REPUBLIC OF RWANDA

MINISTRY OF AGRICULTURE AND ANIMAL RESOURCES (MINAGRI)

LAND HUSBANDRY, WATER HARVESTING AND HILLSIDE IRRIGATION PROJECT (LWH)

UPDATE OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA)/ENVIRONMENTAL MANAGEMENT PLAN (EMP) FOR NYANZA-23 SITE

FINAL REPORT

Prepared by
Green and Clean Solutions Ltd

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EXECUTIVE SUMMARY

LWH intends to carry out civil works to enhance land husbandry and irrigated agriculture at Nyanza 23 site, located in Nyanza District of Southern Province. For the successful implementation of Land-husbandry, Water-harvesting and Hillside Irrigation (LWH) project, an Environmental Impact Assessment was one of the prerequisite as the project was ranked under category B which requires environmental assessment for subsequent EIA study. The Green and Clean Solutions Ltd (GCS Ltd) successfully conducted the EIA study for selected 8 sites including Nyanza 23 and the EIA report was approved by the World Bank and an EIA certificate issued by Rwanda Development Board (RDB) as per national EIA guidelines.

Due to shifting of the dam location, thereby causing a relocation in the irrigated command area to the most suitable site with regard to the Project approach and objectives, the existing EIA was updated to ensure that potential related adverse impacts are identified and mitigation measures are put in place before the commissioning of water harvesting and hillside infrastructures construction works.

This Environmental Impact Assessment study was updated by Green and Clean Solutions Ltd (GCS Ltd). The main objective of this consultancy service was to ensure that the existing EIA report for Nyanza 23 is updated as per the new changes in dam location and irrigated command area.

Methodology
To identify and predict the various social and environmental impacts that may emanate from the planned activities in the new site, various study methods and tools were incorporated. These included checklists, expert opinion and observations. An in-depth analysis of public concerns from the interested and involved parties was undertaken and views incorporated in this report.

This involved the discussions and dialogue with the project stakeholders and partners through public forums and one on one interviews at the project sites.

Positive impacts
The positive impacts identified include increased and diversified agricultural productivity as well as increased household income through improved Land Husbandry, Water Harvesting and Hillside Irrigation.

The acquisition of raw materials and necessary fitting and components as well as employment for these project activities can significantly reduce poverty within the project activities area. The trading of goods and services will contribute to the upward development trend of the district of Nyanza as well as the surroundings.
This LWH project has the following positive environmental impacts and tremendous socio-economic benefits among others:

- **Physical Impacts** (Catchment Rehabilitation and Management, Flood Control, Water Resources Conservation, Improved soil conservation)
- **Ecological Impacts** (Revegetation, Environmental Protection, Birdlife and Fish Habitat)
- **Socioeconomic Impacts** (Increased farm incomes from crop output, Food Security, Poverty Alleviation, Rural employment, Market creation, Appreciation of the value of land, Capacity building of farmers)
- **Impacts on Local and National Production and Economy** (Increased exploitable area and productivity, Crop diversification, Employment generation and poverty alleviation, Livestock Development, Multiplier effects, Increased public revenues, Contribution to national crop production and national economy, Provision of fuel wood).

**Adverse impacts**

The baseline data collection was primarily investigated through desktop studies and sites visits, photographic capture and direct public consultation interviews with the interested and involved stakeholders. Issues that arise as of significance for this project’s environmental performance are the following among others:

- **Physical Impacts** (Soil erosion, Topsoil Stock Piles, Destruction of water points, Borrow Pit Impacts, Reduced Water Flow/Downstream Flooding, Water wastage, Changes in Hydrology, Surface Water Resource Pollution, Sub surface Water Contamination, Fear of an overflow of water if it rained so heavily, Internal Seepage Control Measures, Land Use Change, Canal Siltation, Seepage and leakage)
- **Biological Environment** (Destruction of hillside biodiversity, Water Weeds)
- **Social Environment** (Resource Use Conflict, Population Migration, Increased Spread of Water Borne Diseases, Drowning of livestock and children, Dam Safety Impacts, Resource Use Conflict, Emergence of Pests and Crop Diseases)

However the above potentially adverse impacts identified are mostly short term and manageable in nature and expected to occur during the project implementation but can be improved through the identified and proposed mitigation measures.
Environmental Mitigation and Monitoring Measures
The study has developed environmental mitigation and monitoring measures outlining the areas of consideration. Overall, the project activities in the new site are environmentally feasible and sound with potential negative impacts, which can be minimized or completely mitigated through incorporation of corrective, rehabilitation, restoration and instituting of appropriate mitigation measures. These have been integrated into the project decision-making level so as to ensure that the project designs take into consideration all the highlighted aspects of this study.

Recommendations
This study has proposed a number of generic recommendations while the Nyanza site has a stand-alone Environmental Management Plan. The project would need to implement these recommendations for mitigating adverse impacts and prevent the potential ones.

This study has suggested numerous mitigation measures to curtail the negative environmental impact of LWH project activities in this new site. Those mitigation measures include reforestation, monitoring of water quality from developed valley dams, and supporting of public trainings and sensitization on environment issues.

The suggested recommendations emphasize the necessity to properly implement mitigation measures and highlight roles and responsibilities of stakeholders. All the stakeholders should join efforts to implement them, providing all the technical, financial and manpower resources needed.

Some of the recommendations are given below:

- Devolve prime responsibility to the community, especially farmers: in this regard, they will need to be trained in good farming husbandry and efficient irrigation practices as well as maintenance of hillside irrigation infrastructures.

- Integrated catchment management approach: local community in the project area should be encouraged to undertake integrated catchment management and restoration especially in those areas that are deforested and affected by soil erosion through afforestation, soil and conservation measures including terracing and agroforestry practices on farms.

- Natural processes are strongly interlinked when for example it became clear that construction of a valley dam affects the recharge of ground water, when sediments, nutrients and seeds from the upper catchment’ areas are transported to mark the downstream. That is why an integrated catchment management approach is necessary to co-ordinate use of land, water and vegetation.
This same integrated approach should be the guiding light when implementing mitigation measures for any negative environmental impact of LWH project activities in the new site.

The strategies for an Integrated Catchment Management approach in the LWH project area are proposed:

Areas within a catchment are linked by the flow of water downstream, which cause downstream transport of sediments, nutrients, pollutants and seeds from the upper catchment. It is therefore important to follow an integrated catchment management approach to ensure the recharge of groundwater, and to recognize the role of vegetation in controlling the quantity and quality of surface and groundwater flowing through the catchments. The proposed strategies for an Integrated catchment management approach are described below:

**Catchments**
- Improve communication, consultation and coordination of community-based natural resource management and activities throughout the area/catchments.
- Facilitate implementation and promotion of regional community-based natural resource management planning.
- Enhance whole-of-catchment awareness

**Water**
- Ensure a project zone approach to surface and underground water quality management
- Determine status and extent of water quality and salinity in the project zone
- Develop and implement a whole of project zone approach to the prevention and mitigation of water quality and irrigation salinity.
- Coordinate activities throughout the region that are addressing the issues associated with all forms of runoff entering the water resources around the project zone.

**Vegetation**
- Contribute to a regional approach to management of remnant and protected vegetation.
- Encourage vegetation management at the property scale across the project zone.
- Facilitate involvement of the community in vegetation management activities throughout the project zone.

**Habitat and biodiversity**
- Define status and identify gaps in habitat and biodiversity protection in the project zone.
- Ensure coordinated data collection and benchmarking across the project zone.
- Facilitate project area community awareness and education of the habitat and biodiversity values.

**Soil conservation**
- Define status and extent of soil erosion across the project zone.
- Investigate methods to ensure best practice erosion control is practiced throughout the project zone and across all land uses.
- Facilitate soil erosion awareness in the broader community.

**Social and economic**
- Facilitate whole of community involvement in natural resource management activities throughout the project zone.
- Develop and implement training and capacity building packages for the project zone natural resource management community.
- Investigate methods of addressing the issue of rural decline.

As a vital capacity builder and partner LWH project should keep up with supporting public awareness campaigns on environmental issues. Public training and sensitization exercises should be pursued throughout the intervention zones, targeting various groups especially the youth.

As a matter of national policy, private contractors are indicated to be responsible for the management and maintenance of LWH project infrastructures during operational phase

Enhancing active participation of public in the LWH proposed activities would ensure successful implementation and ownership of the proposed LWH activities. In order to enhance public participation, the following actions are recommended:

- Local authorities need to play a proactive role in ensuring that non-governmental, community-based and private-sector institutions and the public with an interest in the LWH project comply with environmental requirements;
- NGOs, CBOs and private sector activities in relation with LWH project should be coordinated by mapping out objectives, as well as by supporting capacity building and outreach. In particular, this may entail the promotion of local and national networks at LWH project level;
- Efforts should be made to maintain correct data, document environmental best practices and disseminate information to all stakeholders;
- A comprehensive analysis of stakeholders’ strengths and weakness should be performed. This analysis will provide the basis for targeted capacity building focusing on relevant environmental themes pertaining to the LWH project.
Such themes could potentially include the potential economic benefits of reliable infrastructures, safety issues pertaining to the implementation of different Project activities;

- Capacity-building initiatives should also be directed towards local authorities in the LWH project area, as well as district authorities;

- Transparency and accountability should be maintained at all times during dealings with stakeholders;

- Efforts should be made to ensure that sufficient funds are allocated to NGOs, CBOs and private organisations to ensure that they are able to fulfil their roles with regard to the implementation of the LWH project activities. Such efforts could include fundraising and lobbying of the government authorities;

As far as possible, participation structures should build on and cooperate with existing networks in the LWH project area; and

All key stakeholders should be included in the project implementation right from the beginning.
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ACRONYMS AND ABBREVIATIONS

- ARAPs: Abbreviated Resettlement Action Plans
- EMP: Environment Management Plan
- EO: Environmental Officer
- ETo: Evapotranspiration
- FAO: Food and Agriculture Organization
- HCFs: Health Care Facilities
- ISAR: Institut des Sciences Agronomiques du Rwanda
- IPM: Integrated Pests Management
- MINAGRI: Ministry of Agriculture and Animal Resources
- MININFRA: Ministry of Infrastructure
- MINISANTE: Ministry of Health
- LWH: Land Husbandry, Water Harvesting and Hillside Irrigation
- PAPs: Project Affected People
- PMU: Project Management Unit
- PMF: Probable Maximum Flood
- RAPs: Resettlement Action Plans
- REMA: Rwanda Environment Management Authority
- RPF: Resettlement Policy Framework
- WB: World Bank
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Jean BIGAGAZA
Team Leader

This report was prepared by independent consultants with no previous involvement in the activities mentioned. Responsibility for the content and presentation of findings and recommendations rests with the study team. The views and opinions expressed in the report do not necessarily correspond to the views of MINAGRI/LWH.
I. INTRODUCTION

I.1. BACKGROUND TO THE PROJECT

The Government of Rwanda is pursuing a comprehensive Poverty reduction program which includes development and implementation of different sustainable development projects. The Land husbandry, Water harvesting and Hillside irrigation (LWH) Project is one of the development initiatives designed under the Ministry of Agriculture and Animal Resources (MINAGRI) and partly funded by the World Bank in order to tackle the issues related to food insecurity and rural communities livelihoods income.

The LWH project is aiming at modernization and commercialization of agriculture for strengthening the economic access of the rural communities to food for consumption and livelihoods improvement. The emphasis of LWH is on broadening and deepening the support provided to the rural communities.

The Project has three components aimed at (A) developing the human and organizational capacity and (B) the required physical infrastructure for hillside intensification and transformation, as well as a third component (C) for Sector Wide Approach (SWAp) project management.

The Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) Project uses a modified watershed approach to introduce sustainable land husbandry measures for hillside agriculture on selected sites, as well as developing hillside irrigation for sub-sections of each site. The Project envisions the production of high-valued (organic) horticultural crops with the strongest marketing potential on irrigated portions of hillsides of the watershed. It is in this regard that the Project will invest in water harvesting infrastructure, including valley dams and water reservoirs construction on the selected sites. Water harvesting infrastructure will be developed jointly with the irrigation infrastructures including the water conveyance channels.

As per its magnitude and the scale of activities to be implemented under LWH Project, the project requires the preparation of an Environment Impact Assessment (EIA) and the subsequent Environment Management Plans (EMPs). For this purpose, an EIA for Nyanza has been conducted and the site specific EMPs have been developed.

The physical implementation of the project activities in Nyanza 23 site started in January 2011 by the protection of the respective water catchment area with land husbandry technologies including improved bench terraces, soil bunds, Afforestation, etc.
Due to shifting of the dam location to the most suitable site with regard to the Project approach and objectives, the update of the existing EIA was found necessary to ensure that potential related adverse impacts are identified and mitigation measures are put in place before the commissioning of water harvesting and hillside infrastructures construction works.

LWH project contracted Green and Clean Solutions (GCS) Ltd to undertake an update of Environmental Impact Assessment for Nyanza. The EIA process commenced in March 2012, and has culminated in the compilation of the present report.

I.2. OBJECTIVE OF THE CONSULTANCY

The main objective of the consultancy service was to ensure that the existing EIA report is updated as per the new changes in the dam location and irrigated command area.

Specifically, the consultant was requested to update the existing EIA report by evaluating all potential environmental and social impacts proposed dam construction and development of hillside irrigation infrastructure of Nyanza site in Nyanza District of the Southern Province of Rwanda, and suggest necessary mitigation measures which will effectively address the negative impacts in compliance with national and World Bank regulations.
II. REVIEW OF POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

Rwanda has sufficient legal instruments to ensure sustainable use of natural resources and environmental management. Most of the environmental legislation and policies in Rwanda were promulgated through the National Environment Action Plan (NEAP) process. The overall objective of NEAP is to integrate environmental concerns into the social and economic development process in the country. The NEAP therefore outlines a strategy and programme for addressing environmental issues and forms the basis for the current environmental policy in Rwanda.

The main thrust of NEAP is to identify environmental issues and problems, analyze their causes and recommend measures to resolve the issues for each sector. Creation of awareness at all levels of society of the environment and its relationship to socio-economic development and of the necessity for rational resource use among sectors of the country is a vital part of the overall objective. Public participation in the environmental decision-making process is an important element of the Rwandan policy. Amendment of existing legislation to enhance environmental quality is also a part of the NEAP process.

The protection and management of environment are among the pillars of Vision 2020, the development strategy for Rwanda. The environmental objective of the Government is that by 2020, it will have built a nation in which pressure on natural resources, particularly on land, water, biomass and biodiversity, has significantly been reduced and the process of environmental pollution and degradation has been reversed; a nation in which the management and protection of these resources and environment are more rational and well regulated in order to preserve and bequeath to future generations the basic wealth necessary for sustainable development in envisaged.

In this section of the report, the review of the legal, policy, institutional framework and development strategy were made in line with the environmental and social requirements for Rwanda. The review of relevant World Bank Safeguards/Operational Policies applicable to the project as well as the international laws and conventions that bear significance to the implementation of this project was also done.

II.1. LEGAL FRAMEWORK


As the supreme law of the country, the constitution of the Republic of Rwanda stipulates that the state shall protect important natural resources, including land, water, wetlands, minerals, oil, fauna and flora on behalf of the people of Rwanda.
This constitution entrusts the Government with the duty of ensuring that Rwandese enjoy a clean and healthy environment.

Article 49 states that every citizen is entitled to a healthy and satisfying environment. Every person has the duty to protect, safeguard and promote the environment. The state shall protect the environment. The law determines the modalities for protecting, safeguarding and promoting the environment.

**II.1.2. EIA Guidelines for Rwanda**

The Organic Law on environment protection made the Environmental Impact Assessment (EIA) mandatory for approval of major development projects, activities and programs in the Republic of Rwanda. By mandate of parliament of the Government of Rwanda, as conferred upon the Minister of Natural Resources, responsible for environment, in the Organic Law N° 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda, the following guidelines pertaining to the contents of Chapter 4, articles 67-70, concerning Environmental Impact Assessment by the Rwanda Environment Management Authority (REMA) and as endowed with this power in Chapter 3, paragraph 1° of Article 65. Thus, these EIA guidelines serve as a protocol for use by various stakeholders involved in the conduct of environmental impact assessment.

However, besides the legislation, guidance is needed of a more technical nature to streamline the conduct of EIA and appraisal of EIA reports. As such, the establishment of “General Guidelines and Procedures for Environmental Impact Assessment”, which unifies the legal requirements with the practical conduct of EIA, meets a need in the pursuit for sustainable development in Rwanda. The “General Guidelines and Procedures for Environmental Impact Assessment” were prepared to contribute to improvement of EIA practice in Rwanda and they aim to serve agencies and individuals taking part in the EIA process. These guidelines were designed to ensure that participants in the EIA process understand their roles and that laws and regulations be interpreted correctly and consistently.

Two main principles underlie these general guidelines:

- They comply with the legal and institutional frameworks on environmental protection in Rwanda and;
- They contribute to improvement of quality and efficiency of EIA process in the country, and as such merge, step by step, with general global trends and practice of conducting EIA.

These general guidelines were developed with the aim of providing information necessary when carrying out an environment impact assessment. It should be noted
that the team carried out this EIA study under the guidance of these general guidelines.

In addition to General Guidelines and Procedures for EIA, the list of activities that require undertaking EIA was established through the ministerial order No 004/2008 of 15/08/2008. Dam construction and irrigation activity is among activities that are subject to EIA before being granted permission to start.

II.1.3. Use and Management of Land legislation in Rwanda

Article 12 of the law entrusts the state with ownership over land including lakes, rivers, natural forests, national parks, swamps/marshes, and touristic sites among others. Article 29 gives the state control over swamps and/or marshlands.

The law calls for inventory of the all swamps and their boundaries the structure of the swamps, their use, how they can be organized. According to article 29 of the Land Organic Law, swamp land belongs to the state. In order for the swamp land to be efficiently managed and exploited, a Minister having Environment in his or her attributions must give an order that shall determine a list of swamps and their boundaries. The law further requires that such a list shall clearly indicate the structure of the swamps, their use, how they can be organized so that they can be beneficial to Rwandan nationals on a sustainable basis. The ministerial order must also certify the modalities of how swamp land shall be managed, organized and exploited.

II.1.4. Environment Protection and Management Legislation

The Organic Law on Environmental Protection, Conservation and Management stipulates the general legal framework for Environment protection and management in Rwanda. This legislation focuses on avoiding and reducing disastrous consequences on Environment. The Ministry of Natural Resources (MINIRENA) is charged with the responsibility of propagating this organic law regarding environmental conservation.

Legislative and regulatory framework related to Environmental management is established by the Government of Rwanda in organic law Nº 4/ 2005 of 2005. Chapter 4 of Title 3 provides for Environmental Impact Assessment as a requirement for every proposed project that might affect the environment. Article 67, stipulates that: “Every project shall be subjected to environmental impact assessment, before obtaining authorization for its implementation. This applies to programmes and policies that may affect the environment. An order of the Minister having environment in his or her attributions shall determine the list of projects mentioned in this organic law”. Article 68 provides the guidelines for conducting Environmental Impact Assessment. Article 69 stipulates that: “The environmental impact assessment shall be examined and approved by the Rwanda Environmental
Management Authority or any other person given a written authorization by the Authority.

The proponent pays a levy reduced from the operating cost of his or her project excluding the working capital. This tax is determined by the law establishing the National Fund for the Environment. The environment impact assessment shall be carried out at the expense of the proponent”.

Article 70 provides for: “An order of the Minister having environment in his or her attributions establishes and revises the list of planned works, activities and projects, and of which the public administration shall not warrant the certificate, approve or authorize without an environmental impact assessment of the project. The environmental impact assessment shall describe direct and indirect consequences on the environment”.

Article 80 stipulates that: “Buildings, agricultural, industrial, commercial or artisan establishments, motor vehicles and other movable properties that are productive owned either by a person or by a public or a private association, shall be constructed, exploited and used in conformity with existing technical standards approved or indicated by implementation of this organic law”.

Article 81, prohibits the following:

- Dumping or disposal of any solid, liquid waste or hazardous gaseous substances in a stream, river, lake and in their surroundings;
- Damaging the quality of air and of the surface or underground water;
- Non authorized bush burning;
- Smoking in public and in any other place where many people meet;
- Defecating or urinating in inappropriate place;
- Spitting, discarding mucus and other human waste in any place.

Further, Article 82 stipulates that: “It is prohibited to dump any substances, in any place, which may:

- Destroy sites and buildings of scientific, cultural, tourist or historic interest;
- Kill and destroy flora and fauna;
- Endanger the health of biodiversity;
- Damage the historical sites and touristic beauty at the lakes, rivers and streams”.

Article 83 stipulates that: “It is prohibited to dump in wetlands:

- Waste water, except after treatment in accordance with instructions that govern it;
- Any hazardous waste before its treatment. Any activity that may damage the quality of water is prohibited”.

Regarding constructions, article 87 stipulates clearly that: “It is prohibited to construct houses in wetlands (rivers, lakes, big or small swamps), in urban or rural
areas, to build markets there, a sewage plant, a cemetery and any other buildings that may damage such a place in various ways.

It further provides for all buildings to be constructed in a distance of at least twenty meters (20m) away from the bank of the swamp.

If it is considered necessary, construction of buildings intended for the promotion of tourism may be authorized by the Minister having environment in his or her attributions”.

It is also prohibited to carry out any activities, except those related to research and science, in reserved swamps. The order of the Minister having environment in his or her attributions determines the list of plains in which construction is not permitted and the swamps that are reserved according to assessments of the experts.

Article 88 stipulates that: “it is prohibited to:

- Dump, make flow, dispose of and store any substance in a place where it may cause or facilitate water pollution on the national territory;
- Use natural resources in a degrading and illegal manner;
- Release into the atmosphere poisonous gases, smoke, waste, soot, dust and any other chemical substances in an illegal manner”.

Further, Article 89 stipulates that: “In accordance with regulations provided for by International Conventions signed and ratified by Rwanda, it is prohibited to dump, eliminate, immerse any chemical substance in water and in any other place where it may:

- Threaten general public health and biological resources;
- Harm navigation, fishing and others;
- Deteriorate the beauty of a place which is potential for its aquatic tourist interest”.

It is in line with the above legal provisions and Article 95 which stipulates that: “Any one or association that does not carry out environmental impact assessment prior to launching any project that may have harmful effects on the environment is punished by suspension of his or her activities and closure of his or her association and without prejudice to be ordered to rehabilitate the damaged property, the environment, people and the property, for this reason that among others that LWH is conducting an EIA for the proposed projects in Nyanza 23 site.

II.2. POLICY FRAMEWORK FOR RWANDA

II.2.1. Vision 2020

One of the pillars of vision 2020 for the Republic of Rwanda is environmental protection and management. By 2020, the Government of the Republic of Rwanda envisages to have built a nation where stress on natural resources mainly land,
water, forestry, biodiversity will have reasonably been decreased and the pollution process and environmental degradation reversed.

It is further stipulated that, the management and protection of these natural resources be given more attention in order to preserve and conserve for the future generations.

To achieve the objectives of Vision 2020, the Republic of Rwanda will ensure:

- The environment issue is integrated into all education, sensitization, and development policies and programmes as well as in all decision-making processes;
- The promotion of grassroots’ communities participation with more involvement of women and the youth in environment protection and management;
- That the precaution principle is set up to alleviate negative effects of socio-economic activities to our environment;
- A diversification of energy sources that will be made available to the population to decrease pressure on biomass;
- That the “polluter-pays” principle as well as preventive and penal measures are set up to safeguard the environment;
- That a study on environmental impact be conducted for any development project and programme;
- The planning of industrial sites establishment and control of their effects on environment and the population;
- The promotion of more environment friendly transport, stocking and industrial products and waste elimination technologies;
- Regulations relating to mine exploitation and mine discharge treatment are applied;
- Rehabilitation of former quarry sites;
- That the Bureau of Standards for local and imported products is strengthened;
- A statistic database on natural resources and environment and a quick alert system to mitigate anticipate natural disasters are set up and that a scheme for victims of a natural calamity is created;
- That Rwanda Environment Management Authority (REMA) is set up and supported,
- The cooperation with other countries and international institutions in the area of environment protection and management.

II.2.2. National Policy on Environment for Rwanda

The policy seeks to achieve its overall objective of the improvement of human wellbeing, the judicious utilization of natural resources and the protection and rational management of ecosystems for a sustainable and fair development through improved health and quality of life for every citizen and promotion of sustainable socio-economic development through a rational management and utilization of resources and environment, integrating environmental aspects into all the development policies, planning and in all activities carried out at the national,
provincial and local level, with the full participation of the population, conservation, preserve and restoration of ecosystems and maintenance of ecological and systems functions.

The key principles mention among others that:

- It is every person's right to live in a safe and stable environment, but on the other hand, they must keep it healthy;
- The national economic growth must be based on rational use of resources and take into account environmental dimensions;
- Active and effective participation of the whole population for environment protection and management;
- A special emphasis must be laid on environmental education and sensitization programme at all levels with more involvement of women and the youth;
- Environmental impacts are to be analyzed while conducting studies of development projects.

Further, the policy proposes the elaboration or updating of master plans and special planning in urban areas with regard to population and land development aspects. In natural resources management (including land and water), the policy proposes:

- Ensure the preservation and protection of soils against any form of degradation;
- Ensure that a prior study of environmental impact which underlines costs and benefits from slopes and underlying ecosystems protection is conducted for any development projects and;
- Encourage programmes of rainwater collection, stocking and use.

The policy also proposes the following in regard to biodiversity, forests, wetlands management and other natural reserves and or ecosystems:

- Set up protection measures for slopes to avoid degradation of swamps;
- Promote the rehabilitation of ecosystems under degradation and restoring endangered species.
- On the issue of environmental education, information and research, the policy proposes among others to reinforce the human and institutional capacity building with regard to environment and to sensitize the population to protect the environment.

On health and sanitation, the policy proposes among others:

- Set up a system of waste collection, transport, disposal and elimination;
- Establish norms of zone protection between dumps, human buildings and water sources;
- Set up an appropriate canal and evacuation system for waste waters and rainwater in towns and resettlement sites “Umudugudu”.

