medium, High or Very High

Mitigation/Enhancement: Whether mitigation or enhancement is required (Y) or not (N)

? Undetermined

The significance of the impacts on the issues mentioned range from low to very high according to level of operations. However, most of the construction impacts are localized and of temporary nature. For these issues, precautionary measures and quick response are necessary to avoid or minimise negative impacts.

4 Description of Mitigation Measures

As part of mitigating the social and environmental impacts from upgrading Kamuzu Barrage, the ESIA Report and the accompanying Resettlement Action Plan recommend feasible and cost-effective measures to prevent or reduce significant negative social and environmental impacts and enhance Project benefits. This Section outlines the proposed mitigation measures required during the various stages of the Project and includes the location, timing and responsibility for implementation of the mitigation measures as well as an indicative budget estimate.

The mitigation measures are presented in Table 3 which identifies the measures to be undertaken during the pre-construction, construction and post-construction (operation) stages of the Project. The proposed mitigation measures should also form the basis of the Construction Contractor's own Environmental Management System.

4.1 Summary of Environmental Management Measures

A summary of the key management measures during the various stages of the sub-project is provided in the following Sections. Best practice guidelines are also provided in Appendix 2 for use by the construction contractor.

Mitigation is "the elimination, reduction, or control of a project's adverse environmental effects, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means". The full range of mitigation measures are outlined in Table 3. The Table includes details on timing, location and responsibility for each mitigation measure as well as an estimate of costs.

The key actions of the ESMP to be implemented are:

- Revised operating plan for Kamuzu Barrage taking into account environmental requirements both upstream and downstream of the Barrage (prepared as a component of the SRBMP).
- Implementation of the relocation and compensation program as outlined in the Project Resettlement Action Plan.
- HIV/Aids awareness campaign for communities and contract workers.
- Preparation of a disaster preparedness and response plan dealing with flood management as well as Barrage failure.
- Implementation of environmental monitoring as outlined in this Report.
- Referral of the ESIA to the Governments of Mozambique and Tanzania in accordance with the SADC revised Protocol on Shared Watercourses;
- Establishment of a Panel of Experts to oversee construction, Barrage safety and environmental management.

4.2 Physical Environment

River stabilisation works immediately downstream of the Barrage are part of the construction works contract to prevent further erosion of the River bed and banks during high flow releases from the Barrage and during natural flood flows in the Shire River. Monitoring of Shire River banks and lake foreshores is also recommended to ensure Barrage operation is not causing erosion. River bank erosion is a problem in some parts of Liwonde National Park.

Water quality protection measures will be adopted by the construction Contractor to ensure temporary water quality impacts are suitably managed during the construction phase especially as large quantities of excavation and fill materials are involved in the temporary use of coffer dams within the Shire River at the Barrage site. Government enforcement of protective buffer zones along waterways would help to improve water quality. Existing buffer zones are not uniformly enforced and there is confusion over the width of buffer zones.

The Design Consultant has recommended a seismic study be undertaken and this needs to be completed prior to construction to allow for any design modifications to ensure the refurbished Barrage is not at risk of structural failure.

4.3 Biological Environment

4.3.1 Environmental Flow Requirements

The primary cause of impact to the fringing terrestrial habitats resulting from implementation of the project will be associated with changes in environmental flows and flooding regimes. These impacts will be most pronounced in the low gradient areas of Southern Lake Malawi, Lake Malombe and the Upper Shire River.

The Middle Shire River is characterised by a steep gradient, well defined incised river channel and riverine woodlands and escarpments. This reach of the river will be relatively immune to variations in volumes or patterns of water release from the Barrage as the channel has capacity to absorb relatively large fluctuations in water level without flooding the surrounding terrestrial habitats. This will hold true provided a minimal baseline environmental flow is maintained in the Mid Shire Reach.

It is important to maintain the seasonal flooding of the marshlands in order to preserve floodplain and seasonal marsh habitat and support the seasonal dambo agriculture that much of the local community relies upon for sustenance during the dry season when seasonal marshes provide temporal fertile land for cropping.

Downstream of the Barrage it is important that operations do not result in artificially prolonged inundation of crocodile and turtle nesting sites located on Seasonal Flood Plain and Seasonal Marshland during the critical nesting season from October to January.

In order to minimise the impacts of the Project to fringing habitats, the Barrage should be operated to mimic the natural seasonal flooding regime of the Shire River, Lake Malombe and the lower part of Lake Malawi, as closely as possible. This is particularly critical when the Barrage is operating at levels resulting in water levels of 475 masl and above at Lake Malawi.

Annual simulation of natural flood events down the Shire River will help maintain terrestrial and aquatic processes within the Elephant Marsh. The simulation of a natural flood will significantly improve the situation over the baseline (there were no adequate flood releases from Liwonde during the period 1993 – 2002, apart from 1997).

A typical annual hydrograph for the Shire River is shown in Figure 4; peak flows typically occur in February and March while minimum flows are experienced during the dry season in September and October.

The proposed Project to raise the height of the Barrage will increase the existing HRWL of 475.32 masl in Lake Malawi by 20-40 cm i.e. 475.52 – 475.72 masl (which is within the historical range of Lake levels, with a high of 477.25 recorded in 1980). Modelling shows that there will be a minimal change in the area of habitat inundated and the period of inundation associated with a 20 cm increase in Barrage height. However, a potentially significant increase in the area of inundation and the inundation period is possible upstream of the Barrage if the height is raised by 40 cm. This may significantly impact important Perennial Marsh habitat located on the floodplain within Liwonde National Park. It is recommended that if the Barrage is raised by 40 cm, a Perennial Marsh habitat monitoring program is implemented within the boundaries of the Park and an adaptive management program is adopted whereby the operation of the Barrage is regulated in response to the findings of the monitoring program.

It is also recommended that if levels need to be increased above 474.5 masl then the Barrage should be operated to mimic the seasonal flooding patterns of the system i.e. levels of 475.5 masl permitted during the wet season only (i.e. December – April); maintain levels below 475.5 masl during the dry season (May – October).

This operational regime will also minimise the incidences of prolonged (i.e. greater than existing levels) inundation of Seasonal Floodplain and Marshland habitats downstream of the Barrage. This habitat type may support crocodile (and turtle) nesting, during the critical incubation period lasting from October to December (Compass, 2000).

Lake Malombe

The Feasibility Study for the Shire River Flow Augmentation Project (NORPLAN *et. al.* 2002) recommended that water levels in Lake Malombe should not fall below 473 masl to protect fisheries within the Lake. In the absence of further ecological studies of the Lake, it is reasonable to apply this figure in relation to operation of the refurbished Kamuzu Barrage.

4.3.2 Mitigation of Impacts on Liwonde National Park

It is critical that management of the upgraded Barrage takes into account how their actions affect the National Park. Rapid opening and closure of the barrage gates, high flood levels and dampening of the natural rise and fall of seasonal water levels all have short and long-term implications for the Park. Park management should be integrated into the institutional structures responsible for management and monitoring of the Barrage.

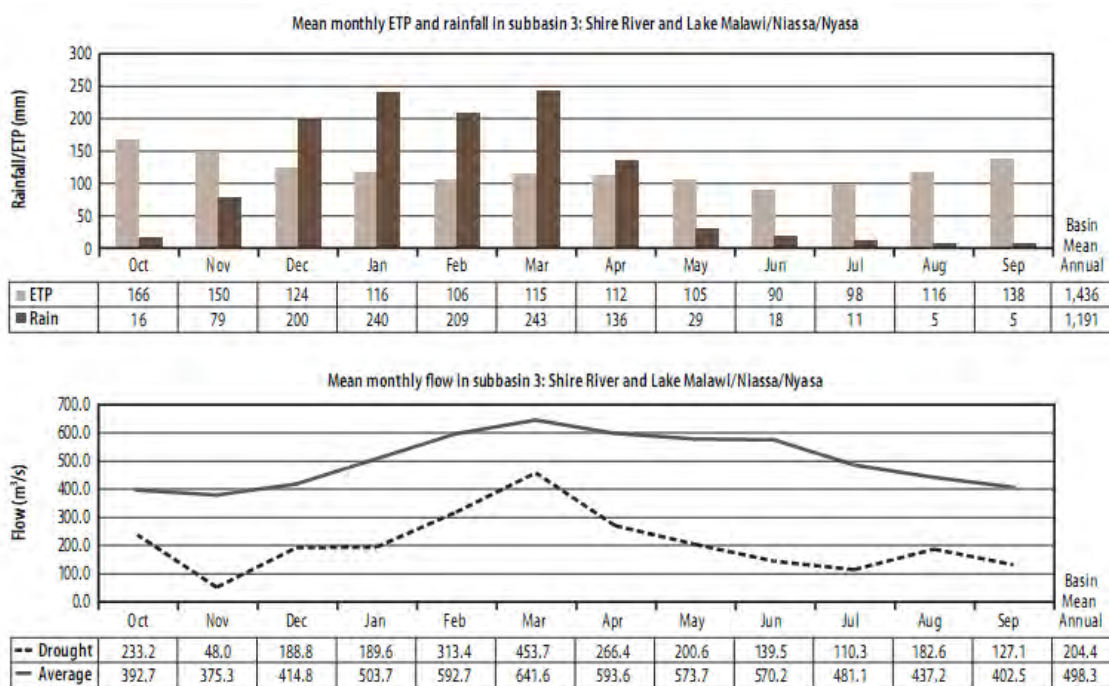


Figure 4. Shire River Hydrograph (World Bank 2010)

4.3.3 Mitigation of Fisheries Impacts

From a fisheries perspective, water release patterns from the upgraded Kamuzu Barrage should be managed so they are generally favourable to downstream fish and fisheries such as:

- i) allowing some natural flooding to occur during the wet season, to stimulate natural fish reproduction and to maintain the vitality of the Elephant Marsh and other areas with important fish populations;
- ii) avoiding significant daily fluctuations in flow rates which can upset the natural cycles of fish and other aquatic life;
- iii) avoiding very sudden decreases in flows due to rapid gate closures at the Barrage. Such sudden drops can cause large-scale fish stranding; and
- iv) maintaining a minimum water level of 473 masl within Lake Malombe to protect fisheries within the Lake.

4.3.4 Construction Mitigation Measures

During construction, the following measures will be implemented:

- Progressive rehabilitation will be under taken as earth works progress for all cut and fill areas.
- All alien vegetation in new temporary / permanent work sites, borrow and quarry areas will be removed and disposed of properly before construction takes place.

- Contractors will take appropriate measures to ensure invasive species of plants are not introduced into the area through vehicle movements.
- For all work areas, after the topsoil has been replaced and worked, appropriate grass mixtures will be planted to initially stabilise the areas before they are landscaped with native plants common to the area.
- Clearing of vegetation will be restricted to only those areas necessary for construction/access activities.
- Workers will not be allowed to harvest natural resources unless approved by local communities and the Project's environmental inspectors.
- Laws and regulations on the protection of plants and animals will be applied.
- Disposal of all waste in an environmentally acceptable manner including re-use or re-cycling where possible. This will apply to waste from removing the existing Barrage gates and the existing weed boom.

4.3.5 Summary of Water Release Boundary Conditions

Table 2 provides a summary of the water release boundary conditions based on the foregoing discussions.

TABLE 2. WATER RELEASE BOUNDARY CONDITIONS

Boundary Condition	Environmental Issue
Avoid releasing more than 400 m ³ /s during the months of October to December	To protect crocodile and turtle nesting sites located on Seasonal Flood Plain and Seasonal Marshland during the critical nesting season; to minimise dry season flooding of emergent boulders used by Rock Pratincoles; to minimise dry season flooding of sand bars used by African Skimmers.
Annual simulation of natural flood events down the Shire River during January to April (wet season)	To preserve floodplain and seasonal marsh habitat (including the Elephant Marsh) and support the seasonal <i>dambo</i> agriculture
Avoid very sudden decreases in flows due to rapid gate closures at the Barrage. Large flow changes should be made gradually over a number of days to simulate natural flood recession.	To prevent large scale fish stranding downstream of the Barrage
Maintain water levels in Lake Malombe at or above 473 masl	Protect fisheries in Lake Malombe
Maintain Lake Malawi water level below 475.5 masl during the dry season (May-October)	Protect Perennial Marsh habitat upstream of the Barrage, particularly within Liwonde National Park.

4.3.6 Aquatic Weed Disposal

A major component of the refurbished Barrage is replacement of the existing ineffective weed collection barrier with a new floating steel boom and weed collector to improve removal of floating weeds (mainly Water Hyacinth) which create problems for downstream power plant operations.

The weed disposal method for the existing barrier involves trucking the weeds to land disposal sites away from the Barrage. A similar method of disposal is proposed for the new weed boom. If land disposal is used it is important that weeds are not disposed by dumping on land surfaces in the vicinity of water courses since the seeds can remain viable for up to 15 years.

