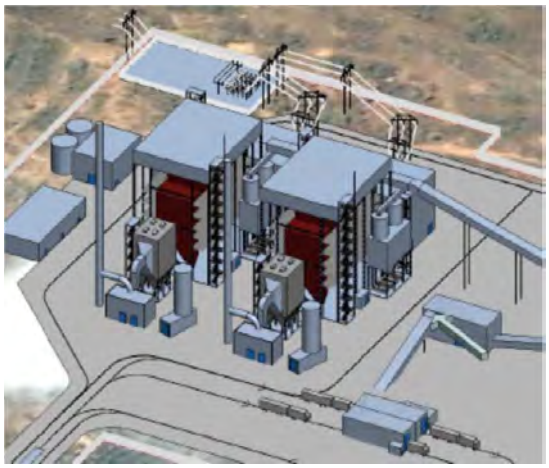

AKANYARU PEAT PRODUCTION AND POWER GENERATION PROJECT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

FINAL REPORT

SWECO INTERNATIONAL IN ASSOCIATION WITH WES CONSULT

July 2013

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ABBREVIATIONS

AAS	Atomic Adsorption Spectroscopy
BOD	Biological Oxygen Demand
B	Boron
Ca	Calcium
Cd	Cadmium
CITES	Convention on international trade in endangered species of wild fauna and flora
CFB	Circulating Fluidised Bed
CP	Construction phase
Cr	Chromium
Cu	Copper
COD	Chemical Oxygen Demand
DDP	District Development Plan
EA	Environmental Assessment
EAC	East African Community
EC	Electrical Conductivity
EDPRS	Economic Development and Poverty Reduction Strategy
EIA	Environmental Impact Assessment

EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
EWSA	Energy, Water and Sanitation Authority
Fe	Iron
FAO	Food and Agriculture Organisation of the United Nations
GIIP	Good International Industry Practice
GoR	Government of Rwanda
HH	Households
IUCEA	The Inter-University Council for East Africa
IUCN	International Union for Conservation of Nature
K	Potassium
LVBC	Lake Victoria Basin Commission
LVFO	The Lake Victoria Fisheries Organisation
m a.s.l.	Meter above sea level
MDG	Millennium Development Goals
MIFOTRA	Ministry of Labor
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
Mn	Manganese
MWe	Megawatt (electricity) – net power output as electricity
Na	Sodium
NBI	Nile Basin Initiative
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme of NBI
NEP	National Environmental Policy
NUR	National University of Rwanda
OHS	Occupational Health and Safety
OP	Word Bank Operational Policies
P	Phosphorus
PAP	Project Affected People
Pb	Lead

PCP	Pre-construction phase
PFPP	Peat Fired Power Plant
PM	Particulate Matter
PPE	Personnel Protecting Equipment
QRA	Quantitative Risk Assessment
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RNRA	Rwanda Natural Resource Authority
SACCO	Savings cooperative
SAR	Sodium Adsorption Ratio
SEO	Site Environmental Officer
SHE	Safety, Health & Environment
SMP	Social Management Plan
TDS	Total Dissolved solids
ToR	Terms of Reference
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
UNCED	United Nations Conference on Environment and Development
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation
WHO	World Health Organisation
WRM	National Policy for Water Resource Management
WSD	Water Storage Dams

SUMMARY

The Organic Law on environmental protection made Environmental Impact Assessment (EIA) mandatory for approval of major projects, activities and programs in the Republic of Rwanda. This report contains the Environmental Impact Assessment for Akanyaru peat fired power plant project to be located in Mamba sector, Gisagara District, Southern Province of Rwanda.

The project consists in the production of Akanyaru peat, the construction and the operation of peat fired power plant of 2*35 = 70 MWe of total net capacity in a first phase and another 35 MWe in a second phase. This ESIA concerns the first phase of 2*35 MWe, and the peat production to fuel the Power Plant.

The identification of the impacts of this project on the environment showed that during the project phases, there will be a significant number of positive impacts on the human and bio-physical environment as well as negative impacts.

Positively, the project will contribute to local employment, electrification, contractor employment and poverty alleviation, local business enhancement, economic diversification, healthcare for employees, possibility of savings for the employees and tax payments.

The project will also have negative impacts on the biophysical and socio-economic environment through geological alteration, soil pollution, waste generation, water use and quality impacts, impacts on land and biodiversity, air pollution, noise and vibration, energy use, visual impacts, water borne diseases, risk of accidents, etc.

Different mitigation measures for these negative impacts have been proposed to reduce their effects on the socio-economic environment as well as on the biophysical environment to a minimum. These include general environmental management conditions and a number of specific mitigation measures including:

- Mitigation measures to geological alteration and hydrological impacts;
- Mitigation measures to soil impacts;
- Water use and quality management;
- Management of non-hazardous waste;
- Hazardous waste management;
- Land and biodiversity protection;
- Air quality management;
- Management of noise and vibration;
- Energy use management;
- Visual impacts management;
- Occupational, health and safety management;
- Water storage dams management and
- Inclusion of a buffer/safety zone.

Training and capacity building for employees are also proposed.

In order to put these measures into practice, environmental and social management plans have been developed to guide all activities of the project concerning the protection of the environment.

Recommendations are also given to enable the project to become a success without unnecessarily harming or with the least negative effect to the receiving environment.

A standalone Executive Summary of this report has also been prepared, dated 28 July 2013.

I. INTRODUCTION

I.1. Project background

Hakan Mining and Electricity Generation Industry and Trade Inc. of Istanbul, Turkey (HAKAN) is developing a project in Rwanda based on the production of peat and its firing in one or more new peat-fired power plants (PFPPs) of total net capacity of 70 MWe in a first phase and another 35 MWe in a second phase. This ESIA concerns the first phase of 2*35 MWe, including the peat production to fuel the Power Plant. In earlier stages of the Project 100 MWe, 2*50 MWe and 2*45 MWe has been considered, and is mentioned in this report as alternatives to the currently agreed power output. HAKAN has registered a company incorporated under the Laws of Rwanda in the name of YUMN Ltd, which is used further on in this report.

A number of reports were earlier produced for the project by Tractebel Engineering, namely:

- ✓ Hakan - Rwanda Peat. Feasibility Study Report peatbog identification R2. Technical Note, dated 12/07/20. Tractebel Engineering. RWAN-FS/4NT/0250256/000/00 [2]
- ✓ Hakan - Rwanda Peat. Peatbog preparation and production planning. Technical Note, dated 12/07/20. Tractebel Engineering. RWAN-FS/4NT/0251156/000/00 [3]
- ✓ Hakan - Rwanda Peat. Pre-feasibility Report. Technical Note, dated 12/07/20. Tractebel Engineering. RWAN-FS/4NT/0251199/000/00 [4]

Other documents produced for the project are:

- ✓ Power Purchase Agreement for a Peat Power Plant at Akanyaru Peat Prospect, signed 11 9 2012 [5]
- ✓ Concession Agreement, signed 11 9 2012 [6]
- ✓ Government Guarantee, signed 11 9 2012 [7]

A number of reports of relevance to the project were also produced by Ekono Energy Ltd. and BRGM in 1993 for the Ministry of Public Works and Energy, Republic of Rwanda, namely:

- ✓ Final Master Plan Feasibility Study for the Development of Peat Deposits.
- ✓ Supplementary Report, June 1993
- ✓ Volume 1/6: Summary Report, January 1993
- ✓ Volume 2/6: Bog Survey, January 1993
- ✓ Volume 3/6: Hydrological Study, January 1993 [8]
- ✓ Volume 4/6: Environmental Impact Study, January 1993
- ✓ Volume 5/6: Peat Market Study, January 1993
- ✓ Volume 6/6: Peat Production and Feasibility, January 1993

HAKAN approached Sweco International in January 2013 with a request that Sweco submit new report(s) to replace the latter two Tractebel Engineering reports referred above, to which Sweco agreed. The new report(s) contain Sweco's own proposals for the project based on a review of the

reports produced by Tractebel Engineering and Sweco's own evaluation and calculations. HAKAN and Sweco signed an agreement for this work and Sweco began its work in early February 2013.