Further, the policy proposes the elaboration or updating of master plans and special planning in urban areas with regard to population and land development aspects. In natural resources management (including land and water), the policy proposes:
The National Policy on Environment for Rwanda harmonizes other policies like agriculture, energy policy. The policy further proposes that the Central Government will be concerned with conservation and protection policies while tourism and environmental management will be transferred to the District and Kigali City levels.

II.2.3. National Water Resources Management Policy

The overall goal of Rwandan water resources management policy is to enhance and promote all national efforts towards the efficient, equitable and optimum utilization of the available Water Resources of Rwanda for significant socioeconomic development on sustainable basis. The policy aims at fair and sustainable access to water, protection of the water resources and promotion of cooperation for management of river basins, etc. through reforestation on hillsides and water catchment areas. The policy underlines the fundamental principles that water is a natural endowment commonly owned by all the peoples of Rwanda and that every Rwandan citizen shall have access to sufficient water of acceptable quality, to satisfy basic human needs.

The policy also needs to adopt a holistic approach to the management of water resources and integrate other policies related to it including the forest, wetlands, agriculture and land. It is relevant to all project activities that will be undertaken in areas with water resources. This policy is therefore relevant to this project as most of the project activities will be undertaken within the water catchment areas of Nyanza 23 site.

II.2.4 Policy on Land Resource

The Rwanda land policy calls for rational use and sound management of national land resources and be based on master plans. The policy also provides development of land use plans based on suitability of the areas/lands thus distinguishing the different categories of land and their purpose.

The policy promotes irrigating areas that are more or less flat and semi-arid to support agricultural production while discouraging overgrazing and pasture burning. On the use and management of hillsides and marshlands, the policy stipulates that marshlands meant for agriculture should be cultivated after adequate planning and Environmental Impact Assessment.

II.2.5. Policy on Agriculture Sector

The main objective of this policy is to intensify and transform subsistence agriculture into market oriented agriculture. The use of contemporary inputs like improved seeds and fertilizers is envisaged. This policy puts emphasis on marshland development for increased food production because the soil on hills is degraded by erosion and rendering it unproductive.
The policy promotes small scale irrigation infrastructure development in the selected marshlands while preventing environmental degradation and ensuring sustainable development. In order to achieve sustainable development in agricultural sector, the policy emphasizes the need to adopt Integrated Pest Management (IPM) practices.

The use of IPM practices is highly recommended in this environmental impact assessment study as this will guide on the best use of pesticides.

II.2.6. Marshlands Development Master Plan
Rwanda has formulated a master plan for marshlands development which among other things provides for the protection of water catchments and soil conservation based on hydrology, pedology, environmental, agro economic and sociological studies. It will target to develop 40,000 ha of marshlands by 2020.

The plan also calls for development of a marshland to go hand in hand with the management of the hillsides associated with them. The master plan recognizes the role of Environmental assessment in planning for economic development especially in the agricultural sector.

II.2.7. National Biodiversity Strategy and Action Plan
This strategy defines the objectives and priorities for the conservation and sustainable management of biodiversity. The action plan includes hillsides, wetlands and protected areas as some of the areas that need to be conserved.

The national biodiversity strategy and action plan approved in June 2000, defined the objectives and priorities for sustainable biodiversity conservation and management. Biodiversity includes wetlands, protected areas and the strategies are ranked as follows: Political and legal frameworks relating to environment unknown by the population and/or decentralized entities; ii) low level of awareness among people with regard to environment; iii) inadequate exploitation of forests; iv) erosion; v) exploiting quarry sites without restoring exploited parts; vi) insufficient knowledge on environment status; vii) weakness of decentralized structures in environment management; viii) absence of appropriate environment-friendly technologies.

The strategy on biodiversity aims at: improving conservation of protected areas and wetlands; sustainable use of biodiversity in natural ecosystems and agro-ecosystems; rational use of biotechnology; development and strengthening of policy, institutional, legal and human resources frameworks; and equitable sharing of benefits derived from the use of biological resources.

There is need to undertake an inventory of wetlands in the country which will allow planning for these ecosystems.
II.2.8. Policy on Health Sector

One of the objectives of this policy is to improve the quality of life and demand for services in the control of disease. The policy identifies the most common illnesses in Rwanda and puts priority to addressing these diseases. Irrigation projects, envisaged for within Nyanza hillside, have a vital role to play in the increased incidences of malaria and schistosomia, especially in the irrigation channels and water reservoir. The policy emphases on environmental control of this disease incidence especially in marshland areas.

II.2.9. Policy on Water and Sanitation Sector

This policy is based on vision 2020, millennium development goals (MDGs) and poverty reduction strategy. The policy provides for decentralization vis-à-vis integrated watershed management, monitoring, assessment and participatory approach to water and sanitation.

The policy identifies the sub-sector constraints and proposes measures to achieve policy objectives of improving the living conditions of the population through optimal use of water resources and access of all to water and sanitation services. One of the programs of this policy is on water supply and sanitation program in rural area.

The policy proposes measures to achieve policy objectives of improving the living conditions of the population through optimal use of water resources and access of all to water and sanitation services. A key programme of this policy is on water supply and sanitation program in rural areas. In order to achieve the MDGs and the 2020 Vision of Rwanda, the Government of Rwanda launched 15 years water and sanitation program in rural area. This program aims to increase the number of people with access to water, presently at 44%, and increase the sanitation services, presently at 8%, to 66% in 2010, to 80% in 2015 and 100% in 2020.

II.2.10. National Poverty Reduction Strategy

The National Poverty Reduction Strategy promotes the transformation of subsistence agriculture into modernized agriculture, which is market oriented as one of the priority area. Other priority areas include human development which covers the actions of improving living conditions of the poor, economic infrastructure, governance, development of the private sector and the institutional reinforcement. All these are part of the projects envisaged by LWH for Nyanza 23 site.
II.3. INSTITUTIONAL FRAMEWORK

II.3.1. Ministry of Natural Resources
The Ministry of Natural Resources (MINIRENA) is the ministry responsible for the environment. It has the following missions:

- Prepare and ensure the follow up and evaluation of policies, strategies as well as environment protection;
- Prepare draft bills and establish norms and practices for rational exploitation and efficient Land management, Environment, Water Resources and evaluate their implementation;
- Promote research and exploit Rwandan underground natural resources and set up appropriate mechanisms for their extraction and valuation;
- Plan and follow up pure water distribution programme and basic health activities;
- Initiate incentive measures and support programmes to private sector and civil society so as to invest in land protection activities, Water Resources and Environment;
- Coordinate stakeholders’ activities and mobilize necessary resources for land management and land use planning, Water Resources as well as Environment protection.
- Reinforce capacities of decentralized entities in matters of land management, Water Resources and Environment.

II.3.2. Rwanda Environment Management Authority
With regards to the management of the bio-physical environment throughout Rwanda, the overall responsibility now lies with the Rwanda Environment Management Authority (REMA). In November 2005, the Government of Rwanda approved the law establishing the Rwanda Environment Management Authority (REMA).

The functions of REMA are:

- To implement Government environmental policy and decisions of the Board of Directors.
- To advise the Government on legislative and other measures for the management of the environment or the implementation of relevant international conventions, treaties and agreements in the field of environment, as the case may deem necessary.
- To take stock and conduct comprehensive environmental audits and investigations, to prepare and publish biannual reports on the state of natural resources in Rwanda.
- To undertake research, investigations, surveys and such other relevant studies in the field of environment and disseminate the findings.
- To ensure monitoring and evaluation of development programs in order to control observance of proper safeguards in the planning and execution of all development
projects, including those already in existence, that have or are likely to have significant impact on the environment.

- To participate in the setup of procedures and safeguards for the prevention of accidents and phenomena which may cause environmental degradation and propose remedial measures where accidents and those phenomena occur.
- To render advice and technical support, where possible, to entities engaged in natural resource management and environmental protection.
- To provide awards and grants aimed at facilitating research and capacity-building in matters of environmental protection.
- To publish and disseminate manuals, codes or guidelines relating to environmental management and prevention or abatement of environmental degradation.

REMA was initially responsible for reviewing and approving EIA reports. However, this duty was now assigned to the recently created Rwanda Development Board (RDB) where a department of EIA has been created and tasked with review and approvals of all EIA studies.

II.3.3. Rwanda Development Board

This is a one stop institution bringing together several government bodies in Rwanda focused at promoting investment in Rwanda. RDB has created a department of EIA responsible for reviewing all projects EIA before approval; a duty that was previously undertaken by REMA.

The Chapter 4 of the Organic Law in Article 65 clearly calls for the need to subject projects to mandatory Environmental Impact Assessment. The Article 65 further specifies that every project shall be subjected to environmental impact assessment prior to its commencement. It shall be the same for programs, plans and policies likely to affect the environment. Specific details of projects referred to in this Article shall be spelt out by the order of the Minister in charge of environment.

The article 66 states that Environmental Impact Assessment (EIA) shall include at least the following:

- A brief description of the project and its variants.
- Analysis of direct and indirect foreseeable consequences on the environment.
- Analysis of the initial state of the environment.
- Measures envisaged reducing, preventing or compensating for the consequences.
- Reasons for the choice.
- A summary of requisitions from clause 1 to 5 of this article;
- A definition of the evaluation and monitoring methods used regularly and environmental indicators before (initial state), during and after implementation of the project or, as the case may be, at the final evaluation stage of the project;
• A financial evaluation of measures recommended preventing, reducing or compensating for the negative effects of the project on the environment and measures for regular monitoring and control of relevant environmental indicators.

Rwanda also adheres to several international agreements, treaties and conventions, though management legal tools are not yet well developed. Among other conventions ratified by the Republic of Rwanda, the most important ones which have influenced or influence the national policy with regard to environment are:

• RAMSAR Convention on February 2nd, 1971 on wetlands

II.3.4. Local Governments

Local Governments (like Nyanza District in this study) under the General Guidelines and Procedure for EIA are tasked to perform the following functions:

• At the request of RDB, review Project Briefs so as to advise on Terms of Reference,
• Provide information or advice to developers and EIA Experts when consulted during EIA process,
• At the request of RDB, review EIA reports and provide comments to RDB,
• Assist RDB in organizing public hearings,
• Host public hearings,
• Host individual consultations,
• Gather written comments from public and transmit them to RDB.

II.4. INTERNATIONAL CONTEXT OF EIA

EIA process operates within and towards the global concept of sustainable development.
It is intended to achieve benchmarks and embrace commitment to international environmental conventions agreed upon in Ramsar (1971), Vienna (1985), Montreal (1990), Rio de Janeiro (1992), Kyoto (1998) and Stockholm (2001) to all of which, Rwanda is a party.

EIA is an invaluable tool for environmental management in a trans-boundary context. It provides a framework for promotion of efficient decision-making in project approval; enables implementation of environmental safeguards to mitigate significant negative impacts, avoid ecological damage and large-scale irreversible loss of natural resource; play role in information dissemination between Rwanda and neighboring countries and widen the scope of understanding of impacts beyond its borders.
EIA process in Rwanda provides a pretext and basis for future international cooperation and conflict resolution concerning environmental impacts at a regional level.

II.5. WORLD BANK SAFEGUARD POLICIES

The World Bank Group (WBG) includes two development institutions owned by 184 member countries – the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). The operations of IDA and IBRD members are guided by a comprehensive set of environmental and social policies and procedures dealing with the Bank’s development objectives and goals, the instruments for pursuing them, and the project sponsor requirements for Bank-financed operations. These policies and guidelines, known as Operation Policies (OPs), are set out in the Bank’s Operational Manual. The OPs are focused statements that follow from the Bank’s Articles of Agreement, general conditions, and Bank policies specifically approved by the Board. The Manual also addresses procedures, good practice and advice on implementation of policies.

Within the overall set of OPs, the Bank has identified ten key policies critical to ensuring that potentially adverse environmental and social impacts are identified, minimized and mitigated. These include:

- Environmental Assessment (OP 4.01);
- Physical Cultural Resources (OP 4.11);
- Disputed Areas (OP 7.60);
- Indigenous Peoples (OP 4.10);
- International Waterways (OP 7.50);
- Involuntary Resettlement (OP 4.12);
- Natural Habitats (OP 4.04);
- Forests (OP 4.36);
- Pest Management (OP 4.09) and;
- Safety of Dams (OP 4.37).

The Bank undertakes screening of each proposed project to determine the appropriate extent and type of Environmental Assessment (EA) to be undertaken. Depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts, the project has been categorized by the Bank as an Environmental Screening Category B – Partial Assessment.

Environmental impacts of the proposed project activities in Nyanza-23 site are likely to be short term, site-specific, non-sensitive or irreversible, and in every case, mitigation measures can be designed to reduce the negative impacts.
The project sponsor is responsible for any environmental due diligence required by the Safeguard Policies, with general advice provided by Bank staff. Further details of the Bank’s environmental and social Safeguard Policies can be viewed at www.worldbank.org. We are also aware that the World Bank has an Inspection Panel that was established by the Executive Directors of the IBRD and IDA on September 22nd, 1993. Its primary purpose is to address the concerns of the people who may be affected by Bank projects and to ensure that the Bank adheres to its operational policies and procedures during the design, preparation and implementation phases of its projects.

The proposed project for Nyanza-23 site shall therefore be implemented in accordance with the requirements of the World Bank Safeguard Policies applicable to the project, as discussed below:

Environmental Assessment (OP 4.01)
This policy requires Environmental Assessment (EA) of projects proposed for World Bank financing to help ensure that they are environmentally sound and sustainable, and thus improve decision making. The EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. The EA process has thus taken into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and cultural property) and trans-boundary and global environmental aspects.

We have assessed and determined future potential environmental and social impacts during implementation of this project, and we have also clearly elaborated various mitigation, monitoring and institutional actions to be taken during the implementation of the project activities. This is geared towards eliminating, reducing the adverse environmental and social impacts to acceptable standards. This EIA report is therefore subject to disclosure to the general public and IDA.

The World Bank system assigns a project to one of three project categories, as defined below:

Category “A” Projects: An EIA is always required for projects that are in this category. Impacts are expected to be ‘adverse, sensitive, irreversible and diverse with attributes such as pollutant discharges large enough to cause degradation of air, water, or soil; large-scale physical disturbance of the site or surroundings; extraction, consumption or conversion of substantial amounts of forests and other natural resources; measurable modification of hydrological cycles; use of hazardous materials in more than incidental quantities; and involuntary displacement of people and other significant social disturbances;

Category “B” Projects: Although an EIA is not always required, some environmental analysis is necessary. Category B projects have impacts that are ‘less significant, not as sensitive, numerous, major or diverse. Few, if any, impacts are irreversible, and
remedial measures can be more easily designed.’ Typical projects include rehabilitation, maintenance, or upgrades, rather than new construction and;

*Category "C" Projects:* No EIA or other analysis is required. Category C projects result in negligible or minimal direct disturbance of the physical environment. Typical projects include education, family planning, health, and human resource development.

The present project for Nyanza site falls under Category B.

**Natural Habitats (OP 4.04)**
The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long term sustainable development. World Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats. Natural habitats are land and water areas where (i) the ecosystems biological communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the areas primary ecological functions. Therefore, the natural habitats policy is triggered in certain cases because the proposed project within Nyanza catchment area may have potential adverse impacts on the catchment area. These ecosystems do support varying degrees of natural complexities of flora and fauna.

Therefore, in regard to the above policy, this ESMF proposes various mitigation measures to eliminate and/ or reduce the likely advance impacts as a result of implementing this project.

**Pest Management (OP 4.09)**
This policy aims at the management of pests that affect either agriculture or public health. The World Bank supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.

Rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use Integrated Pest Management (IPM) techniques of the existing Pest Management Plan of the project. In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and Environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity. The Bank uses various means to assess pest management in the country and support integrated pest management (IPM) and the safe use of agricultural pesticides: economic and sector work, sectoral or project-specific environmental assessments, participatory IPM assessments, and investment projects and components aimed specifically at supporting the adoption and use of IPM.
For World Bank funded agriculture projects, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The policy supports use of environmental methods for public health projects in controlling pests. Where environmental methods alone are not effective, the Bank may finance the use of pesticides for control of disease vectors.

The policy calls for assessment of the nature and degree of associated risks, taking into account the proposed use and the intended users for procurement of any pesticide in Bank financed projects. The policy sets criteria to apply for the selection and use of pesticides in Bank financed projects including must have negligible adverse human health effects, must be shown to be effective against the target species, and must have minimal effect on non-target species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies.

Pesticides used in public health programs must be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them and the use must take into account the need to prevent the development of resistance in pests.

The policy requires that any pesticides it finances be manufactured, packaged, labeled, handled, stored, disposed of, and applied according to standards acceptable to the Bank. The Bank does not finance formulated products that fall in World Health Organisation (WHO) classes IA and IB, or formulations of products in Class II, if the country lacks restrictions on their distribution and use; are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

The policy requires putting in place a Pest Management Plan (PMP) and structure for adoption of IPM and safe use of pesticides. A PMP for LWH Project was prepared and disclosed in-country and in World Bank InfoShop in October 2010.

**Involuntary Resettlement (OP 4.12)**

The objective of this policy to avoid where feasible, or minimize, exploring all viable alternative project designs, to avoid resettlement. This policy is active in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas (like marshlands). The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts.

This policy covers direct economic and social impacts that both result from Bank assisted investment projects, and are caused by (a) the involuntary taking of land resulting in (i) relocation or loss of shelter; (ii) loss of assets or access to assets, or (iii) loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or (b) the involuntary restriction of access
to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to project appraisal of proposed projects. The objective of this policy to avoid where feasible, or minimize, exploring all viable alternative project designs, to avoid resettlement.

The policy requires the displaced persons and their communities, and any host communities receiving them, are provided timely and relevant information, consulted on resettlement options, and offered opportunities to participate in planning, implementing, and monitoring resettlement. Appropriate and accessible grievance mechanisms are established for these groups.

In new resettlement sites or host communities, infrastructure and public services are provided as necessary to improve, restore, or maintain accessibility and levels of service for the displaced persons and host communities. The initial RAP is being revised to reflect changes in the new dam location. The Nyanza-23 RAP is scheduled to be submitted for review and clearance in September 2012.

**Forests (OP/BP 4.36)**

This policy applies to:

- Projects that have or may have impacts on the health and quality of forests;
- Projects that affect the rights and welfare of people and their level of dependence upon or interaction with forests;
- And projects that aim to bring about changes in the management, protection or utilization of natural forests or plantations, whether they are publicly, privately or communally owned.

In line with this policy, World Bank does not support projects which involve significant degradation or conversion of critical forest areas. In Nyanza 23 site, existing catchment forests will be protected and rehabilitated and new forests will be created in areas unsuitable to agriculture and animal husbandry.

**Physical Cultural Resources (OP/BP 4.11)**

This policy addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community.
As this policy is triggered for RSSP3, chance finds procedures should be incorporated into the EMPs and civil works contracts. The following wording is proposed:

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall:
- Stop the construction activities in the area of the chance find;
- Delineate the discovered site or area;
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Institute of National Museum of Rwanda (INMR) take over;
- Notify the supervisory Project Environmental Officer and Project Engineer who in turn will notify the responsible local authorities and the INMR immediately (within 24 hours or less);

Responsible local authorities and the authorities of Institute of INMR would then be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archaeologists of the INMR. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage, namely the aesthetic, historic, scientific or research, social and economic values.

Decisions on how to handle the finding shall be taken by the responsible authorities and the INMR. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration and salvage.

Implementation for the authority decision concerning the management of the finding shall be communicated in writing by relevant local authorities.

- Construction work may resume only after permission is given from the responsible local authorities or INMR concerning safeguard of the heritage.
Projects in International Waterways (OP 7.50)

Any river basins which qualify as international waterways for the purpose of the World Bank’s Operational Policy for Projects on International Waterways (OP 7.50, the Borrower, or as requested, the World Bank notifies riparian nations of the respective river basins of the project, the details of which are provided in the notification. The notification also confirms that the project will not have any adverse effects on the quantity or quality of the flow of the waters to any of the other riparians.

• Safety of Dams (OP 4.37)

The word dam refers to an artificial barrier (and its appurtenant structures), that is constructed to store, control, or divert water. Dams may be classified as small, medium or large. Though there is no universally accepted classification of dams as small, medium or large, a widely accepted definition of large dams is given by the International Commission on Large Dams (ICOLD, 1974). It defines a large dam as a dam which is more than 15 meters in height (measured from the lowest point in the general foundations to the crest of the dam), or any dam between 10 meters and 15 meters in height which meets one of the following conditions:

- the crest length is not less than 500 meters;
- the capacity of the reservoir formed by the dam is not less than one million cubic meters (1 Million m³);
- the maximum flood discharge dealt with by the dam (spillway capacity) is not less than 2,000 cubic meters per second (2,000 m³/s);
- the dam is of unusual design.

The World Bank distinguishes between small and large dams for application of its policy on safety of dams, OP 4.37, states:

a) Small dams are normally less than 15 meters in height. This category includes, for example, farm ponds, local silt retention dams, and low embankment tanks.

b) Large dams are 15 meters or more in height. Dams that are between 10 and 15 meters in height are treated as large dams if they present special design complexities (for example, an unusually large flood-handling requirement, location in a zone of high seismicity, foundations that are complex and difficult to prepare, or retention of toxic materials). Dams under 10 meters in height are treated as large dams if they are expected to become large dams during the operation of the facility (e.g. Tailing dams).
Dam safety plans are also required for high hazard dams. High hazard dams are those between 10 and 15 m height, with special design complexities, e.g. unusually large flood handling requirements, location in zone of high seismicity, foundations that are complex and difficult to prepare, or retention of toxic materials. The dam to be constructed in Nyanza site will be 25 m high from the dam foundation level (or 19 m high from the ground level) and this dam is classified as large dam. For large dams, the bank requires:

1. Reviews by an independent panel of experts of the investigation, design and construction of the dam and the start of operations;
2. Preparation and implementation of detailed plans: a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan;
3. Prequalification of bidders during procurement and bid tendering;
4. Periodic safety inspections of the dam after completion

In compliance with OP/BP 4.37- Safety of Dams, the project has established the Panel of Experts on Dam Safety (PoE), which has so far visited the site, participated in technical workshops and submitted a total of four review reports. The next panel visit is scheduled to take place during excavation of the dam foundation. The project has also prepared:

1. A manual for construction supervision and quality assurance;
2. An operation and maintenance manual which contains details on dam safety instrumentation;
3. An emergency preparedness plan (EPP), which contains guidelines to save lives and reduce property damage in areas that would be affected by dam failure or operation.
III. BASELINE DESCRIPTION

III.1. PHYSICAL ENVIRONMENT

III.1.1. Geographical Location
The study area, Nyanza 23 command area and dam site, is located in Rwabicuma and Nyagisozi Sectors of Nyanza District in Southern Province. It is at about 80 km far from Kigali and 14 km from District office of Nyanza. The Nyanza-23 Dam site is located on Kagondo streams after the confluence of Gisuma and Gasenyi tributaries, in Rwabicuma Sector at the following UTM coordinates: E 0465819, N 9738606. The Dam to be constructed is an irrigation dam that will serve a gross command area of approximately 471 ha and approximate net area of 391 ha.

The command area lies at the right and left bank of the Kagondo stream. The water catchment and command area catchment average 2,580 Ha. The water catchment and command area catchment stretch across Rwabicuma, Cyabakamyi and Nyagisozi Sectors of Nyanza District and Rwaniro Sector of Huye District of Southern Province. The water catchment area of the proposed dam site is 13.8 km² large. The quite larger catchment upstream of the dam location contributes to a considerable increase of the surface runoff quantities that can be stored for irrigation purposes. Figure 1 presents the location of Project site in Nyanza District.
Figure 1: Location of Nyanza dam site and command area

III.1.2. Climate

The project site falls in the Moist Mid-Highland agro-climatic zone, which covers 41.65% of the land of Rwanda with greater potential for agriculture. The annual rainfall of the area is around 1,200 mm. Rainfall maxima around 200 mm/month are usually observed in April, during the main wet season of the year, which lasts from March to June. The second wet annual period from September through December, shows monthly rainfall maxima of more than 100 mm. The dry season extends from June to August, with July as the driest month.

Based on the collected data from relevant sources, Nyanza-23 site is located in moisture deficit zone of Rwanda. Thus, rainfall pattern in terms of distribution, intensity, and reliability pose periodical difficulties in agricultural production.

According to the hydrological study, the project areas rainfall distribution computed for the 1971 – 2006 (35 years period) shows that the mean monthly rainfall can be as low as 26, 7 and 35 mm for June, July and August respectively. On the other hand, the mean rainfall can be as high as 133, 190, 143 mm for March, April and May respectively. The rainfall data of Butare Aero station (1971-1992), which was supplemented by data transfer technique from Kigali station of (1993 -2006), was used for the computations. The monthly mean, max, min and STDV for the 35 years average are given in Table 1.
The data shows that the mean annual rainfall of Nyanza-23 site is 1,177 mm. However, the variation, as observed from the 35 years data is frighteningly high. For instance, at dry year, the total rainfall can be as low as only 788 mm while at wet year it could be nearly double or as high as 1,595 mm. For June, July and August, the minimum mean monthly rainfall is recorded as zero.

In this worst scenario, the mean monthly rainfall at the wettest month (April), the mean monthly rainfall which is recorded to be 190 mm can be as low as only 93 mm. Therefore, for bridging these types of uncertainties, the value of comprehensive land-husbandry practices and use of supplementary irrigation options are significantly important.

Luckily, the temperature at Nyanza-23 is excellent for plant growth. The wind speed is low and the relative humidity shows that there is quite good amount of moisture in the air. The sunshine hours are short in all months except in the driest months of Jun, July and August.

Annual reservoir evaporation and potential evapotranspiration depths were calculated equal to 1,449 and 1,316 mm respectively. These values were reviewed adopted for the current final dam design.

Therefore, all climatic variables indicate that irrigation in these three months is highly important. Table 2 gives climatic data of Nyanza-23 site.