Despite the ecological problems it can cause, Water Hyacinth has some biological benefits:

- Water hyacinth can provide feed for animals i.e. the weed can be used as an ingredient in livestock feeds and research has shown that animals fed on the weed do very well;

- Some human beings have taken the weed as a vegetable;
- Water hyacinth is used as a substrate for mushrooms. Research has indicated that the weed greatly improves the productivity of mushrooms.
- Water hyacinth can be used as a mulch in crop production;
- The weed has a high nutrient level; a favourable C:N ratio and hence forms good compost manure;
- Water hyacinth can form a good soil bio-pesticide for crops through the reduction of some soil pests that affect crops;
- Fish and livestock diets made from the weed have proved very successful;
- Water hyacinth can be used in biogas production i.e. methane production at a larger scale is achieved with use of the weed;

The above uses could be further investigated by the operator of the weed boom as alternatives to dumping weeds on vacant land.

4.4 Socio-economic Environment

The Project's Resettlement action Plan outlines:

- the entitlement framework/matrix for affected persons; defines the eligibility criteria, including the determining criteria, a description of the eligible, and the unit of entitlement;
- procedures for the final verification and valuation of affected assets, and determination of compensation.
- organisational responsibility for the RAP, and recommends institutional and organisational arrangements for the implementation of the RAP.

Although resettlement as a result of the Project is not predicted, compensation for affected persons and assets is required and the RAP includes the following mitigation measures as part of the RAP process.

4.4.1 Preferential Employment Policy

A significant positive impact of the project will be the generation of employment from project activities, through:

- employment for the direct construction workforce; and
- contractual and work-related opportunities in the provision of direct support services to the construction works (procurement of goods and services).

In order for project-affected people to benefit from these opportunities, a preferential employment policy will be implemented by the consulting engineer through the contractor. This policy will be in line with national legislation around labour-related matters, and best employment practices.

In order to achieve the objective of optimising employment for project-affected people through project-related activities, the following measures are required:

- The MoWDI will develop an overall Project Employment Policy, including a Preferential Employment Strategy showing their commitment to the employment of project-affected people. Contained in the Strategy will be relevant procedures and mechanisms recommending: (a) selection criteria; (b) selection and recruitment procedures; and (c) preferential employment guidelines.
- Consideration will be given for the establishment of a committee; an independent body constituted and driven by relevant stakeholders, including the MoWDI, consulting engineer, project-affected households, and contractor. This committee will give input into the Strategy, monitor the recruitment, working conditions and training of local labour for the duration of the project, and provide a channel for mediation. The relationship with this committee will be included in the Project Employment Policy.
- The MoWDI can only encourage a contractor to maximise opportunities for the employment of project-affected people. To this end they will include the Project Employment Policy in tender

documents, citing the Preferential Employment Strategy and calling for contractors to draw a certain percentage of the workforce from those affected. They can also request that all contracts indicate proposed steps to implement a preferential employment policy, including on-the-job training.

- An open and well-publicised process will be conducted by the MoWDI to inform the public about job opportunities. For example, the Ministry will take responsibility for the production and distribution of an Information Sheet to project-affected people well in advance of the commencement of construction, setting out: (a) the number of jobs available, the type of work/skills required, and the proposed length of contract for each job; (b) the job advertising, selection and recruitment procedures that will be followed; and (c) the time frame for the recruitment of job seekers. This will allow sufficient time for people to respond and apply for all jobs. Although the actual advertising of job opportunities and recruitment of a workforce is the responsibility of a contractor, a contractor should endeavour to ensure that recruitment procedures are in keeping with proposals contained by the employment committee.
- A full assessment of skills and training requirements and preferences of project-affected households are required prior to the construction phase of the project. Although training will be offered by contractors and other training agents, the MoWDI will be responsible to ensure that it is provided through:
 - on-the-job training and skills transfer to project-affected people that are employed as the project's workforce; and
 - training to participate in the contractual work offering direct support services to the construction works.
- The policy of preferential employment will be assessed regularly by the MoWDI in conjunction with the employment committee; for example, compliance of project-related contracts will be monitored, as will related training programmes.

4.4.2 Delivery of Entitlements

The principles outlined in the Project Affected Persons (PAP) Entitlement Matrix (ESIA Volume 1, Appendix 7) will apply to the notification of acquisition of land and associated assets, and the delivery of entitlements. The principles are consistent with the Resettlement Planning Framework (RPF) for the NWDP II. Entitlements for compensation shall be based on the eligibility criteria and the various categories of losses identified through the PAP survey undertaken for the Project and which are included in the Entitlement Matrix.

4.4.3 Establishment of an Early Warning System

From consultation with stakeholders it was found that the operation of the Barrage and flooding in the past had caused damage to crops and gardens, which negatively impacts food security and livelihoods. This complaint was consistent amongst communities located downstream of the Barrage. There was a sense that their needs were not important and it was requested that to mitigate these affects an early warning system be implemented which can serve to inform communities of the Barrage release times and potentially the amount predicted to be released, thereby enabling communities to effectively prepare for the change in water levels.

4.4.4 Health and Safety

Due to the range of positive and negative elements the mitigation measures will have a major influence on the balance between an improved or worsened quality of life for the affected population.

4.4.4.1 During the Construction Period

Dust

- Frequent watering of access roads
- Respiratory protective equipment for workers

Combustion gases from construction machinery and vehicles

- Time limitation of work / exposure

- CO: combustion control
- CO₂: reduction of use of fossil fuels
- NO_x: antipollution systems (catalytic reduction)
- VOCs: increase in combustion performance
- Safeguarding combustion performance of machinery and vehicles.

Emissions to soil / Waste management

- Removal of the informal solid waste dump alongside the Barrage approach on the right bank (west side) of the Shire River prior to commencement of main civil works.
- Recovery of waste materials, restoration of site
- Workplaces regularly cleaned, with proper management of garbage disposal (liquid, solid and recyclable waste) according to health standards.

Biological wastes

- Adequate sanitary facilities and have to be established, and removal of solid waste and waste water with no contamination of water and the environment
- Sufficient toilets for both men and women with complete sanitary fixtures
- Safe and clean potable water for drinking and hand washing, with sanitary detergents
- Adequate amount of water for washing facilities and sanitation

Biological contaminants of drinking-water (viruses, bacteria, protozoa, toxins)

- Physical maintenance of water distribution (prevent leakages and recontamination of treated water)
- Ongoing monitoring of physical characteristics of drinking-water, water concentration of chemicals and biological contaminants
- Ongoing monitoring of potential biological contaminants
- Ongoing monitoring of concentration of chemicals using recommended standards:*
- Epidemiological surveillance

Noise

- Distance from crushing sites to households at least 1000m
- Hearing protection equipment for workers
- Limitation of working hours and the movement of trucks between 7:00am and 7:00pm and no work during weekends
- Ongoing monitoring (standards or recommendations: Leq 45 dBA (night) and 55 dBA (day)).

High volume, heavy traffic

- Speed limits depending on location and distance to village
- Strict control of adherence to speed limits
- Road signs in place
- Heavy traffic restricted to day period
- Schooling for communities and children on upcoming traffic risks
- Driving with lights on
- Bright colours of trucks and vehicles

- Increased presence of the police

Indirect effect of construction and presence of construction workers

- HIV/AIDS and STI education campaign among the local population, targeting not only youth but adults as well, before the start of the construction phase and be complemented by increased access to condoms, as well as to voluntary counselling and testing;
- Ongoing HIV/AIDS and STI education campaign targeting all workers hired, both national and international, complemented by easy access to condoms at the workplace as well as to voluntary counselling and testing;
- HIV/AIDS and STI education campaign among sex workers, initiated before the arrival of the workers, pursued throughout the construction phase and complemented by increased access to condoms specifically targeted for this group as well as voluntary counselling and testing, together with improved access to medical services;
- Inclusion specifically also of the diagnosis and treatment of STI and HIV/AIDS in upgrading of the health facilities, as well as the uninterrupted availability of rapid HIV testing and of AIDS counsellors, complementary laboratory tests provided by central laboratories, as well as periodical consultations by qualified physicians. These measures should encompass both the public and private health sector.

Fire, explosion and chemical spill

- Installation of automatic fire control devices in chemical storage areas, preparation of emergency plan, containment and collection measures.

Health and Safety

The safety of communities in the Barrage area may be compromised by construction activities (e.g. increased vehicular traffic, blasting and excavations) and project operation (e.g. risk of drowning). Construction and operation plans will include procedures for the management of these security risks, as well as for flooding and operational releases from the Barrage. These will entail:

- regular liaison with local authorities and community representatives to discuss security and safety risks and management plans;
- fencing of high risk construction sites to prevent accidents;
- an early warning system at blasting areas; and
- preparation of an emergency preparedness plan for Barrage releases under normal operating and flood conditions.

Construction Workforce Impacts

The following measures will be introduced to minimise adverse workforce-induced impacts, and enhance potential benefits:

- The MoWDI will ensure that acceptable facilities are provided at construction camps (e.g. health services, water and sanitation facilities, recreational facilities and fair-price shops).
- A structured consultation programme will be implemented to ensure that there is regular liaison and interaction with community representatives, local authorities and NGOs. The consultation structure will be used to discuss workforce issues and community concerns, to agree on any corrective measures and to discuss ways to enhance the provision of basic services by local entrepreneurs.

Proposed environmental and social mitigation measures for the Project are outlined in Table 3.

TABLE 3. ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
<i>Pre-construction Stage</i>						
Impacts on people, assets and businesses from construction activities	Implement public consultation plan as per the guidelines in the RAP. Inform all communities affected by the Project of schedule of implementation of Project and their rights to compensation. Introduce to Lake foreshore communities a program dealing with latrine, wastewater, refuse pit, water supply and health and hygiene education matters.	All PAPs upstream and downstream of Barrage	Before the commencement of construction	MoWDI	EAD	RAP
Maintain aquatic/riparian habitats and water supply for downstream water users	Develop operating rules and decision support system for environmental flow releases. Include interim flow release strategy for construction phase.	For downstream water users	Before the commencement of construction	MoWDI	EAD	NWDP II
Community and environment safety	Prepare a disaster preparedness and response plan dealing with flood management, and Barrage failure.	Upstream and downstream areas	Before the commencement of construction	MoWDI	PoE	NWDP II
Compensation of PAPs in accordance with RAP	Complete all necessary land and building acquisition in accordance with RAP and Entitlement Framework prior to the commencement of construction works.	Areas of impact	Before the commencement of construction	MoWDI	MoWDI	RAP
	Provide copies of land acquisition details to the SE and Contractor.	Area of impact	Before handover of work sites	MoWDI	MoWDI	RAP
	Provide a list of affected property owners to the SE and Contractor.	Area of impact	Before handover of work sites	MoWDI	MoWDI	RAP

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
PAP and worker Health and Safety	Preparation of a Health and Safety Plan for workers and impacted communities addressing issues including: <ul style="list-style-type: none"> Measures to prevent the spread of HIV/Aids including an awareness campaign Education of workers and impacted communities Provision of safety equipment for workers Use of child labour to be prohibited 	All work sites and affected surrounding areas	Before commencement of construction	Contractor	MoWDI	Civil Works Contract
Air pollution	Trial run of Contractor's plants, machinery and vehicles for ascertaining that their emission and noise levels conform to the standards stipulated by EAD.	Construction Camp / Vehicle depot	Before use of equipment	Contractor	SE	Civil Works Contract
Minimise environmental disturbance	Survey the proposed work sites with a level and peg the area.	All work sites	Before commencement of construction	Contractor	SE	Civil Works Contract
	Jointly inspect the surveyed areas.	All work sites	Before commencement of construction	Contractor / Engineer	SE	
	Locate, peg out and seek approval from the Engineer for each ancillary site prior to the commencement of related activities.	All work sites	Before commencement of construction	Contractor	SE	Civil Works Contract
	Inspect and approve, if correct, all pegged ancillary sites.	All work sites	Before commencement of construction	Engineer	SE	