The technical background data in this report is mainly based on the earlier reports by Tractebel and subsequent Sweco Reports, e.g. Rwanda Peat Production and Harvesting – Final Report, 13 May 2013 and Rwanda Peat-Fired Power Plant - Draft Report, 18 March 2013 and later revisions based on revisions due to EWSA and HAKAN/YUMN Agreements to modify the size of the Power Plant.

HAKAN also contracted Sweco in March 2013 to conduct the ESIA for the same Project, and a Draft ESIA Report was submitted to RDB by Hakan on June 8, 2013 for approval of the Project. After receiving comments from the Client and RDB on 18 July 2013 the Draft Report was amended and the current report comprises the Final ESIA Report.

I.2. Author and developer presentation

I.2.1. Author

This environmental impact assessment has been conducted by SWECO International.

SWECO is one of Europe's leading providers of knowledge and consulting services in the fields of engineering, environmental technology and architecture. Together, Sweco's engineers, architects and environmental experts develop total solutions for a sustainable society.

With about 9 000 employees, Sweco delivers innovative, technically advanced solutions and services to the private and public sectors. The services contribute to better environmental policies, cleaner air and water, attractive and functional living and work environments, roads and bridges that improve traffic safety and shorten travel time, and industries that are efficient, profitable and environmentally sound. In short, Sweco builds for sustainable development for future generations.

Since undertaking its first international assignment in Russia in 1903, Sweco has executed projects in more than 100 countries. Each year, Sweco carries out close to 30,000 projects for some 10,000 clients. Sweco has subsidiaries in a growing number of countries – Sweden, Norway, Finland, Denmark, Russia, Estonia, Lithuania, the Czech Republic, Slovakia, Bulgaria and Poland – and offices in more than 100 locations. Sweco has an annual turnover of € 870 million (2012) and is listed on NASDAQ OMX Stockholm AB. Sweco's business system is certified according to Quality Standard ISO 9001, Environmental Standard ISO 14001 and Occupational Health & Safety Management Standard OHSAS 18001.

I.2.2. The Project Team

The Team engaged in the preparation of this ESIA is depicted below

Name, Swedish Specialists	*Position*
1. Dr. Per Olof Seman	Team Leader/ Peat, Waste and EIA Specialist
2. Ms. Amparo Ismodes	Socio-economic Specialist
3. Mr. Lazare Nzeyimana	Hydologist, QA and Environment Management Specialist
4. Mr. Leif Axenhamn / Stig Andreasson	Air Pollution Specialist / Atmospheric Impact Specialist

5. Mr. Crispin Dickson	Noise Specialist
6. Mr. Daniel Persson / Admasu Gebeyehu	Water and Environment Specialists
7. Ms. Emma Eriksson / Annika Börje	Socio-economic Specialist / Biodiversity Specialist
Name, Rwandese Specialists	*Position*
1. Dr. Fabien Twagiramungu	Environmental/EIA Specialist
2. Dr. Alphonse Rubagmya	Socio-economic Specialist
3. Mr Fidèle Ruzigandekwe	Zoologist and Natural Resources Specialist
4. Mr. Sylvain Rusanganwa	Rwandan Team Coordinator

Moreover, support staff, like enumerators, drivers etc. were contracted.

I.2.3. Developer

The developer is Hakan Mining and Electricity Generation Industry and Trade Inc, a company incorporated in Istanbul, Turkey with the following address: Kore Sehitleri Cad. Yzb.Kaya Aldogan Sok. No:4, 34394 Zincirlikuyu, Istanbul, TURKEY. Email: hakankarasoy@hakanas.com. The developer has registered a company in Rwanda under the name YUMN Ltd, incorporated under the laws of Rwanda. Address: Umujyi wa Kigali, Gasabo District, c/o Plot No: 1372, P.O. Box 6381. YUMN is the Operator that entered into a Power Purchase Agreement and the Concession Agreement with the Government of Rwanda.

I.3. Objective of the study

The main objective of this study is to carry out a comprehensive Environmental and Social Impact Assessment (ESIA) study for the Akanyaru Peat harvesting and power generation project.
Reducing the burden of environmental impacts is necessary if development is to become sustainable. As resources become limited, environmental impacts become more complex. ESIA has become of ever increasing importance as a tool for development and decision making. This role is formally recognized in principle 17 of the Rio Declaration on Environment and Development (UNCED 1992):

"Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent national authority".

In practice, ESIA is applied primarily to prevent or minimize the adverse effects of major development projects. It is also used as a planning tool to promote sustainable development by integrating environmental considerations into a wide range of proposed actions.

The aim and objective of ESIA can be divided into two categories. The immediate aim of ESIA is to inform the process of decision making by identifying the potentially significant environmental effects and risks of development projects. The ultimate (long term) aim of ESIA is to promote sustainable development by ensuring that development projects do not undermine critical resource and ecological functions or the well-being, lifestyle and livelihood of the communities and people who depend on them.

The immediate objectives of ESIA are to:

- Improve the environmental design of the project;
- Ensure that resources are used appropriately and efficiently;
- Identify appropriate measures for mitigating the potential negative impacts of the project; and
- Facilitate informed decision making, including setting environmental terms and conditions. for implementing the project.

Long term objectives of ESIA are to:

- Protect human health and safety;
- Avoid irreversible changes and serious damage to the environment;
- Safeguard valued resources, natural areas and ecosystem components; and
- Enhance the social aspects of the project.

The following are specific objectives of the study:

- To detect the effects of the project on the neighbouring environment such as the water bodies, the soil, neighbouring communities, the infrastructure, the fauna, the flora and possible atmospheric impacts;
- To propose alternative measures where it is noticed that adverse effects may occur;
- To propose mitigation measures where adverse effects may have occurred;
- To carry out a diagnosis of the existing environment and activities in the area of the project;
- To highlight the potential of Akanyaru peat harvesting and power generation project with regard to environmental and social issues, specifically to guide the engineering team of Sweco to adapt environmentally and socially sustainable BAT practices in the project design;
- To propose enforcement measures where beneficial effects from the project are detected; and
- To set up an environmental management plan that will govern all activities of the project for the protection of the environment.

I.4. Objective of the project

The objectives of the present project are: the harvesting of Akanyaru peat, the construction and the operation of peat fired power plant of max 70 MWe of total net capacity in a first phase and 35 MWe in a second phase.

I.5. Methodology used for the study

Based on the terms of reference (ToR) prepared by Sweco and approved by the Rwanda Development Board (RDB) through its department in charge of EIA, the methodology used by the consultants consisted of the following:

- **Literature review:** Review of documentation on policies, laws, regulations and guidelines related to environmental management, mining sector, waste management, land use, EIA process, etc., at the national level as well as the international levels.

- **Interviews:** The consultant consulted people living in the area of the Akanyaru peat bogs to be exploited; various institutions have been consulted in order to determine the perceived benefits of the project and the likely negative impacts on the environment and society as a whole.

- **Data collection:** Through site visits, required qualitative and quantitative data have been collected. Checklist and impact matrices were used during the assessment of the potential impacts.

- **Stakeholders' consultations:** The consultant consulted key partners/stakeholders including Ministry of Natural Resources (MINIRENA), Ministry of Infrastructures (MININFRA), Rwanda Natural Resource Authority (RNRA), Rwanda Environment Management Authority (REMA), Rwanda Development Board (RDB), Energy, Water and Sanitation Authority (EWSA), Gisagara and Nyanza Districts, etc. to establish their involvement, roles and responsibilities during the project implementation.