Table 2. Climatic data of Nyanza-23
III.1.3. Topography

In terms of topographic configurations, Nyanza-23 watershed shows five distinct slope categories. These are: the undulating plain (0-6%) that covers 10.66 % of the watershed, 6- 16% that covers 30.02% of the watershed, 16-40% slope which covers 52.71% of the watershed, 40 -60 % slope that covers 6.0 % of the watershed and 60 – 120% slope that covers 0.61 % of the watershed. Within the respective slope categories, the deep soil depth coverage in about 31 % which is almost 1/3rd of this area while the other 2/3rd is covered by shallow soils units.

III.1.4. Soils

Soils of the entire Nyanza-23 watershed were studied from the soil survey conducted on the ground and from the existing 1:50,000 scale Soil map of the area.

Various sources were consulted. Findings from these regarding their physical and chemical characteristics as well as depth of the soil were substantiated by physical field diagnosis and profile descriptions as well as results from laboratory analysis. Maps were generated using the GIS software.

Nearly 30 % of the total watershed is occupied by two soil types that are having greater than 50 cm soil depth: Humic Acrisols and Dystric cambisols. When we consider the other different kinds of soils which contribute in different amounts, soils of less than 50 cm in depth are about 70%. Naturally, Dystric Cambisols are found at greater depths than 50 cm. However, due to the severity of soil erosion in Nyanza site and due to its susceptibility nature to erosion, some of the Dystric Cambisols have less than 50 cm soil depth. This makes about 20% of the entire watershed or covers 1,596 ha. This is one of the reasons why land-husbandry in this watershed is crucially essential. The detailed soil types and their corresponding area coverage are presented in Figure 2 below.

The soil types and their corresponding area coverage in Nyanza 23 site are presented in Figure 2 below.
III.3.5. Geology

According to the general geological map of the area, the Archaean basement of Rwanda shows occurrences on the south and southwest of the country where dominate the pre-Burundian migmatites and gneisses accompanied by crystalline whitish quartzite. Some of these rocks have been retro-metamorphosed.

The contact between these formations and the sedimentary succession of the Burundian Supergroup has not been observed yet inside Rwanda. The Burundian Supergroup overlay can be subdivided into formations of quartzite and various undifferentiated rocks. There are also at least four types of granitic rocks, the two of which are synorogenic and the other two postorogenic. Main tectonic event that has affected the area is the Kibaran orogeny, which occurred from about 1,370 to 1,310 million years ago.

A wide variety of formations is apparent not only within the inundation area but also at the dam site. The main geological setup can be described as metamorphic and/or sedimentary, formations being intruded by magma at various stages at structural events of the geological time, resulting in zones of retrometamorphosed diagenesis in contact with magma crystallization products. The sequence of the faulting-intrusion-metamorphosis stages that the formations have undergone is quite complicated. The weathering products as well as river flow sediments cover the slopes and the bottom of the reservoir with a significant thickness range.

It is noted that weathered bedrock is also exposed in various locations of the reservoir ranging from schists to granite or combinations of both (migmatites).
In essence, the following main rock types as a result of the above processes, dominate the area of interest:

- Metamorphic rocks comprise mica schists, schists, quartzites and gneises. Meta-sedimentary rocks fall also into the metamorphic category but they have undergone metamorphosis due to pressure and mainly due to temperature effects that can be identified at deeper parts of the dam axis. The abundance of quartzites indicates the silica rich sandstones as a source rock pattern that has been altered by metamorphosis. The particular rock type is found at the dam site and forms the slopes of the upstream valley with a weathered zone, the thickness of which is conversely proportional to the associated quartz-silica content.

- Magmatic siliceous rocks that are represented mainly of granite, which was found in outcrops in many places within the inundation area and downstream of the dam. Pegmatitic veins or layers, were also found at the dam site investigations, usually underneath the above formations. They have also been spotted outcropping in some locations within the inundation area.

- Combinations of granitic-granophyric magma that contains segments of mother rocks and mainly schists and mica schists. These were found mainly at the right side of the valley close to the dam site.

**Figure 3.** General geology of Nyanza area

Colluvium and weathered zone materials exhibit a wide range of particle size distribution with the minority being the gravels percentage. They cover the bedrock formations that have been described above having in most cases reddish to light brown colour. They comprise mostly silts to silty clay soils with a significant fine
sand percentage. The latest fraction increases both in percentage and in particle size within the areas of the granite or combined granitic intrusions and metamorphic formations.

River alluvium deposits appear to be a mixture of both the weathered zone in the immediate vicinity of the river as well as other materials that have been transported by the river flow from upstream areas. As a result they exhibit a high fines content attributed to the metamorphic weathering, whilst the sand fraction remains also significant due to the upstream granite areas sources. Due to intense cultivation of the riverbed at various locations, a significant organics load is also present within those deposits.

### III.2. BIOLOGICAL ENVIRONMENT

#### III.2.1. Flora

The natural ecosystems that covered Nyanza 23, both in dam site and command area, have been modified due to human activities especially agriculture and settlement. Those changes caused secondary formations consisting essentially of graminaceous plants, numerous seasonal or perennial species alternating with crops.

These cultivated areas have changed from natural ecosystems to agroecosystems. *Cyperus latifolius* species are only founded in isolated patches in the dam site. In the command area, seasonal crops mainly bean, maize, cassava, rice and perennial crops like banana, as well as scattered Eucalyptus and *Grevillea spp* trees and *Acanthus spp* bushes are the most common vegetation. No endangered plant species were observed in the area.

#### III.2.2 Fauna

In addition to domestic animals, different species of birds are found in the area. No endemic or endangered species are reported in the area.

### III.3. SOCIO- ECONOMIC ENVIRONMENT

Nyanza-23 site is located in Nyanza District of Southern Province. The Nyanza-23 Dam, is to be constructed on Kagondo stream, tributary of Mwogo river. The shifting of the dam site as well as the changes in the potential irrigable area may induce other views and expectations from the local communities with regard to their socio-economic conditions.

The socio-economic analysis of the beneficiaries of LWH activities in Nyanza-23 site and financial analysis of the projects activities to be implemented in Nyanza-23 site is a pre-requisite for the proper implementation project activities. Therefore, a field survey was conducted to update the socio-economic study report for Nyanza-23 new site and the main findings can be summarized as follows:
The dam site is intensively cultivated and covered with seasonal crops mainly bean, maize, vegetables (cabbage, onion, carrot, eggplant). The crops grown in the command area include bean, sorghum, maize, rice in swamps, banana and sweet potatoes intercropped with cassava, vegetables and scattered woodlots of Eucalyptus, Grevillea. The same crops, except rice, are found in the command area catchment (CAC) and water catchment (WC).

Currently 40 households will be likely relocated as they are within the dam site (20 households) and silt trap zone (20 households). The RAP report is under preparation.

The majority of farmers' plots in the command area are small. About 45% of farmers possess a land whose size is smaller than 0.5 ha and another 45% has a land of the size is comprised between 0.5 ha and 1 ha. Only 10% has a land of the size is greater than one ha.

The main activities of the farmers consist of cropping and livestock keeping. These activities are also the main sources of income in Nyanza-23 site. The income from cropping activities ranges from 2,000 Rwf to 150,000 Rwf per season while the income from livestock keeping ranges from 54,000 Rwf to 576,000 Rwf per year. The majority of farmers eat twice (lunch and supper) a day and the meals are mainly from agricultural products found in the area. The majority of farmers respondents have only achieved primary education.
IV. PROJECT DESCRIPTION

IV.1. PROJECT LOCATION

The proposed project for the development of Nyanza 23 is located in the District of Nyanza, in Rwabicuma and Nyagisozi Sectors of Nyanza District, Southern Province. Specifically, the project site covers six (6) cells of Rwabicuma Sector, namely Gishike, Mushirarungu, Gacu, Runga, Nyaransange, Mubuga and four (4) cells of Nyagisozi Sector, namely Rurangazi, Gahunga, Kabirizi and Kirambi.

IV.2. OVERVIEW OF THE CLIMATE AND HYDROLOGY

The project site falls in the Moist Mid-Highland agro-climatic zone, which covers 41.65% of the land of Rwanda with greater potential for agriculture. The annual rainfall of the area is around 1,200 mm. Rainfall maxima around 200 mm/month are usually observed in April, during the main wet season of the year, which lasts from March to June. The second wet annual period from September through December, shows monthly rainfall maxima of more than 100 mm. The dry season extends from June to August, with July as the driest month.

Based on the collected data from relevant sources, Nyanza-23 site is located in moisture deficit zone of Rwanda. Thus, rainfall pattern in terms of distribution, intensity, and reliability pose periodical difficulties in agricultural production. According to the hydrological study, the project area rainfall distribution computed for the 1971 – 2006 (35 years period) shows that the mean monthly rainfall can be as low as 26, 7 and 35 mm for June, July and August respectively. On the other-hand, the mean rainfall can be as high as 133, 190, 143 mm March, April and May respectively.

IV.3. GEOLOGY

A geological survey and geotechnical investigation were performed along the dam axis. Findings from this survey revealed that:

1. The left abutment is dominated by alterations of quartzite with zones of silica rich politic metasediments, schists and/or mica schists.
2. The valley is dominated by highly weathered metasediments (mainly schists and mica schists) and granite in intercalations with quartzite.
3. Highly weathered mica schists in granitic matrix were found in the right abutment; after 13 m depth weathered granite is met.

IV.4. SEISMICITY

The site at Nyanza-23 falls within the area of moderate seismic hazard and the earthquake with a Peak Ground Acceleration (PGA) of 0.12 g has been identified
with the Operating Basis Earthquake (OBE) having a return period of about 500 years.

IV.5. SOCIO-ECONOMIC DATA
The dam site and command area extend across Rwabicuma and Nyagisozi Sectors of Nyanza District. About 80 % of the command area is located in Rwabicuma Sector. The command area counts approximately 3,500 inhabitants with a surface area of 471 ha. Results from a socioeconomic study in Nyanza 23 command area revealed that 75 % of the total population are married, 5 % divorced and 20 % widow/widower. Females are dominant and occupy 55 % of the total command area population. Majority of farmers (45 %) are between 30 and 50 years of age. The household members are composed by 55 % male over 14 years old against 75 % of female over 14 years.

The settlement pattern has been scattered since time immemorial. The District is encouraging a clustered habitat commonly known as «Umudugudu». This is the present policy of the Government of Rwanda regarding settlement. Woody fuels and biomass wastes are the only sources of energy used in households.

The project site economy is predominantly agricultural featuring mainly subsistent agricultural production in small holdings using intensive traditional farming methods. The income from cropping activities ranges from 2,000 Rwf to 150,000 Rwf per season while the income from livestock keeping ranges from 54,000 Rwf to 576,000 Rwf per year.

IV.6. LAND USES IN NYANZA 23

IV.6.1. Land Use Categories in Nyanza 23
For the sake of planning and implementation of the different land-husbandry options with distinct influence to the overall irrigation program, the entire watershed is partitioned and categorized into the following 5 major categories.

1. Water-catchment---- areas of the entire watershed that are the main source of the water to be harvested in the down-catchment reservoir and drains through the Silt-Trap zone

2. Silt Trap-zone ----a land part of the Water-catchment as it contributes to the water that drains directly to the Reservoir, and which is designed to filter the silt that comes from the water catchment to the reservoir

3. Reservoir ---- land designed to be filled by water draining from the Water-catchment and the Silt-trap Zone.

4. Command-area Catchment ---- land which is up-hill of the command area that could contribute run-off and flood to the down-catchment command area
5. Command area - lands designed to be irrigated in dry seasons by the water to be harvested in the reservoir during the rainy seasons.

The figure 4 below illustrates the different sections of the entire Nyanza-23 watershed.

**Figure 4:** Different sections of the entire Nyanza-23 watershed as discussed in the following paragraphs in this project design

The locations of the five catchment units of the Nyanza-23 watershed are shown in Figure 4 above. Majorly, five function-based land units form the entire watershed. These are the Water catchment (nearly 1,307ha), the silt-trap zone (some 73 ha), the Command-area catchment (nearly 1,200 ha) and the command area which is 471 ha. The Silt-trap zone is again partitioned into: grass layers, shrub layer and tree layers as we go further away from the periphery of the Reservoir. A live fence that is situated between along the outside perimeter of the grass strip and the inside perimeter of the shrub-layer is contained within the same Grass-strip zone.

In the project formulation process, the land-husbandry program was intentionally decided to be at a watershed setting because watershed approach accommodates both the human and the physical environment in an integrated manner.
Under the project situation, the agriculture system in both the water-catchment and the Command-area Catchment will remain rain-fed while the command area is intensively cultivated under supplementary irrigation. In such a case, the yield increment for the watersheds would come from the improved agricultural management of the rainfed catchments and from implementations of comprehensive land-husbandry program. Still, in this scenario, land-husbandry would have to be practiced in all except at the area where it will be inundated by the reservoir.

Often, soil conservation practices are viewed as artificial alterations of the land relief to control water movement, and tillage erosion while land-husbandry includes the use of improved farming practices which impact on changing the soil characteristic such as changing its acidity/alkalinity, infertility, infiltration/water holding capacity, etc. Unless these alterations are made and the land fertility status of the farm land is enhanced, the maximum production response from the costly supply of irrigation water alone will not be realized to the fullest. In the absence of irrigation, rainfed agriculture would be implemented over the entire 5,800 ha and land husbandry would be the only yield improvement option.

In a way, LWH is unique in that the irrigation is to be planned in conjunction with comprehensive land-husbandry. Unlike flatland valley irrigation, hillside-irrigation requires land-husbandry interventions in the up-slope catchments that are contributing water to the reservoir and the irrigable land that are both situated at the lower slopes. Therefore, in the detailed design and planning, soil and water conservation was viewed as part of the comprehensive land-husbandry practices.

**IV.6.2. Description of Different Land Types Categories**

During the technical design and feasibility studies, the land use/land cover status was analyzed from recent Satellite imagery taken in the driest month. The coverage of the different land use types significantly varies in line with its position in the entire watershed. To this effect, we have chosen to discuss land use/land cover status of the study site at the entire watershed level and catchment by catchment and as it occurs in the different slope ranges as follows.

**IV.6.2.1. Water Catchment Area**

The water catchment of Nyanza-23 project site is about 1,380 ha including the silt trap zones of 73 ha and the water catchment covers 53.5 % of the total land area of the project site. In the water-catchment area, agricultural land covers 62 % of the water catchment. The topographic feature of the water catchment includes slope ranges up to 60 %.

To this effect, all types of physical and biological soil conservation measures including radical terraces are recommended for the Nyanza-23 project area.

**IV.6.2.2. Silt-trap zones**
The pre-existing land use/land cover situation was analyzed by using a high resolution satellite imagery taken and purchased for the purpose of this study. As it stands today, 86.3 % of the area (63 ha) is agricultural land which can be a huge source of silt to down-catchment reservoir.

As a blessing in a disguise, significant portion of this land unit is in slope range of 6-16 percent which indicates that the water propelling into the reservoir after the rain is not flowing rapidly as it could have been if the slope range was very steep. No land is in slope category of >40% slope.

Some 9 % of the area (~7 ha) is covered by Bush and shrub-land. Though it surrounds the outlet of the Water-Catchment, there is no riverine vegetation identified in this land unit. Compensation of the agricultural land is an issue here as this may be the only source of food crop for some families.

The land covered by planted forests is quite significant. It accounts for 4.7% of this land unit or 3 hectare. The quality and stalking density is poor and requires good attention for improvement. Stalk refinement operations and enrichment planting is required. Those in the tree-belt would have to be enriched by tree planting while those in the shrub-belt would have to be enriched with quality shrub seedlings.

The spacing and configuration of the planting would have to be done as specified in the Specifications. Those in the grass-belt would have to be replaced by sawing or sodding grass sods or sods respectively.

Land owners have already the experience of planting trees in this land unit. Therefore conducting comparative assessment of the best alternative tree species of commercial value and up-scaling the tree planting effort would contribute to successful Silt-Trap zone establishment.

Because some 14 % of the land is already covered by perennial vegetations, changing the total land use into perennial cover may not be difficult. However, one needs to consider fruit plants, palatable and known feed quality shrubs and fodder grasses which can fetch comparatively better income for the land users. For such species to be used please refer to the section “Land-husbandry Interventions” of this document.

Table 3. Land use/land cover of the Silt-trap zones in the different slope categories
IV.6.2.3. Command area Catchment

The command area catchment is more than 1,200 hectares and accounts for 46.5 % of the entire project site. Both plantation and natural forests account for less than 25 % of the area and the forest stalk is very poor where stalk refinement and improved management would make significant difference in its economic contributions to the owners.

Nearly 72 % of the command area catchment is intensively cultivated. More than half of this is situated in slope ranges of 6-16 % slope where radical terracing is designed. Even in higher slopes of 40 – 60 %, the contribution of agriculture is dominating as compared to other land uses. Therefore, unless comprehensive land-husbandry is put in place, the fact that majority of this catchment is under agriculture poses significant danger to down-catchment irrigable fields.

Most of the lands in the command area are in slope ranges of 16 – 40 %. This is typical land topography of Rwanda. This is also where we have recommended and designed to be the cropping limit for annual crops unless otherwise intercropped along with perennial crops. Lands in slope ranges of greater than 60 % are negligible in size and are occupied by natural bushy vegetation and Grasses. However, in the entire catchment, the coverage of grasslands, natural forest and plantations forest is 15.7 and 6.3 % respectively.

IV.6.2.4. Command-Area

The command area covers a total gross area of 471 ha. In the proposed and designed command area, nearly 75.8 % of the area is already covered by agricultural land including the alternately cropped riverine lands of 14.2%. The grassland coverage is 0.2 % of the total command area. The total land area that can easily be changed into irrigable land becomes 76 % when it includes the grassland.

The portion of the land that is covered by plantation and natural vegetations accounts for some 17 %. This requires clearing and causes change of land use/land cover.

Most of the land in the command area (70 %) occurs in slope ranges of less than 16 %. Therefore, leveling for irrigation could be achieved by soil bunds that are not costly. But quite substantial amount of the topography is in slope ranges of 16-40 % slope where radical terracing would be required. Land above 40 % is almost inexistent.

IV.7. PROJECT COMPONENTS

This section describes the different components of the project, design and construction equipment description.
IV.7.1. Water Harvesting Works Component

The water harvesting works consist of the new Nyanza storage dam and the related ancillary works (spillway, irrigation and bottom outlet, etc.). They may also be considered to include the restoration of the local road network that is affected by the dam construction and the inundation of the reservoir area.

The new Nyanza dam is proposed to be constructed at a location lying on the same stream as the initial but further downstream at a distance of about 4 km. Thus a much larger catchment is formed, which reaches 13.8 km², taking also advantage of inflows from an adjacent significant tributary. On the other hand the narrow valley at the dam location looks quite favorable for the construction of an embankment of rather small volume, while the wide valley upstream is also favorable for the reservoir. The new dam location is determined by the following UTM coordinates: E 0465819, N 9738606.

All main aspects of the dam design have been addressed in the feasibility study report, so that its safety and normal performance are ensured. The most important design criteria or other design parameters issues have been also set, in order to avoid delays in the next stage caused by vagueness in relation to them. Preliminary calculations have been carried out in order to approach a reliable sizing of the particular dam structures and a respective cost estimate, which is used for the determination of the project feasibility. The feasibility study report is also accompanied by the necessary drawings which present the main works at a preliminary level.

It is noted that new hydrology, site geology and geotechnical approaches were undertaken for the new location of the Nyanza-23 dam based on new site visits and investigations that were done meanwhile.

The feasibility stage, after its approval by MINAGRI, will be followed by the final design stage. All final design topics have been addressed at this feasibility stage of conceptual design, so that no serious design criteria or other design parameters issues remain vague.

The following topics, which address all main dam design issues, have been addressed at this conceptual design stage:

- Reservoir
- Dam Design
- Spillway
- Diversion works
- Irrigation and bottom outlet
- Road network restoration
- Hydrology
- Geology
Reservoir

On the basis of the new map of the reservoir area stage — water surface and stage — reservoir volumes relationships were established and the respective curves were drawn. These are shown on Figure 5.

![Figure 5. Water elevation vs. reservoir volume](image)

According to the hydrological analysis of inflows and the reservoir water balance the total storage capacity, which is required in order to fulfill the reliability criteria set for meeting the irrigation demand, is 1.82 Million m³. According to the above diagram, this corresponds to a maximum normal water elevation at +1597.0 m. The total storage volume includes the dead storage of 300,000 m³. The water elevation corresponding to this volume is 1589.0 m and, as the minimum elevation for water supply, determines the water intake level. The above data comes from the final Dam design report for Nyanza-23.

The permeability of the formations met in the reservoir area is rather low, and the general topography is favourable. No water losses are estimated from the reservoir.
The slopes of the reservoir area are mild, on average 5:1 (H:V) (only locally slopes as steep as 2.5:1 are met). During the geological survey, no slope instabilities were located. No instabilities are expected; the reservoir slopes will be stable when the water at maximum level (steady state seepage conditions) and rapid drawdown.

**Dam**

The new Nyanza dam is located on Kagondo streams, which is the main tributary of river Mwogo. This location is determined by the following UTM coordinates E 0465819, N 9738606. The main characteristics of the new location are the following:

- The catchment area is equal to 13.8 km², by far larger than that of the initial dam location (2.94 km²).
- The mean annual runoff is estimated to be of the order of 0.18, according to the stream flow calculations presented in this report.
- A narrow valley with rather steep slopes is formed at the dam site. This means that a relatively small embankment volume will be required for the dam construction.
- The geological and geotechnical conditions at the dam site are considered rather favorable, although permeability conditions indicate that a grout curtain will be required to seal the foundation under the dam core.
- A wide valley is formed upstream of the dam, so a relatively large storage reservoir will be created. The reservoir area is considered impermeable from geological point of view as well as having stable slopes.

It must also be noted that appropriate dam construction materials for all the dam cross-section zones have been located in the near vicinity of the site and from this point of view two types of dam, earthfill or rockfill, may be constructed. All aforementioned factors indicate that the selected location is appropriate for the construction of a safe and functional dam.

The proposed construction of a dam in Nyanza 23 new site will contain a maximum height of 25 m from the dam foundation level (or 19.0 m from the ground level), 163 linear meters, with a storage capacity of 1.82 Million cubic meters spread over a water surface of approximately 29 ha.

**Spillway**

According to the design criteria agreed in previous stages, the 10,000 years period flood was adopted as the spillway design flood. The flood routing calculations resulted to a peak spillway discharge of 39.20 m³/s. This is used for sizing the spillway crest and chute. However, the 1000 years period flood is also examined, so that the cost benefits from adopting a lower design flood can be evaluated. The respective routed peak discharge is 27.80 m³/s. For the stilling basin a design flow of 17.50 m³/s was adopted which corresponds to the routed 100 years period flood.
A frontal ogee crest spillway 4.0 m wide was proposed on the left abutment of the dam. Concrete walls upstream of the crest were provided so that favorable water approach conditions are ensured. An approach channel was formed between the walls.

The spillway chute is 4.0 m wide and 98.83 m long; it has an open rectangular concrete section with 1.55 m minimum high walls, according to the flow depth and freeboard requirements. However, in the sections close to the dam crest and the stilling basin the wall heights increase gradually to 5.50 and 5.0 m respectively. The longitudinal section of the chute is designed so as the canal is founded on firm soil.

A USBR type III hydraulic jump stilling basin is proposed at the toe of the right abutment. It is 4.0 m wide, 10.00 m long and 5.5 m high. It has an open rectangular concrete section. A trapezoidal section ditch 3.0 m wide at the bottom with 1:1 side slopes and rip-rap protection on its upstream section is proposed for conveying the spillway flows to the existing riverbed downstream. A transition section with a reversed slope is proposed between the stilling basin and the ditch.

**Diversion Works**

The 5 years period flood is used for sizing the diversion works. According to the results of the hydrology study the flood peak value is equal to 40 m$^3$/s. As this is a rather high value that would lead to an expensive diversion conduit, flood routing in the reservoir formed by the cofferdam is considered.

For the routing calculations, the 5 years flood hydrograph and the elevation – reservoir volume curves are taken into account. Also a water elevation – diversion conduit discharge was composed. It is derived from the routing calculations that the maximum water elevation during the diversion design flood is 1587.82 m. Therefore the cofferdam crest is set at 1588.00 m.

The diversion works consist of a 1.0 m diameter steel pipe conduit, 95.20 m long, having a uniform longitudinal slope equal to 2.1 %. The conduit will be constructed along the right abutment and embedded in concrete. Its alignment is determined to a great extent by the requirement that it must cross the core trench area with its crown below the core foundation level, as shown on the drawings. It is also pursued that favorable orientation of both the entrance and exit of the conduit to the upstream and downstream riverbed is achieved. The conduit entrance is a rectangular reinforced concrete structure 1.00 x 1.30 m at the upstream edge with a gradual transition to 1.0 x 1.0 m downstream. After the section corresponding to the future location of the irrigation and bottom outlet shaft a transition from the rectangular 1.0 x 1.0 m to the circular 1.0 m diameter section is provided, as shown on the drawings. The upstream cofferdam is also part of the diversion works. Its original crest is fixed at elevation 1588.00 m, so it is approximately 6.5 m high. It is constructed with weathered metasediments and schist material, which is used for building the dam shoulders, and is then incorporated in the main dam. This material
is considered adequately impermeable for the requirements of the diversion operation phase.

**Water Intake and Bottom Outlet**

The irrigation and bottom outlet works are combined with the diversion conduit. The works that shall have been constructed in the diversion phase will be complemented by:

- The intake shaft. This is 6.2 m high concrete structure having an internal 1.0 m diameter circular section. The circular section is formed by a steel pipe segment welded to the steel diversion conduit that is encased in concrete. A coarse screen is provided at the entrance of the shaft.