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Protect water quality in Shire River downstream of Barrage	Remove all waste from the informal dump on the downstream bank of the western approach to the Barrage	Western approach to Barrage	Prior to commencement of main civil works	Contractor	SE	Civil Works Contract
<i>Construction Stage</i>						
Maintenance of river flows for the downstream environment and water users.	Maintain downstream flows in the Shire River to meet existing water demands.	Barrage	Throughout the Barrage re-construction process	SE	MoWDI	Environmental Monitoring Plan
Minimise vegetation clearance	Clearly mark out the extent of clearing within the approved worksite areas with pegs at 50m intervals or less. Identify and mark individual trees for retention within the marked extent of clearing. Seek approval for clearing from the Engineer at least 1 week prior to any proposed clearing.	All work sites	Before clearing the vegetation	Contractor	SE	Civil Works Contract
	Inspect and approve all correctly located and pegged clearing sites. Vegetation clearance shall only be undertaken once consent to clear plantation / individual trees at work sites has been obtained from each owner. Instruct all construction workers to restrict clearing to the marked areas and not to harvest any forest products for personal consumption.	All work sites	Before clearing the vegetation	SE	MoWDI	Environmental Monitoring Plan
	Ensure that all clearing is undertaken with minimal disturbance to the surrounding environment, within the extent of approved sites only.	All work sites	Before clearing the vegetation	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Minimise vegetation clearance	Stockpile cleared shrub foliage where possible for later use as a brush layer.	All work sites	Throughout construction period	Contractor	SE	Civil Works Contract
Construction traffic causing damage to local roads due to overloading, increase in congestion, and increased road safety hazards	Contractor and subcontractors, to use appropriate vehicles, and to comply with legal gross vehicle and axle load limits. Contractor to repair damage at own expense.	Construction areas, quarry and borrow areas	Throughout Construction period	Contractor	SE	Civil Works Contract
Road safety hazards associated with temporary traffic diversions	Contractors to minimise road safety hazards and inconvenience to other road users by taking all appropriate measures, use of flag men.	All traffic diversion stretches	Throughout Construction period	Contractor	SE	Civil Works Contract
Soil erosion	Clearly mark the areas to be cleared of vegetation before clearing commences. No clearing of vegetation shall occur outside of these areas.	All work sites	Prior to commencement of vegetation clearing	Contractor	SE	Civil Works Contract
	Wherever possible avoid locating construction areas, access tracks and construction camps in areas with intact natural vegetation.	Throughout Project area	Prior to commencement of construction	Contractor	SE	Civil Works Contract
	Identify vehicle access tracks and parking areas prior to commencement of construction. Ensure construction workers are aware of the locations of these areas and that vehicles are restricted to these areas.	Construction areas, quarry and borrow areas	Prior to commencement of construction	Contractor	SE	Civil Works Contract
	Prior to commencement of works construct necessary temporary/ permanent erosion and sedimentation control structures.	Construction areas, work camps	Prior to commencement of works	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
	Ensure topsoil is left in a non-compacted condition following completion of works. Ensure re-vegetation at the earliest time.	At all work sites	Immediately following construction work	Contractor	SE	Civil Works Contract
Soil erosion	Following completion of works prepare areas for rehabilitation by revegetation or engage local community to plant vegetation.	At all work sites	Immediately following completion of works	Contractor	SE	Civil Works Contract
	Where culverts or pipes have been installed, line waterflow exit points with stone or cement rip-rap for a length of at least two metres.	At cross-drainage structure with erosion potential	During construction	Contractor	SE	Civil Works Contract
Sedimentation of water bodies and water courses	Identify and map all areas where soil disturbance will occur. For each of these areas, identify appropriate sediment control structures and install structures prior to commencement of work.	At all work sites	Prior to commencement of construction work	Contractor	SE	Civil Works Contract
	Carefully manage removal of existing weed boom to avoid soil and weeds polluting the Shire River. Dispose of material away from any surface water courses.	Existing weed boom	Once new weed boom is operational	Contractor	SE	Civil Works Contract
	If possible, schedule works requiring large areas of soil disturbance or newly formed embankments to avoid the rainy season / high river flows.	At all work sites	Prior to commencement of construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
	<p>Where possible, a bund or trench shall be constructed on the down slope of the construction areas to divert run-off to sediment control structures.</p> <p>The bund or trench shall be removed upon completion of construction works.</p>	At proposed cross-drainage structure locations	<p>Prior to commencement of work</p> <p>Immediately following completion of construction</p>	Contractor	SE	Civil Works Contract
Water pollution	<ul style="list-style-type: none"> Ensure that potential sources of petro-chemical (including bituminous materials) pollution are handled in such a way to reduce chances of spills and leaks. Train work crews in safe handling of petro-chemicals. Minimise soil sedimentation as outlined under sediment control. Contractor to make suitable arrangements for water requirements and to provide alternative supply to any users affected by contractor's abstraction of local water source. 	All work sites	Prior to commencement of construction	Contractor	SE	Civil Works Contract
Management of stockpiles, spoil heaps and batters	<ul style="list-style-type: none"> Consult with nearby landholders and community about suitable locations for stockpiles and spoil heaps. Site plans shall include all drainage provisions for construction sites. Locate stockpiles or spoil heaps so there is no blocking of drainage lines. If stockpile locations are not level, the base shall be levelled and contained. If a spoil heap or stockpile containing fine sediments is to remain bare during rainfall periods, it shall be covered to prevent erosion and sediment run-off. 	At potential locations for stockpiling	<p>Prior to commencement of work</p> <p>Prior to commencement of work</p> <p>Prior to stockpiling</p> <p>Immediately following stockpiling</p>	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Management of stockpiles, spoil heaps and batters	<ul style="list-style-type: none"> Where spoil heaps and stockpiles are large, they must be subject to stability calculations for provision of toe wall to safeguard against slips occurring. If local landowners or community groups plan to use spoil locally, a suitable site must be prepared to which the spoil can be dumped. In the event of spoil being available, it shall be used to backfill waste disposal pits. These areas should then be revegetated using labour from local communities. 		<p>Prior to stockpiling</p> <p>Prior to dumping of spoil</p> <p>Throughout construction period and upon completion of construction works</p>	Contractor	SE	Civil Works Contract
Noise pollution	<ul style="list-style-type: none"> Use well maintained equipment (with mufflers where appropriate). Use noise screens or mounds near residences, schools and health centres. Carry out noisy construction activities during daylight. Advise local people when there will be unusually high levels of noise. 	All work sites	Throughout construction period	Contractor	SE	Civil Works Contract
Water and soil pollution	<ul style="list-style-type: none"> Contain all solid wastes at designated location within construction sites. During site clean-up, re-cycle, re-use or dispose by burying away from watercourses / groundwater all spilled fuel oils and bituminous waste materials. Crush, burn and bury all inorganic solid waste in an approved disposal area. Remove disabled equipment, including machinery, existing Barrage gates from the area. Use above-water table pit latrines at major construction sites. Compost all green or biodegradable waste. 	All work sites	<p>Throughout construction</p> <p>During site clean-up</p> <p>During site clean up</p> <p>Throughout construction</p> <p>Throughout construction</p> <p>Throughout construction</p>	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Protection of environmentally sensitive areas	<ul style="list-style-type: none"> Identify natural habitat areas (including Liwonde NP) and cultural heritage sites, and other environmentally sensitive areas in site plans. Locate construction sites/activities away from sensitive areas. Ensure those involved in construction are aware of these areas and the usage limits of such areas. Provide training to construction teams to ensure an understanding of the requirements regarding environmental protection of sites. 	All work sites	Prior to commencement of works Throughout construction	Contractor	SE	Civil Works Contract
Protection of vegetation	<ul style="list-style-type: none"> Identify vegetation that will need to be protected; demarcate on the ground any areas where vegetation needs to be removed. Remove identified trees in such a way as to minimise damage to surrounding vegetation. Ensure the construction crew is aware remaining vegetation must not be touched or damaged. 	All work sites	During site preparation Prior to construction Prior to commencement of construction	Contractor	SE	Civil Works Contract
Pollution from Worker's Camp	<p>Contractors to prepare for approval detailed site environmental plans for the base camp and other work sites, which make adequate provision for safe disposal of all wastes, and prevention of spillages, leakage of polluting materials etc.</p> <p>Contractor to be required to pay all costs associated with cleaning up any pollution caused by his activities and to pay full compensation to those affected.</p>	All works sites and temporary camp Post-use of the site	Prior to and throughout construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Pollution from Workers camp	<p>If necessary, solid waste from the camp shall be disposed of in a 'sanitary' landfill area. The process will involve three stages:</p> <ul style="list-style-type: none"> • burning non-recyclable wastes in a pit • crushing all un-burned residues; and • burial of the crushed residues in a pit dug to avoid contamination of the water table. The pit will be covered regularly with a layer of soil or sediment. 	Camp sites	Throughout construction	Contractor	SE	Civil Works Contract
Socio-environmental issues	<ul style="list-style-type: none"> • Advise the local community of Project plans in advance of construction, and involve them in the site / construction planning process. 	For all Project activities	Prior to commencement of works	Contractor	SE	Civil Works Contract
	<ul style="list-style-type: none"> • Avoid disturbances near residential areas where possible. • Control run-off and manage sediment near residential areas. • Arrange for local people to be employed and trained. • Include women, poor & vulnerable groups in the implementation of the Project activities. 	Work sites	<p>Throughout construction</p> <p>Throughout construction</p> <p>Prior to commencement of, and throughout construction</p> <p>Prior to commencement of, and throughout construction</p>	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Drainage	<ul style="list-style-type: none"> Negotiate and agree on with community about soil disposal areas and stockpile sites. Make available any waste wood to local people as building material or fuel wood. 		Prior to commencement of, and throughout construction			Civil Works Contract
	<ul style="list-style-type: none"> Survey and peg all designed drainage works prior to construction. Outlet drains into existing stable drainage lines, or where this is not possible, consult with adjoining down-slope landowners on mutually acceptable locations for drain outlets. Jointly inspect the pegged drainage works. Construct all designed drainage works prior to, during or immediately following excavation work in order to minimise the erosion hazard. Inspect all works and ancillary sites for drainage and erosion problems after each storm event during the period of construction. Repair all failed drains and take other appropriate action as directed by the Engineer. 	All work sites	Beginning with and continuing throughout construction	Contractor SE / Contractor Contractor Contractor	SE MoWDI SE SE	Civil Works Contract
Topsoil saving and re-use	<ul style="list-style-type: none"> Save all available topsoil from work sites and other borrow pit areas and re-use it for site rehabilitation approved by the Engineer. Strip and stockpile topsoil from all ancillary sites that are to be disturbed. If topsoil is to be stockpiled, keep it separate from sub-soil material. Sow a cover crop on each top-soiled batter within 2 days of top-soiling. 	All work sites	Throughout construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Loss of productive land for borrow pits and adverse financial effects associated with exploitation of landowners by Contractors	<ul style="list-style-type: none"> • Equitable agreements for borrow pit development to be reached between contractors and landowners, with post-use restoration. Temporary lease arrangements to include an element which fully reflects post-use rehabilitation actions and costs. • Remove top soil and retain in a protected heap for post-use rehabilitation of the borrow area. • Avoid penetration of aquifers. • Fill excavation site with appropriate fill or incinerate construction waste in it, top and finally cover with stored topsoil. • With respect to borrow pits, estimate the quantity of material required and the period of extraction and seek approval from the Engineer. Before opening additional pits, operating pits shall be closed as per relevant Specifications. No borrow area shall be located in sensitive areas such as prime agricultural land. • Inspect and approve all correctly located borrow pits. • Ensure that each quarry or borrow pit drains into a sediment trap before runoff is discharged off the site. • Seek approval from EAD for borrow pits 	All temporary access roads, quarry site and borrow areas	Whenever encountered during construction	Contractor	SE	Civil Works Contract
				Contractor	SE	
				Contractor	SE	
				Contractor	SE	
				Contractor	SE	
				SE	MoWDI	
				Contractor	SE	