- **Reporting:** The data and information collected were processed and compiled to achieve this Environmental and Social Impact Assessment Report.

II. INSTITUTIONAL, LEGISLATIVE AND REGULATORY CONSIDERATIONS FOR ENVIRONMENTAL MANAGEMENT

II.1. Institutional Framework for Environmental Management in Rwanda

The institutional framework for environmental management is currently enshrined in the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda, published in the Official Gazette RWA Nº 9 of the 1st May 2005, particularly in chapter III relating to the establishment of the institutions.

II.1.1. Ministry of Natural Resources (MINIRENA)

MINIRENA is a multi-sectoral ministry covering five sectors: Lands; Water; Forestry; Mines and Geology and Environment. MINIRENA is responsible for the development of policies, laws and regulations as well as coordination of all the activities in the management of land, water, forestry, mining and quarrying and environment, as well as their follow up and evaluation.

II.1.2. Ministry of infrastructure (MININFRA)

MININFRA is a ministry covering of energy, water and sanitation, transport, habitat and urbanism and meteorology. The mission of the Ministry of infrastructure is the following:

- To ensure the sustainable development of infrastructure and contribute to economic growth with a view to enhancing the quality of life of the population.
- To develop institutional and legal frameworks, national policies, strategies and master plans relating to transport, energy, habitat and urbanism, meteorology, and water and sanitation subsectors;
- To initiate programmes to develop, rehabilitate and maintain an efficient and integrated national transport infrastructure network, including roads, bridges, airports, railways, and water transportation which will contribute towards economic development and regional integration.

II.1.3. Rwanda Environment Management Authority (REMA)

In 2002, Rwanda Environment Management Authority (REMA) was established to act as the implementation organ of environment-related policies and laws. REMA is also tasked to coordinate different environmental protection activities undertaken by environmental promotion agencies; to promote the integration of environmental issues in development policies, projects, plans and programmes; to coordinate implementation of Government policies and decisions taken by the Board of Directors and ensure the integration of environmental issues in national planning among concerned departments and institutions within the Government; to advise the Government with regard to the

legislation and other measures relating to environmental management or implementation of conventions, treaties and international agreements relevant to the field of environment as and when necessary; to make proposals to the Government in the field of environmental policies and strategies.

II.1.4. Rwanda Development Board (RDB)

RDB was created by the Organic Law No 53/2008 of 02/09/2008. It has a mission of improving the well-being of all Rwandans by fast-tracking development, catalysing sustainable economic growth, and creating prosperity for all. According to the recent restructuring of government institutions including RIEPA, ORTPN, CAPMER etc., the responsibility for follow-up of environmental impact studies is now under RDB, the department in charge of EIA.

II.1.5. Rwanda Natural Resources Authority (RNRA)

Rwanda Natural Resources Authority was established by the law N°53/2010 of 25/01/2011, which merges the four institutions (National Land Centre, National Forestry Authority and National Geology and Mines Authority) together with the Ministry of natural resources' department of integrated water resources management.

RNRA is an authority that leads the management of promotion of natural resources which is composed of land, water, forests, mines and geology. It shall be entrusted with supervision, monitoring and to ensure the implementation of issues relating to the promotion and protection of natural resources in programs and activities of all national institutions. Particularly, RNRA is responsible for:

- Implementing national policies, laws, strategies, regulations and government resolutions in matters relating to the promotion and protection of natural resources;
- Making a follow up and implementing international conventions Rwanda ratified on matters relating to the conservation of natural resources;
- Advising the Government on appropriate mechanisms for conservation of natural resources and investments opportunities;
- Registering land, issuing and keeping land authentic deeds and any other information relating to land of Rwanda;
- Ensuring proper geological data and their respective maps;
- Providing technical advice on the proper use of natural resources;
- Making follow up and supervising activities relating to proper management, promotion and valuation of natural resources;
- Rehabilitating and conserving where natural resources are damaged in the country;
- Making a follow up and supervising activities relating to the proper use of natural resources;
- Promoting activities relating to investment and added value in the activities of use and exploitation of natural resources in Rwanda;

- Initiating research and study on natural resources and to publish the results;
- Instituting regulations, guidelines and appropriate mechanisms for management, use and conservation of natural resources and ensuring their implementation; and
- Establishing cooperation and collaboration with other regional and international institutions with an aim of harmonising the performance and relations on matters relating to management of natural resources.

II.1.6. Energy, Water and Sanitation Authority (EWSA)

EWSA was created in 2010 by the law no 43/2000 of 7/Dec/2010 from the National parastatals charged with water and electricity distribution, RECO & RWASCO.

EWSA has as mission to create conditions for the provision of sufficient, safe, reliable, efficient, cost-effective and environmentally appropriate Energy, Water and Sanitation services to households and to all economic sectors on a sustainable basis. EWSA has a vision of contributing effectively to the growth of the national economy and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner

II.2. Legislative and Policy Framework for Environmental Impact Assessment (EIA) in Rwanda

II.2.1. Constitution of the Republic of Rwanda

Article 49 of the Constitution of the Republic of Rwanda (4 June 2003) 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.2.2. Rwanda Vision 2020

Vision 2020 is a policy statement on the long-term development aspirations of the Government and the implications for country's occupants (essentially Rwanda's National Development Strategy). The vision 2020 of Rwanda gives strategic actions and inter alia institutes the principle of precaution to mitigate the negative effects caused to the environment by the socio-economic activities (which require an environmental impact study), to institute the "polluter pays" principle as well as preventive and penal measures to ensure the safeguarding of the environment.

II.2.3. Economic Development and Poverty Reduction Strategy (EDPRS)

Economic Development and Poverty Reduction Strategy (EDPRS) focuses on economic growth and prioritizes the environment "both as one of the critical cross-cutting issues and as a stand-alone sector" regarding this strategy. Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS) is a medium-term framework for achieving the country's long term development aspirations as embodied in Rwanda's Vision 2020, and the Millennium Development Goals (MDG). Millennium

Development Goals (MDGs) are global targets to halve the number of people living in absolute poverty by 2015, using 1990 as the baseline. Rwanda signed the commitments to achieve these targets.

The strategy builds on strong achievements in human capital development and promotes three flagship programmes. These programmes serve as a device to prioritize actions by the GoR, mobilization of resources for development and improvement of policy implementation through more coordinated interventions across sectors.

II.2.4. Rwanda Policy of the Mines and Geology

Rwanda has many assets in the sector of mines and quarries. It is within this framework that in 2004, a policy of the mines and geology were defined in order to ensure good mineral stock management characterized by research, exploitation and optimal valorisation of the ores and products of the quarries without negative impacts on the environment and occupational safety. Its focus is the fair management of mining resources so as to contribute sustainably and equitably to poverty eradication and sustainability. It expands on the importance of geological resources and the responsible exploitation of these on the economy of Rwanda. It also touches on the need to have the mining policies and frameworks properly implemented.

The overall general objective is to contribute to the improvement of national revenue through a fair management of mining resources.

II.2.5. Law on Mining and Quarry Exploitation (Law N° 37 /2008 of 11/08/2008)

This Law determines mining and quarry exploitation in Rwanda. The Law caters for activities relating to prospecting, search, exploitation, purchase, stocking, handling, transport and commercialization of transferable substances, other than hydrocarbon, as well as quarry products within the Republic of Rwanda.

II.2.6. National Environmental Policy (NEP)

The National Policy on Environment adopted by the Cabinet in November 2003 has an overall objective to improve health and promote socio-economic development through the sustainable management and utilization of natural resources and the environment; to integrate environmental aspects across national, provincial and local levels; conserve and restore ecosystems and national biodiversity; optimize sustainable use of natural resources; sensitize the population on various environmental values and the relationship between environment and development; ensure participation of individuals and communities in activities aimed at improving the environment; and ensure that the basic needs and those of future generations are met.