- The valve chamber. These houses the equipment provided for controlling the flow to the irrigation system as well as to the bottom outlet system. It consists of the following items in particular:
  
  1. The main 1000 mm diameter pipe, which is the continuation of the diversion conduit.
  2. The 400 mm diameter on the same alignment to the previous pipe section, which serves the bottom outlet operation. This section starts from the 1000/400 mm taper at the entrance of the chamber and ends at the outflow point to the downstream stilling basin. It is equipped with two butterfly valves of 400 mm nominal diameter. The upstream one is installed as a guard valve for safety purposes, in order to be used when the other must be repaired or removed, and is of the off-on mode, while the downstream one is used for the operation of the bottom outlet.
  3. The two branches of the main pipe serving the supply of the two separate main irrigation canals. They are of 400 and 350 mm diameter for the northern and the southern main canal respectively. Each one of the branches is equipped with a guard butterfly valve (400 and 350 mm nominal diameter respectively) installed for safety purposes, as in the case of the bottom outlet pipe, and a flow regulation valve of the same nominal diameters. These are proposed to be needle valves or of a similar type (e.g. plunger type), which combine relatively low cost and possibility to operate at intermediate flow rates.

- The impact type stilling basin used for the energy dissipation of the high velocity flow during the rapid drawdown process. This is a concrete structure, while a rip-rap lined ditch is excavated for conveying the water to the existing riverbed downstream:

- The two main irrigation pipes supplying the respective two main irrigation canals on the north and the south bank of the stream. The north branch is a D450 mm and the south branch a D400 mm diameter PVC pipe.

- The two small concrete structures at the downstream edges of the above main pipes serving the energy dissipation of the flow and ensuring the smooth conveyance of the water to the main irrigation canals.
The proposed outlet works permit a downstream control of the system and from this point of view they differ from the configuration presented in the feasibility stage. In that case a larger diversion conduit was provided and a separate outlet pipe was installed in the conduit downstream of the concrete plug that was constructed almost at the middle of it. This configuration presented several advantages compared to the one proposed by this design but for reasons of considerably higher cost it was abandoned.

**Road Network Restoration**

The Nyanza dam construction and the consequent inundation of an extensive area upstream will affect the existing local road network. The dirt road coming from Nyanza town and serving a few local settlements approaches the narrow valley where the dam is proposed from the northern slopes of the future reservoir, crosses the stream with a small bridge at a small distance upstream of the dam axis and follows the southern slopes of the reservoir towards the southeast. A great part of this road has to abandoned, as it lies at elevations lower than the dam crest (+1600.0 m).

As it is absolutely necessary to preserve the access infrastructure in the wider area, a new road is proposed to be constructed which will replace the section that will be abandoned. The new road will be constructed at elevations above the dam crest and has a total length of 1277 m approximately, including the 165 m long section of the dam crest, which is incorporated in the new road network. A new 315 m long section is proposed on the northern part of the reservoir and a second 797 m long section on the southern part. A road bridge is proposed at the intersection of the dam crest and the spillway. The proposed layout of the new road is shown on the relevant drawings.

An additional small road section 195 m long approximately will be constructed so that access from the dam crest to the valve chamber at the downstream toe of the dam is achieved.

**IV.7.2. Irrigation Network Component**

The objective is to plan and design an irrigation system such that it is technically feasible, economically viable, socially acceptable and environmentally sustainable. The engineering component i.e. the layout of different components of the system is dictated by the topography and has to fit appropriately into the topography of the command area. The agricultural sub-system has to be planned and designed in such a way that it fits into the prevailing land and soil characteristics, and climatic factors besides other socio-economic and agro-economic condition.

The new command area is developed downstream of the dam site, mainly along the banks of the Kagondo and Mwogo rivers. The floodplains of river Mwogo cannot be utilized for irrigated agriculture as it consists of wetlands to a great extent. Thus the
maximum gross area on both sides of the two rivers that can be incorporated in the
command area approximates 471 ha.

This is a longitudinal area which, because of its shape, presents natural constraints
in the development of an irrigation system. From this point of view, while a pressure
pipe system could supply almost completely the above area although with a
significant cost, an open canal network, which is a more economical alternative,
could not supply more than max 230 ha. A mixed system could serve an
intermediate size of land.

According to the crop pattern proposed, the main agricultural products that will be
cultivated are onions, chili and peas on a rotational basis, as well as mangoes and
grapes. The soil survey study that was carried out detected a soil quality problem in
the new command area. This is the high acidity of the soils with average pH4.2. The
only treatment that can address the high acidity problem is the use of lime (CaCO3
or CaO) in a dose of 5,000 to10,000 Kg/ha.

**Design of the Irrigation System**

An irrigation system is designed to use the available water as more efficiently as
possible by minimizing the losses in conveyance, distribution and application. The
irrigation system consists of the following two sub-systems:

- The engineering sub-system comprising various structures for storage and
diversion of water and canal/pipe networks.
- The agricultural sub-system comprising the cultivated field with different
types of crops, farming system and agricultural practices.

For the feasibility study two alternatives were examined:

**Alternative1:** Pressurized System

Using pipes for the main and the secondary network.

**Alternative2:** Gravity System

Using canals for the main network and pipes for the secondary.

The criteria to be adopted for the planning and design of the Nyanza 23 irrigation
project are presented below.

**Irrigation Duty**

The irrigation water duty was calculated on monthly basis with the design flow for
month July to be 0.74 l/s/ha. In the case of canals as the main lines the irrigation
water duty is 0.82l/s/ha. This is based on 24 hour operation of the system.
However, due to practical limitations only 12 hours of irrigation is assumed per day.
Therefore, the capacities of the water supply and distribution system has been
calculated on 12 hour operation of the system and the design flow is 2 x0.74 = 1.48
l/s/ha and 2 x0.82 = 1.64 l/s/ha for pipes and canals respectively.
In order to meet any future changes in demand as well as to provide flexibility in operation, it was agreed from previous discussions to increase the design flow of all components of the irrigation system by 20%. In the detailed design phase if agreed the 20% factor can be reduced or even omitted in order to lower the cost of the network.

Thus the main network is designed with a peak duty of 1.76 liters per second per hectare and 1.97 liters per second per hectare for pipes and canals respectively.

The Size of the Command Area
The size of the command area was determined mainly from the available water. The dam design study and the hydrology study adopted the following criteria for the system reliability: Satisfy 90% of the demand on 70% of the time, meaning that seven years out of ten, 90% of the water demand is satisfied by the reservoir.

The results of the above are depending on the height of the dam and the available water storage and the selected irrigation system:

Table 4. Size of the command area

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>System</th>
<th>Total Reservoir Volume ($10^3 m^3$)</th>
<th>Dam Crest Level (masl)</th>
<th>Dam Height (m)</th>
<th>Command Area Served (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Pipes</td>
<td>2,000</td>
<td>1600.60</td>
<td>19.60</td>
<td>280</td>
</tr>
<tr>
<td>2nd</td>
<td>Pipes</td>
<td>3,600</td>
<td>1604.60</td>
<td>23.60</td>
<td>450</td>
</tr>
<tr>
<td>3rd</td>
<td>Canals</td>
<td>1,800</td>
<td>1600.00</td>
<td>19.00</td>
<td>230</td>
</tr>
<tr>
<td>4th</td>
<td>Canals</td>
<td>2,500</td>
<td>1602.00</td>
<td>21.00</td>
<td>300</td>
</tr>
</tbody>
</table>

System Design
For the first alternative, the command area is 280ha and 450ha respectively and for the second one the total area is 229 ha and 292 ha respectively. In both alternatives HDPE pipes are proposed for the secondary network.

In the Nyanza 23 command area, the elevation difference between the upper and the lower parts is not exceeding 50 m, so with the proposed layout the pressure in the system will be less than 10 atm even taken into account water hammer phenomena. The required class of the pipes is PN10.

The main design criteria of the system are:

- Discharge at the terrace 3lt/sec (estimated minimum discharge in order the water to be able to flow in the soil channel)
- Minimum diameter for the secondary pipes D90
- Maximum length of each terrace 100 m
• The system should be able to supply with the required daily water the command area within the time limit of the 12h irrigation
• The command area has been divided in blocks. Each block is supplied by one secondary pipe.

**Dam Size vs. Command Area Size Analysis**
A critical point at this stage of the contract is to prepare a dam size vs. command area analysis in order to determine the most feasible combination. This analysis includes:

• The simulation of the dam / irrigation system operation, in order to determine the size of the command area that can be irrigated at a prescribed level of reliability by a variable reservoir size.
• The relationship between the reservoir volume and the dam size, which takes into account not only the respective live and dead storage but also the required freeboard for the design flood routing and the wave run-up.
• The cost estimate for the construction of the dam and the respective irrigation system for each one of the examined combinations.
• The estimation of the unit cost, i.e. the total construction cost per ha, which according to WB criteria should not exceed the threshold of 20,000 USD/ha.

The dam / irrigation system operation was simulated by an appropriate model used to determine the live storage that is required to ensure the supply of irrigation water to the command area at a certain level of reliability. The model was based on the following parameters:

• The reservoirs inflows for a period of 47 years (1958÷2008 excluding 1993÷1996) as derived from the rainfall-runoff model.
• The monthly evaporation losses based on the mean monthly evaporation depth, and the respective reservoir surface corresponding to the mean elevation during each month.
• The permanent environmental flow releases from the reservoir assumed equal to 4 l/s.
• The irrigation demand rate during the three dry month period (June, July, and August). This depends on whether a pressure pipe or an open canal irrigation network is adopted and is given in Table.....

The total irrigation demand is calculated by multiplying the above rates by the command area (in ha) that is considered in each particular case.

• The level of reliability expressed as the percentage of time that an accepted percentage of the total demand is met. In the case of the Nyanza project an accepted level of reliability is considered to be achieved when 90% of the total demand is met at 70% of the time.
The reservoir stage — water surface and stage — volume relationships, as well as on the assumption that the dead storage volume will be taken equal to 300,000 m³.

The reservoir balance simulation determines for several reservoir storage volumes (and for the respective max operational levels) the area that can be irrigated when adopting a certain level of reliability. It is evident that the size of this area depends on the criteria adopted. Strict criteria result in narrower areas, while loose criteria in wider areas.

The water balance calculations were carried out by using the above criteria. Based on the results of these calculations, the following tables are composed, which present the command area size that can be served at the prescribed level of reliability for different reservoir volumes for each one of the irrigation type networks.

In the case of the open canal system the natural constraints posed by the shape characteristics of the command area trace a limit to the development of the network. So an exclusively open system, which is the cheapest alternative, cannot extend to an area larger than 230 ha. If an open system is adopted combined with pipes for transferring the water to the northeast of Mwogo river, an alternative that increases the unit cost, the area to be served can reach the 290 ha.

The next step is to determine, for the examined reservoir volumes, the max operational elevations and the respective dam crest elevations, taking into account the required freeboard. This is done by considering the routing of the 10,000 years flood, as well as the additional min 0.60 m freeboard for the wave run-up. On the basis of the routing calculations the following table is composed.

**Table 5. Irrigation Duty/24 hours (l/s/ha)**

<table>
<thead>
<tr>
<th></th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure pipe network</td>
<td>0.42</td>
<td>0.74</td>
<td>0.59</td>
</tr>
<tr>
<td>Open canal network</td>
<td>0.47</td>
<td>0.82</td>
<td>0.66</td>
</tr>
</tbody>
</table>

**Table 6. Pressure Pipe Irrigation Network**

<table>
<thead>
<tr>
<th>Total Reservoir Volume (x10³ m³)</th>
<th>Command Area Served (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500.0</td>
<td>240</td>
</tr>
<tr>
<td>2000.0</td>
<td>280</td>
</tr>
<tr>
<td>2500.0</td>
<td>335</td>
</tr>
<tr>
<td>3600.0</td>
<td>450</td>
</tr>
<tr>
<td>4100.0</td>
<td>475</td>
</tr>
</tbody>
</table>
Table 7. Open Canal Irrigation Network

<table>
<thead>
<tr>
<th>Reservoir Volume ($\times 10^3$ m$^3$)</th>
<th>Max Water Level (masl)</th>
<th>Dam Crest Level (masl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500.0</td>
<td>1596.0</td>
<td>1599.0</td>
</tr>
<tr>
<td>1800.0</td>
<td>1596.9</td>
<td>1600.0</td>
</tr>
<tr>
<td>2000.0</td>
<td>1597.6</td>
<td>1600.6</td>
</tr>
<tr>
<td>2500.0</td>
<td>1599.0</td>
<td>1602.0</td>
</tr>
<tr>
<td>3600.0</td>
<td>1602.0</td>
<td>1604.6</td>
</tr>
<tr>
<td>4100.0</td>
<td>1603.0</td>
<td>1605.5</td>
</tr>
</tbody>
</table>

An additional small road section 195 m long approximately will be constructed so that access from the dam crest to the valve chamber at the downstream toe of the dam is achieved.

From the above tables the following conclusions are derived:

- In the case of a pressure pipe network the maximum command area of 471 ha can be served by a dam 19 m high (dam crest at 1,605.5 m) at the prescribed level of reliability. This is also the most feasible of all the alternatives concerning pipe networks examined with the unit construction cost falling marginally below the critical value of 20,000 USD/ha.

- In the case of an open canal network, the most feasible alternative is achieved with a dam 21.0 m high (dam crest at 1602.0 m). In this case the lower unit construction cost than all the examined cases is achieved, however not far from the respective lower cost in the case of pressure pipe network.

On the basis of the above results the alternative with the dam crest at 1605.5 m is elaborated from design point of view at this conceptual stage, as it serves the whole command area at acceptable cost and reliability.

### IV.7.3. Land Husbandry Component

The fertility status of soils of the study areas are variable depending on the parent material (which influences soil texture and clay mineral type), terrain, type of vegetation, land use and climate which generally affect the organic matter content of the soil and consequently affect the nutrient dynamics in the soil plant relationship.
In the context of agricultural problems of the proposed project sites, the slope gradient is the most important point that should get adequate attention in the project implementation period. The project has been designed to minimize land degradation of the area prior to implementation of any other successive programs.

To improve the agricultural productivity in general and the soil resource in particular, it necessitates concerted effort to tackle all possible constraints arising from all angles. For areas like these, a single factor solution cannot bring solution to the natural resource management in general and to soil resources management in particular.

Some 15% of the project area (471 ha) will be put under irrigation. Already, in the reservoir area and around the valley bottom especially in the upstream, farmers use intermittent and perennial streams as supplementary irrigation to produce potatoes, sweet potato and vegetables such as cabbage, and tomato employing traditional irrigation management practices. However, the yield that is being obtained from irrigated plots is not as it was expected, mainly due to poor water management practices and low level of input utilization.

On the other hand, on steep slopes of the mountains and hillside slopes, farmers plant mostly root crops like Irish potato, sweet potato, cassava and stock crops. A good part of the entire Nyanza-23 watershed is put under rainfed-agriculture. So far, all agricultural operations including land preparation is done manually without any other external support like animal or machineries. Generally, external input utilization of the farmers is none existent. Currently, due to low level of input utilization and use of rudimentary farm tools, which are coupled with fragmented land holding, the average production and productivity at the project site is low.

For rain fed agriculture, major crops of the area will be promoted to be cultivated in the different slope categories. Improved cultivars and the required materials shall be availed for the project beneficiary farmers.

However, in the water catchment, mountain and hills side slopes starting from the Silt trap towards the overlaying slopes, farmers will be advised to plant fruit trees on the constructed terraces so that not to disturb the soil and moved downwards to the silt trap and then to the reservoir.

In the first three seasons of the constructed terraces, beans will be planted and incorporated in to the soil so that the sub soil will be well mixed with the green manure to improve the organic content of the soil.

Thus agricultural production can be substantially increased through primarily hillside irrigation development along with land husbandry, water harvesting and the use of modern agricultural inputs. Parallel to the agricultural development the capacities of the beneficiary farmers will be strengthened through effective credit and marketing services to enhance the buying power of the project beneficiaries, so
that participant farmers use the required inputs like improved seeds, agrochemicals, fertilizers and other inputs.

The farmers will be encouraged to form producers cooperatives to empower themselves in the bargaining power of their products and to alleviate transport cost of inputs they required.

![Image](image_url)

**Figure 7.** Different land-husbandry sections of the entire Nyanza-23 watershed requiring different husbandry interventions

**Land Husbandry at the water catchment**

The water catchment, excluding the Silt-trap zones is about 1,307ha in land coverage. In terms of soil depth, 47% of the water catchment is covered by shallow soils and the remaining balance is covered by soils with deep profiles. The dominant of the topography of the watershed lies in between 6-16% and the 16-40% slopes. The 6-16% is relatively suitable for agricultural activities.

Utilization and management of the soil types has to be dependent on the soil depth and on the soil fertility status of the project site. The shallow soils of steep slope area should get adequate attention from the project management not to damage the
thin layer of the top soils during the terrace construction and during the land labeling activities.
The reclamation of these soils especially the organic matter application is utmost important to enhance the fertility status of these soils and to arrest the soil’s movement. The problem of the steep slope area is the soil movement which does not give the chance to accumulate mineralized soil layers i.e. Each time when the sub soil exposed to the outer atmosphere the soil mineralized and micro and macro organizes start their standard functions, however, due to the location of the soil the mineralized soil moves toward the low laying terrain with or without mineralization and the vicious circle continues. Because of this, it is utmost important to break the vicious circle and encourage accumulation of the mineralized soil layer employing different biological, physical as well as soil reclamation measures.

One of the management options to improve the soil is to reduce the level of acidity with application of agricultural lime at least under annual crops like Maize, Sorghum and Beans and also application of the same under seedlings of fruit trees during the transplanting of the seedlings.

Table 8. Area coverage of land-husbandry units of the Water-catchment at Nyanza-23

<table>
<thead>
<tr>
<th>SLOPE</th>
<th>Area in hectare by soil depth</th>
<th>% by slope range</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=50cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-6%</td>
<td>53.66</td>
<td>12.90%</td>
</tr>
<tr>
<td>6-16%</td>
<td>224.28</td>
<td>44.39%</td>
</tr>
<tr>
<td>16-40%</td>
<td>295.68</td>
<td>41.54%</td>
</tr>
<tr>
<td>40-60%</td>
<td>14.48</td>
<td>1.17%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>588.1</td>
<td>100.00%</td>
</tr>
<tr>
<td>% by soil depth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47.40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52.60%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Check-dam constructions*

One of the activities to arrest the soil movement is to retard the velocity of the run off in the intermittent streams of the secondary-level streams, occurring at the start of the streams is a dry drainage system that can easily be treated by gully reshaping and planting with perennial grasses, shrubs and trees. Therefore, it is assumed that gully treatment is required in 80% of the secondary-level streams (drainage systems).

The Water Catchment at Nyanza-23 is more of level to steep land (0-16 % account for over 57 % of the area while 16-40 % accounts for 41 %). Therefore, on the average, the check-dams can be spaced at 1 m vertical interval, at every 30 meters distance within the level lands but in the steep lands the check dams should be made closer to each other. It is also estimated that the average width of the drainage system to be 10.
The estimated benefits from the water catchment protection come from the land-husbandry effort which is to be reflected in increased production and productivity of the rainfed farming system. The water-catchment areas at Nyanza-23 account for 1,307 ha (excluding the silt-trap of 73 ha). The fodder grasses growing on the risers of both soil bunds and radical terraces could yield a minimum of 2 tons /ha per year. In addition, about 754 ha of the water-catchment is agricultural land in slope ranges of less than 40 % slope.

The yield increment in these areas due to the comprehensive land-husbandry interventions estimated to be a minimum of 60 %. The current level of production in Nyanza-23 is about 30-40 tons per hectare for at least three of the best varieties of Plantain (average and dominant crop). In the benefit estimation, it is estimated that this production will be increased by 60-70 % or 13 tons/ha. Detailed cost and benefit calculations are subjects of the economic and financial report. However, the indicated crude investment budget and possible income show that the activities to be implemented in the water catchment may be attractive.

**Silt-trap system Design and Management**
The silt-trap zone is intentionally designed to avoid silt coming with the water that originates from the water-catchment and from the silt-trap-zone itself. It covers the perimeter which is a drainage contact with the reservoir down-slope. The silt-trap zone of the Nyanza-23 project site is 73 ha which is partitioned into three distinct sub-zones (Figure 6). The first and outermost layer is the Tree-zone which is further-down adjoined by shrub- zone. The tree zone covers 37.8 ha while the shrub-zone accounts for 22.92 ha. The zone between the reservoir and the shrub-zone is a 12.16 ha grass covered strip. Between the Grass strip and the shrub-zone, a 50 cm-wide live fence is to be constructed along the perimeter between the shrub and the grass-belt zones. By doing so, the reservoir and the grass-zone are completely excluded from any human and livestock interferences and drowning dangers.
Figure 7. Location of the different silt trap zones along with the reservoir boundaries

*Design of tree-belt*

The tree belt is the outer and upper part of the silt-trap zone and covers an area of 37.8 hectares. This is the zone which is to filter out and contain the boulders that are coming with run-off during the rains. As it has been discussed earlier in this Sub-volume, the water catchment will be given the necessary catchment treatment measures including gully rehabilitation works. However, experience has shown that the catchment –treatment may not be done as prescribed in the study documents and treatment procedures may be violated that up-stream run-offs may contain gravels and boulders when flowing down-stream. This will be environmentally detrimental to the fish in the reservoir and life-span of the reservoir itself. Hence, filtering the boulders with the tree-crop becomes a necessity.

The trees will be planted along the contour in a spacing of 1.0 meters along the same contour. The same spacing is recommended for the spacing of consecutive contour lines on which lines of trees will be planted. The total number of lines in one meter spacing in this 37.8 ha land is 37.8 km. At one meter spacing between trees in the same contour lines which are spaced 1 meter apart from each other, the total number of seedling requirement becomes 37,800. However, fruit trees will be planted at every third row and in every sixth meter in the same line. The remaining trees will have multiple uses, such as forage or construction material.
Hence, the need for grafted seedlings per hectare becomes 555 while for forage becomes 9,445 seedlings per hectare. Commercial rainfed fruit tree species that are suited to Dry Lowland agro-climatic zone such as *Citrus medica*, *Casimiro aedulis*, *Tamarindus indica*, and *Ziziphus mauritiana*, etc. are recommended.

**Design of shrub-belt**
The shrub belt is the middle part of the silt-trap zone and covers an area of 22.92 hectares. This is the zone which is to filter out and contain the gravels that are rolling to the Silt trap from over laying terrains. Therefore, the movement of boulders in this kind of slope terrain is very limited and with limited force of crawling (if any during heavy rains). Therefore, it can be handled by the shrub-belt effectively.

The forage value shrubs will be planted along the contour in a spacing of 1.0 meters along the same contour line. The same spacing is recommended for the spacing of consecutive contour lines on which lines of shrubs will be planted. The difference between the tree-belt and the shrub-belt is that the individual shrubs are multiple stems which can densely fill up the line creating a good blockage that serves as a barrier to the gravels escaping the tree-belt and coming down to this zone.

The total number of shrub lines in one meter spacing /ha is 1 km in length. Therefore, in this 22.92 ha land, we are having 22.92 km lines to be planted with forage shrubs. At the spacing of one meter between each shrub plant in the same contour line which is spaced 1 meter apart, from any adjacent line, the seedling requirement is 22,920. Similar to the tree belt, fruit –value shrubs will be planted every third row and in every sixth meter spacing. Therefore, the fruit-value shrubs to be planted per hectare become 555 per hectare.

The remaining forage value seedlings will be planted at the rate of 9,445 seedlings per hectare that do not need to be grafted. Forage and fruit value species that also do well under rainfed conditions in Dry Lowland agroclimatic zone such as *Ehretia cymosa*, *Citrus medica*, and *Zimenia americana* are recommended here.

**Design of Grass-belt**
The grass belt is the inner and lower part of the silt-trap zone and covers an area of 12.16 hectares. This is the zone which is to filter out and contain the silt that is escaping through the tree and shrub belt of the Silt-trapping zones.

This layer needs to be very thick to contain the silt and release only the filtered water down to the reservoir. In addition to protection of the reservoir from the silt deposition, this zone serves as a buffer zone for protecting the dam from any contaminant and hazard happenings. In order to avoid any such hazard, a tight live fence will be constructed at the outer layer of the Grass-belt. In the live-fence
construction, *Zimenia americana* and/or *Dovyalis abyssinica* will be planted in a spacing of 0.5 cm distance in a line and in two lines that are spaced 0.5 meters apart.

The *Erythrina brucei* will be planted in a spacing of 1 meter within the planting of the *Dovyalis* or *Zimenia* and it will be in between the two lines that are planted in a staggered fashion. The *Zimenia americana* and the *Dovyalis abyssinica* will be planted from seedlings while the *Erythrina brucei* will be planted from cuttings immediately after the rain period is completed.

In between the live fence and the water body, grasses that have course-culm and spreading-sod such as Elephant Grass and Rhodes Grass will be planted along the contour. Cuttings of the Elephant grass will be planted in a spacing of 0.25 meters along the line and 20 cm between the adjacent lines. All lines will be oriented along the contours. The coverage of grass in slope ranges of no more than 16% will be on 99% of the grass belt. For the first 25 m width, grasses will be planted regardless of the slope range; but along the contour.

**Land Husbandry in the Command Area Catchment**

This area is situated uphill of the command area. Based on survey findings, the agricultural activity accounts for 72% of the total catchment and extended up to 60% slope. The largest area is situated in slope category of 16-40% and the terrain as well as the agricultural practices extends up to 60% slope. Thus, the land husbandry interventions which will be proposed in Nyanza-23 include all possible practices as it is found to be relevant.

Most of the area, 70%, is covered by shallow soil units with equal or less than 50 cm depths. At the same time, over 58% of the Nyanza-23 site is exhibiting slope range in between 16-40% slope which covers greater than 50% of the catchment.

The command catchment of Nyanza-23 is the ridge of mountain to the Northern West direction of the Dam site. The command catchment as well as the whole watershed is covered by four soil units. The soil units that cover the area are Dystric Cambisols and Humic/haplic Acrisols and Dystric Leptosols and all these soil units are characterized in the water catchment.