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Soil erosion, surface water pollution from material stockpiles	<ul style="list-style-type: none"> • Locate, peg and seek approval from the SE for the use of stockpile sites. • Obtain written permission from landowners for stockpiling on their temporarily acquired land. • Inspect and approve all correctly located stockpile sites. • Seed topsoil stockpiles with a cover crop where they are to be retained for more than one month. • Site plans shall include all drainage provisions for construction sites. • Locate stockpiles or spoil heaps so there is no blocking of drainage lines. If stockpile locations are not level, the base shall be levelled and contained. • If a spoil heap or stockpile containing fine sediments is to remain bare during rainfall periods, it shall be covered to prevent erosion and sediment run-off. 	All work sites	Whenever encountered during construction	Contractor Contractor SE Contractor Contractor Contractor Contractor	SE SE MoWDI SE SE SE SE	Civil Works Contract
Sanitation and waste disposal from temporary Contractor site on eastern side of Shire River upstream of the Barrage (Figure 3)	<ul style="list-style-type: none"> • Provide and maintain worker's health check-up. • Recycle or dispose of solid waste as directed by the SE. • Sufficient measures will be taken in the construction camp, i.e. provision of garbage tanks and sanitation facilities including septic tank and soak pits. Waste in septic tanks will be cleared periodically. • Drinking water will meet National Standards. • Garbage will be collected in bins and disposed of daily. • Special attention shall be paid to the sanitary condition of camp. • Make certain that there is good drainage to avoid creation of stagnant water bodies including water in old tyres which could harbour disease vectors such as mosquitoes. 	Temporary Contractor site	Throughout construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Workforce management	<ul style="list-style-type: none"> • Liaise with affected communities regarding proposed construction activities. • Ensure workers act in a responsible manner to local people and do not harvest or take personal resources, native plants, fish or wildlife. • Ensure that no wood is burnt by any construction workers on or off site. • Provide kerosene or gas for all workforce cooking needs. • Restrict working hours near habitations to between 06.00-18.00 hrs. 	Near Construction camp site	Before and during building of construction camps	Contractor Contractor Contractor Contractor Contractor	SE / MoWDI	Civil Works Contract
Dust air pollution	<ul style="list-style-type: none"> • Vehicles delivering materials shall be covered to reduce spills and dust blowing off the load. • Use of water tankers to control dust along access roads and at construction sites adjacent villages/houses, crushing plants etc. 	All work sites	Beginning with and continuing throughout construction	Contractor	SE	Civil Works Contract
Gaseous air pollution	<ul style="list-style-type: none"> • Vehicles and machinery will be regularly maintained so that emissions conform to National Standards. 	All work sites	Beginning with and continuing throughout construction	Contractor	SE	Civil Works Contract
Noise pollution	<ul style="list-style-type: none"> • Workers in vicinity of strong noise will wear earplugs and their working time should be limited. • Construction would be stopped from 21:00 to 06:00 hrs at construction sites located within 150 m of residential areas. • Machinery and vehicles will be maintained to keep noise at a minimum. 	All work sites	Beginning with and continuing throughout construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Siltation of water bodies and water courses	<ul style="list-style-type: none"> Construction materials containing fine particles e.g. aggregates, limestone etc. will be stored in an enclosure away from water bodies to ensure that sediment laden water does not drain into nearby water courses. 	Near cross-drainage structures and water bodies	Throughout construction	Contractor	SE	Civil Works Contract
	<ul style="list-style-type: none"> Trees and grass will be planted on slopes and other suitable places to stabilise works areas. 	Whenever encountered during construction	Upon completion of construction activities at these sites	Contractor	SE	
	<ul style="list-style-type: none"> In sections along water courses, earth and construction waste will be properly disposed of so as to not block natural channels, resulting in adverse impact on water quality. 	Near cross drainage structures	Whenever encountered during construction	Contractor	SE	
Alteration of Drainage	<ul style="list-style-type: none"> All necessary measures will be taken to prevent earthworks from impeding cross drainage at streams, canal/existing irrigation and drainage systems. 	Near cross drainage structures	Whenever encountered during construction	Contractor	SE	Civil Works Contract
Water resources contamination from wastes	<ul style="list-style-type: none"> All justifiable measures will be taken to prevent the wastewater produced at construction camp from entering directly into natural water courses and irrigation systems. A minimum distance of any sewage source or toilet facility should be 100 m from water sources. 	Near camps drainage structures and water courses	Throughout construction	Contractor	SE	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Water resources contamination from fuel and lubricants	<ul style="list-style-type: none"> Vehicle maintenance and refuelling will be confined to areas in construction camp designed to contain spilled lubricants and fuels. Waste petroleum products must be collected, stored and taken to approved disposal sites. Absolutely no washing of vehicles or changing of lubricants in any water courses, including but not limited to the Shire River. 	Construction camp lease area	Throughout construction	Contractor	SE	Civil Works Contract
Cultural resources	<ul style="list-style-type: none"> If archaeological relics or remains are discovered, the Department of Antiquities should be notified immediately. The construction should be stopped until the Department of Antiquities assesses the remains and approves continuation of work after appropriate measures are implemented. An Archaeologist will supervise any necessary excavation to avoid any damage to the relics. 	Wherever such archaeological/cultural remains are discovered	Throughout construction	Contractor with Department of Tourism	SE / MoWDI	Supervision Consultancy
Hazards and hazardous materials handling	<ul style="list-style-type: none"> Safely handle and store hazardous materials. Seek directions from the Engineer for the disposal of hazardous materials. Provide disposal directions to the Contractor when requested. Clean up spills of hazardous materials immediately. Suppress fires on or adjacent to construction or ancillary sites. In case of spill of hazardous materials, relevant departments will be informed at once and will deal with it in accordance with the spill contingency plan. 	All work sites	Throughout construction as and when required	Contractor Contractor SE Contractor Contractor	SE SE MoWDI SE SE SE / MoWDI	Civil Works Contract

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Soil Erosion	<ul style="list-style-type: none"> On slopes and other suitable places along the alignment, trees and grass shall be planted 	Primarily at cross drainage structures	Upon completion of construction activities at these sites	Contractor	SE	Civil Works Contract
	<ul style="list-style-type: none"> On sections with high filling and deep cutting, slopes shall be covered by mulch walls and planted with grass. 			Contractor	SE	
Compaction of soil	<ul style="list-style-type: none"> Construction vehicles should operate within designated work sites to avoid damaging soil, and vegetation. 	All work sites	During Construction	Contractor	SE	Civil Works Contract
Loss of trees	<ul style="list-style-type: none"> Tree clearing outside designated work sites should be avoided beyond what is required for construction activities. 	All work sites Areas of proposed tree plantings	During clearing / grubbing activities After completion of construction activities	Contractor	SE	Civil Works Contract
	<ul style="list-style-type: none"> All vegetated areas cleared for temporary work sites will be revegetated according to a Re-vegetation Action Plan. 			Contractor	SE	

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Work site decommissioning	<ul style="list-style-type: none"> Establish a site revegetation plan. Where possible involve local community to provide materials and implement revegetation. <p>The revegetation plan shall include:</p> <ul style="list-style-type: none"> Name(s) of contact landowner/community group Summarised outcome of discussions, and decisions on what will be planted; and list of seedlings/stock to be provided and by whom. 	All work sites, quarry and borrow areas	Immediately following completion of construction work	Contractor	SE	Civil Works Contract
Ancillary Site Rehabilitation	<ul style="list-style-type: none"> Rehabilitate ancillary sites such as borrow areas, camp sites, material storage sites etc. within 1 month of their final use, including the removal of structures, refuse, stockpiles and other temporary features. Revegetate the sites with a cover crop and permanent vegetation as appropriate. 	At all ancillary sites	Within 1 month of final use of the ancillary site	Contractor	SE / MoWDI	Civil Works Contract
POST-CONSTRUCTION (OPERATION) STAGE						
Hazardous Waste Management	<ul style="list-style-type: none"> Prepare a Hazardous Waste Management Plan to dispose of oil and other lubricants resulting from routine maintenance of pumps and other operating equipment. 	Barrage	Prior to operation	Plant Operator	MoWDI	
Aquatic Weed Disposal	<ul style="list-style-type: none"> Dispose of aquatic weeds collected via the weed boom upstream of the Barrage as per guidelines in Section 4.3.3 of ESMP. 	Weed collector	During operation of new weed collector	MoWDI	EAD	

Environmental Impact / Issue	Mitigation Measures	Location	Timing	Responsible Organisation		Funding Source
				Implementation	Supervision / Monitoring	
Protection of Lake, River and wetland habitats upstream and downstream of Barrage	<ul style="list-style-type: none"> Implement social and environmental water releases as per boundary conditions of ESMP as part of the operating rules for Kamuzu Barrage 	In vicinity of Barrage and work sites Liwonde NP and Majete Wildlife Reserve Downstream of Barrage to Elephant Marsh	Parallel with commencement of operations	MoWDI	EAD	RAP Environmental Monitoring Plan

Note: Reference to SE refers to the Supervising Engineer of the Contractor (under the Consultancy Services for the Implementation of the Upgraded Kamuzu Barrage).

Table 4 outlines the management measures and task descriptions required to implement Project mitigation.

TABLE 4. MITIGATION MANAGEMENT

Management Issue	Task Description	Timing	Responsibility
Environmental Legal Compliance	Obtain all necessary permits / approvals from landowners, local government and EAD as necessary	Prior to commencement of work	Contractor
Health, Safety and Environment Training	Conduct environmental management and safety training for all Contract workers and site visitors	Prior to commencement of work	Contractor
Health, Safety and Environment Training	Conduct training for Contractor supervising staff, field inspectors and MoWDI Project staff	Prior to commencement of work	Supervision Consultant
Environmental Management	Preparation of Contractor Environmental Management Plan	Prior to commencement of work	Contractor
Panel of Experts (POE)	Establish POE to oversee social and environmental management	Prior to commencement of work	MoWDI
Environmental Management Programs	<ul style="list-style-type: none"> • Implement a resettlement and compensation monitoring program as per the RAP. • Implement a health monitoring program, based on baseline data collected before and during Barrage construction. • Implement a wildlife monitoring program as described in the ESIA. • Implement a vegetation monitoring program for Liwonde NP as per the ESIA • Implement monitoring Program for operational releases from the Barrage 	Prior to commencement of operation	MoWDI
Resettlement Action Plan	Implement	Prior to commencement of construction	MoWDI
Environmental Monitoring	Implement	During construction and operation	MoWDI

5 Monitoring Program

This Section addresses the proposed social and environmental monitoring program for the Project. Monitoring has been divided into compliance monitoring and outcome monitoring (Table 5). The purpose of the environmental monitoring program is to ensure that the envisaged outcome of the Project is achieved and results in the desired benefits to Malawi. To ensure the effective implementation of the ESMP it is essential that an effective monitoring program be designed and carried out. The environmental monitoring program provides such information on which management decisions may be taken during construction and operational phases. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that may need to be taken to achieve the desired Project outcomes. Monitoring also provides information for periodic review and possible modification of the ESMP to optimize environmental protection at all stages of project cycle.

The most important objective of the Outcome Monitoring is to provide input to the revision of the water release Operating Rules for the upgraded Kamuzu Barrage. Other objectives of the environmental and social monitoring are:

- Evaluation of the efficiency of mitigation and enhancement measures;
- Updating of the actions and impacts of baseline data;
- Adoption of additional mitigation measures if the present measures are insufficient;
- Generating the data, which may be incorporated in an environmental management plan in future projects.

Environmental monitoring is an essential component of project implementation. It facilitates and ensures the follow-up of the implementation of the proposed mitigation measure, as they are required. It helps to anticipate possible environmental hazards and/or detect unpredicted impacts over time. Monitoring includes:

- Visual observations;
- Selection of environmental parameters at specific locations;
- Sampling and regular testing of these parameters.

Monitoring will be undertaken at a number of levels. First, compliance monitoring will be undertaken by the Supervising Engineer (SE) at work sites during construction, under the direction and guidance of the Supervision Consultant who is responsible for reporting the monitoring to the implementing agency, MoWDI. It is not the Contractor's responsibility to monitor land acquisition and compensation issues. It is recommended that the SE employ a local full time qualified environmental inspector for the duration of the Contract capable of undertaking the required monitoring. The Supervision Consultant should include the services of a highly qualified environmental and monitoring specialist as part of their team.

The MoWDI should in turn undertake independent monitoring of selected parameters to verify the results of the Contractor and to audit direct implementation of environmental mitigation measures contained in the ESMP and construction contract clauses for the Project. MoWDI also has the direct responsibility to implement and monitor land acquisition and compensation issues as outlined in the RAP. The Project team should include an environmental monitoring and management specialist as well as a sociologist experienced in land acquisition and compensation issues. A total of 4 person months per year should be allocated to the Project during the pre-construction and construction stages for social and environmental management issues. Periodic ongoing monitoring will be required during the life of the Project and the level can be determined once the Project is operational.

Environmental monitoring of the following parameters is recommended as a minimum for the Project. Monitoring methodology covers the following key aspects:

- Components to be monitored;
- Parameters for monitoring of the above components;
- Monitoring frequency;
- Monitoring standards;

- Responsibilities for monitoring;
- Direct responsibility;
- Overall responsibility;
- Monitoring costs.

5.1 Compliance Monitoring

Compliance monitoring involves assessing whether the Project is being implemented in accordance with the Project's Environmental and Social Management Plan. It is undertaken during the Project construction phase and involves monitoring contractor performance with respect to social and environmental management issues. A key requirement to effective monitoring is that the construction Contractor's environmental obligations are included in all tender documents so they are enforceable.

5.1.1 Physical Environment

5.1.1.1 Soils

The excavation of earth for the establishment of temporary borrow areas, temporary and permanent access roads, work camp and storage facilities will exacerbate soil erosion. It will, therefore, be the responsibility of the Contractor's environmental inspectors to ensure the implementation and effectiveness of erosion control measures. Focus should be given to work sites where soil is disturbed and its immediate environ.

5.1.1.2 Water Quality Monitoring

Construction camps are often a source of significant surface and groundwater pollution if not managed and sited properly. Therefore the Contractor will be required to undertake monitoring of any effluent, waste water, or rainfall runoff discharged from campsites. This will encourage the Contractor to implement proper wastewater treatment facilities on site through the use of settling and treatment ponds.