The recommendation of the policy on population and land-use management is to balance the national policy in terms of population, land-use management and environment, while the recommendation on

land is to ensure that land, which is the major resource of the country, is not degraded and used in an unplanned manner.

II.2.7. National Environmental Law

Chapter IV of Title III of the Organic Law n° 04/2005 of 08/04/2005 determining modalities of protection, conservation and promotion of environment in Rwanda regulates the Environmental Impact Assessments. Some pertinent points from the Law regarding impact assessments for developments include:

- In article 67: 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.
- Article 68 specifies the main points that an Environmental Impact Assessment must include.
- 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 environmental impact assessment shall be carried out at the expense of the promoter.
- Article 70 states that an order of the Minister having environment in his attributions establishes the list of projects for which the public administration shall not warrant any authorization without an Environmental Impact Assessment describing direct and indirect consequences of the project to the environment.
- Article 13 states that any soil development and exploitation project for industrial, urban organisation as well as any research project or the one of exploitation of subsoil raw materials is subject to authorisation issued through procedures determined by the order of the Minister concerned.
- Article 14 stipulates that the issuance of authorisation mentioned in article 13 of this organic law is subject to:
    - Urgency and effectiveness of measures to prevent environmental degradation due to research activities, land use and planned extractions;
    - Taking into consideration the interests of the local community by the promoter; and
    - The obligation to rehabilitate in any possible way in order to restore the beauty of the landscape or the natural systems modified by human activity, in accordance with a pre-established rehabilitation plan approved by the competent authority.
- Under Title VI of this Organic Law, article 81 stipulates that the following activities are prohibited:

- 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 an inappropriate place; and
- Spitting, discarding mucus and other human waste in any place.

- Under article 87, 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. All buildings shall be constructed in a distance of at least twenty (20) meters 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 the 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. For the purpose of enforcement, article 95 announces that anyone 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. Falsification and alteration of documents of environmental impact assessment is punished in the same manner as what is provided for in paragraph one of this article.

- Article 88 of the Rwanda organic law on the environment states that it is prohibited:

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

- The 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; and
    - Deteriorate the beauty of a place which is potential for its aquatic tourist interest.

II.2.8. National Land Law

Land ownership in Rwanda is determined by the Organic law N° 08/2005 of 14/07/2005 determining the use and management of Land in Rwanda. It also institutes the principles that are respected on land, legal rights accepted on any land in the country as well as all other appendages whether natural or artificial.

In this Law the following definitions are given:

- **Construction area** is an area purposely for human settlement, trade and industries, an area reserved for recreation and other basic activities of public utility.
- **Area not for construction** is an area reserved for agriculture, afforestation, grazing, reserved tourist places and recreational gardens.

The ownership of Land is determined by article 4, which announces that, any person or association with legal personality has the right over the land and to freely exploit it as provided for by this organic law in article 5 and 6.

Article 5 states that any person or association with legal personality that owns land either through custom, or who acquired it from competent authorities or who purchased it are allowed to own it on long term lease in conformity with provisions of this organic law.

Article 6 of the Law determines that any person whether a Rwandan or a foreigner who invested in Rwanda, or an association with legal personality shall enjoy full rights of ownership of land reserved for residential, industrial, commercial, social or cultural and scientific services.

The procedure to obtain authentic documents of such personal property is determined by the Minister having Land in his or her attributions.

The rights and obligations of landlords are determined by article 54 which states that without prejudice to laws related to human settlement, general land organization and use, the landowner shall enjoy full rights to exploit his or her land in accordance with the existing laws and regulations.

Article 57 states that all buildings, crops and other works found on land are presumed to have been performed by the owner of the land using his or her money or otherwise, and are presumed to be his or hers in case there is no proof to the contrary. However, this does not prohibit any other person to own buildings, crops or any other works on other persons' land in procedures provided for by law.

II.2.9. Ministerial Order N° 003/2008 of 15/08/2008 Relating to the Requirements and Procedure for Environmental Impact Assessment

Article 1 stipulates that Environmental Impact Study is a systematic way of identifying environmental, social and economic impacts of a project before a decision of its acceptance is made.

In article 3, the developer submits an official application which includes a project brief of the proposed project to the authority.

Article 4 specifies that within thirty (30) calendar days after receipt of the project brief and after its analysis, the Authority shall submit the Terms of reference to the developer for the Environmental Impact Study.

In Article 7, upon completion of the Environmental Impact Study, the developer shall deposit with the Authority five (5) hard copies and a soft copy of the report.

II.2.10. Rwanda Biodiversity Policy

The document was published on in September 2011. The document takes cognizance of the commitments of the Convention on Biological Diversity and makes provision for the development and implementation of strategies, plans, and programmes that will promote biodiversity conservation and the sustainable development of Rwanda. The objectives of this policy include:

- Provide a comprehensive and cohesive policy framework that will strengthen the Government's ability to conserve and protect Rwanda's natural and cultural resources;
- Provide a legal and institutional framework for biodiversity conservation and management throughout the country;
- Promote partnerships, incentives and benefit sharing to enhance biodiversity conservation and management;
- Promote generation, management of conservation knowledge, including traditional knowledge, and its application in the conservation of biodiversity;
- Provide a framework for access to genetic resources and the sharing of benefits derived from those resources; and
- Promote positive attitudes towards biodiversity conservation and management.

Specific strategies are addressed in this policy for various objectives related to the various identified threat to biodiversity including the management of alien invasive species.

II.2.11. National Policy for Water Resource Management (WRM)

The document was published on 17 May 2012 and is governed by the existing water and sanitation policy developed in 2004. The various post-war institutional changes have transformed the framework for managing water resources which are not adequately reflected in the water and sanitation policy. Therefore this policy has been formulated for water resource management which also contributes to new national objectives regarding Vision 2020 and the EDPRS.

With regards to the mining sector, the following has been extracted from the WRM Policy:

"The current mining policy promotes the need to use modern mining techniques that minimise harm to land, forests, water, wetlands and the environment. However, due to inadequate implementation of the policy, mining activities cause deterioration and pollution of water bodies. The WRM policy underscores the need for appropriate minerals' exploration and exploitation techniques to prevent pollution and deterioration of the quality and quantity of water bodies."

Several institutions are involved in the water resource management in Rwanda; the responsibilities are divided largely into policy and oversight, financing, regulation, management and services institutions.

II.3. International Legislative Framework

The following laws, regulations and conventions are in line with this project and the national policies and laws:

- The international Convention on Biological diversity and its habitat signed in RIO DE JANEIRO in BRAZIL on 5 June 1992, as approved by Presidential Order No 017/01 of 18 March 1995;
- The CARTAGENA protocol on biodiversity to the Convention on Biological biodiversity signed in NAIROBI from May 15, to 26, 2000 and in NEW YORK from June 5, 2000 to June 4, 2001 as authorized to be ratified by Law No 38/2003 of 29 December 2003;
- The United Nations framework Convention on Climate Change, signed in RIO DE JANEIRO in BRAZIL on 5 June 1992, as approved by Presidential Order No 021/01 of 30 May 1995;
- The KYOTO Protocol to the framework on climate change adopted at KYOTO on March 6, 1998 as authorized to be ratified by Law No 36/2003 of December 2003;
- The RAMSAR International Convention of February 2, 1971 on Wetlands of International importance, especially as water flows habitats as authorized to be ratified by Law No 37/2003 of 29 December 2003;
- The STOCKHOLM Convention on persistent organic pollutants, signed in STOCKHOLM on 22 May 2001, as approved by Presidential Order No 78/01 of 8 July 2002;
- The ROTTERDAM International Convention on the establishment of the international procedures agreed by states on commercial transactions of agricultural pesticides and other poisonous products, signed in ROTTERDAM on 11 September 1998 and in NEW YORK from 12 November 1998 to 10 September 1999 as approved by Presidential Order No 28/01 of August 2003 approving the membership of Rwanda;
- The BASEL Convention on the Control of Trans boundary Movements of Hazardous wastes and their disposal as adopted at BASEL on 22 March 1989, and approved by Presidential Order No 29/01 of 24 August 2003 approving the membership of Rwanda;

- The MONTREAL International Conventional on Substances that deplete the Ozone layer, signed in LONDON (1990), COPENHAGEN (1992), MONTREAL (1997), BEIJING (1999), especially in its article 2 of LONDON amendments and Article 3 of COPENHAGEN, MONTREAL and BEIJING amendments as approved by Presidential Order no 30/01 of 24 August 2003 related to the membership of Rwanda;
- The BONN Convention opened for signature on June 23, 1979 on conservation of migratory species of wild animals as authorized to be ratified by Law No 35/2003 of 29 December 2003; and
- The WASHINGTON agreement of March 3, 1973 on International trade in endangered species of Wild Flora and Fauna as authorized to be ratified by presidential Order No 211 of 25 June 1980.