**Land Husbandry in the command area**

**Land Management**

The irrigable (command) area of Nyanza-23 project site is 471 ha. The existing topography of Nyanza-23 site is composed of flat, gentle and steep. Lands in slope range of 0-6% are above 27%. Grass strips of 1 meter width and spaced in every 10 m is planned for these lands. The grass strips will be inter-spaced by trash lines of half meter width and 20 cm height that are spaced in 5 meter interval either with the grass strip or adjacent trash line.
Lands in slope range of 6 – 16% are the dominant (42%). Soil bunds of 1 meter height that are spaced in one meter vertical interval are recommended and budgeted. The risers of the bunds are level in a horizontal vertical ratio of 1:3 and the surface is planted with fodder-value perennial grasses and/or herbs. For all bund/terrace stabilization Ciratro, green-leaf desmodium, Elephant grass, Rhodes grass, Phalaris, and any other to be approved by the Client are recommended.

Lands that require radical terraces for leveling (16 – 40%) are also significant. About 241 ha or 31% of the command area is in this slope range. The major leveling possibility here is construction of radical terraces. Radical terrace construction, often buries the top soil. Usually, putting aside first the top soil and spreading it over the top surface after leveling is completed is advised. However, this often said than done. It is practically difficult and time consuming. In order to minimize such a problem, the cutting will be started from the upper half of the lowest terrace that needs to be added to the lower untouched surface of the next above terrace. This will minimize but not avoid burial of the top soil. However, in Nyanza site, except in slopes of less than 16%, the top soils of all lands above 16% are lost by water erosion. Luckily, the B-horizon and even part of the C-horizon are often deep and homorganic. Therefore, burying the top soil is not possible for it is already gone.

Lands that exceed 40% slope are only 0.5% or less than 0.7 ha in area. These are also found in scattered form that is identified in the irrigation infrastructure layout. Therefore, no special land husbandry would be designed.

Just after construction of the different slope reduction strips, bunds and terraces plus the installation of the irrigation schemes, the improved coffee and plantain will be planted as per the recommended spacing. After the seedlings coffee and plantain seedlings are planted, lime shall be side dressed around the seedlings to help the planted coffee and plantain seedlings can grow well and afterwards develop tolerance to acidic nature of the soil in the area.

To alleviate the constraints of the soil resources and to utilize the resources in a sustainable manner, it is required to improve the soil reaction, water holding capacity and the statues of the chemical contents of the soils employing natural and commercial fertilizers as well as soil property amending materials like lime for annuals.

To enhance the general fertility status of these soils it is indispensable to apply organic matter. A huge amount of well-decomposed manure and compost preparation and application are recommended and budgeted for this purpose. The organic matter from these sources improves water holding capacity, the structure of the particles and the nutrient supply conditions. It reduces the pH and other toxic effects of other elements.

**IV.7.4. Equipment and Material Description**
The following equipment and materials are planned for use during the construction phase of the project.

**Equipment**
Earth moving equipment including excavators, tractors, graders, trucks, local excavation implements for trenches like forks, spades, wheelbarrows, Dozer, crushers, mixers, dump trucks, etc.....

**Material**
Materials that will be used in the construction works include Cement, sand, water, boulders, wire mesh, PVC etc. Most of these materials are readily available in the local markets in Kigali. However; local material will be sources as defined in the section below in order to reduce costs.

**Identification of Natural Construction Materials**
A search for natural construction materials has been conducted within the vicinity and outside the dam site. The search includes identifying fine-grained soil for the impervious core of a zoned dam or for the entire body of a uniform embankment dam, materials for the shell of a zoned dam, filter sand, stones for rip rap, sand and aggregates for concrete, and water for construction. The results of the search are presented in the following sections.

*Material for Impervious Core*
As described in the previous sections, the majority of the reservoir area is made up of sandy soil, which is not suitable for an impervious core. For this reason, it was necessary to explore availability of potential borrow sites for such a purpose outside the reservoir area. It was, however, difficult to identify such a borrow area in the immediate vicinity (within a kilometer distance) of the dam site as the site is dominated by the residual sandy soil described above as a result of weathering of the predominant granite intrusion that is typical of the region. A suitable material is located at a location northwest of the dam site about half way the height of the seemingly tallest hill in the surrounding. The site is located at about 1.5 to 2 km from the dam site in a locality called Gacu. Its geographic coordinates are 9742724 m N and 0468120 m E with an elevation of 1793 m asl. It is accessible with an existing all-weather dust road having moderate slope.

The selected soil covers an area of more than 10 hectares, but the majority of the site is inhabited and cultivated. There are, however, pockets of land covered with eucalyptus trees owned by individuals that can be considered for the intended purpose. An area of about 2 to 3 hectares of such lands can be delineated. Since the thickness of the soil is estimated at more than 4 m, about 100,000 m³ of the material can be borrowed without difficulty. Exploitation of such a volume of soil from a hilly area like this one would have adverse effects like facilitation of erosion, slope instability and creation of unwanted water ponds. Therefore, the environmental impact needs to be properly addressed.
In this regard, those borrow pits will immediately be backfilled after excavation related works and replanted with vegetation.

Shell Material
Source area for granular soil that can be used for shell zone of the dam is available within a distance 100 m both upstream and downstream of the dam site. The upstream continuation of the foot of the left abutment hill and the downstream continuation of the foot of the right abutment hill are mainly composed of completely weathered granite that can be borrowed for this purpose. Two specific borrow areas have been delineated: one at about 70 m upstream of the left abutment peak on the left side of the small intermittent tributary stream closest to the dam; the second site is proposed at about the same distance downstream, at the foot of a continuation of the right abutment hill following the dust road. As much material as needed can be exploited from these sites. The soil is similar in composition to the residual sandy soil described earlier.

The proposed borrow areas for the shell material is free from human settlement and agricultural activities, except that they are covered by sparsely distributed eucalyptus trees. The environmental effect appears to be kept at a minimum. In addition the soil from essential excavation for the foundation of the dam, especially the portion below 1 m, can be used as a shell material as this has a similar property as the selected shell material described above. A schematic location of the borrow areas is shown in Figure 8.
Figure 8: Schematic location map of the construction materials

Rock source for Various Purposes

A quarry site for extracting stone for different purposes, like for masonry, rip-rap, rock toe and concrete works has been identified at about 2.5km north west of the dam site, at the peak of the mountain, where the impervious material is also located. It has the geographic co-ordinates of 9743010mN and 04672391mE, with elevation of 1861 m asl. The site, locally known as Rubona, can be accessed on a rugged dust road; which will require rehabilitation and rerouting for better performance.

The proposed site is dominated by outcrops of quartzite Rock, which is one of the strogents and chemically inert rocks in the metamorphic rock category. The rock is exposed over a wide area forming rather long (more than half a kilometre) isolated ridge.

The identified site is a properly selected existing quarry site, which is being actively exploited and conveniently located in view of minimizing adverse environmental impact. However, since the site is located on the slope of a steep hill, the risk of rock sliding and rock fall needs proper attention.
Filter Sand
Generally, sandy soil that can be used for concrete works and as a filter material cannot be found from stream beds in sufficiently large quantity as the streams transporting capacity is low. The main sources for sands and gravel in the region including this project are related to in-situ weathering of quartzite and other quartz-rich rocks like granite. Such a site is proposed about 2 km downstream of the dam site, at a locality called Rwabicuma of Gasiza village. The geographic coordinates of the source area are 9740786 m N and 0466227 m E with elevation of 1644 m asl. It is accessed by the same all weather soil road passing by the dam site and crossing the stream there.

The sand at this site is uniformly graded covered at the top by a silt-rich soil horizon of about 1m thick that needs stripping. The area is also being utilized by the local people for construction purposes, but is limited in extent, as it is in the middle of an inhabited locality. An area of about one hectare can possibly be delineated. Since the site is located amidst a cluster of residential houses, its further use may have adverse environmental effects like ponding of water. Thus, the actual consequences and the necessary measures need further considerations.

Water for Construction
Water abstractions for compaction, concrete works and other construction activities will be from the Kagondo stream, a tributary of the Mwogo River, at the dam site. For environmental and social purposes, a minimum flow of 4 liters per second must remain in the stream downstream of the point of abstraction at all times. Should the continuous flow rate by direct pumping - that is available in excess of minimum flows - not suffice to meet construction water demand, the contractor will have to provide (night) storage as required.
V. PROJECT NEED AND ANALYSIS OF ALTERNATIVES

V.1 Nyanza 23 Project Alternatives
This section discusses and assesses alternatives in terms of alternative activities site, alternative technologies, and finally No project option. The study undertook a comparative analysis of various alternatives considered to avoid or minimize impacts that would be inevitable if technically best fit options are followed.

V.1.1 Alternative sites
Nyanza 23 site was preselected based on an assessment of its potential for water-harvesting, irrigation and water management needs as well as incidence of poverty, population pressure and levels of food insecurity. Allocating the resources to the selected site is seen as a good and reasonable alternative. Changing the site would mean abandon this population and the whole project area that needed these interventions. The best option would be to expand the activities to other vulnerable areas that can profit from Nyanza project activities.

In selecting a feasible site for this project, the following criteria were considered:

Socio-political Criteria
- Responsiveness/interest of beneficiaries—
- District leadership and ownership—
- Level of social impact:
  - number of beneficiaries on the site, relative to site size;
  - proportion of female-headed HHs therein;
  - flood risk (i.e excess rainfall measure)
  - presence in a drought zone (—also to be used as a food security indicator);
  - number of displaced households (using a ratio that measures displaced people relative to the site size);
- Accessibility to markets (year-round access road to the command area exists or is planned)

Economic Criteria
- Using the common economic and financial analysis (EFA), the site must have an economic rate of return greater than 12 percent (ERR > 12 %).

Technical and Environmental Criteria
- Command area greater than 50 ha
- Sufficient water harvesting potential
- Severity of soil erosion; higher severity more meritous of investment;
- In a moisture regime where irrigation makes a difference
- Coincidence of excess rainfall and drought (using indicators for drought and rainfall in the socio-economic criteria);
- Level of environmental impact i.e. sites that would lead to high and significant adverse impacts were rejected
- Hydrological significance of the water bodies to be developed which entailed selection of water bodies that are capable to have irrigation infrastructure developed on them without compromising their ability to perform their ecological functions. Water bodies without
these capabilities were rejected because of the potential adverse impacts that they would cause.

- Ecological functions were also important criteria in selecting the water bodies. This means that water bodies that provided sensitive ecological functions and contained species of rare significance were regarded as critical and if selected the need for stringent mitigation measures would be adopted.

The selected site was considered after subjecting it to the above criterion and thereafter it was found to meet these requirements.

**V.1.2 Technology Alternative**

The commercialization objectives of LWH project require year-round production, which in turn require storage of water. Given the invocation of land consolidation for economies of scale in production, a uniform application of inputs (including water) made it desirable to have one collectively managed infrastructure rather than many small ones with ensuing variance. It was also clear that micro schemes could not have the same flood-control benefits as the reservoir model. Furthermore, such a highly decentralized approach and large number of schemes would limit the opportunities for environmental oversight. Finally, the economic and financial analysis (EFA) conducted for Nyanza site indicated that the return to the pump models were lower than those for the dam-conduit-gravity model adopted by the Project.

**V.1.3 No Project Alternative**

The no Project activities option will entail leaving the population in the present situation. For a country emerging from war, this option is not desirable considering the need of the population to sustain their livelihood. The environmental effects of the proposed activities will be avoided making the option desirable considering the state of the environment. The actual LWH project activities and many other similar ones will immensely contribute to achieving this ambition. The Project will result in a direct injection of millions of Rwanda Francs to the local economy and therefore a no project alternative will mean foregoing such investment.

**V.2 Project activities development with mitigation measures**

The most preferred alternative would be implementing the Project with mitigation measures in place. A pursuant of this alternative will entail going on with the activities but taking into account the potential impacts on the environment by incorporating mitigation measures. This alternative is more desirable as it will inject a significant amount of money into the economy thereby promoting sustainable development and providing better livelihood which is one of the government’s goals. The potential impacts to the environment will also be improved by coming up with an Environmental Management Plan (EMP) that will incorporate mitigation measures.
VI. POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

A number of environmental issues were identified during the scoping process of the study. The purpose of this section is to predict and make an assessment of the impacts on the environment that may potentially arise as a result of the implementation of the project.

Impacts that could occur are grouped and discussed below under the headings of the various environmental components (e.g. fauna, air quality, ground water, flora, etc) that it is anticipated are likely to be affected by implementation of the project. A certain amount of overlap between these components is unavoidable and therefore cross referencing is used where possible to avoid repetition.

An assessment of these impacts was made on the basis of information gathered during the scoping process, the detailed environmental baseline study of the project area which has included several field visits to the project site and its surrounds, as well as a desk study of relevant existing documents and information pertaining to the study and information describing the nature and design of the proposed project.

V.1. PROJECT POSITIVE IMPACTS

The Land Husbandry, Water Harvesting and Hillside Irrigation report identifies many of the positive impacts of the proposed activities. These include poverty reduction, food security, hillside restoration, rural development, irrigation efficiency among others.

VI.1.1. Impacts during Planning and Construction Phase

VI.1.1.1. Physical Impacts

a) Catchment Rehabilitation and Management
Soil erosion has been indirectly caused by degradation of catchments through farming and deforestation. The LWH project component on marshland and hillside development through reforestation and terracing of the hillsides is to a great extent a sound practice for protecting the catchments.

b) Flood Control
The dam to be constructed will control floods downstream by storing excess water during heavy rains. Flood control effect of the project will free more land for farming as well as prevent destruction of food crops for those farmers exploiting floodplains during dry season and command area in the wet season. The socio-economic feasibility survey report revealed that 13 % of households within the project site experienced flooding of their farms during rainy season; which devastate their crops.
Houses falling within the command area were also affected by the flowing water during heavy rains. This is helping to minimize the flood related impacts downstream that could include crop and property destruction. Flood control will also help achieve food security, mainly for rain dependent crops.

c) **Water Resources Conservation**
The Land Husbandry and Hillside Irrigation project will invest in the protection of hillside through water harvesting, reforestation and terracing. This will reduce soil erosion and protect the hydrological systems from sedimentation, flooding and contamination. This will curb the rate of irrigation in the area and the country.

d) **Improved soil conservation**
The development of land husbandry technologies on hillsides will contribute to soil conservation as a result of reduced erosion and proper management of runoff. As a result from livestock diversification, there will be an increase in the volumes of manure used to replenish soil fertility. Continued use of this manure will improve the soil quality and sustainably enhance soil fertility thus improving the yields. Improved soil conservation through improved land husbandry practices in the command area catchment and water catchment area will lead to improved crop production resulting in an increase in income to farmers.

VI.1.1.2. **Ecological Impacts**

a) **Revegetation**
The implementation of hillside activities will improve the vegetation of these erosion susceptible areas. This may modify existing habitats and ecosystems.

b) **Environmental Protection**
The project promotes intensification of agriculture as opposed to extension. This is arguably protecting marginal areas as more food is being produced in a smaller area. Sustainable agricultural intensification is not only important to increased employment and income, but also is critical to protecting the environment.

c) **Birdlife and fish Habitat**
The dam reservoir area will attract birdlife in the project area. Fishes will also be introduced. This is a beneficial impact on the biological environment of the project area.

VI.1.1.3. **Socioeconomic Impacts**

a) **Increased farm incomes from crop output**
An increase in farm incomes as a result of increased marketed crop output is anticipated. This would additionally be due to better and reliable market access of
high-value crop produce that would fetch a good selling price as well as increased volumes of marketable output of different crops. An increase in output value by 220% from the current crop production in the command area based on gross margins of the projected high value crop output at the exporter’s prices and the current output’s gross margins.

b) Food Security
The project is targeting bean, maize and fruit production in the area and crop productivity is set to increase significantly. Beans are one of the staple food at Nyanza site. As staple food and other food crop are increasing in the area, the project will contribute to food security at local and national level. This would imply that if the production is improved, there will be more food thus resulting in a decrease in prices hence making it affordable to all the members within the community to have access to food.

c) Poverty Alleviation
The Rwandan Poverty Reduction Strategy Paper (PRSP, Rwanda, 2002) identifies five potentially competitive crops that will be targeted for expansion in addition to the traditional cash crops of coffee and tea. These are rice, maize, potatoes, soya and beans. Based on the Rwanda LWH, the project is in line with the objective of tackling poverty through promotion of agriculture.

At the local level, the irrigation infrastructure project will promote increased agricultural productivity, diversification of agricultural crops and commercialization of agriculture from subsistence. Improvement in crop productivity will raise the income for the rural poor above the poverty line of less than a dollar a day. This is an indirect impact that will take a long process that will be felt after many years.

d) Raise Rural Income
According to the socio-economic feasibility study report, Ninety one percent (91%) of the sampled households indicated that the implementation of the project will introduce new crop-husbandry practices that have not been used in the area previously, or even lead to expansion of existing crop enterprises. Within the entire water catchment area and command area catchment, land husbandry practices that will improve crop production will be adopted, but the prevailing cropping patterns will be maintained.

e) Rural employment
Land husbandry implementation and dam construction are labour intensive activities and for that reason, the labour needed in the project area will create much needed employment opportunity to the rural population.

f) Market creation
The project will create market for farm inputs including seeds, compost and pesticides. The production of bean, maize and different kinds of fruits (mango,
avocado, citrus, etc.) will provide many rural communities with a cash commodity for local markets.

g) Other benefits

*Appreciation of the value of land*
Nominal land prices may increase thus making the high value irrigable land useful for cultivation and marketable which was otherwise less favored due to flooding and as a result of the improved potential of its productivity, then it would appreciate in value.

*Capacity building of farmers*
In the course of the implementation of the project, farmers will be sensitized and trained on land husbandry techniques and their maintenance, the use of water and production of different crops, IPM, etc., thus imparting skills to them for improved production as well as to access markets, which they will utilize even after the project’s exit.

VI.1.2. Impacts during the Operation Phase

VI.1.2.1. Impacts on Local and National Production and Economy

a) *Increased exploitable area and agricultural productivity*
A good portion of Nyanza 23 has low agricultural productivity. The implementation of land husbandry technologies and the construction of dam and irrigation infrastructures in Nyanza 23 will increase the exploitable land area, improve soil fertility. In addition, water supply in the hillside irrigation scheme will be sufficient and reliable to enable a triple crop growing season per year. The part of Nyanza 23 area which is usually inundated during rainy season will no longer face the same extent of severe flooding. The increase in exploitable area, improved soil fertility, reduced flooding as well as hillside irrigation will lead to increased productivity. This will also improve on rural livelihoods.

b) *Crop diversification*
Bean, cassava, banana are some of the crops grown by farmers in the area for their subsistence. The implementation of the project will introduce new crop-husbandry practices that have not been used in the area previously, or even lead to expansion of existing crop enterprises. Within the entire water catchment area and command area catchment, land husbandry practices that will improve crop production will be adopted, but the prevailing cropping patterns will be maintained. As a result, there will be an increase in the value of output from both the water catchment area and command area.

c) *Employment generation and poverty alleviation*
The implementation of the project will result in the creation of more than 3,500 direct new employment opportunities for surrounding local communities and Rwanda in general. This will include opportunities for employment on dam site as well as various aspects of infrastructure management and maintenance.

d) **Livestock Development**

Major constraints hampering the development of the livestock sector include inadequacy of animal feed both in quality and quantity, which arises due to poor and narrow pastures and water shortage among other issues (MINAGRI, 2008). The implementation of the project interventions will indirectly lead to the development of the livestock subsector as a result of increased quality fodder production which will be harvested from fodder trees and perennial forage legumes intended for the water catchment protection through the project interventions, thus improving the low productivity of livestock on these farms. This will complement the government’s initiative on one-cow one-family program, thus improving the welfare of the farmers within the project site, through provision of required nutrients at household level and income that may be used to purchase essential goods and services.

Availability of fodder for livestock will be an incentive for farmers to diversify and expand their livestock enterprises and enhance adoption rates of improved breeds which are early maturing and high yielders. Livestock development is envisaged to have a potential to contribute to poverty reduction through increased farm incomes. Livestock development projects often act as catalysts that enable farm households to join the market economy and thus to achieve a decent standard of living (ILRI, 2007). In addition to contributing to household level welfare, the increased milk and meat production will have a positive effect on the national dairy and meat sector. The livestock development in the area will lead to increased organic manure that will be used to improve soil fertility, thus increasing land productivity.

e) **Multiplier effects**

Substantial economic multiplier effects will result during operation of the project. These include: Numerous jobs, numbering in the several of thousands, will be indirectly created or supported in secondary related agricultural providing goods and services to the project. Sectors of the economy that are closely related to the project include the retail and whole sale trading sectors, tourism, agriculture, horticultural, manufacturing, construction, transport and financial sectors; the development will enhance the value of neighboring properties.

f) **Increased public revenues**

Operation of the project will provide increased revenue in terms of rates payable to Nyanza and Huye Districts. Increased employment opportunities and other multiplier effects downstream in the economy will provide opportunities for
increased revenue for RRA due to increased payments in the form of PAYE, VAT and corporate income tax from retailers and suppliers. The businesses operating on the site will also make substantial contributions in the form of corporate income tax. There will also be increased revenue to utility providers such as Energy, Water and Sanitation Authority (EWSA).

g) Contribution to national crop production and national economy

Table 9: Contribution to National crop Production and National Economy

<table>
<thead>
<tr>
<th>Crop</th>
<th>Before the project</th>
<th>After the project</th>
<th>Increase in yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bean</td>
<td>2,720 tons (800 kg/ha on 3,400 ha)</td>
<td>20,400 tons (3.0 tonnes/ha on 6,800 ha)</td>
<td>17,680 tons</td>
</tr>
<tr>
<td>Maize</td>
<td>2,720 tons (800 kg/ha on 3,400 ha)</td>
<td>23,800 tons (3.5 tons/ha on 6,800 ha)</td>
<td>21,080 tons</td>
</tr>
</tbody>
</table>

There will be increase in the produced bean and maize due to increase in the cultivated area and improvement in the farming practices.

h) Provision of fuel wood

Trees and shrubs will be integrated during the implementation of land husbandry works. Firewood will be produced to satisfy farmers’ demand.

VI.2. PROJECT ADVERSE IMPACTS

VI.2.1. Impacts during the Planning and Construction Phase

Significant negative impacts are those effects that will, as a result of the implementation of the activities, contribute to unintended results. These impacts have been described in the different phases of the project and are further categorized in terms of impact duration, magnitude and type respectively.

The design phase of this sub project involved identification of a suitable site for the infrastructure and undertaking of a detailed feasibility study. There are no adverse impacts expected during this stage. Negative impacts are likely to occur during the construction phase.

VI.2.1.1. Physical Environment

a) Soil erosion
During the construction of improved bench terraces or soil bunds within the command area, unprotected embankments or waterways will be exposed to agents of erosion, mostly water. This impact will occur during project construction and operational phase. The magnitude of this impact will include loss of soil and siltation of marshlands/swamps and water bodies downstream. This impact will be long term and will manifest after a long period. This impact will correspond with a decline in agricultural productivity that will lead to cultivating marginal areas that are prone to environmental degradation.

During the construction of the dam and its ancillary facilities which will involve clearing of vegetation, excavation works etc., the soil will also be exposed to the agents of erosion, mostly water.

*Impact Significance*
This impact is going to be low in significance in terms of magnitude because the project in itself is aimed at improving soil conservation through reduction of erosion. The erosion that will occur during the construction will be minimal and localized in the areas where excavation will take place only. The impact duration is only expected to be felt during the construction phase.

*Mitigation Measure(s)*
Soil erosion occurring during the construction phase of the project can be avoided through:
1. Revegetating the cleared sites immediately after construction of terraces and soil bunds' embankments and waterways;
2. Only clear areas earmarked for construction.

**b) Topsoil Stock Piles**
During the construction phase, excavation earth from the reservoir in addition to canals and drainages will create a pile up of soil. These activities may result in the increased erosion in areas where vegetation has been stripped and stockpile. This could lead to increased suspended solids being deposited into the valleys and the feeding rivers

*Mitigation*
The stripped soil should be used to construct the dam walls and floor of the dams. An alternative preventive measure is to construct the subprojects during the dry season. This measure may delay the project implementation program, therefore the protection and use of the stock pile is the alternative choice to prevent this impact.

**c) Destruction of water points**
Water points and water infrastructures are located within the water catchment, command area, command area catchment or silt trap zone. During the construction
of dam and implementation of land husbandry technologies in command area, some of these water points will be destroyed.

**Mitigation**
The Project in consultation with the local authority and EWSA should identify sites for water point development and put in place a water supply programme or identify protected domestic sources of water in the area.

d) **Borrow Pit Impacts**
Borrow pit are generally associated with scaring of the general environment and landscape owing to the excavation related works. If not backfilled immediately and replanted, the borrow pits end up becoming a health hazard and a source of spread of water borne related diseases like bilharzias, malaria, etc. This is because the pits end up collecting water that stagnate and hence becoming a rich breeding ground for the disease vectors. Borrow pits are also known to be potential sources of hazards especially accidental drowning of livestock and human beings.

**Impact Significance**
This impact is going to be low in significance in terms of magnitude and scope and scale will be localized. The duration of the impact will be short term and only experienced during the construction phase. It is possible to reverse the impacts through rehabilitation.

**Mitigation Measure(s)**
This site is an existing borrow area, which is being actively exploited and conveniently located. The environmental effect due to the additional exploitation is thus kept at a minimum. The borrow pits are immediately backfilled after excavation related works and replanted with vegetation.

VI.2.1.2 **Biological environment**
a) **Destruction of hillside biodiversity**
All crop enterprises and trees established in the project area will have to be destroyed. This is because they are either in areas that would be inundated by water at the reservoir or in areas where land husbandry technologies are to be implemented. The PAPs would lose benefits which they were already reaping from these enterprises including getting food for home consumption, getting produce for sale and getting fodder for livestock.

**Impact Significance**
This impact is going to be fairly significant in terms of magnitude because local population in Rwanda depend a lot on agriculture as a means of livelihood. The scope will be localized and felt in the reservoir area. The impact will also be long
term in terms of duration because the crops and land will be lost for as long as the project is implemented.

*Mitigation Measure(s)*
This impact is unavoidable and will be mitigated through compensation for crop, grass and tree loss. The Resettlement Action Plans (RAPs) will be prepared and implemented.