The parameters to be analysed include the following:

- pH
- Electrical Conductivity (EC)
- Suspended Solids (SS)
- Turbidity
- Ammonia (NH₄⁺)
- Nitrates (NO₃⁻)
- Total Nitrogen
- Total Phosphorus
- Filterable Iron (Fe)
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Grease and oil
- E-coli

If the discharged effluent does not meet the WHO standards then the Contractor must take further treatment measures or refrain from discharging effluent directly into watercourses.

5.1.2 Socio-economic Environment

5.1.2.1 Monitoring of Resettlement / Compensation

Monitoring will be undertaken in accordance with the RAP and monitoring and evaluation will form an integral part of the RAP. The monitoring programme will have three broad components:

- Performance monitoring, coordinated by the MoWDI, to measure progress with involuntary resettlement against scheduled actions and milestones, using input and output indicators.
- Impact monitoring, focusing on the effectiveness of relocation and livelihood restoration measures, the identification of constraints, and the recommendation of any corrective measures that may be necessary. While the internal monitoring reports will be a source of information, impact monitoring will require the generation of new data to compare against baseline conditions, at (1) household level, through the use of quantitative socio-economic survey instruments; and (2) group/community level, through the use of qualitative (participatory) monitoring and evaluation techniques.
- A Completion Audit, undertaken by an independent agency, such as an NGO. The overall aim will be to verify that compensation and livelihood restoration activities have been undertaken in compliance with the objectives and principles of the RP, and describe any outstanding issues that require attention prior to the closing of the project's compensation and relocation programme.

5.1.2.2 Monitoring of Accidents / Health

The Contractor's environmental inspectors will be required to ensure that periodic health surveys are carried out around the Barrage site. MoWDI will have overall responsibility to oversee that all environmental measures are put in place and that regulations are enforced. The construction supervision consultant will assist MoWDI in this process in order to make sure that contractors fulfil the environmental requirements.

The parameters listed below are proposed as indicators to assist with the follow-up of the health related impact of the construction and operation of the Project. Monitoring will commence with construction and continue for 2 years after construction completion.

- Number of cases of malaria by sex and age groups
- Proportion of households with mosquito nets in use
- Number of cases of bilharzias by sex and age groups
- Number of cases of STI seen at the facilities, by sex, age groups and types
- Current knowledge on key HIV/AIDS issues among the young and adult population
- Number of individuals counselled for HIV/AIDS
- Number of cases of road accidents by sex and age groups and types - records on actual accidents associated with the Barrage refurbishment could be compiled with the help of local community officials, teachers/students of local schools
- Number of cases and types of work related injuries seen in the health facilities and the facility specifically assigned to the construction workers - records on actual accidents associated with the Barrage refurbishment could be compiled with the help of local community officials, teachers/students of local schools
- Drinking water quality (surface and / or groundwater) in relation to concentration of chemicals and biological contaminants beyond standard (WHO) values
- Presence of posted visible signs at work sites, etc.
- Presence of sanitary facilities at campsites
- Level of awareness of communities pertaining to dangers/risks associated with Project construction activities

5.1.2.3 Noise Level Monitoring

Periodic sampling of Contractor equipment and at work sites will be undertaken to confirm that noise levels are within recommended standards (WHO as mentioned below). Noise level monitoring could be supplemented by consulting with Project Affected People in the first instance to identify the level of monitoring required. During construction, quarry sites, Barrage site and concrete batching / aggregate crushing sites will be the main sources of noise pollution. Noise is not expected to be a problem during operation of the refurbished Barrage.

The measurement most often used for measuring sound is the average equivalent sound pressure level (Leq) per unit time (e.g. 24 hours) using a logarithmic decibel scale (the noise intensity doubles with any increase of 3 decibels (dB)). WHO recommends an outdoor noise limit of 55 dBA Leq during the day and 45 dBA Leq during the night. In industrial areas or work environments such as during Barrage refurbishment, a level of 75 dBA Leq (8 hours) is considered acceptable.

5.1.3 Monitoring ESMP Implementation

Implementation of the overall ESMP will be monitored by MoWDI on a monthly basis and an annual progress report provided to EAD. Monthly reports will be based on progress reports provided by the Contractor and Supervision Consultant as well as periodic field inspections by MoWDI staff.

An annual report will be prepared which reviews the overall ESMP and makes changes to the following year's monitoring program based on progress and experience to date.

5.2 Outcome Monitoring

The purpose of outcome monitoring is to provide feedback usable for adaptive project management such as adjustment of Kamuzu Barrage operating rules to reflect new findings. Outcome monitoring extends beyond the construction period into the operation period.

5.2.1 Physical Environment

5.2.1.1 Water Resources

The Project will further alter the flow regime in the Shire River resulting in fluctuations in water levels downstream and these will impact on downstream water users and the river channel. Monitoring will consist of recording downstream river levels in relation to flow releases from the heightened Barrage to assess the effects on downstream water users and downstream channel stability (river banks) and riparian habitats. Based on this monitoring, an assessment will then be made to determine the need to develop and implement additional mitigation measures including any changes to Barrage operating rules.

5.2.2 Biological Environment

5.2.2.1 Vegetation

Temporary work/storage sites will be located to cause the least disturbance to areas of native vegetation and this will be monitored by the Contractor's environmental staff and by the SE inspectors.

The Contractor's environmental inspector will ensure that areas used as temporary campsites for workers are progressively rehabilitated as they are no longer required. Once a site is rehabilitated it will be "signed off" by MoWDI environmental staff.

During the operation phase, a monitoring program will specifically target the impacts of high water levels on the Liwonde National Park, as a priority. High resolution (0.25m contour level) colour aerial photography covering the NP and downstream riparian areas was flown in October 2011 and this can be used as a starting point for monitoring vegetation changes in the NP.

For monitoring purposes, the analyses of the proportional vegetation composition will be reassessed at regular intervals (approximately every 2 years). The reassessment will be conducted by sampling map boundaries and noting the change in vegetation structure due to different water levels in the Park.

The air photos will be used to construct maps showing vegetation zone boundaries. These zone boundaries will then be verified using a GPS, and establishing fixed GPS monitoring points.

At the GPS monitoring points, a fixed photo site will be set up and photos will be taken during the same season at each monitoring event (dry season and wet season, and approximately the same dates each monitoring year). In addition to photographs, the general species composition, plant height, plant distribution (clumped, regular, dispersed) and species composition will be recorded for each monitoring site.

The expected results from the monitoring will be a general shift in the boundaries of the vegetation types normally occurring at the perennial swamps, marshes, and seasonal floodplain interfaces. This is to be expected, if the water levels under the management regime of the refurbished Barrage are higher than the water levels under the current management regime.

It must be clearly understood, however, that shifts in the boundaries of the vegetation types will be land gradient dependant. Steep ground will only show very small shifts, while flat ground will show much larger boundary changes.

5.2.2.2 Terrestrial Wildlife

With respect to terrestrial wildlife, the monitoring priorities are the Rock Pratincole (dependent upon emergent boulders downstream of the Barrage), African Skimmer (dependent upon sandbars upstream of the Barrage), crocodiles and turtles (dependent on sand banks/bars for nesting), and some indicator species that are highly dependent upon the Permanent Marsh ecosystem upstream of the Barrage (such as hippopotamus and waterbuck). Monitoring of species that are sensitive to disturbance will need to be conducted carefully by trained professionals, to avoid causing nest abandonment and other undesired effects.

Since large grazing mammals (dependent upon the Floodplain Grasslands ecosystem) are already being monitored annually by Liwonde National Park personnel, monitoring would not need to be duplicated by the Kamuzu Project, although a financial contribution towards the Park's monitoring would ensure its continuation.

It is recommended that the following key species are monitored periodically (at least every 2 years) to assess any changes in population in relation to operation of the Barrage.

- Status of African Skimmer, crocodile, turtles, Lillian's Lovebird, hippopotamus and waterbuck populations upstream and downstream of the Barrage and rock pratincole in Majete National Park.
- Parameters that could be measured include the population size and reproductive success of these species.

5.2.3 Monitoring the Operational Release Strategy

The release strategy is an integral part of the project and it will be regularly monitored. Key issues will be:

- Appointment of a competent Government Agency or independent organisation to review gauging information and conduct their own spot checks to compare actual and recorded discharge;
- Clear lines of communication between the discharge monitoring agency and the body overseeing the operation of the Barrage;
- Feedback mechanisms for ecological monitoring; cross-referencing against Lake level and River discharge patterns;
- Institutional flexibility to micro-manage release in exceptional circumstances with defined information dissemination procedures towards the discharge monitoring agency;
- Establishment of routines and funding arrangements that ensure the sustainability of the discharge monitoring programme.

TABLE 5. MONITORING PLAN

Environment Component	Project Stage	Parameter	Standard	Location	Frequency	Duration	Implementation	Monitoring
Compliance (Construction) Monitoring								
Land Acquisition and Compensation	Pre-construction / operation	Compensation payments	RAP	All work sites	Monthly until complete	As per RAP	MoWDI	EAD
Water Quality	Construction	pH, EC, SS, turbidity, colour, NH4+, NO3-, total P, Fe, DO, BOD, grease & oil, E-coli	WHO guidelines	Construction Camps	Monthly during operation of camps		Contractor	EAD
Noise Levels	Construction	Noise levels on dB (A) scale	WHO guidelines	All work sites	Monthly as required by Supervision Consultant		Contractor	EAD
		Noise levels on dB (A) scale	WHO guidelines	Noise level readings taken at nearest residential house to work site	As directed by the Supervision Consultant	Readings to be taken at 15 second interval for 15 min every hr and then averaged	Contractor	EAD
Soil Erosion	Construction	Turbidity in storm water	ESIA guidelines	As identified by MoWDI	As required		Contractor	EAD
Vegetation Clearing	Construction	Area cleared (ha)	ESMP	All work sites	As required		Contractor	EAD
Rehabilitation of Work Sites	Construction	Monitoring to ensure all work sites are progressively rehabilitated	ESMP	Work camps, material storage sites, borrow areas, quarry	As required		Contractor	EAD
Health	Construction	Signs, posters displayed, health awareness lectures, health checks for workers	ESMP	All work sites, work camps and surrounding areas	Monthly		Contractor	EAD
Accidents	Construction	Number workers trained, accident reports, community consultation	ESMP	All work sites	Monthly		Contractor	EAD
Implementation of EMP	All stages	All	ESIA	Project impact area	Monthly	Life of Project	MoWDI	EAD
Outcome (Operating) Monitoring								
Downstream hydrology	Construction / operation	River levels, bank erosion	ESMP	Shire River channel	Daily River levels; monthly bank erosion	Ongoing with annual review	MoWDI	EAD
Operation release strategy	Operation	Operational discharge	ESIA	Downstream of Barrage	Daily	Project life	MoWDI	EAD
Vegetation	Operation	Vegetation communities	ESIA	Liwonde NP	Every 2 years	Review after 10 years	MoWDI	EAD
Wildlife	Operation	Key species	ESIA	Upstream / downstream	Every 2 years	Review after 10 years	MoWDI	EAD

5.2.4 Monitoring Budget

Table 6 provides a preliminary budget estimate for the monitoring outlined previously.

TABLE 6. MONITORING BUDGET

Component	Item	Unit Cost (USD)	Quantity	Total Cost (USD)
Resettlement Plan	Monitoring and evaluation (RAP)	45,000	1	45,000
Water Quality (construction)	At locations specified in monitoring plan \ ESIA	5,000/year	During 2.5 year construction period	12,500
Operation release strategy	Monitoring operational discharge	600/month	Initially 5 years then review	36,000
Vegetation Monitoring	Establish baseline, monitor change in Liwonde NP	3,000/year	Life of SRBMP then review	30,000
Wildlife monitoring	Establish population numbers of key species	3,000/year	Life of SRBMP then review	30,000
Noise Levels	At equipment yards, work sites	200	30 months	6,000
Health monitoring (local people and workers)	At local health clinics / work camp	5,000/year	Initially 5 years then review	25,000
Contractor Staff	Environmental Inspectors	6,000 / person / month	1 full time equivalent staff for duration of Construction (30 months)	180,000
MoWDI Staff	Environmental monitoring staff	7,000 / month	1 full time equivalent staff for duration of Project construction (30 months)	210,000
Training	As per training program in Section 8.4	35,000	During 2.5 year construction period	40,000
TOTAL				614,500

6 Institutional Arrangement and Training

This Section identifies the institutional needs to ensure the effective implementation of the social and environmental management and monitoring program as outlined in the ESIA, ESMP and RAP so that the Project's benefits are maximised and that the Project is implemented on a sustainable basis. It is important that the institutional arrangement provides the capacity to implement social management plans, including compensation programs relating to social impacts. Recommendations are also included for operation and maintenance training of MoWDI and contractor staff on environmental monitoring and management aspects.