II.4. Regional Legislative and Institutional Framework

Due to its location within the Congo and Nile basins, Rwanda subscribes to the East African Community (EAC) Treaty and its Protocol for the Sustainable Management of Lake Victoria and its Basin and the Nile Basin Cooperative Framework.

EAC is a regional intergovernmental organization which comprises five countries: Burundi, Kenya, Rwanda, Tanzania and Uganda. EAC is endowed with various ecosystems, some of which are transboundary. Transboundary aquatic ecosystems in the region which concern Rwanda are:

- Lake Victoria (Kenya, Tanzania, Uganda) + Burundi and Rwanda for the Lake Basin
- The Nile system (all 5 Partner states)
- Akagera River (Burundi, Rwanda, Uganda, Tanzania)

The water governance in EAC takes root from the environmental instruments focusing on utilization and conservation of water as a resource. These are laws, policies and institutions for the management of water resources.

The five Partner States of EAC have existing water resource management instruments which operate within national contexts. However, national environmental policies and programmes have not explicitly provided for regional management of shared ecosystems. They are focused on promoting resource management within national territorial boundaries.

The five Partner States have signed and ratified the Convention on Biological Diversity and are thus obliged to implement its provisions including those on regional cooperation to promote the conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of benefits arising from the utilization of genetic resources.

II.4.1. Legal Instruments

- **The Treaty of Establishment of the East African Community:** The Treaty (Chap 19 Art. 111 and Art.114) provides for joint management and utilization of natural resources within the Community for the mutual benefit of the partner States. The treaty also provides for joint development and adoption of harmonized common policies and strategies for sustainable management of transboundary natural resources within the Community. With regard to water issue, the actions by the community shall have the following objective: "To ensure sustainable utilization of natural resources like lakes, wetlands, forests, and other aquatic and terrestrial ecosystems and to jointly develop and adopt water resources conservation and management policies that ensure sustenance and preservation of ecosystems." (Art.111.2c and d).

- **The Protocol on Environment and Natural resources Management:** The protocol on environment and natural resources management provides for the cooperation in environment and natural resources management (Chap. 3). More specifically, in Art. 13 related to the management of water resources, the protocol has these provisions: The partner States shall develop, harmonizes and adopt common national policies, laws and programmes relating to the management and sustainable use of water resources and shall utilize water resources, including shared water resources, in an equitable and rational manner.(13.1 and 2).

- **The EAC Regional Environment Impact Assessment Guidelines for shared ecosystems**: Noting the urgency to institute measures, policies, guidelines, laws and programmes that will promote their cooperation in the conservation and sustainable use of the shared ecosystems. EAC has developed the regional EIA Guidelines for shared ecosystems. The EIA Guidelines were adopted by the Council of Ministers in its 9th meeting. The regional EIA Guidelines enable the identification and application of environmentally sound approaches to manage and ensure the sustainability and biophysical integrity of the shared ecosystems within the EA region Such guidelines are crucial for the proper conduct of impact assessment studies on shared ecosystems such as fresh water, forests and protected areas.

II.4.2. Regional Institutional Framework

EAC secretariat and autonomous institutions: EAC secretariat is the executive organ for East African Community. The coordination at EAC secretariat levels provides a forum for Partner states to harmonise their laws, policies and standards. Other specialized institutions involved are:

- **Lake Victoria Basin Commission (LVBC):** is a specialized institution of EAC established by EAC Partner States through a negotiated protocol for sustainable development of Lake Victoria Basin. LVBC is the EAC organ for ensuring sustainable development and management of natural resources of the Lake Victoria Basin.

- **The Lake Victoria Fisheries Organisation (LVFO):** is an institution under EAC based in Jinja, Uganda. The main objectives of the LVFO are to harmonise national measures for sustainable use of the lake's fisheries resources and to develop and adopt conservation and management

measures accordingly. The Convention delineates a set of functions to achieve the overall objective, inter alia, to provide a forum for discussion of initiatives to deal with environmental conditions and water quality in the Lake Basin, to promote research with respect to the living resources of the lake, and to address problems of non-indigenous species.

- **The Inter-University Council for East Africa (IUCEA):** is a regional inter-governmental organisation whose mission is to encourage and develop mutually beneficial collaboration between Universities in East Africa, and between them and governments and other organisations, both public and private. It is one of the autonomous institutions of EAC. The IUCEA, through Lake Victoria Research (VicRes) Initiative, is supporting staff of Universities to undertake research on poverty reduction and environmental restoration.

II.5. World Bank Safeguards

The World Bank policy OP 4.01 Environmental Assessment has been established to ensure Environmental Assessment (EA) of projects proposed for Bank financing to an acceptable level, to ensure that such projects are environmentally sound and sustainable, and to improve internal decision-making.

This report assesses the potential environmental and social impacts which may arise in future through the proposed project. This impact assessment has then informed the mitigation and management measures needed to either prevent the impact completely or reduce the impact significance to within acceptable levels. Lastly off-set approaches to impacts that cannot be satisfactorily mitigated may be considered where necessary. These mitigation and management measures inform the overall environmental management plan. Further to this a detailed monitoring programme has been included to ensure all aspects of the project which may have the potential to impact the environment or social wellbeing of surrounding communities are frequently monitored. Environmental indicators selected for the specific project have also been included in the detailed monitoring programme to indicate if any issues arise. The monitoring programme further details action plans that should be instigated should monitoring activities indicate any issues.

This study is therefore also considered in line with the World Bank's requirements. The World Bank system assigns a project to one of three project categories, as defined below:

- Category A Projects: Always require a full EIA as impacts are expected to be 'adverse, sensitive, irreversible and diverse; pollutant discharges may be 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 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.

The present peat production and fired power plant project (PFPP) is in this category.

- Category B Projects: may not always require a full EIA but some environmental analysis is necessary. Impacts are less significant and few are irreversible. Remedial measures and rehabilitation can be more easily designed. Usually related to rehabilitation, maintenance, or upgrade projects rather than new developments.
- Category C Projects: require no EIA as they result in negligible or minimal direct disturbance of the physical environment.
- Category FI Projects: involve investment of Bank funds through a financial intermediary.

Table 1 specifies the World Bank Operational Policies which are relevant to the current Project.