**VI.2.1.3 Social environment**

*a) Resource Use Conflict*
Wetland and hillside in Rwanda are used mostly for domestic water supply and agropastoral purpose respectively. The development of the hillside/wetland, therefore might trigger resource use conflict over agro pastoral land and water supply. This impact is not going to be significant as the government has in place a zero grazing policy. But for water use conflict, this might be a problem in areas where communities depend on wetland for domestic water. Wetlands in these areas are a source of water for domestic water supply.

Loss of grazing land and water for livestock through development of the wetlands will have cumulative impacts on the already effects of competition between land tillers and livestock keepers.

*Mitigation*
To prevent conflict over agricultural and domestic water uses, LWH should have in the dam design, requirement for identifying and developing domestic water sources. It is recommended that the community water points are sited upstream of the marshland to prevent water contamination. These facilities will act as a compensatory mitigation measures for the benefits forgone by the community in terms of water use loss. The project should also compensate for hillside land parcels affected by water reservoir and the silt trap zone. The RAP report is being prepared.

*b) Population Migration*
The construction of dam and irrigation infrastructures and the execution of land husbandry techniques as well as installation of other activities planned for Nyanza 23 will attract many people in search for employment and settlements. The effect of this impact will be felt in the health sector through increased rates of AIDS infection and other diseases that are spread through demographic changes and in environmental sector in terms of degradation. This impact will put pressure on social facilities including heath care, water, energy, sanitation and land. This indirect impact could also lead to degradation of marginal areas including hill sides, wetlands and forested areas as sources of fuel wood. Water resources will also be degraded through contamination with fecal matter as the sewer system is lacking in the area.
There are approximately 40 households’ housing structures located within the proposed reservoir area and silt trap zones. Those affected households have to be relocated. The Project is preparing a Resettlement Action Plan, which will guide the resettlement of affected households on the site.

Managing Population Influx
There are no measures for preventing population influx into the subproject areas. However the project and the local government in that site should control settlement in fragile areas including marshlands and steep hills. Another measure to manage influx is through provision of social infrastructure including water and sewer. During construction phase of the project, the contractors should have employment policy which gives preference to the local people. By employing the locals, this would discourage population influx to the area.

Impact Significance
This impact is going to be fairly significant in terms of magnitude because local population in Rwanda depend a lot on agriculture as a means of livelihood and any loss of land cannot be taken lightly. The scope will be localized and felt in the reservoir area and the duration will be long term and permanent but reversible if the project closes out.

Mitigation Measure(s)
This impact is unavoidable and will be mitigated through compensation for crop and vegetation loss, land and housing through the preparation of Resettlement Action Plans (RAPs) and guided by the Resettlement Policy Framework (RPF) document.

There are 40 households settled within the proposed reservoir area and silt trap zones that will be required to relocate. As mentioned earlier, implementation of the LWH project at the Nyanza-23 project site will have resettlement implications, with the affected households falling in two categories:

Households owning farms within the proposed reservoir area (29 ha), will lose their land permanently but this shall not affect many people as much of the land in the reservoir area is the valley/marshland and this land belongs to the Government. In the command area, land parcels affected by irrigation canals/channels development shall be compensated.

Farmers with farms surrounding the reservoir area will change their land-use. This will be the silt-trap zone (73 ha), comprising of a grass-zone (12 ha), shrub-zone (23ha) and tree-zone (38 ha) protecting the water reservoir from siltation. The proposed reservoir area and the silt trap zones have mainly been used for crop production mainly for subsistence purposes. After the vegetation within the silt-trap zone is established and becomes productive, households owning those pieces of land will control the benefits. Though the grass-covered fields could yield within
three months time, the shrub and tree zone will generate income after 4 years. Therefore, these farmers will be compensated accordingly.

VI.2.2 Impacts during the operation phase

The operation phase entails the actual irrigation of the hillsides after the water has been harvested. It also includes the valorization of areas treated with land husbandry technologies. The potential adverse impacts in this phase include:

VI.2.2.1 Physical environment

a) Reduced Water Flow/Downstream Flooding

Dam construction for irrigation involves blocking and deviation of the flow of water to the marshlands or valleys. Due to this, the downstream water users might experience temporary shortfall (until the reservoirs fill) in the amount of water available therefore disrupting activities and sources of livelihood that depend on the water. This is a short term impact that only happens when the water will be diverted to the dam. The impact will change flood plain, land use and ecology downstream for a short period especially in the Kagondo stream.

*Impact Significance*

The impact will be moderate in terms of magnitude, severity and scale. This is because even though the stream Kagondo will be blocked for a while to fill up the dam, the damming will be partial, hence ensuring that downstream users are not totally denied access. This will also ensure that the ecosystem is not totally deprived of water.

The scope of the impact will be felt at the point of dam/reservoir construction and downstream along the stream Kagondo confluence hence fairly significant. This impact is short term and only expected to occur during the reservoir fill up.

*Mitigation Measure(s)*

- Regulate water abstraction for irrigation and other uses. The dam should only be filled during the wet season to enable other users downstream to continue to receive water all season and in adequate quantity.
- To achieve this measure, a river that's feeds to the marshland/valley should only use quantities of water that will not compromise the flow of water downstream.
- Compensation for temporary livelihood loss due to reduced water flow while the dam fills through a compensation note or addendum to RAP.

There is a need to install master meters as part of the infrastructure to be developed in the marshlands. The master meter will be used to control the amounts of water abstracted from the streams thus allowing for management of water flow downstream.
b) Water wastage
The retention of water in the reservoir would lead to increase evaporation leading to surface water loss, ground seepage and spills. However due to mild climate of the area, no much loss of water through evaporation is anticipated. The only anticipated water loss will be through leaks and ground seepage.

The water loses will be through percolation, spills and leaks, evaporation among other factors. As the temperatures in certain subproject sites are mild, loss of water is not going to be a significant impact. But for subprojects sites in drier parts of eastern province the impact could be significant.

Mitigation
For losses through ground seepage, the transfer canals should be lined. This will prevent ground seepage of water in loose soil. This measure will only apply in areas where the soils are loose or sandy. The irrigation farmers can adopt water saving irrigation approach.

Alternatively to reduce water wastage through seepage, the design should reduce the distance between reservoir and irrigation fields i.e. reducing the distance in water transfer. However this measure could be labour intensive and expensive to undertake.

c) Changes in Hydrology
The construction of drainage network in the command area will affect the hydrological flow of the riverine system crating an environmental flow thus affecting the command area habitat. This effect will be compounded by building of the reservoirs which will reduce the flow of water during the period its filling up to the capacity.

Mitigation
To reduce the impact of the subprojects on the catchment hydrology, the reservoir and irrigation design should not divert more that 20 % of the water flowing in the river. In case the design abstract more than 20 %, the return flow from the farms should compensate for this flow. In cases there are more than one catchment feeding the river, only one catchment should be used for irrigation while the other will continue flowing to ensure continuous water flow in the marshland and downstream.

d) Surface Water Resource Pollution
The use of fertilizers and pesticides in the command area is going to be a potential source of introducing nutrients into the water resource of the Kagondo and Mwogo rivers and marshland that flows through the area.
These chemicals, if applied in large amounts and at inappropriate time, will pollute water resources in the stream and marshland and have cumulative effects in the basin and groundwater. Pesticides applied will bio-accumulate in the soaked soils of the marshlands and command area, upset the natural ecological balance and biodiversity of the wetlands downstream.

*Impact Significance*

The impact can be high in terms of magnitude and depending on the quantities of chemicals used. The scope of the impact will be felt throughout the drainage system and beyond hence cumulative and will be long term for as long as the chemical runoff continue ending up in the drainage network causing nutrient load effect. However, taking into consideration the national consumption of fertilizers per hectare (less than 4 kg/ha/year) (MINAGRI, 2007) and pesticides (0.1 kg/ha/year), the impact of fertilizer and pesticide is not going to be severe.

*Mitigation Measure(s)*

The LWH project has prepared a Pest Management Plan for the entire project which will provide guidance on the judicious use of chemicals in the cultivation and production of crops. Farmers will also be trained in techniques of agrochemical applications (handling, labeling and application of agro-chemicals under field conditions). The training should be incorporated in a farmer's field school curriculum. Extension workers should also be able to deliver awareness program on the amounts and conditions for applying fertilizers and pesticides to prevent water pollution.

To mitigate against destroying the capacity of the marshlands to filter pollutants introduced into the water system through farm runoff, buffer zones conservation areas) should be created downstream of the marshlands.

e) Sub surface Water Contamination

Infiltration of irrigation water in excess of available root zone storage will penetrate beyond the reach of roots and eventually recharge groundwater. Nitrates, salts, and other chemicals used in crop cultivation that dissolves in the soil water will move with the water. Crops with high water and N requirements (rice and vegetables) will increase the potential risk of nitrate pollution to groundwater. Because they do not evaporate, nitrates/nitrites are likely to remain in water until consumed by plants or other organisms. This impact will be felt more in areas with light-textured soils and intensive production of shallow-rooted crops that will contribute to considerable nitrate losses by leaching.

*Mitigation*

Mitigating against ground water contamination will require similar measures as used in preventing surface water pollution. Preventive measures will include
practicing IPM and rational application of fertilizer only as a last results while use of organic manure.

**f) Fear of overflow of water with increased rainfall**
The PAPs interviewed during the public consultation exercise expressed fear of water overflowing out of the reservoir in case unusual heavy rains occurred causing havoc in the project area. The Dam spillway was designed taking this information into account.

*Impact Significance*
The impact could be fairly severe and significant if it was to occur leading to destruction of crops and structures if not loss of life. The scope will be felt downstream so it can be significant and the duration is expected to be short term in nature and only felt if the wall of the dam collapses.

*Mitigation Measure(s)*
The project design has included spillways to address this potential adverse impact which is considered long term and expected to occur throughout the project operation phase. During the sensitization and awareness meetings, it will be important to reassure them of the intentions of having a spillway to address this.

**g) Internal Seepage Control Measures**
The design of adequate filters in zoned embankment dams is vital to control erosion of the earth core and dam foundations under the forces generated by seepage through and under the dam. These filters are essential to the performance of the dam. Their failure to perform satisfactorily can lead to piping failure of the dam.

Filters designated as “Critical” will be placed in areas of the embankment where the prevention of erosion is vital. Other Filters designated as “Non-Critical” will be also provided upstream of the earth fill core, beneath riprap and in other selected places.

As described by Indraratna and Locke (1999), to function correctly, filters must be:

- Sufficiently fine grained such that the pore constrictions (smallest opening between pores) are small enough to retain the core material which may wash out into the filter;
- Sufficiently permeable to facilitate seepage flow out of the base soil, preventing the buildup of pore pressure;
- Non-cohesive so that any cracks in the base are not propagated into the filter and they cannot develop cracks due to deformation.
The critical filters of the dam have been designed using the recommendations of ICOLD (1994) and Fell et al. (2005).

**h) Land Use Change**
The subprojects will change land use from marshland and farming land to reservoir use. A total of 29 hectares of marshland/farmland will be used for reservoir. This is a permanent impact that will reduce the area under agriculture and/or marshland land use. Marshland can revert back to its status after decommissioning of the project but it will take a long period of time before the rejuvenation of the marshland habitat/vegetation. Already all these areas have shown changes in land use from marshland to dry land used for agriculture.

*Mitigation*
This impact is unavoidable and can only be compensated through allocating those who will be displaced from their farms and conservation of marshlands downstream. To enable sustainable land use in the project areas, an integrated land use plan should be developed within the catchments based on the three tier approach that considers hillsides, middle grounds and the lower areas/marshlands. This impact will be well understood and mitigated after the completion of the Resettlement Action Plan (RAP).

**i) Canal Siltation**
Canal siltation is an adverse impact that clogs the canals leading to less flow of water into the command area and farming fields and this can reduce the crop yields. Increased soil erosion and siltation is generally impacting the hydrology of the marshlands and rivers negatively. Furthermore, clogged canals could soon become possible breeding site for mosquitoes if not maintained and unclogged.

*Mitigation Measure(s)*

1. **Establishment of silt trap zones**
   Silt trap zones have been included in the general design of the project and the canals will be flushed as frequent as possible to minimize this impact.

2. **Training on maintenance of the water canals**
The project team should provide training for the local farmers on how to operate and maintain the water intake points and canals to ensure that there is no blockages or flooding.

**j) Seepage and leakage**
Measurement of seepage through the dam body, foundations & abutments of the dam may indicate erosion or blocking of downstream drains and relief wells by increase or decrease of seepage respectively at constant reservoir level.
Seepage and erosion may take place along the lines of poor compaction and through the cracks in formation and fills. This may be indicated by such measurement. Measurement of seepage water at interface of dam and its foundation will provide direct indication of the efficiency of cutoff and indicate about the necessary remedial measures. The chemical analysis of water will provide the information of seepage of water through the foundation drainage arrangement and any foundation material being washed out. Corrective measures could be planned. The wet spots on the downstream slope or at abutment locations would indicate seepage problem, and remedial measures could be suggested.

Surface movement measurement
The measurement of surface movement of the embankment dam shall be made by means of installing 6 numbers of surface settlement points on the dam slope, dam crest at 50.0 m center to center and shall be monitored by using a theodolite at regular intervals from bench mark established and readings each time taken shall be compared with the earlier reading to arrive at the settlement of the surface.

Earthquake Measurement
The dam site falls within the area of moderate seismic hazard and the earthquake with a Peak Ground Acceleration (PGA) of 0.12 g has been identified with the Operating Basis Earthquake (OBE) having a return period of about 500 years. For a dam with houses downstream, one would normally design for a Design Basis Earthquake (DBE) with a longer return period. However in this case it is considered acceptable to design for a Factor of Safety exceeding 1.0 in the OBE for the following reasons:

(i) the relatively low consequences of failure.
(ii) the absence of a risk of liquefaction.
(iii) the likelihood that permanent settlement following an event larger than the OBE will be modest.

There are no houses downstream of the dam site; therefore loss to human life would probably be minimal. However, the lives of those working in the fields would be at risk from an unexpected failure and the sudden release of 1.82 Million m³ would cause considerable damage downstream. Therefore, the following are considered to be the minimum acceptable standards:

(i) There should be at least 600 mm freeboard to the crest of the dam during the passage of the flood with a return period of 1,000 years.
(ii) There should be no overtopping of the dam in the 10,000 year flood.
(iii) The spillway should be designed for the 1,000 year flood but the right sidewall in the upper part of the chute (where overtopping could endanger the dam) should be designed to contain the flood with a return period of 10,000 years.
(iv) The stilling basin should be designed for a flood with a return period of not less than 100 years.
In this regards, the spillway has been designed to have discharging capacity sufficient enough to pass the inflow floods corresponding to a return period of 1 in 1000 years, as it is defined as large dam from both the height and storage capacity aspects. The spillway chute is 4.0 m wide and 98.83 m long; it has an open rectangular concrete section with 1.55 m minimum high walls, according to the flow depth and freeboard requirements. However, in the sections close to the dam crest and the stilling basin the wall heights increase gradually to 5.50 and 5.0 m respectively. The longitudinal section of the chute is designed so as the canal is founded on firm soil. Hence, the spillway has adequate capacity.

*Dam Safety Monitoring /Measuring Instruments*

The program plans to buy and install instruments for recording seismic events. The instruments for recording of seismic events proposed to be installed for the dam consists of one acceleograph at the base of the dam and one at the top of the dam. Strong motion accelerographs and structural response recorder are to be installed at the base and at the top of dam. The location selected should be free from the background seismic noise erected due to vibrations of the appurtenant works. The instrument located at the top would provide information about responses of structure resulting from earthquake.

*Other Measurements*

Wave Height Recorders: Wave height Recorders installed would be helpful in finding the wave height and in deciding the free board requirements on a more realistic way.

Rainfall: measurement of rainfall will be helpful for interpretation of pore measurement and seepage development in earth dam.

**VI.2.2.2 Biological environment**

**a) Water Weeds**

There is a potential of water weeds infesting the reservoirs especially with increased use of fertilizers in the marshlands and in the catchments. Improper application and increased application of fertilizers in these areas will lead to leaching of the nutrients into the reservoir providing a good environment for weeds to grow in the reservoirs.

Based on the high incidence of water hyacinth growth in Rwandan lakes, there is a possibility of the subproject dams being infested by weeds if the water will be polluted with nutrients from the catchments and the marshland farming.

*Mitigation*

Water weeds survive in water bodies due to supply of nutrients. To prevent infestation of weeds in the reservoir, nutrients should not be allowed to enter the
reservoir. This should be achieved through practicing protection of the catchments and rational application of fertilizer in farms.

VI.2.2.3 Social Environment

a) Increased Spread of Water Borne Diseases
Households feared that there would be an increase in the incidences of malaria because the water reservoir would serve as a breeding ground for mosquitoes. They also feared that there would be a “cool breeze” prevailing as a result of the water mass that would result in respiratory related problems due to continuous exposure of residents. They also cited stomach-related disorders specifically infestation by worms, as a result of young household members using the irrigation water for domestic purposes (drinking and cooking) when not supervised.

Impact Significance
The impact of disease spread will be long term for as long as the reservoir is existing and drainage canals which are habitats for disease vectors and the scale and severity is also moderately high and can be severe especially for children under 5 years and pregnant mothers who are vulnerable to malaria.

The scope of the impact will initially be localized but transmission of the disease is likely to extend the scope beyond the project area.

Mitigation Measure(s)
LWH should support the introduction of fish in the dam as a strategy for reducing the breeding of mosquitoes in order to contain malaria spread. The LWH should develop a program in collaboration with the Ministry of Health (MINISANTE) and the local communities which undertakes bi-annual survey of health records in Health Care Facilities (HCFs) to ascertain the spread of malaria. This data should then be used to develop a malaria prevention programme within LWH that could include use of Insecticide Treated Nets, Indoor Residual Spraying among others.

Based on survey findings from the study area, nine percent (9 %) of the households also reported water-related stomach disorders, specifically infestation by worms. The beneficiaries should be avoided to use water from the reservoir or canal for domestic purposes. The project should also develop water points or, in collaboration with EWSA, supply water to PAPs for domestic uses. Awareness meetings on hygiene of potable water will be encouraged.

b) Drowning of livestock and people
During the public consultation process respondents expressed fears in drowning incidents of people (particularly children) and livestock that they foresee with the implementation of the project. However, the project design includes a silt-trap and live fencing which will take care of these fears effectively. The study revealed that
households within the project site had not experienced incidences of drowning by humans or livestock.

**Impact Significance**
The impact can be severe and high in terms of magnitude. In terms of scope, it is expected that the impacts will be localized but long term in nature for as long as the reservoir area is existing.

**Mitigation Measure(s)**
The LWH should before the construction undertake education and awareness of the local communities and making them aware of the hazards related to unrestricted entry into the dam reservoir.

LWH should establish a live fence in the reservoir silt trap, erect warning signs and control access to the dam but much more efforts should be put on teaching local people proper safety behavior and swimming.

LWH should also construct water drinking points for the local communities as a strategy and a way for reducing increased access to the reservoir to get water which causes incidents.

**c) Dam Safety Impacts**
The construction of the dam is faced with a potential collapse of the dam wall due to earth tremors, treks etc that can be a source of destruction of crops and property and even life if the walls fail and cause flooding downstream when there are heavy rains that the walls of the dam cannot withstand.

**Impact Significance**
The impact could be fairly severe and significant if it occurs leading to destruction of crops and structures if not loss of life. The scope will be felt downstream so it can be significant and the duration is expected to be short term in nature and only felt if the walls of the dam collapse.

**Mitigation Measure(s)**
The dam site is located in a seismic zone of low intensity and there is no earthquake recording station in the vicinity of the project area. Records to show the earthquake events experienced in the project area are not there.

**d) Resource Use Conflict**
Nyanza site are used mostly for crop production and animal production. The development of the water catchment and command area therefore might trigger resource use conflict over grazing land and crop land. This impact is not going to be significant as the government has in place a zero grazing policy.

**Mitigation**
To prevent conflict over agricultural and pastoral uses, LWH should integrate fodder production in the cropping systems of the area.

d) Emergence of Pests and Crop Diseases
The increased acreage of irrigated hillside land will create a more humid environment that may result in an increase of agricultural pests and plant diseases. Change to a more uniform environment on the subproject areas will favour vigorous species adapted to a wide variety of conditions. Diseases and weeds will spread quickly via the re-use of waste-water and drainage water.

Increase pests and plant diseases will affect farm harvest and lead to food insecurity and malnutrition in areas of Southern part of the country. Increased pests and crop diseases will trigger increased use of pesticides leading to water contamination.

Mitigation
To mitigate against emergence of pests and diseases an incorporation of IPM approaches are proposed. These measures should involve rotational cropping practices which preserve greater diversity in habitat thus reducing impact of pest and diseases. Maize or bean varieties used in this project should be selected from the ones already introduced in Rwanda in order to avoid new diseases and pests.
VII. ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING FOR NYANZA 23

The Environmental Management and Monitoring Plan (EMMP) is divided broadly into an Environmental Management Plan (EMP) and an Environmental Monitoring Plan. The Environmental Management Plan details mitigation and management measures to be undertaken during the construction and operational phases of the project in Tables 9 and 10 respectively. The Environmental Monitoring Plan details monitoring activities and measures to be undertaken during construction and operation in Tables 11 and 12 respectively.

VII.1. ENVIRONMENTAL MANAGEMENT PLAN

VII.1.1 Environmental Management Plan for the Construction phase

Table 9: Environmental Management Plan for construction Phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Adverse Impacts</th>
<th>Mitigation Measures</th>
<th>Implementation Schedule</th>
<th>Responsibility</th>
<th>Budget (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Execution of land husbandry works in the command area (Estimated cost per 1 ha is 2,500 USD.)</td>
<td>Soil erosion, siltation of valleys and contamination of water in the adjacent streams</td>
<td>Protection of embankments with vegetation immediately after construction; Protection of waterways with vegetation and check dams immediately after construction; Construction works will not be done during the period of heavy rains</td>
<td>During construction</td>
<td>Contractor, LWH Engineers</td>
<td>1,177,500</td>
</tr>
<tr>
<td>Contamination of surface and ground water including water in the</td>
<td>Adequate sanitary facilities shall be provided for workers in the form of portable chemical toilets. Water supply for domestic use</td>
<td>During construction</td>
<td>Contractor</td>
<td>LWH, EWSA</td>
<td>32,787</td>
</tr>
<tr>
<td>Adjacent Streams</td>
<td>Construction Phases</td>
<td></td>
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<tr>
<td>------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Land degradation</td>
<td>Topsoil removed will be stockpiled in a designated area and well leveled after terrace construction. Lime and organic manure will be applied to restore soil fertility. During construction.</td>
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</tr>
<tr>
<td>Earthworks for site preparation for dam construction</td>
<td>All earthworks for site preparation will be carried out during the dry season of each implementation phase and the permanent storm water, road and site drainage system will be in place before the onset of the following rains. During construction.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Purchase of materials during construction such as laterites, stones and sand</td>
<td>All raw materials and construction inputs shall be procured from approved sources and RNRA authorized quarry sand existing approved gravel pits. Before construction.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dust nuisance during construction</td>
<td>All work areas and access roads on site will be regularly watered by water browser in order to reduce dust levels. During construction.</td>
<td></td>
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</tr>
<tr>
<td>Exhaust pollution during construction</td>
<td>Equipment like engine, fuel and emission systems of construction machinery and vehicles shall be well maintained and calibrated in accordance with manufacturers’ recommendation to minimize exhaust smoke, fuel and oil leaks. During construction.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Air pollution during construction</td>
<td>The burning of any kinds of waste or construction materials shall not be permitted. During construction.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Noise nuisance from construction activity and traffic</td>
<td>Contamination of surface and ground water</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>------------------------------------------------------</td>
<td>------------------------------------------</td>
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</tr>
<tr>
<td>The Contractor shall restrict any of his operations, which result in undue noise disturbance to nearby communities and dwellings (e.g. blasting activities and operation of heavy machinery and construction traffic) between hours of 18:00 and 06:00.</td>
<td>All routine maintenance of construction machinery and vehicles, if carried out on site, shall be carried out in a designated workshop / maintenance area with concrete hard standing surface and drainage to an oil interceptor.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>During construction</td>
<td>During construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor, District authorities, LWH EO</td>
<td>LWH EO, contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

All wastes shall be collected on a regular basis by approved Waste Collection Company and disposed of at approved dumping sites in accordance with REMA Waste Management Regulations.

During construction | LWH EO, contractor, waste management companies | 1,000

All hazardous wastes, and empty containers of hazardous materials shall be stored on site in an approved manner, and be removed at regular intervals to

During construction | LWH EO, Contractor, Waste management company | 1,000

None
<p>| Ensuring safety on public access roads | Accidents on access roads | The Contractor must establish traffic and safety barriers and signs wherever needed or required by the local police authorities. | During construction, Contractor, District authorities | None |
| Civil Works Removal/destruction of all vegetation from the subproject site /Site clearing/civil works/earth moving works, trenching, excavations, construction of camping site, excavation of borrow materials. | Loss of crops, vegetation, structures (homesteads) and trees. | Compensation for property loss, crop loss, land loss and trees | Compensation should occur in line with the RAP and before construction commences | LWH social safeguards Will be reflected in the RAP |
| Soil erosion | Create contour drains during construction Soil erosion management strategies to including revegetation, bunding. | During the construction | Contractor, LWH Engineers | Contract Cost |
| Borrow sites create disease vector breeding ground and hazards | Backfilling, leveling and revegetating the borrow pits to prevent stagnant water | Immediately after the construction | LWH EO, Contractor Part of the contractor budget |
| Construction Fugitive dust could cause respiratory diseases | Wetting the surface during construction | During Construction | LWH Engineers, Contractor None as water is available and near the sites |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Responsible Party</th>
<th>Funding Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers Accident from equipment and machinery operation</td>
<td>Providing all workers with PPEs Employment of qualified workers Providing training to all workers</td>
<td>During Construction</td>
<td>Contractor</td>
</tr>
<tr>
<td>Erection of dam wall</td>
<td>Reduced Water Flow into Kagondo stream Ecosystem changes</td>
<td>During construction and operation</td>
<td>LWH Engineers &amp; Cooperative/ WUA members</td>
</tr>
<tr>
<td>Potentials accidents</td>
<td>Personal Protective Equipment (e.g. hard hats, gloves, overalls, boots, respiratory protection, hearing and eye protection, high visibility waist coats, fall protection harnesses) shall be issued as required to the various categories of the workforce and replaced when necessary.</td>
<td>During construction</td>
<td>LWH and the contractor</td>
</tr>
<tr>
<td></td>
<td>The Contractor will install temporary lighting for roads, pathways and work areas according to applicable local standards.</td>
<td>During construction</td>
<td>Contractor</td>
</tr>
<tr>
<td></td>
<td>Key personnel shall receive training in basic First Aid. The Contractor shall provide a First Aid post on site, which is appropriately equipped and staffed by fully trained First Aid personnel. In case of serious injuries on site, e.g. accidents</td>
<td>During construction</td>
<td>Contractor</td>
</tr>
</tbody>
</table>
with heavy machinery, etc., the Contractor shall formulate a plan to deal with such emergencies, prior to possession of the site.