6.1 Institutional Arrangement

The ESMP is based on MoWDI having the overall responsibility for the coordination, planning and implementation of the Project as well as the actual implementation of the environmental monitoring and management and land acquisition and compensation components. It is also based on the appointment of a construction Supervision (Management) Consultant with responsibilities under the direction of MoWDI of directly supervising the Contractor implementing the works (as outlined in Figure 5).

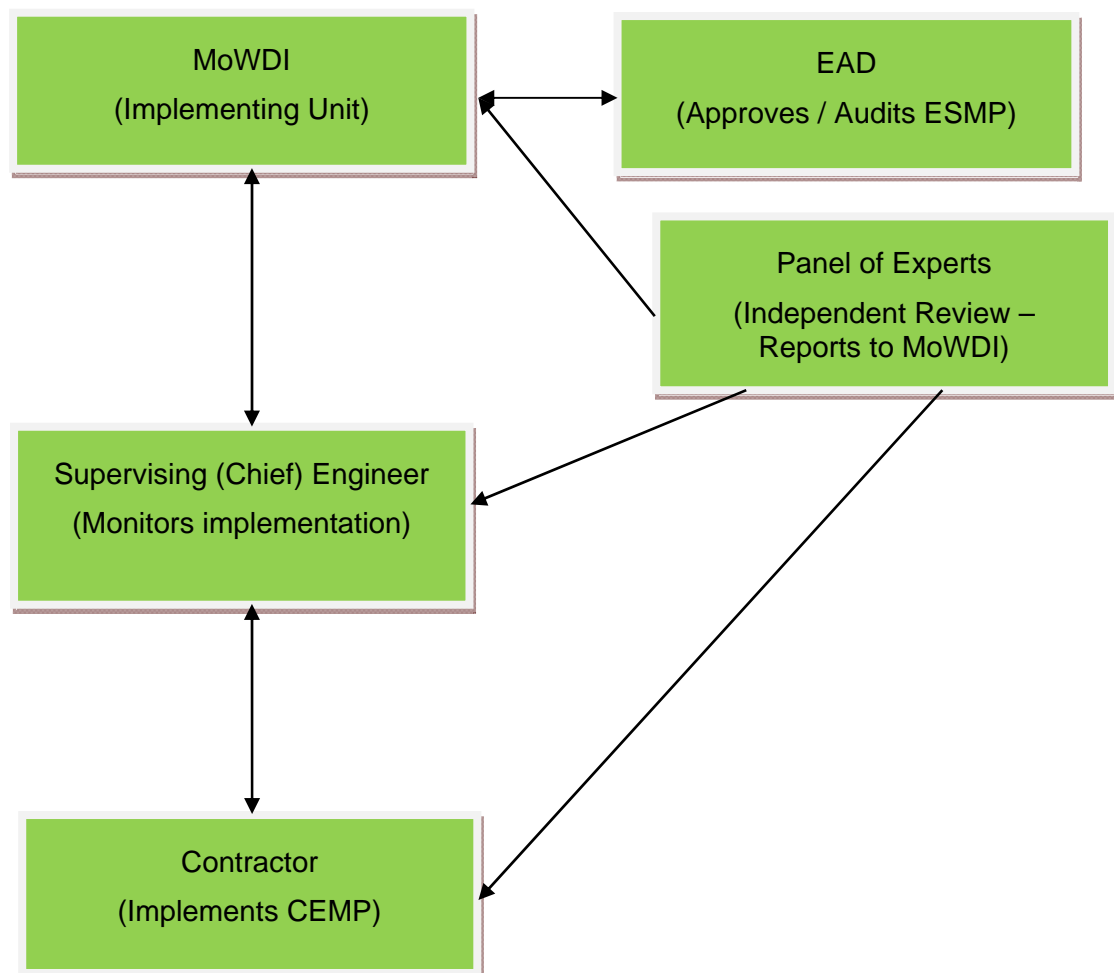


Figure 5. ESMP Organisation Chart

6.2 Environmental Training

Table 7 outlines the proposed training for MoWDI staff and Barrage operating staff as well as employees of the Contractor. The training is aimed at the practical aspects of environmental monitoring and management. Training will be provided at Project commencement and then as required. Estimated cost is USD 40,000 based on 2 workshops being held, one at site (Liwonde) and one in Lilongwe.

TABLE 7. TRAINING FOR MOWDI AND CONTRACTOR STAFF

Timeframe	Training Recipients	Mode of Training	Environmental Aspects to be Covered	Training Conducting Agency
Prior to construction	MoWDI Environmental and supervision Staff	Lecture System Workshops Group Discussion Visit to case study	<ul style="list-style-type: none"> • Environmental and social overview • Environmental and social regulations & acts • Environmental, social and health issues associated with water supply dam projects • Environmental Management Plans • Requirements of the Resettlement Plan • Environmentally sound construction management • Risk assessment and management 	Environmental and Social Specialists, Supervision Consultant
After mobilisation and prior to construction	Contractor's Staff	Seminar Workshop Lectures	<ul style="list-style-type: none"> • Environmental and social overview • Environmental impact assessment • Environmental Management Plan implementation • Requirements of the Resettlement Plan • Environmental and social regulations & Acts • Environmental pollution associated with water supply dam projects • Environmentally sound construction management • Water supply dam projects and environmental issues 	Environmental and Social Specialists, Supervision Consultant MoWDI Environmental Staff
Prior to operation of the refurbished Barrage	Barrage Operation/Maintenance Staff	Seminar Workshop Lectures	<ul style="list-style-type: none"> • Environmental Management Plan implementation • Environmental flows • Environmental pollution associated with water supply projects • Best environmental practices 	Environmental and Social Specialists, Supervision Consultant MoWDI Environmental staff, Environmental flow Specialist

7 Reporting Procedures and Implementation Schedule

7.1 Reporting System

The MoWDI shall be responsible for the implementation of the ESMP and for compliance auditing. The Supervising Engineer (SE) will be responsible for the day to day monitoring of environmental performance of the Construction Contractor and for monthly reporting of environmental performance which is to be submitted to the MoWDI.

7.1.1 Non-compliance Reporting

Where the Environmental staff of the MoWDI or SE observe activities or conditions at Project construction sites or on adjoining sites which do not comply with the requirements of the ESMP, as incorporated under the construction contract documents, they will make a written report to the SE to the Contract. On no account shall the Environmental staff give directions to any contractor, employed under a Contract with the MoWDI, in relation to any non-compliance. The report shall define the non-compliance with the ESMP and shall note the time and date of the non-compliance. Based on the report, the SE to the Contract can issue instructions to the Contractor to forthwith instigate procedures to correct the non-compliance and to avoid any recurrence of such non-compliance or to stop work until compliance is achieved. The SE to the Contract shall confirm in writing to the Manager from MoWDI as soon as practicable after correction of the non-compliance.

7.1.2 ESMP Audit Reporting

As mentioned previously the MoWDI will be responsible for undertaking environmental audits for the Project. Audit reports will be undertaken every 6 months and submitted to the Project's Panel of Expert's if one is established or alternatively to EAD. Environmental audits will report on progress with the ESMP and the effectiveness of the environmental monitoring and management program in minimising or avoiding adverse social and environmental impacts from the Project. The ESMP will be reviewed and revised, as necessary, based on the findings of an audit.

7.1.3 Reporting on In-voluntary Resettlement

Reporting on the activities concerning involuntary resettlement (compensation) involves:

- Internal reporting: Results of all resettlement activities documented and archived by MoWDI, to compile a monthly internal report and a quarterly report for distribution to the Project Steering Committee (PSC) and the Local Liaison Committees (LLCs) or other bodies outlined in the RAP.
- External reporting: Reporting to all stakeholders on project-related matters, primarily through project structures; reporting to an external monitoring agent and an Evaluation Panel; and undertaking a Completion Audit.

7.2 Implementation Schedule

Table 8 provides an implementation schedule for the monitoring and mitigation measures for the ESMP. This schedule will be reviewed and revised at least every 6 months during the construction period and on an annual basis during Project operation.

TABLE 8. ESMP IMPLEMENTATION SCHEDULE

Environmental Issue	Pre-construction Phase	Construction Year 1	Construction Year 2	Construction Year 3	Operation Phase
Physical Environment					
Soils (floodplain, erosion; soil removal from construction activities)		✓	✓	✓	✓
Water resources					
Shire River flows		✓	✓	✓	✓
Downstream river banks (erosion)		✓	✓	✓	✓
Water quality					
Lake Malombe	✓	✓	✓	✓	✓
Shire River upstream of Barrage	✓	✓	✓	✓	✓
Shire River downstream of Barrage	✓	✓	✓	✓	✓
Biological Environment					
Riparian vegetation (inundate some floodplain areas of Liwonde NP)	✓	✓	✓	✓	✓
Disposal of aquatic weeds					✓
Wildlife (loss of habitat)					
Emergent boulders in Shire River (Rock Pratincole)	✓	✓	✓	✓	✓
Sand banks along Shire River and Lake foreshores (crocodiles and turtles)	✓	✓	✓	✓	✓
Sand bars within Shire River channel (African Skimmer)	✓	✓	✓	✓	✓
Fish					
Loss of habitat in Lake Malombe		✓	✓	✓	✓
Socio-economic Environment					
Local economic benefits	✓	✓	✓	✓	✓
Land Resources					
Temporary loss of access/use (temporary work sites)		✓	✓	✓	
Permanent loss (cultivation/grazing land)					✓
Livelihoods (loss of small businesses at construction site)	✓	✓	✓	✓	✓
Livestock farming (loss of pasture land)	✓	✓	✓	✓	✓
Local access (across Barrage)	✓	✓	✓	✓	✓
Downstream irrigators along Shire River		✓	✓	✓	✓
Town water supplies		✓	✓	✓	✓
Tourist facilities					
Construction site at Barrage (Shiri Lodge, Shire Camp)	✓	✓	✓	✓	✓
Health					
Air quality		✓	✓	✓	
Potable water supply		✓	✓	✓	✓
Waste disposal		✓	✓	✓	✓
Noise (close to work sites, 2.5 year construction period)		✓	✓	✓	

Environmental Issue	Pre-construction Phase	Construction Year 1	Construction Year 2	Construction Year 3	Operation Phase
Increased communicable diseases (HIV/Aids, etc., influx of workers)		✓	✓	✓	
Community safety		✓	✓	✓	✓
Water born / vector diseases		✓	✓	✓	✓
Technical disaster scenarios					
Barrage failure		✓	✓	✓	✓
Downstream flooding		✓	✓	✓	✓
Fire, explosion, chemical spill		✓	✓	✓	
Waste management from existing Barrage gates and existing weed boom		✓	✓	✓	
Cultural heritage		✓	✓	✓	

Note construction in year 3 is scheduled for 10 months only.

8 Cost Estimates

All the various costs related to the implementation and management of monitoring and mitigation outlined in the ESMP/ESIA, including institutional development, capacity building and training are summarised in this Section. The cost estimates are essential for future planning purposes of the project.

8.1 Environmental and Social Management Budget

Estimated item costs for all mitigation and enhancement measures and monitoring to be implemented under the ESMP, ESIA and RAP for the Project are provided in Table 9. Certain good practices in engineering act as environmental mitigation and the costs of these are reflected in the Civil Works Contract for the Project rather than under environmental management in this Report.

TABLE 9. ENVIRONMENTAL MANAGEMENT COSTS

Item	Cost (USD)
Resettlement Action Plan Implementation (refer to RAP)	777,482
Environmental Monitoring (including environmental training / capacity building) from this ESMP	614,500
Total	1,391,982

The resettlement / compensation costs are preliminary estimates which will be revised once the Resettlement Action Plan for the Project is completed, in parallel with the Final ESIA.

It should be noted that the costs outlined in Table 9 cover the 34 month construction period and provision will need to be made for some monitoring to continue beyond this time and in some instances for the life of the Project. The extent of ongoing monitoring will be dependent on the outcomes of the review of the monitoring program after construction has been completed.

9 Reference Material

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9.1 Websites

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9.2 Maps/Aerial Photos/Images

The following maps were obtained from the Department of Surveys, Lilongwe:

Malawi 1:50 000 topographic map sheet 1535 A1: Liwonde

Malawi 1:50 000 topographic map sheet 1435 C1: Lake Malombe West

Malawi 1:50 000 topographic map sheet 1435 C2: Lake Malombe

Malawi 1:50 000 topographic map sheet 1435 C4: Naifulu



Figure 6. Floodplain grassland ecosystem, Liwonde National Park (Report cover).