Table 1: World Bank Operational Policies relevant to the environment and the proposed project and their relevance to the current development and associated EAR

World Bank Document	Current status
OP 4.01 – Environmental Assessment	The report has been compiled as per the recommendations of Annexure B for Category A developments. The management plan within this report has taken into account Annexure C. The public consultation process was recently completed for the Rwanda EIA process. Pollution Prevention and Abatement Handbook has been considered in the compilation of this management and monitoring plan where applicable.
OP 4.02 – Environmental Action Plans (EAPs)	The monitoring plan submitted within this document incorporates a list of actions that should be considered should issues be identified through the monitoring programme. The action plans have been devised taking Rwanda policy and strategies into account.
OP 4.04 – Natural Habitats	The most part of area relevant to this project has been largely transformed from natural vegetation to predominantly cultivation and primary grasslands. Natural habitat and floral management has been discussed within this report, but natural habitat conservation is considered as a priority where possible.
OP 4.07 – Water Resources Management	The primary river of the peat concession area and receiving surface water flow is Akanyaru. The Akanyaru River flows in a predominantly south to south-east (boundary between Rwanda and Burundi) and after the confluence with Nyabarongo forms the Kagera River, which forms the boundary between Rwanda and Tanzania and flows into Lake Victoria.

World Bank Document	Current status
OP 4.09 – Pest Management	This operational policy is not strictly relevant to this project. The alien invasive management plan briefly discussed within the report has taken into consideration mechanical removal of alien invasive plant species. Where the need for chemical treatment arises, then known chemicals will be utilised for the specific treatment as per their specifications and application will only be considered during drier seasons and applied on days when it is not raining.
OP 4.10 – Indigenous Peoples	This operational policy is not relevant to this project as no indigenous people as defined occur in the area.
OP 4.11 – Physical Cultural Resources	This operational policy is not relevant to this project as no physical cultural resource is in the project area.
OP 4.12 – Involuntary Resettlement	This operational policy is relevant to this project as some people will be displaced from the area where PFPP will be constructed. A Resettlement Action Plan will be prepared for that purpose*.
OP 4.36 – Forests	No natural forests occur and this operational procedure is not relevant.
OP 4.37 – Safety of Dams	All required dams on site will be designed and supervised by a qualified and certified civil engineer to ensure that the dams are constructed with adequate capacity and safety measures.
OP 10.04 – Economic Evaluation of Investment Operations	This project will provide employment for several local people. The generation of 70 MWe in Rwanda will have several direct and indirect positive impacts to local, national and regional population through regional electricity interconnection project being implemented by NELSAP.
Environmental Assessment Sourcebook Update – Environmental Assessment of Mining Projects	This document has been consulted and relevant issues incorporated in the report.

*Since less than 200 persons in the vicinity of the Project are expected to be subject to relocation a simplified Resettlement Action Plan would apply.

III. BASELINE DATA

This section gives background information on the project area as a whole, then narrows down to the project specific site in terms of its location, administrative setup, climate, settlement patterns, and the major environment attributes, which will play a crucial role in the identification of impacts and influence the overall direction in the development of the project.

III.1. Description of the study area

The peat fired power plant (PFPP) will be constructed at Buye village, Kabumbwe cell, Mamba sector, Gisagara District in southern province of Rwanda, see *Figure 1*. Akanyaru Peat bogs to be exploited are located in two sectors of Gisagara District (Mamba and Gishubi sectors) and in one sector of Nyanza District (Ntyazo sector).

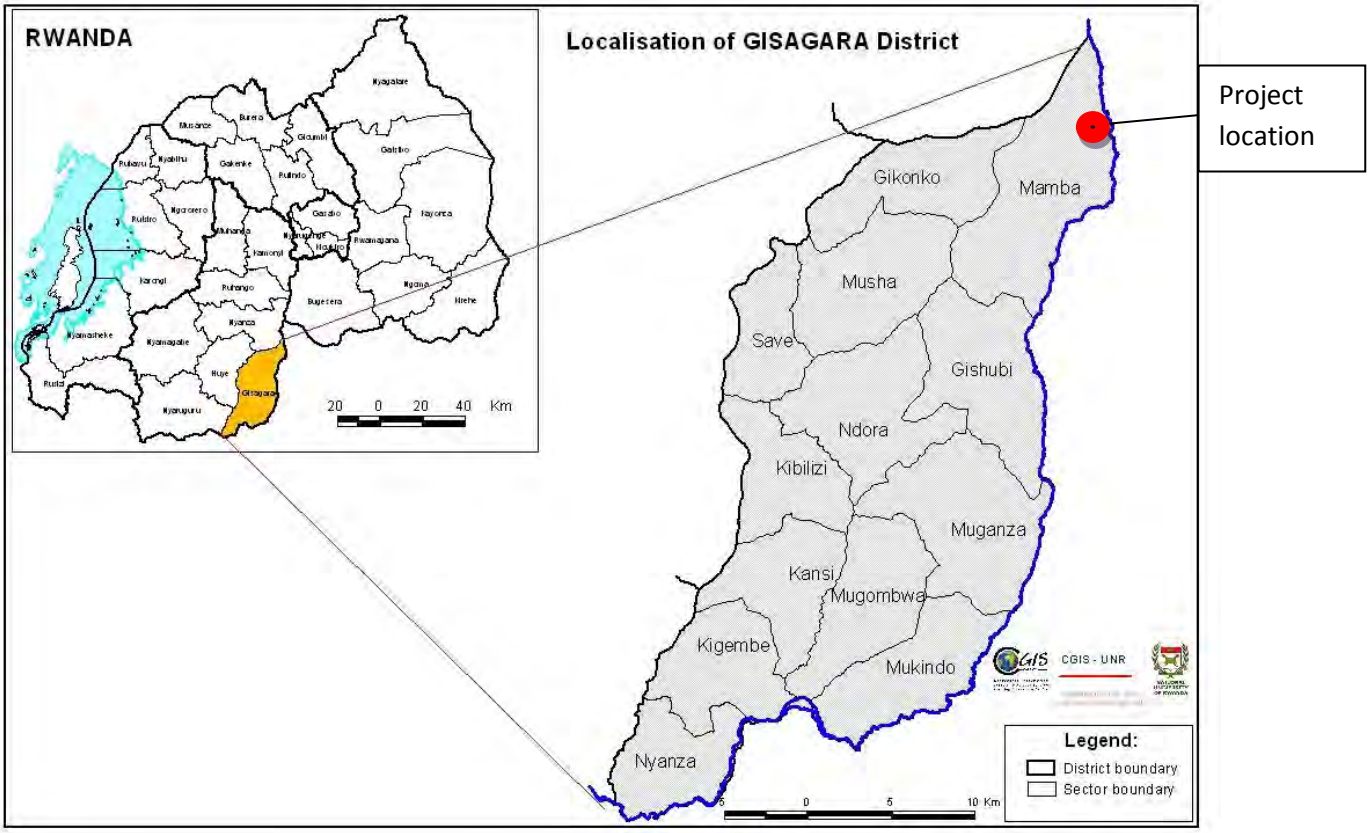


Figure 1: PFPP location within Gisagara District

III.2. Socio Economic Profile

III.2.1. Population

The population of Gisagara and Nyanza Districts are indicated in *tables 2 and 3* for 2002 and 2012 where the three concerned sectors are highlighted.

The population of Gisagara district was estimated at **322 803** inhabitants with the density of **475** inhabitants per sq.km in 2012 whereas the population of Nyanza District was estimated at **323.388** with the density of **481** inhabitants per sq.km during the same period.