<table>
<thead>
<tr>
<th>Potential spread of malaria and other water borne diseases</th>
<th>The Contractor shall ensure adequate drainage of site to prevent stagnant water that can provide a breeding habitat for mosquitoes.</th>
<th>During construction</th>
<th>LWH Engineers and the contractor</th>
<th>Part of contractor’s budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment leading to influx of people from parts of the country into the project area</td>
<td>Risk of HIV and communicable disease transmission</td>
<td>The Contractor will conduct HIV/AIDS awareness and prevention campaigns amongst all members of the workforce in conjunction with the local Health Centre under which the catchment area of the development falls. Free condoms will be made available to all members of the workforce.</td>
<td>During construction</td>
<td>LWH EO, Contractor</td>
</tr>
</tbody>
</table>
### VII.1.2. Environmental Management Plan for the Operation Phase

**Table 10. Environmental Management Plan for Operation Phase**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Adverse Impacts</th>
<th>Mitigation Measures</th>
<th>Implementation Schedule</th>
<th>Responsibility</th>
<th>Budget (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir filling</td>
<td>Reduced water flow downstream during the time that the reservoir will be filling up.</td>
<td>Control abstraction rates to half the river flow to replicate natural flooding regime. Install master meter</td>
<td>Design and operation phases</td>
<td>LWH Engineers, Contractor and Cooperatives</td>
<td>Part of the contract costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proper design and operation of dam spillways and gates (timing and volume of discharges).</td>
<td></td>
<td>LWH and feasibility</td>
<td>Part of the feasibility costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construct coffer dam</td>
<td></td>
<td>Contractor</td>
<td>Part of the contract costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fill the reservoirs during wet season when there is high flow</td>
<td></td>
<td>LWH Engineers &amp; Contractor, LWH Engineers</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compensation for temporary livelihood loss through a compensation note or addendum to RAP</td>
<td></td>
<td>Contractor, LWH EO, cooperative, WUA</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,000</td>
</tr>
<tr>
<td>Increased spread of water borne disease vector including Malaria, Cholera, Bilharzias, etc</td>
<td>Introduce fish in the dam</td>
<td>After reservoir filling Continuous</td>
<td>PAIGELAC, LWH EO</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Create awareness on malaria, worms, Cholera, Bilharzias prevention methods</td>
<td>As required</td>
<td>LWH and Ministry of Health</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide treated mosquito nets</td>
<td></td>
<td>LWH EO</td>
<td>50,000</td>
</tr>
<tr>
<td>Flooding</td>
<td>Increase overflow spillway capacity</td>
<td></td>
<td>During construction</td>
<td>LWH Engineers and Contractor</td>
<td>Part of the Contract's cost</td>
</tr>
<tr>
<td></td>
<td>Protection of water catchment and</td>
<td></td>
<td></td>
<td>LWH Land</td>
<td>2,760,000</td>
</tr>
<tr>
<td>Activity</td>
<td>Responsibility</td>
<td>Budget</td>
<td></td>
<td></td>
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<tr>
<td>-------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Safety Hazards (drowning, flooding and breakage of dam wall)</td>
<td>Safety Hazards Specialist</td>
<td>Budget for silt trap establishment 32,787</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>establishment of silt trap zone around the dam</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fencing of the reservoir area</td>
<td>Construction and Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of community water points</td>
<td>LWH EOLWH Engineers &amp; EO WUA</td>
<td>WUA budget</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posting of a security guard</td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct community awareness and sensitization</td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of dam safety measures including dam instrumentation for</td>
<td></td>
<td>Part of the contractor's</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seepage and leakage analyses, quake recording and movements analysis</td>
<td></td>
<td>budget</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct the dam to meet international technical and safety standards</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Loss of agricultural land by inundation to form the reservoir</td>
<td>Provide alternative land for agriculture or compensate for land loss</td>
<td>Planning stages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LWH Social Safeguards, Local authority</td>
<td>Compensation according to RAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Erosion and siltation of the reservoir</td>
<td>Water catchment protection and creation of a silt trap zone around the dam</td>
<td>During construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Husbandry Contractor</td>
<td>Included in the contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>document</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hillside irrigation</td>
<td>Construction of terraces, soil bunds &amp; their stabilization and creation of a</td>
<td>Construction and operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil erosion</td>
<td>buffer zone along the canals</td>
<td>phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contractor, farmers</td>
<td>Budget for land husbandry</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>works &amp; irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue</td>
<td>Action</td>
<td>Timeframe</td>
<td>Responsible Bodies</td>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Appropriate installation and use of irrigation infrastructures (pipes)</td>
<td>Regulate water abstraction through practices and design of the intake structures</td>
<td>During construction and operation</td>
<td>LWH &amp; Cooperative / WUA LWH &amp; RNRA</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Undertake hydrological assessment of the catchments</td>
<td>Should be done before project commissioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced Water Flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water wastage</td>
<td>Adopt water saving irrigation approach</td>
<td>During operation phase</td>
<td>LWH Engineers, Cooperative,</td>
<td>Part of capacity building budget for cooperative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water abstraction fees</td>
<td>During operation phase</td>
<td>Cooperative / water users association</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Change in hydrology</td>
<td>Control water abstraction through management practices</td>
<td>During irrigation</td>
<td>LWH &amp; Cooperative members</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Soil salinization or acidification</td>
<td>Control irrigation water quality</td>
<td>During irrigation</td>
<td>LWH &amp; Cooperative members</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Water borne diseases</td>
<td>Prevent or remove aquatic vegetation&lt;br&gt;Line canals with cement or plastic&lt;br&gt;Regularly fluctuating water levels&lt;br&gt;Periodic rapid drying of irrigation canals;&lt;br&gt;Preventing contamination of water bodies with faeces;&lt;br&gt;Supply of safe and clean drinking water</td>
<td>Operational phase</td>
<td>Cooperatives, LWH and local authorities</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Control measures including:&lt;br&gt;(i) Providing for biological vector control (eg. Suitable fish species) in reservoir;&lt;br&gt;(ii) Preventative measures (provision and promotion of insecticide treated mosquito nets)&lt;br&gt;(iii) curative measures (provision for medications at the health center/Hospital)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population migration</td>
<td>Control settlement in fragile areas (marshlands &amp; steep hills)&lt;br&gt;Provision of social infrastructure including water, sewer</td>
<td>Construction &amp; operational phase</td>
<td>LWH Engineers and Local authorities</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Loss of livelihoods</td>
<td>Compensate for properties, land and crops loss&lt;br&gt;Integrate the people into the project beneficiaries</td>
<td>Planning stages</td>
<td>LWH Social Safeguards and Local authorities</td>
<td>Dependant on the outcome of RAP</td>
<td></td>
</tr>
<tr>
<td>Emergence of pests and crop diseases</td>
<td>IPM approaches are proposed</td>
<td>Operation phase</td>
<td>LWH &amp; MINAGRI</td>
<td>Capacity building budget for cooperative</td>
<td></td>
</tr>
<tr>
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<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Application of agrochemicals (fertilizer and pesticides)</td>
<td>Water Pollution</td>
<td>Adoption Integrated Pest Management Plan (PMP) approach.</td>
<td>Design and planning stages</td>
<td>LWH Agronomist &amp; RAB</td>
<td>LWH budget</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A training program on application of agro-chemicals under field conditions</td>
<td>Design and planning stages</td>
<td>LWH Agronomist &amp; RAB</td>
<td>LWH budget</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Create buffer zones/ silt trap zone around the dam and command area downstream</td>
<td>During construction phase</td>
<td>LWH Land Husbandry Specialist &amp; EO</td>
<td>LH Contractor’s budget</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identification and protection of domestic sources of water</td>
<td>During construction phase</td>
<td>LWH EO, Engineers</td>
<td>LWH Budget</td>
</tr>
<tr>
<td>Displacement of staple food crops in favour of high economic crop value</td>
<td></td>
<td>Promote importance of diversifying crop production and good farming practices like rotational cropping</td>
<td>Planning and operation phases</td>
<td>LWH Agronomist, RAB, Local authorities</td>
<td>LWH budget</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Promote diversification of staple diet so that farmers do not rely on traditional crops as their most important crop even when it has little economic returns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of child labour</td>
<td></td>
<td>Enforce compulsory free twelve years education policy</td>
<td>During construction and operational phases</td>
<td>Local authority</td>
<td>None</td>
</tr>
<tr>
<td>Demolition of the Dam &amp; irrigation network infrastructures</td>
<td></td>
<td>Providing protective gear, such as; eye goggles, nose masks, overalls, wellington boots, gloves and working ear phones to Workers participating in the demolition</td>
<td>At the Commissioning phase</td>
<td>MINAGRI, Local authority Cooperative</td>
<td>Cost can only be determined at the time of demolition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spraying water to reduce dust. For works that could cause noise, these will be done at hours when locals are</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Failure of the dam</td>
<td>Excessive seepage</td>
<td>Lowering the water to a safe level; determining the source of seepage and do repairing</td>
<td>During operation phases</td>
<td>Reservoir operator, Supervising LWH Engineer, Dam Monitoring Unit (DMU), MINAGRI</td>
<td>Cost can only be determined at the time of Dam failure</td>
</tr>
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</tr>
<tr>
<td>Movement of the Dam on its Foundation</td>
<td>Lowering the water level until the movement stops</td>
<td>Operating continuously at a reduced level until repairs can be made</td>
<td>During operation phases</td>
<td>Reservoir operator Supervising LWH Engineer Dam Monitoring Unit (DMU) MINAGRI</td>
<td>Cost can only be determined at the time of Dam failure</td>
</tr>
<tr>
<td>Failure of Appurtenant Structures such as Outlets or Spillways</td>
<td>Implement temporary measures to protect the damaged structure like closing an outlet or providing temporary protection for a damaged spillway</td>
<td>During operation phases</td>
<td>Reservoir operator Supervising LWH Engineer Dam Monitoring Unit (DMU) MINAGRI</td>
<td>Cost can only be determined at the time of Dam failure</td>
<td></td>
</tr>
<tr>
<td>Cracks in the Dam</td>
<td>Lowering water level through the low level outlet until a safe elevation is reached</td>
<td>Doing repairing after determining the source of cracks</td>
<td>During operation phases</td>
<td>Reservoir operator Supervising LWH Engineer Dam Monitoring Unit (DMU) MINAGRI</td>
<td>Cost can only be determined at the time of Dam failure</td>
</tr>
</tbody>
</table>
VII.2. ENVIRONMENTAL MONITORING PLAN

VII.2.1. Environmental Monitoring Plan for the Construction Phase

**Table 11. Environmental Monitoring Plan for the Construction Phase**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Adverse Impacts</th>
<th>Proposed Mitigation measures</th>
<th>Responsibility</th>
<th>Implementation schedule</th>
<th>Frequency</th>
<th>Budget ($ US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance</td>
<td>Potential absence of compliance to the EMP and REMA licenses and regulations</td>
<td>Routine inspections of the site, routine environmental records (water, sanitation and waste management), Construction materials, audits and incident Reports as and when required (e.g. for pollution, accidents, etc.)</td>
<td>LWH EO</td>
<td>During construction</td>
<td>At least once three months</td>
<td>None</td>
</tr>
<tr>
<td>Erosion control</td>
<td>Soil erosion</td>
<td>Embankments, Cut-off-drains and waterways in water catchment and command area will be inspected routinely for suitability and erosion problems.</td>
<td>LWH Land Husbandry Specialist</td>
<td>During construction</td>
<td>Daily</td>
<td>None</td>
</tr>
<tr>
<td>Dam design and construction</td>
<td>Odors produced by the decay of plant biomass in the reservoir area or decay of algal and macrophytes biomass as a result of eutrophication</td>
<td>Incorporate eutrophication prevention measures in dam design parameters e.g. minimize hydraulic retention time, reduce nutrient input from catchments, etc. Removal of plant materials in the reservoir area</td>
<td>Contractor &amp; LWH EO</td>
<td>During construction</td>
<td>As required</td>
<td>Part of the contractor’s budget</td>
</tr>
<tr>
<td>Access road construction</td>
<td>Dust nuisance</td>
<td>All construction work sites and all gravel access roads will be inspected routinely to ensure adequate watering for dust abatement.</td>
<td>LWH EO</td>
<td>During construction</td>
<td>Daily</td>
<td>None</td>
</tr>
<tr>
<td>Monitoring site activities</td>
<td>Exhaust pollution</td>
<td>Maintenance records will be kept for all construction vehicles and plant equipment engines.</td>
<td>LWH Engineers</td>
<td>During construction</td>
<td>Ongoing</td>
<td>None</td>
</tr>
<tr>
<td>Activity</td>
<td>Adverse Impacts</td>
<td>Proposed Mitigation measures</td>
<td>Responsibility</td>
<td>Implementation schedule</td>
<td>Frequency</td>
<td>Budget ($ US)</td>
</tr>
<tr>
<td>--------------------------------</td>
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<td>-----------------------------------------------------------------------------------------------</td>
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<td>---------------</td>
</tr>
<tr>
<td>Construction</td>
<td>Contamination of surface and ground water</td>
<td>Records will be kept on site of inspection and approval of fuel and oil storage and dispensing facilities. Routine inspections will be made of such facilities for leaks and discharges to ground.</td>
<td>LWH Engineers &amp; EO</td>
<td>During construction</td>
<td>Daily</td>
<td>None</td>
</tr>
<tr>
<td>Sanitation facility construction and maintenance</td>
<td>Contamination of surface and ground water</td>
<td>Sanitation facilities will be inspected routinely for compliance to public health standards</td>
<td>LWH EO</td>
<td>During construction</td>
<td>Daily</td>
<td>None</td>
</tr>
<tr>
<td>Safety on public access roads</td>
<td>Potential accidents</td>
<td>Designated access routes will be determined in the contract documents</td>
<td>LWH EO, Engineers</td>
<td>During construction</td>
<td>As required</td>
<td>None</td>
</tr>
<tr>
<td>Safety on public access roads</td>
<td>Potential accidents</td>
<td>Minutes and records will be maintained of community liaison meetings discussing traffic safety issues. Records of site procedures and permits- to – work issued to employees and sub-contractors will be maintained on site to document compliance with the safety regulations</td>
<td>LWH EO, Engineers</td>
<td>During construction</td>
<td>As required</td>
<td>None</td>
</tr>
<tr>
<td>Activity</td>
<td>Adverse Impacts</td>
<td>Proposed Mitigation measures</td>
<td>Responsibility</td>
<td>Implementation schedule</td>
<td>Frequency</td>
<td>Budget ($ US)</td>
</tr>
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</tr>
<tr>
<td>Regular inspections</td>
<td>Potential accidents</td>
<td>Regular inspections will be carried out for works to audit safety of the site including actual construction operations, workshops and storage facilities, documents required to certify conformity of equipment, tools and materials used by the Contractor.</td>
<td>LWH EO</td>
<td>During construction</td>
<td>At any time</td>
<td>None</td>
</tr>
<tr>
<td>Occupational Health and Safety</td>
<td>Potential accidents</td>
<td>An inventory shall be kept of all explosives brought to site and used on site</td>
<td>LWH EO and Engineers, Contractor</td>
<td>At any time during construction</td>
<td>Ongoing</td>
<td>None</td>
</tr>
<tr>
<td>Sanitary</td>
<td>Risks to Health and Safety on the construction site</td>
<td>Sanitation, waste management and pollution control protocols will be monitored</td>
<td>LWH EO</td>
<td>Every 2 months</td>
<td>Ongoing</td>
<td>None</td>
</tr>
<tr>
<td>Compliance</td>
<td>Risks to Health and Safety on the construction site</td>
<td>Documents to certify conformity of tools, equipment and materials used by the Contractor shall be kept on site and be available for inspection.</td>
<td>Contractor</td>
<td>During the construction phase</td>
<td>-</td>
<td>None</td>
</tr>
<tr>
<td>Dam safety monitoring and inspection</td>
<td>Loss of livelihood downstream</td>
<td>Routine monitoring of the behavior of the Dam throughout the life of the dam</td>
<td>Reservoir keeper</td>
<td>During operation phase</td>
<td>On daily basis</td>
<td>To be negotiated with the Project</td>
</tr>
<tr>
<td></td>
<td>Safety inspection (full inspection of the dam and appurtenant works)</td>
<td></td>
<td>LWH Dam Engineer</td>
<td>During operation phase</td>
<td>Every six months</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Independent inspection</td>
<td></td>
<td>Senior reservoir safety Engineer</td>
<td>During operation phase</td>
<td>Every five years</td>
<td>To be negotiated with the Project</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Activity</th>
<th>Adverse Impacts</th>
<th>Proposed Mitigation measures</th>
<th>Responsibility</th>
<th>Implementation schedule</th>
<th>Frequency</th>
<th>Budget ($ US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam maintenance</td>
<td>Loss of livelihood downstream</td>
<td>Prepare a maintenance schedule for 6 month period (routine maintenance &amp; repair)</td>
<td>LWH Supervising Engineer</td>
<td>During operation phase</td>
<td>As required</td>
<td>Cost can only be determined at the time of Dam maintenance</td>
</tr>
<tr>
<td></td>
<td>Unnecessary repair work</td>
<td>Regular removal of floating debris in the reservoir</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mechanical plant and civil works (protection of dam embankments, spillways, cleaning of valve chambers, etc.)</td>
<td></td>
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</tr>
</tbody>
</table>
VII.2.2. Other Stakeholders in Environmental Monitoring during Construction

Other major stakeholders apart from the Developer (MINAGRI/LWH) have a monitoring role and responsibility during development, construction and operation of the project. These include the Contractor, REMA and RDB, Traffic Police, district authorities and other public authorities as well as various utility providers and will automatically monitor some of the effects of the project during their daily work. On a regular basis, this information should be collected and analysed by those with a formal monitoring responsibility.

Table 12 below shows other stakeholders and their monitoring responsibilities and reporting during the construction phase.

Table 12: Other Stakeholders in Environmental Monitoring during Construction

<table>
<thead>
<tr>
<th>Responsible</th>
<th>Parameters to be Monitored</th>
<th>Output</th>
<th>Estimate ($)</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>REMA, RDB, and Nyanza District</td>
<td>Overall environmental performance of the project</td>
<td>Discussions / reports</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Traffic Police</td>
<td>Traffic accidents, Traffic nuisance, Traffic safety measures.</td>
<td>Police reports and instructions to Contractor and Project Management Team.</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Local Authorities/communities</td>
<td>Negative social and environmental impacts</td>
<td>Complaints to Contractor and Project Management Team</td>
<td>none</td>
<td></td>
</tr>
</tbody>
</table>
VII.2.3. Environmental Monitoring Plan for the Operational Phase

The monitoring plan defines and identifies monitoring activities will take place, when and by whom and identifies the indicators and data collection methods and identifies training and capacity building needs of the institutions and persons to implement the plan.

As indicated on the monitoring schedule below, monitoring will be done by numerous institutions and persons but coordinated by M&E division of LWH secretariat in Kigali and the focal person will be the Environmental Officer who should be employed by LWH immediately before the commencement of the project.

To ensure effective and reliable data collection, the key persons from the institutions to be involved in the monitoring will be trained on the indicators to be monitored, sampling methods, and data collection techniques to be used. The LWH M&E division will organize a 2 day training program in one of the project sites and train the participants. The key resource persons for this training will be the Environmental Officer and the M&E coordinator. Participants for this training will be from the institutions involved in implementation of the monitoring plan which are LWH M&E division, Environmental Officer, Agronomist, and irrigation engineer, REMA, Cooperative/association members from each subproject site, MINAGRI, Ministry of Health diseases surveillance division or public health and engineers from Ministry of infrastructure (MININFRA). LWH can commission a consultant to develop modules for M&E if need be.

The LWH M&E division will be the monitoring data depository and bank and will coordinate the collection of these data as described in the schedule. The division will need to install a monitoring and tracking system.

Technical data that might not be collected by the cooperative members /beneficiaries, LWH provincial M&E officers will be in charge of this.

LWH Project secretariat will need to facilitate the Environmental Officer to purchase sample collection equipment especially for water sample collection. The national metrological survey will be responsible for monitoring the river flows. A portable hydro flow meter (river flow measuring gadget) will be ideal for a project of this nature that has many sites to be monitored.

As the LWH has M&E component with budget, the cost of implementing this plan will be minimal as the plan will be integrated into the project component.

Food and Agriculture Organization seasonal crop assessments capacity can be used in monitoring food security indicators in all the subproject sites.

It should be noted that, LWH is a project of MINAGRI and as such it will come to an end after the already determined cycle, while the project operations will continue
even after the end of the project. At the end of the project, the responsibility of monitoring the project impacts will rest with the respective agencies and REMA and the respective cooperative members.

**Water Quality Monitoring**

During the operation period, monitoring is proposed for water quality especially to determine the level and concentration of pesticides and fertilizer content in the command area.

The consultant proposes the identification of different points of the command area in order to monitor the quality of water. Periodic taking of water samples should be undertaken preferably twice a year during the cultivation season to determine water quality. Water sampling points should be at the beginning of the command area, middle and at the mouth of the marshland. These samples should be taken by the LWH Site agronomist to the LWH environmental officer who should then take them in an accredited laboratory for testing. The results should be used to design appropriate water quality mitigation programs. The same will apply to analysis of water quantities in relation to the abstraction impacts. Different stations will need to be identified and flow quantities recorded during different times of the year preferably during the wet and dry season respectively. The results should be used to deduce the impacts of the abstraction of water on the hydrology of the marshlands and the wider catchment basin.

**Monitoring Diseases Spread**

In order to monitor the possible impacts of the marshland development to malaria and bilharzias spread in the area, the LWH sociologist together with the provincial LWH staff need to undertake periodic surveys of the health records around the marshland to ascertain prevalence of disease spread. The surveys should be done 2 times in a year. Even though it cannot be proven that the LWH project could be directly contributing to the spread of these diseases, the results can be used to assist LWH increase its interventions on malaria and bilharzias prevalence.

**Monitoring Seepage and Leakage**

Measurement of seepage through the dam body, foundations & abutments of the dam may indicate erosion or blocking of downstream drains and relief wells by increase or decrease of seepage respectively at constant reservoir level. Seepage and erosion may take place along the lines of poor compaction and through the cracks in formation and fills. This may be indicated by such measurement. Measurement of seepage water at interface of dam and its foundation will provide direct indication of the efficiency of cutoff and indicate about the necessary remedial measures.

The chemical analysis of water will provide the information of seepage of water through the foundation drainage arrangement and any foundation material being washed out.
**Surface Movement Measurement**
The measurement of surface movement of the embankment dam shall be made by means of installing 6 number of surface settlement points on the dam slope, dam crest at 50.0 m center to center and shall be monitored by using a theodolite at regular intervals from bench mark established and readings each time taken shall be compared with the earlier reading to arrive at the settlement of the surface.

**Earthquake Measurement**
The dam site is located in a seismic zone of low intensity and there is no earthquake recording station in the vicinity of the project area. Records to show the earthquake events experienced in the project area are not there:

The instruments for recording of seismic events proposed to be installed for the dam consists of one acceleograph at the base of the dam and one at the top of the dam. Strong motion accelerographs and structural response recorder are to be installed at the base and at the top of dam. The location selected should be free from the background seismic noise erected due to vibrations of the appurtenant works. The instrument located at the top would provide information about responses of structure resulting from earthquake.

The spillway has been designed to have discharging capacity sufficient enough to pass the inflow floods corresponding to a return period of 1 in 1000 years, as it is defined as large dam from the height and storage capacity aspects.

Best practice safety measures specify that if the failure of dam poses danger to human life, the spillway must have sufficient capacity to accommodate the routed flood discharge corresponding to probable maximum Flood (PMF) and if the failure of dam would result only in heavy damage to property but does not pose appreciable risk to life then the spillway may be designed for flood discharge corresponding to 1 in 10,000 year return period.

The dam location is in an area where failure may probably remain restricted to the irrigation farms and the dam area itself. Loss to human life would probably be minimal. For such a situation and for the sake of economy, a routed flood discharge corresponding to 1 in 200 years return period has been considered as there is not much habitation downstream of the dam site. The flood with a return period of 1 in 200 years as computed in the hydrology resulted in a flood lift of 0.56 m and spillway width of 4.0 m. Hence, the spillway has adequate capacity. This design takes into consideration the Dam Safety Assessment developed for the site in March, 2012.