Appendix 1: List of Consulting Staff

Foreign Key Professional Staff

Team Leader / EIA Expert Michael Holics

Regional / Local Key Professional Staff

Water Resources / Hydrology Engineer Barasa Irenius Wandera

Civil Engineer Japhet Rutere

Fisheries Expert Fanuel Kapute

Wildlife Expert Cuthbert Nahonyo

Ecologist Michiel Karl Reinecke

Social Expert Annastella Kaijage

Legal Expert Titus Mvalo

Administration Support Staff

Secretary Evelyn Mwasi

In order to support the Project Team the Consultant has also mobilised the following additional local staff:

EIA / Wildlife Specialist Felix Kalowekamo

Water Quality Specialist Austin Mtethiwa

Social Specialist Emmily Kamwendo

Social Specialist Murphy Kajumi

Botanist Montford Mwanyambo

Appendix 2: Environmental Best Practice Guidelines

ENVIRONMENTAL MANAGEMENT GUIDE

Public Awareness and Community Relations

Objectives	To ensure an awareness of the project exists in the community. To minimise negative impacts and maximise benefits of the proposal on the local community.
Control Measures	The Construction Contractor shall: <ol style="list-style-type: none">1. Advise the local community of project plans in advance of construction, explain safety precautions where necessary and where possible involve them in planning;2. Avoid disturbances near living areas where possible;3. Identify culturally sensitive areas and avoid disturbing them;4. Control runoff and manage sediments especially near privately owned areas;5. Arrange for local people to be employed and trained;6. Include women's and other community groups in project activities; and7. Advise community about approved disposal areas and stockpiles.
Monitoring	The Construction Contractor shall maintain regular contact with the local community to minimize the potential for any problems arising.
Corrective Action	The Construction Contractor shall ensure that the local community has been kept informed about project issues and the above issues resolved prior to commencement of construction works.

ENVIRONMENTAL MANAGEMENT GUIDE

Workforce Training

Objectives	<p>To ensure the construction workforce has a practical understanding of the management measures so that activities are performed in accordance with those measures.</p> <p>To ensure the construction workforce understands the occupational health and safety requirements and that these are implemented at all times.</p>
Control Measures	<p>The Construction Contractor shall implement the following control measures prior to the construction of the works, as indicated below.</p> <ol style="list-style-type: none">1. The Construction Contractor shall organise and conduct induction training for all employed workers covering the following issues:<ul style="list-style-type: none">- site hygiene and health issues, in particular nutrition awareness and the sexually transmitted diseases, HIV/AIDS and hepatitis. This instruction will ideally be provided by local community health centres;- gender and other social issues relevant to each community (as identified by the project's Social Scientist and local authorities);- occupational health and safety requirements, including hazard awareness training, materials handling, industrial deafness, industrial diseases such as silicosis etc; and- waste management, including use of garbage bins and toilet facilities.2. No worker shall be allowed to work on the project unless they have received the above induction training.3. The Construction Contractor shall keep a written and signed attendance record of all workers who have been inducted.4. The Construction Contractor shall ensure all occupational health and safety requirements are in place on construction sites and in work camps.5. The Construction Contractor shall establish a project hazard awareness and hazard reduction plan.
Monitoring	<p>The Construction Contractor shall ensure that all workers have been inducted. The Construction Contractor shall regularly monitor that occupational health and safety requirements are implemented. The Client Representative shall audit that all requirements are met.</p>
Corrective Action	<p>Where occupational health and safety requirements are not being implemented relevant workers shall immediately be trained and instructed to implement these requirements.</p>

ENVIRONMENTAL MANAGEMENT GUIDE

Erosion and Sediment Control

Objectives	To minimise on-site erosion. To prevent off-site sedimentation.
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Control Measures	<p>The Designer shall.</p> <ol style="list-style-type: none">1. Ensure pipeline routes do not follow gully lines or drainage paths.2. Include the requirement for a site rehabilitation plan is included in contract documentation. <p>The Construction Contractor shall implement the following control measures prior to, during and following the construction of the works, as indicated below.</p> <ol style="list-style-type: none">1. Restrict vehicle access onto/from the site to sealed surfaces and designated earth access tracks.2. Schedule construction so that ground disturbance does not occur during the highest rainfall months.3. Schedule construction work so that the river intake work is done in a period of minimum flow.4. Minimise the area of site clearance and ground disturbance by surveying and marking out work sites prior to site disturbance.5. Instruct workers involved in site clearance and earthworks to restrict construction activities to the marked out sites.6. Minimise the period of site disturbance by staging site clearance. Do not clear a site before two weeks of the scheduled bulk earthworks.7. Strip and stockpile all available topsoil as per ESMP prior to land-forming earthworks.8. Control runoff onto, through and from the site via stable temporary and/or permanent drains and/or banks installed early in the construction programme. Drains shall collect and convey clean water around the site, and direct on-site runoff into sediment traps.9. Install sediment controls prior to earthworks, including sediment fences, traps and basins as necessary. Locate controls in order to divide each site into manageable sub-catchments.10. Clean out sediment fences/traps/basins when 60% or more of the capacity is full.11. Maintain erosion and sediment controls during the period of soil disturbance and until the site is stable (i.e. equal to or greater than 70% ground cover).12. Progressively revegetate disturbed areas as soon as construction is
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completed.

13. Backfill and compact pipeline trenches as soon as possible after pipes have been bedded. Avoid long lengths of exposed trenching.
14. Undertake restoration/revegetation of pipeline routes as soon as pipelines have passed pressure and compliance tests.
15. Maintain records of locations where excess spoil has been disposed of.

Monitoring	<p>The Construction Contractor shall monitor erosion and sediment controls until the site is stable and the temporary controls are removed. Controls shall be monitored every fortnight and after each significant storm event, to check that they are in place and working effectively, with sufficient sediment trapping capacity available.</p> <p>The Construction Contractor shall retain photographic records of the condition of all the controls.</p>
Corrective Action	<p>If erosion and sediment controls are inadequate, the Construction Contractor shall redesign and install additional controls in accordance with the EMP measures and the Supervising Engineer instructions.</p> <p>If off-site sedimentation occurs, the Construction Contractor shall immediately make good the damage and improve sediment controls by cleaning out existing controls and/or installing additional controls. The Construction Contractor shall then notify the Supervising Engineer, then review the effectiveness of on-site drains and sediment controls.</p>

ENVIRONMENTAL MANAGEMENT GUIDE

Topsoil Removal and Stockpiling

Objectives	<p>To save all available topsoil for reuse in site revegetation. To minimise the decline in topsoil fertility and seed and vegetation viability during stockpiling. To minimise impacts from topsoil stockpiling.</p>
Control Measures	<p>The Construction Contractor shall save all available topsoil for reuse in site revegetation and minimise impacts from topsoil stockpiling by:</p> <ol style="list-style-type: none">1. stripping all available topsoil from earthwork sites prior to the commencement of earthworks. If the site is only vegetated with ground cover grasses, grass shall be stripped with the topsoil;2. stockpiling topsoil on existing cleared sites on flat land and located at least 10 m away from open drains, watercourses and waterbodies;3. if the stockpile is to remain bare for long in a high rainfall area or during a high rainfall period, it should be covered to prevent erosion and sediment runoff; and4. installing a sediment fence or low earth bank on the downslope side of the stockpile to retain sediment where a grass filter strip does not exist, or where the site is over 3% grade. <p>The establishment of weeds in topsoil stockpiles shall be managed by engaging members of the local community to hand weed topsoil stockpiles. No herbicides or other chemicals shall be used to control weeds. Where excess topsoil results from the works, topsoil should be used to backfill waste disposal sites.</p>
Monitoring	<p>The Construction Contractor shall inspect topsoil stockpiles after each significant rainfall event to check for erosion and downslope sedimentation.</p>
Corrective Action	<p>If sediment is eroding from stockpiles, the Construction Contractor shall install a sediment fence or earth bank along the downslope toe of the stockpile to retain sediment.</p>

ENVIRONMENTAL MANAGEMENT GUIDE

Air Quality Protection

Objectives	To minimize the deterioration of air quality from project activities.
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Control Measures	<p>The Designer shall:</p> <ol style="list-style-type: none">1. Review designs to ensure that structural foot prints are of minimal area2. Ensure that haul distances between sites/structures are minimised <p>The Construction Contractor shall minimise the deterioration of air quality by:</p> <ol style="list-style-type: none">1. Spraying water on exposed surfaces, including earth access roads and exposed rock surfaces, if conditions are dry and windy work may have to cease as large volumes of dust may be generated;2. Earth or soil being transported in trucks is to either be covered or wetted to prevent loss during transit.3. Establish wind speed monitoring: stop all excavation work when wind speed exceeds agreed threshold.4. Installing wind breaks or fences around cement-batching plants;5. Ensure all construction machinery used on site is running efficiently and not producing excessive exhaust emissions.6. Ensure no burning-off of waste is undertaken.
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Monitoring	The Construction Contractor shall monitor wind velocity and site dust levels during earthmoving activities. The Construction Contractor shall also monitor emissions from vehicles and plant.
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Corrective Action	If excessive dust is generated, the Construction Contractor shall immediately water down areas generating dust or, if this is not effective, cease the activities generating dust. Stop all excavation work if wind threshold velocity has been exceeded.
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ENVIRONMENTAL MANAGEMENT GUIDE

Waste Management

Objective	To reuse suitable waste materials generated from the proposed works for productive and non-polluting purposes.
Control Measures	<p>The following measures shall be implemented:</p> <ol style="list-style-type: none">1. All stores waste shall be contained within construction sites;2. Solid waste: all site waste is to be collected and disposed of in an approved registered landfill. Where possible segregation of waste (paper, glass, metal) should be undertaken and recycling opportunities identified.3. Compost or use as animal food all green or organic wastes; and4. Sewage shall be disposed of into sealed pit latrines or into a septic tank system, or other approved sanitation devices.
Monitoring	The Construction Contractor shall regularly monitor the management of wastes to ensure that the above measures are being complied with.
Corrective Action	If it is found that waste is not being managed in accordance with the above measures the situation shall be remedied immediately.

ENVIRONMENTAL MANAGEMENT GUIDE

Noise Control

Objectives	To minimise noise impacts on neighbouring communities.
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Control Measures	<p>The Designer shall:</p> <ol style="list-style-type: none">1. Select and specify only equipment that (in addition to satisfying all other technical requirements) minimizes sound output.2. Incorporate acoustic bafflers in all structures housing noise generating machinery. <p>The Construction Contractor shall minimise construction noise levels and associated impacts by:</p> <ol style="list-style-type: none">1. Undertaking all construction activities strictly within approved hours of operation. Where night-time activities are required, the Construction Contractor shall notify local residents at least three days in advance.2. Ensuring that all machinery and vehicles used are modern and well maintained, and have mufflers correctly fitted.3. If generators are used, located them as far as possible from residential dwellings. Where these are near residential dwellings, noise reduction barriers such as soil bunds/stockpiles or sandbags shall be installed to minimise the level of noise emitted.
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Monitoring	The Construction Contractor shall monitor noise levels at dwellings closest to the work sites during the range of noise-generating construction activities.
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Corrective Action	If local people complain about noise levels or they are deemed to be excessive by the Supervising Engineer, the Construction Contractor shall undertake mitigation measures as directed.
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ENVIRONMENTAL MANAGEMENT GUIDE

Site Decommissioning/ Stabilization

Objectives	To clean up work areas so there is no construction debris left at the sites. To facilitate rapid re-establishment of a grass cover over work areas.
Control Measures	<p>The Construction Contractor shall prepare and implement a site rehabilitation/restoration plan for all areas disturbed by the work. The Contractor shall rapidly stabilize sites and provide long-term surface stability by progressively revegetating discrete areas of each work site as they are completed. The sites shall be revegetated by:</p> <ol style="list-style-type: none">1. Raking or loosening any over-compacted ground surface areas identified for vegetation cover;2. Re-spreading stockpiled topsoil evenly across completed, disturbed sites (including over any permanent fill stockpiles) immediately following construction works. As the vegetation cover of all areas to be stabilised will be grass there will be no need to undertake any planting or weeding. Regular mowing of stabilised areas should ensure that only grasses become established. <p>Sites shall be cleaned-up by:</p> <ol style="list-style-type: none">1. Removing all disabled machinery and construction debris from the works area; and2. Disposing of any oils in an approved manner.
Monitoring	The Construction Contractor shall visit all work areas following completion of works to ensure that no construction material is left there and to check that topsoil has been re-spread as specified above.
Corrective Action	If any construction debris is found at the work sites this will be removed from site immediately.

ENVIRONMENTAL MANAGEMENT GUIDE

Vegetation Clearance and Protection

Objectives	To restrict vegetation clearance to the minimal area necessary, and thereby prevent damage to vegetation outside the work site. To properly dispose of cleared vegetation.
Control Measures	The Construction Contractor shall restrict vegetation clearance to the minimal area necessary and prevent damage to vegetation outside this area. This shall be achieved by surveying and pegging each work site before the commencement of clearing. Where earthworks are proposed, site clearance shall be staged so that no site is cleared more than two weeks before the earthworks to minimize the time that cleared areas are exposed and vulnerable to soil erosion.
Monitoring	The Construction Contractor shall monitor vegetation clearance daily to ensure that it is restricted to the designated work site/s and that no damage occurs to vegetation outside of works areas.
Corrective Action	If clearance occurs outside the marked area, the Construction Contractor shall notify the Project Manager and facilitate re-vegetation of the cleared area by immediately re-spreading the cleared vegetation over the area.