Table 2: Population of Gisagara District per sector

Sector	2002 Total Population	2012 Population			Sex Ratio	Population Change (2002-2012) (%)	Average Annual Growth Rate (2002-2012) (%)	Population Density (sq.km)
		Male	Female	Total				
GIKONKO	16.914	10.894	12.260	23.154	89	36,9	3,2	467
GISHUBI	17.033	11.776	13.166	24.942	89	46,4	3,9	408
KANSI	18.344	8.472	10.032	18.504	84	0,9	0,1	441
KIBILIZI	22.584	11.912	14.364	26.276	83	16,3	1,5	658
KIGEMBE	19.421	9.397	10.765	20.162	87	3,8	0,4	460
MAMBA	24.502	16.460	18.497	34.957	89	42,7	3,6	442
MUGANZA	21.321	13.881	16.265	30.146	85	41,4	3,5	434
MUGOMBWA	18.575	10.578	12.294	22.872	86	23,1	2,1	459
MUKINDO	22.755	12.257	13.875	26.132	88	14,8	1,4	521
MUSHA	18.039	11.486	13.135	24.621	87	36,5	3,2	494
NDORA	18.572	11.112	12.742	23.854	87	28,4	2,5	392
NYANZA	18.737	8.965	9.975	18.940	90	1,1	0,1	504
SAVE	25.331	13.122	15.121	28.243	87	11,5	1,1	688
GISAGARA	262.128	150.312	172.491	322.803	87	23,1	2,1	475

Table 3: Population of Nyanza District per sector

Sector	2002 Total Population	2012 Population			Sex Ration	Population change (2002-2012) (%)	Average Annual Growth Rate	Population Density (sq.km)
		Male	Female	Total				
BUSASAMANA	33.828	21.391	21.705	43.096	99	27,4	2,5	875
BUSORO	24.146	16.435	17.705	34.140	93	41,4	3,5	465
CYABAKAMYI	18.018	10.567	11.751	22.318	90	23,9	2,2	371
KIBIRIZI	22.032	15.464	16.988	32.452	91	47,3	3,9	390
KIGOMA	26.956	16.887	18.555	35.442	91	31,5	2,8	536
MUKINGO	27.904	30.132	19.595	49.727	154	78,2	5,9	654
MUYIRA	22.793	16.570	18.741	35.311	88	54,9	4,5	437
NTYAZO	16.247	12.722	14.163	26.885	90	65,5	5,2	431
NYAGISOZI	20.730	12.297	13.727	26.024	90	25,5	2,3	357
RWABICUMA	12.555	8.412	9.581	17.993	88	43,3	3,7	382
NYANZA	225.209	160.877	162.511	323.388	99	43,6	3,7	481

The population of Mamba Sector, which is the main area of concentration of the project is constituted of 33,887 population with dominance of women (53%) compared to men (47%). The estimations are in line and concur with District statistics according to national Population and housing census 2012[1]. Due to the high proportion of women in Gisagara District, and particularly in project zone, there is urgent need to integrate gender and women empowerment in the project programming, as strategy to enhance their access to any opportunity (especially employment) in the project development area. *Table 4* depicts the details of the population in the Mamba sector.

Table 4: Detailed population distribution in the project area (Mamba sector)

Cell	Number of Villages	Number of Households (HH)	Number of population		Total
			Men	Women	
Kabumbwe	8	1453	3133	3121	***6254***
Gakoma	10	1654	3365	3596	***6961***
Ramba	11	1594	3364	3817	***7181***
Mamba	9	1224	2427	3178	***5605***
Mayaga	9	1655	3615	4271	***7886***
Total	**47**	**7580**	**15904**	**17983**	**33887**

Source: Local Administration

The detailed characteristics of the population within the project zone are presented in *table 5*.

Table 5: Characteristics of the population in the project area

Factor/indicator	Project Zone	Gisagara District
Administrative Composition	The project Zone is located in two districts: Gisagara District and Nyanza districts. Two Sectors, Mamba and Gushubi; in Gsagara, and one sector, Ntyazo; in Nyanza District. 4 cells boarder the project zone and includes Kabumbwe and Gakoma in Mamba Sector, Nyeranzi in Gishubi sector and Katarara cell in Ntyazo sector. It is important to note that the big part of project area is concentrated in Gisagara district, Mamba sector, precisely in Kabumbwe Cell, especially in Kirwa and Gahararo village	Gisagara have 13 sectors, 59 cells and 524 villages. It has 322,803 populations. (2012 Population and Housing Census (Comprehensive Report) at www.statistics.gov.rw)

[1] **The general population of Gisagara is about 322,803 with 172491 women (53%) and 150,312 men (47%)**

Factor/indicator	Project Zone	Gisagara District
Population and Density	The Total population of Mamba Sector (made of 8 cells) is **33 887** grouped into 7 580 House Holds.	The Density of population in Gisagara is 475 per Square mater
Population Growth	Over the past ten years, average population growth was 2.1%/year, which is below the national average of 2.6%.	
Age Structure for Head of HH	The majority of surveyed households is comprised between 50-59 age group (56%), followed by 36-45 (21%), 40-49 (19%) and finally 20-35 (4%). No under 19 was identified as head of household.	
Gender Ratio	The ratio in project area was estimated to the ratio of the Gisagara District and is estimated to 87 58% of the surveyed HH was all female and only 42% was male.	About 52% of the population is constituted by female individuals and the majority of the population is young, with about 81% still under 40 years of age. It shows that females outnumber males in Gisagara district, with 108 females per every 100 males. This is below the national average of 111 females per 100 males. The average size of the household in Gisagara district is 4.6, which is below the national average. Gisagara ranks among the nine districts with lower average sizes of household
Household Size	87% of HH surveyed have between 1-3 members while 17% of HH is comprised of 3-5 members. This is contrary to general trends of Gisagara where the average HH size is estimated to 4.6. The reason being the fact that most of head of HH surveyed are in old age (56 % are in group age between 50-59) and there is high chance that family members have graduated and formed their own families.	
Education Levels and Access to Education	83% per cent of the head of HH In the surveyed HH never attend any school (illiterate), 13% attended primary school and only 4 pe rcent attended the secondary level.	Gisagara district is ranked last in terms of its literacy rate of 57.5% among people aged 15 and above, compared to 69.7 national average. In regards to school attendance, Gisagara is ranked third lowest-ranking district (above only

Factor/indicator	Project Zone	Gisagara District
		Nyaruguru and Nyamagabe) in terms of the percentage of individuals aged six and above that have ever attended school (79%).
Migration Status	90% of the surveyed HH live in the area for more than 3 years while 10% live there for 2 years and some of them were returning to their born places to cultivate the heritage land.	The population of Kabumbwe generally is stable. However, insignificant mobility of people to other regions was observed especially to look for more fertile and big size land. A trans boundary phenomenon of people mainly from neighbouring Burundi was also highlighted for agriculture related employment opportunities (Abapagasi) in project zone.

III.2.2. Employment /Economic Trends-Local Economy/Incomes

Agriculture is practiced as a labor intensive, intercropping system with both cash crops and subsistence crops. In the project zone, cassava, rice and coffee are the most cultivated for income generation. Women are responsible for food supply and other household duties whereas men are responsible for cash income including cash crops.

The main socio-economic trends/ factors of the project zone are indicated in *table 6*.

Table 6: Table Socio-Economic Factors of the project area

Factor	Indicator	Findings in Project Zone	General comments and perception of Community (FGDs)
Livelihood Factors			
Main Occupation/ activities	• Primary occupation • Secondary occupation	• 90% of the surveyed HHs responded agriculture as their primary occupation followed by breeding at 62%, casual worker at 38%and finally civil and private servant at 6%. Note that the total is beyond 100% because HHs exercise more than one occupation	Agriculture has been their primary occupation, seconded by the animal husbandry. The major crops that generate income include beans, maize, cassava and horticulture mainly practiced in or close by the marshland. For animals, we found cows, poultry, chicken and goats. Some few people, especially men practice also informal fishing in the Akanyaru marshland especially during the main raining seasons in April. The most productive agriculture season is the dry season (C season) called Ishagasha. Other occupations identified are small business but very limited due to poor economic infrastructure such us market, electricity and roads. It was reported that employment for income generation remains the major factor for poverty and vulnerability in the project zone.
Land and Land Tenure, house and other asset ownership	• ownership of House • Land for Agriculture ownership • Land for forestry ownership	• All the surveyed HH was living in their own house • 100% of the surveyed HH own land for agriculture activities • 65% of the surveyed own land for forestry	
Other Economic Activities	• Farming • Small business	• No specific data were identified	
Financial Institution	• Existence of financial institution (bank, saving cooperative, SACCO • Working with financial institution	All the surveyed confirmed the existence of different financial institutions in their area but only 42% work with those financial institutions. 83% among those who don't work with financial institution (58%) said that it is because of insufficient of money and other 17% said that there is no need to do so for them.	• A need in financial literacy in the project area is mandatory. Also in group discussion it was shown that the distance to reach the nearest financial institution is discouraging as the only bank available is Umurenge SACOO and Bank Populaire both located at Mamba centre in 5kms