**Monitoring Framework**
The monitoring plan for operation is laid out in Table13 below.
Table 13. Monitoring plan for the operation phase

<table>
<thead>
<tr>
<th>Impact</th>
<th>Parameter</th>
<th>Indicator</th>
<th>Method</th>
<th>Frequency of Measurement</th>
<th>Responsibility</th>
<th>Cost Estimate (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water pollution</td>
<td>Quality</td>
<td>Nutrient Load (Nitrates, phosphates, potassium, pesticide residue, COD &amp; BOD, Turbidity)</td>
<td>Bi-annually during wet and dry season (samples should be taken from the inlet and outlet points of the developed area)</td>
<td>Once every dry and rainy season (i.e., 4 times a year)</td>
<td>LWH</td>
<td>30,000</td>
</tr>
<tr>
<td>Reduced Water flow</td>
<td>Quantity</td>
<td>Flow rates per second</td>
<td>River/stream gauging</td>
<td>Continuous</td>
<td>RNRA &amp; LWH &amp; REMA</td>
<td>2,000</td>
</tr>
<tr>
<td>Soil erosion</td>
<td>Soil loss</td>
<td>Soil productivity, gullies/rills, water turbidity</td>
<td>Observation</td>
<td>Continuous</td>
<td>LWH, RAB/ICRAF/ISAE, &amp; Community beneficiaries</td>
<td>Part of the project M&amp;E budget</td>
</tr>
<tr>
<td>Flooding</td>
<td>Area inundated</td>
<td>Floods downstream of project area</td>
<td>Observation and reported cases of flooding</td>
<td>Continuous</td>
<td>Community beneficiaries &amp; LWH</td>
<td></td>
</tr>
<tr>
<td>Water wastage</td>
<td>Water availability</td>
<td>Install water meters in the intake point</td>
<td>Continuous</td>
<td>LWH, REMA &amp; contractor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Table 13. Monitoring plan for the operation phase (Cont’d)**

<table>
<thead>
<tr>
<th>Socio-economic Environment</th>
<th>Water-borne Diseases</th>
<th>Safety Hazard</th>
<th>LWH, community and Ministry of Health</th>
<th>Part of the project M&amp;E budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease prevalence</td>
<td>Increased cases of malaria and bilharzias among other water borne diseases</td>
<td>Reported cases of incidences and accidents</td>
<td>Review of health records</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seepages and leakages reported or observed on the dam</td>
<td>Review and evaluation of incidents and accidents register</td>
<td>LWH (engineer) &amp;RNRA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Color, turbidity and change in seepage chemical content</td>
<td>Instrumentation equipment including; Acceleograph, theodolite</td>
<td>Part of the project M&amp;E budget</td>
</tr>
</tbody>
</table>
|                             |                      | Direct observation of seepage water | Continuous monitoring of leakages, seepages, movements through instrumentatio

LWH (engineer) &RNRA
VII.3 ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION

The environmental management plan (EMP) will be implemented by several institutions mentioned below which are directly or indirectly involved in this subproject.

VII.3.1 World Bank

World Bank is the financier of the project including the implementation of the EMP within the budget of LWH. The main role of the bank is to ensure that compliance is achieved as per the requirements of the EMP.

VII.3.2 Ministry of Agriculture and Animal Resources (MINAGRI)

Ministry of Agriculture and Animal Resources (MINAGRI) through the LWH is the lead agency in the implementation of this EMP and the project. The role of the LWH is to implement mitigation measures, building the capacity of other actors in IPM, and in environmental management.

The LWH Environmental Officer will be the focal point for training in EMP and agrochemical application and will liaise with the Ministry of Agriculture and Animal Resources for technical support. It should be noted that all the capacity building activities should be hands-on through the FFS approach. The project should establish one farm in one of the project areas which will act as the field school.

The MINAGRI through LWH will also supervise infrastructure design and construction including dams and drainage. The role of MINAGRI will to ensure that the dams and drainages are constructed according to the specifications international technical and safety standards.

VII.3.3 Land Husbandry Hillside Irrigation and Water Harvesting Project

Land Husbandry Hillside Irrigation and Water Harvesting Project (LWH) is the lead agency in the implementation of this EMP and the project. The role of the LWH will be to implement mitigation measures, coordination of monitoring activities maintenance of monitoring information, building the capacity of other stakeholders in collection and analysis of monitoring data.

The Environmental Officer of LWH will be the focal point for the EMP and will liaise with other stakeholders to execute the plan.

The training for capacity building of cooperative will include among others:

a) Pesticide/Fertilizer Application Training

The training objective is to ensure beneficiary farmers in the project area do not pollute water resources through unsustainable application of inorganic
fertilizers. This capacity building activity can be undertaken by MINAGRI with the technical support from Rwanda Agriculture Board (RAB) and research institutions such National University of Rwanda, ISAE.

The LWH Agronomist and the district level field agronomist will conduct training to the local farmers on the safe application of pesticides and fertilizers. This is a practice that can immensely contribute to the reduction of possible chemical pollution of the marshlands. The training on pesticide application touches on the quantities to apply, timing (when), and protective gears to wear among others and should be incorporated in the Pest Management Plan that is under preparation.

b) Training on IPM
The training program will cover amounts of fertilizer to be applied per hectare of land and during what conditions should be undertaken before commissioning of the project. The types and amounts of pesticides should also be part of this training. This training should be a hands-on that can be introduced in the Farmer’s Field School (FFS) model adopted by the project. Food and Agriculture Organization (FAO) and RAB and the RSSP project have the capacity to undertake this activity and could be partners with LWH.

c) Maintenance of land husbandry infrastructures
The maintenance of improved bench terraces, soil bunds, constructed waterways, terraces’ embankments, planted trees/shrubs and grasses as well as silt trap zone is needed to control erosion on hills and protect the dam from siltation. The farmers will be trained on the maintenance of those infrastructures.

VI.3.4 Rwanda Environment Management Authority

Rwanda Environment Management Authority (REMA) is the oversight authority over the environment in Rwanda. Its role will be of monitoring environment indicators as identified in this EMP. The role of Rwanda Environment Management Authority (REMA) includes:

Oversight Monitoring
As the lead agency responsible for the protection of environment in Rwanda, REMA will play the leading oversight role of monitoring the activities of the project according to the Organic Law establishing REMA and its functions.

Site Inspection Visits
REMA will undertake regular site visits to inspect and verify for themselves the nature and extent of the impacts. REMA will undertake also undertake regular site visits to inspect and verify for themselves the extent to which the mitigation measures proposed in this EMP are being complied with or vice versa. They will then be expected to make viable recommendations based on their findings to the LWH.
Periodic Reports
REMA will prepare periodic environmental consolidated reports on the monitoring progress of the water catchment and command area development.

VII.3.5. Community Group/Project Beneficiaries
The project beneficiaries being the people on the ground will have the role of execute some of the mitigation measures, collecting and monitoring the identified indicators and practicing sustainable farming as well as catchment rehabilitation and management. The project beneficiaries are organized in cooperatives which have management committees for water, production and maintenance.

VII.3.6 Contractors
The contractor will be in charge of designing and constructing the infrastructure according to the World Bank operation policy on dam safety, restoring the borrow pits and degraded areas, ensuring the safety of the users and others.

VII.3.7. Ministry of Health
Due to possible health impacts especially malaria and bilharzias in the subproject areas, the Ministry of Health comes into the picture of this project. The role of the Ministry of Health will be to promote environmental health, health prevention methods including sleeping in treated nets and monitoring incidences of malaria and bilharzias.

VII.3.8. Local Authorities
The LWH subprojects are being implemented in several districts which are administered by the respective district authorities. These local authorities have jurisdiction over the subproject areas and control the marshlands including use and conservation. The marshland farmers pay taxes to the respective authorities for use of these areas. The department of agriculture and animal husbandry would be the focal point in the respective local authorities.

The role of the local authorities will be to monitor and ensure sustainable utilization of the marshlands after the project period. They will be the agency close to the project and will ensure the EMP is implemented by the different stakeholders as indicated.

VII.4. SUMMARY MEASURES TO MITIGATE WORLD BANK SAFEGUARDS TRIGGERED BY LWH PROJECT

<table>
<thead>
<tr>
<th>Bank Safeguards</th>
<th>Mitigation/Response</th>
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</thead>
<tbody>
<tr>
<td>Involuntary Resettlement (OP 4.12)</td>
<td>Preparation of RPF and RAP</td>
</tr>
<tr>
<td>Pest Management (OP 4.09)</td>
<td>Adoption of Integrated Pesticide Management (IPM) Practices including Training, Implementation of Pest Management Plan</td>
</tr>
<tr>
<td>Natural Habitats(OP 4.04)</td>
<td>Undertaking EIA studies and avoiding locating</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
</tr>
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<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Physical Cultural Resources (OP 4.11)</td>
<td>Undertaking investigation and inventory of cultural resources that may adversely be affected by the Project in each project site and putting in place mitigation measures whenever required</td>
</tr>
<tr>
<td>Environmental Assessment (OP 4.01)</td>
<td>Undertaking screening to categorize projects and developing EMPs as required.</td>
</tr>
<tr>
<td>Projects in International Waterways (OP 7.50)</td>
<td>Notification to riparian countries</td>
</tr>
<tr>
<td>Forests (OP 4.36)</td>
<td>Undertaking EA studies and avoiding locating projects in natural habitats. During site screening it was concluded that due to nature of activities at Nyanza-23 site (i.e. afforestation), this policy will not be applied to this particular sub-project of LWH.</td>
</tr>
</tbody>
</table>
The objective of the public consultations with stakeholders is to gather information on their concerns, perceptions and fears of the livelihood changes to be brought about as a result/consequence of LWH project.

Public consultations and disclosure of information about LWH project were organized in Nyanza 23 on March 20th and August 10th, 2012. They involved organized group discussions with purposively selected individuals/stakeholders (between 6 and 10) to gain information on their concerns, perceptions, reactions and experiences of livelihood changes brought as a result/consequence of Nyanza 23 LWH project. Group discussions provided multiple views within a group context and were particularly useful in exploring the level of consensus on a given felt impact.

During the scoping process, a stakeholder mapping exercise was carried out to identify Interested and Affected Parties to Nyanza 23 project. The exercise identified all the stakeholders within and in the surrounding of the command area and includes local community, local authorities, civil society and LWH staff among others.

Interviews were conducted around the following points:

- Awareness, concerns, perceptions and interests of the Nyanza-23 LWH project
- Other development projects operating in the project area (district).
- Employment opportunities during the project implementation (Gender, youth and Vulnerable people)
- Education, health and welfare of the community
- Land tenure, conflicts and use of fertilizers
- Concerns, risks and fears of the community

VIII.1. DATA COLLECTION TECHNIQUES

**Semi Structured Interviews**

Semi structured interviews were organised to gather information from focus groups participants in public consultation settings, by means of discussions guides. The guiding questions were prepared, and a feedback was sought from the MINAGRI_LWH project manager.

The semi-structured interviews were conducted in order to get information on:

- The perceptions of the population regarding the Nyanza-23 LWH project, its constraints and benefits;
- Development projects/ institutions operating in the area
- Employment opportunity (Gender, Youth and Vulnerable People)
- Land tenure and exploitation and use of fertilizers
• Education Health and welfare of the community
• Concerns, risks and fears of the community about the project

Those questions were improved after a pilot test at the very first field visit in Nyanza-23 site. Their wording was again continuously readapted to different groups throughout the field research. Besides, sometimes guides were not rigidly followed, but served merely as guides, the team was adapting the interview process to the local setting in order to ensure a free flow of discussion.

Observations
Whenever possible, before and/or after the public consultations, the team made physical visits and observations of the proposed site of the project in order to verify and corroborate respondents’ perceptions and descriptions with the reality.

Data collection process
Prior to the actual public consultations, the consultant together with a district project Agronomist officer visited the selected cells and discussed with the beneficiaries about the Nyanza 23 project activities and their implementation, beneficiary perception on the project, constraints and benefits as well as issues, comments, suggestions and information from beneficiaries.

The District Project Agronomist Officer kindly made all necessary arrangements with regard to participants’ invitation, the timing and venue for the public consultation sessions. All discussions were conducted in Kinyarwanda. They lasted three to four hours. Afterwards, led by one participant, the consultant visited site where the said project (Land husbandry, water harvesting and hill side irrigation) will be implemented.

VIII.2. KEY FINDINGS

Awareness, Attitude, Perceptions and Interests of the Community about the project

According to a Socio-economic study conducted in 2012 for the new site of Nyanza 23, it was found that the majority of the people view the LWH project as focusing primarily on land husbandry (91.7%). Though sensitization/ awareness meetings on rain water harvesting and hillside irrigation were done by the project officials, they are not well understood by the locals. The respondents are not well informed about the specific area that would be covered by the project and how they will be compensated and relocated. However, majority of the respondents have confirmed the value and opportunity of the project. They pointed out that the construction of water reservoirs with the objective to irrigate their cultivable land will increase the productivity of their farms as they will be cultivating throughout the year without depending on the rainy season. The respondents also indicated that this project will be of much interest as there
will be improved soil fertility as a result of soil erosion control and fertility restoration through lime and compost application. There will also be improved access to water for domestic purposes.

Other Development Projects Operating in the Area

- ACTION AID: is involved in the construction of schools, supplies school materials, adult literacy, good governance, training of farmers and breeder, provision of agricultural fertilizers
- Care-International Women’s Rights, (women association and cooperatives
- Fvea: counseling of women in conflicts situations and HIV/AIDS
- AVSI International: HIV/AIDS, epidemic, payment of “Mutuelle de Sante” of vulnerable people
- RAB : distribution of fertilizers and selected seeds, breeding, training of agronomists and inseminators
- CIP (Crops intensification program)

Employment opportunity (Gender, Youth and Vulnerable People)
The community in the proposed site believe that the project would not only benefit farmers within the irrigable area but would also create employment opportunities for other community members who will provide services in the farms (casual laboring), in construction of reservoirs, irrigation canals, etc. The priority will be much on gender, youth and vulnerable people as they are organized in cooperatives and associations to better assist them.

Land tenure and exploitation and use of fertilizers
The land conflicts are much family business when it comes in sharing the land among children and are mostly solved by the abunzi (Conciliators) at the village level. Concerning the use of fertilisers, the population of Rwabicuma and Nyagisozi is not familiar with the use of inorganic fertilizers except for some crops such as tomatoes. They normally use organic/manure fertilizers.

Education Health and welfare of the community
In general, health has greatly improved with the introduction of” Mutuelle de santé” and children have access to school as per the government policy of free education.

Concerns, risks and fears of the community about the project
One of the major concerns of community in the area was whether there will be compensation for properties (houses), crop and land that will be affected by the water reservoir, silt trap zone and canals in the command area.

They also expressed fear of water overflowing out of the reservoir in case of heavy rains, uncertainty in getting another fertile and cultivable land. The
respondents also fear that there would be an increase in the incidences of malaria because the water reservoir would serve as a breeding ground for mosquitoes. They also feared that there would be a “cool breeze” prevailing as a result of the water mass that would result in respiratory related problems due to continuous exposure of residents.

The table below illustrates some of the main concerns of consulted people and their suggestions to minimize the project adverse impacts to PAPs.

<table>
<thead>
<tr>
<th>PAPs Concern</th>
<th>Stakeholder's Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode of Compensation for property, land &amp; crops loss</td>
<td>Compensation in cash through bank/ Umurenge Sacco accounts to allow them to freely choose their preferred sites to resettle in.</td>
</tr>
<tr>
<td>Timeline of the compensation</td>
<td>Needs to be done immediately before and after the cut-off date (final notice to vacate the premises is given). Most PAPs indicated that they need 4-6 Months to move to new settlements.</td>
</tr>
<tr>
<td>Adequacy of the Compensation, process and valuation of property.</td>
<td>Adequacy of the cash compensation and at the prevailing market rates. They insist on considering the real value of their properties during the compensation period.</td>
</tr>
<tr>
<td>Employment of the locals during the project implementation.</td>
<td>Local population should be given priority in employment within the project area at the implementation and operation stage.</td>
</tr>
</tbody>
</table>

**Conclusions and Recommendations**

a) All the PAPs and communities consulted were much concerned with compensation. There are 40 households settled within the proposed reservoir area and silt trap zone. About 95 percent of the PAPs are willing to be resettled to new areas as long as they are fully compensated. It is therefore recommended that all the PAPs be fairly compensated for their properties, land and crop (if any) loss. Appropriate measures should be put in place to accompany the relocation of concerned farmers for keeping the good image of the project in the area.

b) Prior to compensation, a detailed valuation of affected assets in the presence of the PAPs and local authorities, should be undertaken and up-to-date value of the affected assets be negotiated with the PAPs and communities for payment.

c) Prior to compensation and resettlement, the PAPs and affected communities should be given free counseling, training on financial management and legal assistance where required.

d) The project has to seriously intervene in the transformation of subsistence agriculture into commercial oriented agriculture. This implies the introduction of good agricultural technologies by the project and their adoption by farmers.

e) For the successful implementation of Nyanza 23 project, there shall be much of sensitization and mobilization of the community to be more involved in compensation process, project planning and implementation.
IX. CONCLUSION

The LWH Nyanza 23 subproject activities considered in this study are environmentally feasible due to the fact that proposed interventions are environmentally friendly e.g. hillside irrigation and land husbandry. In addition, the adverse impacts anticipated can be effectively managed by following the designed EMPs which includes mitigation measures already thought out in the design and feasibility study phase.
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ANNEX I. LIST OF CONSULTED PEOPLE

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Position/Designation</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vincent Nsabuwera</td>
<td>LWH/RSSP Project Agronomist</td>
<td>078 873 3768</td>
</tr>
<tr>
<td>2</td>
<td>Benjamin Muligande</td>
<td>RSSP/LWH Social Safeguards Specialist</td>
<td>078 846 2778</td>
</tr>
<tr>
<td>3</td>
<td>Chantal K. Umulinga</td>
<td>RSSP/LWH Social Safeguards Specialist</td>
<td>078 856 2798</td>
</tr>
<tr>
<td>4</td>
<td>Dan Folta</td>
<td>LWH Irrigation Engineer</td>
<td>078 273 7424</td>
</tr>
<tr>
<td>5</td>
<td>Philbert Nkurunziza</td>
<td>LWH/RSSP Nyanza Project Site Coordinator</td>
<td>078 877 1660</td>
</tr>
<tr>
<td>6</td>
<td>Didace Habamenshi</td>
<td>RSSP/LWH Environmental Officer</td>
<td>078 861 3065</td>
</tr>
<tr>
<td>7</td>
<td>Euphralie Nzamusanganira</td>
<td>Farmer</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Aimable Nsegimana</td>
<td>Environmental Officer/Nyanza District</td>
<td>078 887 7119</td>
</tr>
<tr>
<td>9</td>
<td>Claire Uwumuremyi</td>
<td>Land Officer/Nyanza District</td>
<td>078 846 2811</td>
</tr>
<tr>
<td>10</td>
<td>Fidele Bayingana</td>
<td>Agronomist/Rwabicuma Sector</td>
<td>078 852 4628/072 587 4977</td>
</tr>
<tr>
<td>11</td>
<td>Jean Claude Muyumba</td>
<td>Infrastructures/Rwabicuma Sector</td>
<td>078 827 2388</td>
</tr>
<tr>
<td>12</td>
<td>Josephine Uwantege</td>
<td>Social Affairs/Rwabicuma Sector</td>
<td>078 873 0154</td>
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<tr>
<td>Names</td>
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<tr>
<td>ABATICU MUGAUBI  Cooperative VUNA BANDI</td>
<td>Representative (President)</td>
<td>0782036633</td>
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<td>Appolaina</td>
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<td>TUZAMURANE (Cooperator) NDAGI MANA Augusti</td>
<td>V/President</td>
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<td>Muhirwa Traduction</td>
<td>Farmer</td>
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<td>Makabola Prisca</td>
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ANNEX III. SITE MAP

Nyanza-23 LWH Site
Command area:
Gross = 453 ha
Net = 380 ha

Map of the site showing canals and reservoirs.
ANNEX IV. TERMS OF REFERENCE FOR UPDATING ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF LWH PROJECT IN NYANZA-23 NEW SITE

1. Background

For the successful implementation of Land-husbandry, Water-harvesting and Hillside irrigation (LWH) project, an Environmental Impact Assessment (EIA) was one of the prerequisites as the project was ranked under category B which requires environmental assessment for subsequent detailed EIA study. In this regard, terms of reference for LWH EIA study have been developed and cleared by the Bank early November, 28, 2008. After advertisement, the Green and Clean Solution (GCS Ltd) has won for this consultancy service and successfully conducted EIA study for the first selected 8 sites including Nyanza-23 and Gatsibo-8 sites. Note that this EIA report has been approved by the WB and an EIA certificate has been issued by the Rwanda Development board (RDB).

The physical implementation of the project activities in Nyanza-23 and Gatsibo-8 sites has started in January, 2011 by the protection of the respective water catchment areas with comprehensive land husbandry technologies. While preparing the construction of water harvesting and hillside irrigation infrastructures, a technical team (WB and Project engineers) during the last June 2011 project support mission found that there is a need to shift the dam location in both sites as the most suitable sites were identified with regard to the project approach and objectives. As these new dam locations were not considered, it is really relevant to make sure that EIA study is updated in the two sites with regard to these new dam sites and irrigated command areas in order to ensure that the potential related adverse impacts are identified and mitigation measures are put in place before the commissioning water harvesting and hillside infrastructures construction works.

2. Objective of the consultancy

The main objective of this consultancy service is to ensure that the prior EIA study is updated in Nyanza-23 and Gatsibo-8 sites as per the new changes in dam location and irrigated command area. For this purpose the consultant will be requested to update the existing EIA and EMP reports by evaluating all environmental and social issues that may arise with the development of the new project activities and suggest necessary mitigatory measures and monitoring plan, in compliance with national and World Bank regulations.
3. Specific tasks to the consultant

Taking into account the guidelines of the Rwanda Environment Management Authority (REMA) and World Bank policies concerning impact analysis and address all relevant issues related to the project activities, the main tasks for the consultant to update EIA study for Nyanza-23 and Gatribo-8 sites are the following:

i. Go through the existing EIA Study in the proposed project area and review them to integrate major sensitive issues with relevance to the new proposed areas.

ii. Forecast and update the magnitude of the problem of silting in the hillside dam reservoirs, in main canals and irrigation systems.

iii. Determine and update the magnitude of land degradation in the watersheds and recommend immediate appropriate protective measures to reduce the risks of silting.

iv. Reassess the potential development works’ impacts on health of concerned communities and users in downstream zone and assess environmental impacts (study of drinking water needs, livestock watering, irrigation, etc., downstream the project) and environmental impacts (effects on flora and fauna) notably due to reduced flow rates and possible deterioration of the water quality through contamination (fertilizers, pesticides);

v. Reanalyse and update the potential loss of land due to flooding caused by envisaged dam reservoirs and reduction in land due to the use thereof on construction of dam embankment, headworks, main canal, access/circulation roads, etc., and their economic and social impacts, as well as needs in terms of compensation and rehabilitation and/or resettlement for affected families, if necessary;

vi. Re-evaluate the potential increased risks of waterborne diseases, particularly malaria and schistosomiasis associated with irrigation development, especially for those programs. The likely impacts of the proposed programs will be evaluated taking into account the current conditions of transmission of these diseases;

vii. Assessment of potential salinization and/or alkalinization, siltation, flooding and soil erosion risks in and around the affected areas upstream and downstream the dams;

viii. Assessment of potential contamination of drainage water by agricultural chemicals and of possible effect of reducing basic flow rates on increased concentrations, and determination of the dilution capacity of the receiving water body;

ix. Assessment of risks of proliferation of aquatic weeds, crop diseases and pests, and evaluation of any other side effects not listed above, on biophysical and socioeconomic aspects of the project area.

x. Propose appropriate mitigation measures for likely impacts.

xi. Prepare self standing Environmental management plan clarifying the contribution of each stakeholder.

xii. For Gatribo-8 additional consideration shall be made for aspects with regard to the refugee camp above the reservoir, including provision of an alternative water supply, sewage disposal, safety issues, water borne diseases, etc.
4. Duration of the assignment

This assignment is expected to last within 14 working days as following

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5. Reporting

The consultant is requested to present to the Client the first draft reports (EA and related separate EMPs for two sites) to 12 days after the start of the assignment and the latter will have three days to make comments which will be incorporated in the final report within the following two days. In both cases, reports are handed into three hard copies and one soft copy.
ANNEX V. ABOUT THE CONSULTANT GCS Ltd

Green and Clean Solution (GCS) Consultants Ltd is a regional multi-disciplinary consultancy firm with its regional offices in Kigali Rwanda specialised in Environmental Assessment and Management. The firm is a privately owned company established in 2007. The firm has in the recent past undertaken environmental assessments and strategic environmental assessments for various sectors in Rwanda and currently offers technical support in the following fields:

**Environmental Assessment and Management** including
- Environmental and Social Impact Assessment (ESIA) for projects related to Hydropower, Gas Extraction, Housing, Construction, Rural Development (Agriculture and Livestock, Feeder Roads, Valley dams, Biogas, Marshlands Development, etc.), Solid Waste Management, Water Supply and Sanitation, Humanitarian Response, Coffee Roasting, etc.
- Strategic Environmental Assessment (SEA),
- Environmental Audit,
- Environmental Risk Assessment,
- Environmental Modelling and Forecasting,
- Environmental Economics,
- Training and Capacity Building in EIA

GCS also has immense Experience in Baseline Survey including Biomass Energy and Rural Stoves Survey, Rapid Social Survey Analysis for Hydropower projects, Baseline Survey for Rural Development Projects. We have also implemented numerous projects in Communities Involvement and Civil Society Participation in Water Development Projects, Agriculture Production.

Our expertise in Water and Sanitation including Solid Waste Management (Valorization, Collection and Recycling of Domestic Wastes) and our expertise in the development of regulatory framework for water supply and sanitation services in Rwanda including elaboration of a strategic planning and implementation of technical and economic regulations in Water and Sanitation is unrivalled. We have installed some of the major wastewater treatment systems in Rwanda in the recent past.

The firm also undertakes Geographical Information Systems (GIS) including remote sensing images (Landsat TM, SPOT and Radar) i.e. rectification, interpretation, classification among others.

GCS Consultants Ltd engages a staff of more than 10, majority of who have professional degrees. Our staff covers a wide range of environmental studies, planning and engineering disciplines, with significant presence of environmentalists in addition to hydrologists, engineers, geologists, ecologists, economists, natural and social scientists, representing a working environment that is truly multi-disciplinary. A strong focus of GCS Consultants Ltd activities lies in working with local partners and building local capacity.

For more information on GCS is available on [www.gcsconsultants.rw](http://www.gcsconsultants.rw)