ENVIRONMENTAL MANAGEMENT GUIDE

Excess Fill Disposal

Objectives	To utilize excess fill material for productive purposes where possible, and thereby avoid the double handling of material. To minimize environmental impacts from fill disposal. To prevent the creation of obstacles or the future removal of disposed fill to install other developments.
Control Measures	The Construction Contractor shall: <ol style="list-style-type: none">1. Dispose of excess fill in approved areas. Sites shall generally be at least 10m from watercourses, not excessively steep (i.e. usually less than 10% grade) and free of trees and any other significant vegetation.2. Mark the boundary of the fill disposal site with pegs at 10m intervals.3. Install erosion and sediment controls as required.4. Clear vegetation and strip topsoil off the disposal site and stockpile as per EMP for reuse for site revegetation.5. Landform the fill by placing it in horizontal layers with a maximum depth of 200mm, then compacting each layer to the degree required for the proposed land use, as directed by the Supervising Engineer, creating a free draining profile.6. Revegetate the filled landform by ripping the final compacted layer of fill to a depth of 150-300mm along the contour to create a slightly roughened surface and re-spread stockpiled topsoil.
Monitoring	The Construction Contractor shall monitor the fill disposal activities to ensure that the specified process is correctly followed.
Corrective Action	If the Construction Contractor discovers that the above process has not been properly followed actions will be taken to ensure that fill disposal is in accordance with the specified process.

Appendix 3: Generic Management Plans for Project Construction Phase

The examples below provide an outline of what should be included in each management plan. Each should be modified so they are specific to the Project. The various plans must be prepared by persons with demonstrated skills and experience relevant to a particular plan. The Plans are to supplement the Contractor's Environmental Management Plan (CEMP).

The plans must include all areas affected by the work under Contract including:

- Access and haulage tracks
- Borrow pits and quarries
- Stockpile and storage areas
- Temporary work areas
- Materials processing areas
- Compound areas such as the Contractor's facilities, and
- Concrete batching areas, aggregate washing and sorting areas

Environment, Health and Safety

A well developed Environment Health and Safety (EHS) plan will result in fewer work-related, injuries and illnesses. An EHS Plan should detail the procedures to ensure that healthy and safe working conditions for all people associated with the project, including employees, contractors, visitors and members of the public is provided. The contents of the plan should include the following:

- 1 INTRODUCTION
 - 1.1 Justification for EHS Management
 - 1.2 Benefits of EHS Management
 - 1.3 Scope of the EHS Plan
- 2 PROJECT DESCRIPTION
 - 2.1 Proposed Works Layout
- 3 LEGAL AND OTHER REQUIREMENTS
 - 3.1 Laws and Regulations
 - 3.2 Codes of Practice, Standard Operating Procedures and Technical Guidance Documents
- 4 EHS POLICY
- 5 ORGANISATION, ROLES AND RESPONSIBILITIES
 - 5.1 DIU
 - 5.2 Supervising Consultant
 - 5.3 Contractor
- 6 COMMUNICATION PROCEDURE
- 7 TRAINING AND COMPETENCE
 - 7.1 Induction Training
 - 7.2 Specific Site Safety
 - 7.3 Specialised Training

8	SITE INSPECTION AND MONITORING
9	INCIDENT REPORTING AND INVESTIGATION
9.1	Reporting
9.2	Investigation
10	SITE EHS RULES AND INSTRUCTIONS
11	PERSONAL PROTECTIVE EQUIPMENT
12	EHS DOCUMENT CONTROL AND RECORDING SYSTEM
13	RISK MANAGEMENT
13.1	Objectives
13.2	Risk Register
13.3	Hazard Control Measures
13.4	Risk Assessment and Control Plan
14	OPERATING PROCEDURES AND CODES OF PRACTICE
15	EMERGENCY MANAGEMENT PLANS
16	AUDIT PLAN AND REVIEW PROCEDURE
17	REFERENCES

Traffic Management Plan

This plan sets out the requirements for the management of traffic past, through and/or around a work site. It includes the provision for the safe movement of traffic, the protection of workers from passing traffic and the provision for access to adjoining properties located within the limits of the Contract.

The scope includes the design, construction, maintenance, upgrading and removal of any necessary temporary roadways and detours, the provision of Traffic Controllers to direct and control traffic, and the installation of temporary signs, road markings, lighting and safety barriers. The contents of the plan should include the following:

1	PLANNING
2.1	General
2.2	Project Specific Restrictions and Additional Requirements
2.3	Temporary Speed Zoning
2.4	Traffic Management Plan
2.5	Traffic Staging Plans
2.6	Temporary Roadways Design and Drawings
2.7	Traffic Control Plan
2.8	Road Safety Audit
3	TEMPORARY ROADWAYS AND DETOURS
3.1	Construction of Temporary Roadways and Detours
3.2	Access to Side Roads and Properties
3.3	Opening Temporary Roadways and Detours to Traffic
3.4	Road Safety Audit of Temporary Roadways or Detours
3.5	Removal of Temporary Roadways and Detours

4 TRAFFIC CONTROL DEVICES

4.1 Safety Barriers

4.2 Pavement Markings and Signs

4.3 Portable Variable Message Signs

4.4 Radar Activated Speed Signs

4.5 Temporary Traffic Signals

5 MONITORING OF TRAFFIC CONTROL MEASURES

6 ROAD CONSTRUCTION WORK ADJACENT TO TRAFFIC

6.1 General

6.2 Approved Clothing for Workers Working Adjacent to Traffic (Personal Protective Equipment)

6.3 Plant and Equipment Used for Work Adjacent to Traffic

7 MAINTENANCE OF ROADWAYS

7.1 Existing Roadways

7.2 Temporary Roadways and Detours

7.3 New Roadways Opened to Traffic

Soil and Water Management Plan

The scope of this plan is the design and construction of facilities and implementation of work methods to avoid pollution of water and control erosion and sedimentation for construction works. The contents of the plan should include the following:

1 SOIL AND WATER MANAEGMENT PLAN

2 SOIL AND WATER MANGEMENT MEASURES

2.1 Erosion and Sediment Control

2.2 Stockpile Management

2.3 Water Quality

2.4 Water Quality Monitoring

2.5 Water Extraction

3. OPERATIONAL AND CONSTRUCTION SEDIMENT BASINS/TRAPS

3.1 Design and Construction

3.2 Maintenance of Sediment Basins/Traps

3.3 Removal of Basins/Traps

Erosion and Sediment Control

The scope of this plan is the design and construction of facilities and implementation of work methods to avoid pollution of water and control erosion and sedimentation for construction works. The contents of the plan should include the following:

1. EROSION AND SEDIMENT CONTROL PLAN

2. EROSION AND SEDIMENT CONTROL MEASURES

2.1 Erosion and Sediment Control

2.2 Stockpile Management

- 2.3 Water Quality
- 2.4 Water Extraction
3. DROP INLET SEDIMENT TRAPS AND INLET CONTROL BANKS
4. CLEANING SEDIMENT RETENTION STRUCTURES
5. REMOVAL OF TEMPORARY SOIL AND WATER MANAGEMENT MEASURES

Clearing of Vegetation

The scope of this plan consists of the clearing of all vegetation, both living and dead, all minor built structures (such as fences and livestock yards), all rubbish and other materials which are unsuitable for use in the works, and the grubbing of trees and stumps from works areas.

The work includes the mulching of native trees, stockpiling the mulch, and the removal from site and disposal of all materials from built structures, rubbish, weeds and exotic plants. The contents of the plan should include the following:

1. CLEARING
 - 2.1 Area to be cleared within works area (dam embankment) – to be shown on drawings
 - 2.2 Area to be cleared outside works area (contractor camps, borrow areas etc.) – to be shown on drawings
 - 2.3 Clearing – identify limits of clearing based on statement from ecologist on any plants to be protected as identified in the ESIA.
 - 2.4 Clearing for built structures
3. GRUBBING
4. PRODUCTION AND STOCKPILING OF MULCH
 - 4.1 Mulch
 - 4.2 Mulch Stockpiles
5. DISPOSAL OF MATERIALS (in accordance with waste management plan)

Waste Management Plan

The goal of a waste management plan is to reduce waste across all activities of a Contractor in the exercise of its activities. The key objective of this waste management plan is to provide Contractor personnel with guidance in developing appropriate environmental controls to avoid and minimise adverse environmental impacts associated with waste generation, handling, storage and disposal.

The first step in managing waste is classifying waste into groups that pose similar risks to the environment and human health to facilitate their management and appropriate disposal. The following waste classes are commonly recognised:

- Special waste (e.g. waste from health clinic)
- Liquid waste
- Hazardous waste
- General solid waste (putrescible)
- General solid waste (non-putrescible)

Once a waste is properly classified, appropriate management options for it can be considered. The contents of the plan should include the following:

- 1 INTRODUCTION
 - 1.1 Goal

- 1.2 Objectives
- 1.3 About the Waste Management Plan
- 1.4 Contractor Waste Management Policy
- 1.5 Waste Generating Activities
- 2 KEY LEGISLATIVE REQUIREMENTS AND GUIDELINES
- 3 WASTE MANAGEMENT PRINCIPLES
 - 3.1 Waste Management Principles
 - 3.2 Waste Management Hierarchy
 - 3.3 Waste Classification Procedure
 - 3.4 Waste Classification Summary
- 4 SITE/ACTIVITY SPECIFIC WMAP
 - 4.1 Principle of Site/Activity Specific WMAP
 - 4.2 Developing Site or Activity Specific WMAP
 - 4.3 WMAP For all Contractor Sites
- 5 OIL SPILLS MANAGEMENT
 - 5.1 Introduction Oil Spill Management Plan
 - 5.2 Handling of Waste Oil
 - 5.3 Storing Waste Oil
 - 5.4 Oil or Waste Oil Spill Emergency Procedures
- 6. MONITORING AND REPORTING OF WASTE MANAGEMENT

Appendix 4: Examples of Reporting Forms

Monitoring Form for Land Acquisition and Resettlement/Compensation

Public Consultation

No.	Date	Place	Contents of the consultation/main comments and answers

Resettlement Activities

Resettlement Activities	Planned Total (Unit)	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organization
		During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Updating of RAP								
Employment of Consultants								
Implementation of Census Survey (including Socioeconomic Survey)	Man-month							
Approval of RAP		Date of Approval:						
Finalization of PAPs List	No. of PAPs							
Progress of Compensation Payment	No. of HHs							
Construction-related sites	No. of HHs							
Reservoir area	No. of HHs							
Progress of Land Acquisition (All Areas)	ha							
Construction-related sites	ha							
Reservoir area	ha							
Progress of Asset Replacement (All areas)	No. of HHs							
Construction-related sites	No. of HHs							
Reservoir area	No. of HHs							

Restoration of Income and Living Standard,

Date of Survey:

No.	Name of the Village/Area	No. of Surveyed HHs	No. of HHs with Increased Incomes	No. of HHs with Decreased Incomes	No. of HHs with Unchanged Incomes	Types of Problems Encountered	Perceived Need for Additional Assistance

Grievance Redress

No.	Contents of the Complaints and the response	Resolved/Not yet resolved
1		
2		

Kamuzu Barrage Upgrading Environmental Compliance Monitoring Form

Location: Construction-related site at: (provide GPS coordinates)

Activity (from Project EMP)	Contract Specific Reference (Clause Number)	Compliance Status (1, 2, or 3)	Notes
Access and site roads condition <ul style="list-style-type: none"> ▪ Water diversion berms installed along access roads ▪ Vegetation clearance limited ▪ Other erosion control features in place ▪ Roads detour around homesteads 			
Site clearance <ul style="list-style-type: none"> ▪ Conservation of trees and vegetation during site clearance ▪ Topsoil conservation during site clearance 			
Noise / dust / vibration			
Safe operation of any construction detours			
Safe management of construction traffic			
Construction camps <ul style="list-style-type: none"> ▪ Water supply ▪ Sanitation ▪ Waste management ▪ Fuel and storage ▪ Hazardous materials storage ▪ Energy supply ▪ Health and social services 			

Compliance monitoring key:

- 1 Activity complied with specifications and recommendations
- 2 Activity not at stage for compliance at time of audit
- 3 Activity does not comply with contract specifications (see notes)

Follow-up action taken:

.....

COMPLIANCE MONITOR:

Print name..... Signature..... Date.....

SUPERVISION CONSULTANT (RESIDENT ENGINEER) ACKNOWLEDGEMENT

Print name..... Signature..... Date.....

CONTRACTOR'S REPRESENTATIVE ACKNOWLEDGEMENT

Print name..... Signature..... Date.....