Factor	Indicator	Findings in Project Zone	General comments and perception of Community (FGDs)
Poverty and Vulnerability			
Monetary Income	• HH Income	• 71% of the surveyed indicated to have monthly income of RWF 30,000 and below , 10% have just 30,000, 10% have between RWF 30,000 -45,000 while only 10% have income more than 60,000	In general, the average income per capital/HH is estimated between 12.500-30000 RWF per month (the lowest income is 50,000 RWF and the highest 250,000 during the agriculture season) The main source of income is from selling agriculture produces supported by casual work (Ibiraka), small business and animal husbandry. The main expenditures are related to buying agriculture inputs, lending land for agriculture, payment of casual workers, health services (mutuelle de santé), buying the gasoil for lighting, school fees and clothing. However, there still an imbalance between expenditure and income and it is recommended to the project to invest in off farm activities to create more jobs for a more sustained monetary income and poverty reduction
	• Expenditure	• 100% of HH surveyed pointed out that they spend their money on buying food and agriculture inputs, paying for health services and clothes. 90% spend money on education and only 6% spend money on buying water.	
	• Contributor to HH Income	• 94% of the surveyed responded that the head of HH is the main contributor to the HH income, 4 % by family member and 6% from a relative leaving in other area.	
Poverty	• Poverty Status (use: Ubudehe data)	• 85% of the surveyed HH reported to be in the 3rd category, 10% are in the 2nd category while only 6% are in the first category.	Most of the population in the FGDs disclosed that they belong to the 3rd category of Ubudehe. The results were confirmed with village survey which founds that, on 52 House Holds visited, 44 HH were classified in category 3 (85%) while 10% and % are respectively classified in the category 2 and one. None of the HHs were categorised in 4 and above.
Socio-Economic Infrastructures and utilities			
Housing, Energy, water and sanitation	• Size of House in term of rooms	• 65% of the surveyed HH have between 1 and 3 rooms, 35% have more than 3 rooms	Generally the housing has improved significantly in Rwanda in the past years, including Gisagara,

Factor	Indicator	Findings in Project Zone	General comments and perception of Community (FGDs)
	• Roofing status • Construction material • Access and quality of sanitation facilities • Drinking water Source • walking Distance to water source • domestic energy Source (cooking, lighting)	• 77% of the surveyed have tiles as roofing material and 23% have metal sheets • 81% of the surveyed houses are constructed from both wood and mud while 19% are in local mud bricks (Rukarakara). • All the surveyed HHs have latrines (toilet) in their home • 90% use designed source of water as drinking water source and only 10% still using the river. • 90% responded to walk 1 to 5 Km, and 10 per cent assumed to walk more than 5kmfor fetching water. • For cooking, 96% of the surveyed use firewood and other biomass residues while another 4 per cent use also charcoal The main use for lighting is oil lamps at 46% and torch at 48% while 6% use candles.	through Nyakatsi eradication program (hatched house) by the Government of Rwanda and most of the HHs resides in durable roofing such us iron sheets and tiles. However, the size of houses in Gisagara (generally 3 rooms compared to 4.6 HH size) remain critical. The wall construction material is also very fragile as most of the houses are made of tree trunks with mud. The main source of drinking water is the Akanyaru River and its affiliated swamps. During the discussion, it was revealed that there is only one water tap in the whole zone and it is not functioning. On the average, it takes one hour to reach water source which is very critical and under the national average and far worse than MDGs target that recommend 500 meters to a water source. Two spring water sources (Isoko) were identified in Kirwa and Buye. Water treatment practices are not common in the zone and the population is likely to be exposed to diseases related to poor quality of water and sanitation. However, in relation to sanitation facilities, the FGD indicated that most of the households have got latrines and the remaining challenge is meet the required standards. ***Lighting:*** most of the population expressed that they use the oil lamp (Agatadowa) to illuminate the house. Other means includes torches and candles but these are used by very few people because it is expensive compared to their income. ***Cooking:*** firewood collected from forest and

Factor	Indicator	Findings in Project Zone	General comments and perception of Community (FGDs)
			biomass residues are the main source of cooking energy.
Road network, transportation and Access to Market	• Number of modern markets	• The surveyed showed that people walk more than 10Km to get to nearest market which is normally a small business centres but there is no any modern market in project zone. • 96% said that they go to the market both as buyers and as sellers (mainly agriculture produce)	***Road network*:** generally, the project zone is characterised of a poor road network and that phenomenon is observed across the whole district. Gisagara is among the few Rwandan Districts which are not crossed by any tarmac road. The time to reach the main road (tarmac road) is one and half hour on a distance of 30 km from Mamba Centre. In some remote area, it may take up to 2 hours to move within the project area (from Kabumbwe of Mamba Sector to Gishubi Sector). ***The cost of transport*** is high due to poor infrastructure and the project investment in rural and transport facilities will reduce the cost of doing business and facilitate easy access to market. For instance, the cost of transport to move from Kabumbwe Cell (project site) and Mamba business centre to Huye Town (tarmac) are respectively 4000 and 3000 RWF by motorcycle and 2000 and 1600 RWF by public buses. It is important to note that motorcycle is the most reliable transport mean to get to Huye because Mamba Centre has got only 2 buses and most of time they are stranded. **As consequence,** the poor road network has significantly affected the access to market especially for agriculture commodities and in some cases caused losses of harvest due to poor conditions of conservation and limited markets. It was observed that the whole project zone does not have any single modern market and Kabumbwe

Factor	Indicator	Findings in Project Zone	General comments and perception of Community (FGDs)
			which is a small business centre was indicated as the ''reliable market''. There is urgent need to construct a modern market in the project area.
Access to Health and Education Services	• Number of health facilities (centre, hospital) • Distance to get there • Frequent diseases	• The nearest health facility is located on sector level and from the project area they said that they walk between 5 to 10km to reach the Health Centre. • Malaria was identified to be the main frequent disease in the area	The whole sector has got one Health Centre of Gakoma and it is situated at 15 km of the project zone which is far to support emergencies. No post de santé was registered in the project zone as recommended by the Ministry of Health which provides at least one post de santé for each cell of the country. The project zone has got one primary school (Kabumbwe Primary school) with total enrolment of 1 600 pupils and provides program up to P6. Efforts are needed to increase number classes and teachers to reach 9 and 12 year basic education as adopted by the government of Rwanda. It is worth to note that no secondary schools were observed in the project zone and the distance to the nearest Universities (Butare Campus of National University and the private Catholic University) is respectively estimated at 40 and 35 Km

III.3. Description of Biophysical environment

III.3.1. Physical Conditions

III.3.1.1.Topography

The project site is part of hilly topographic system which is a typical characteristic of the central plateau of Rwanda. The land form is a result of the flattening surface of the southern province of Rwanda and its basement consists of granitic rocks.

The high altitude is 1560 meters (above sea level) as recorded at Kigarama, while the low altitude (1350 meters above sea level) is found in the valley of Akanyaru. The difference in elevation is thus about 200 meters. The gradient is estimated at around 15 % and comes up to about 20% at some locations. The slopes in the area are slightly concave. Although the area is not really mountainous, it consists of a range of small hills surrounded by a range of shallow and wide valleys.

III.3.1.2. Geology

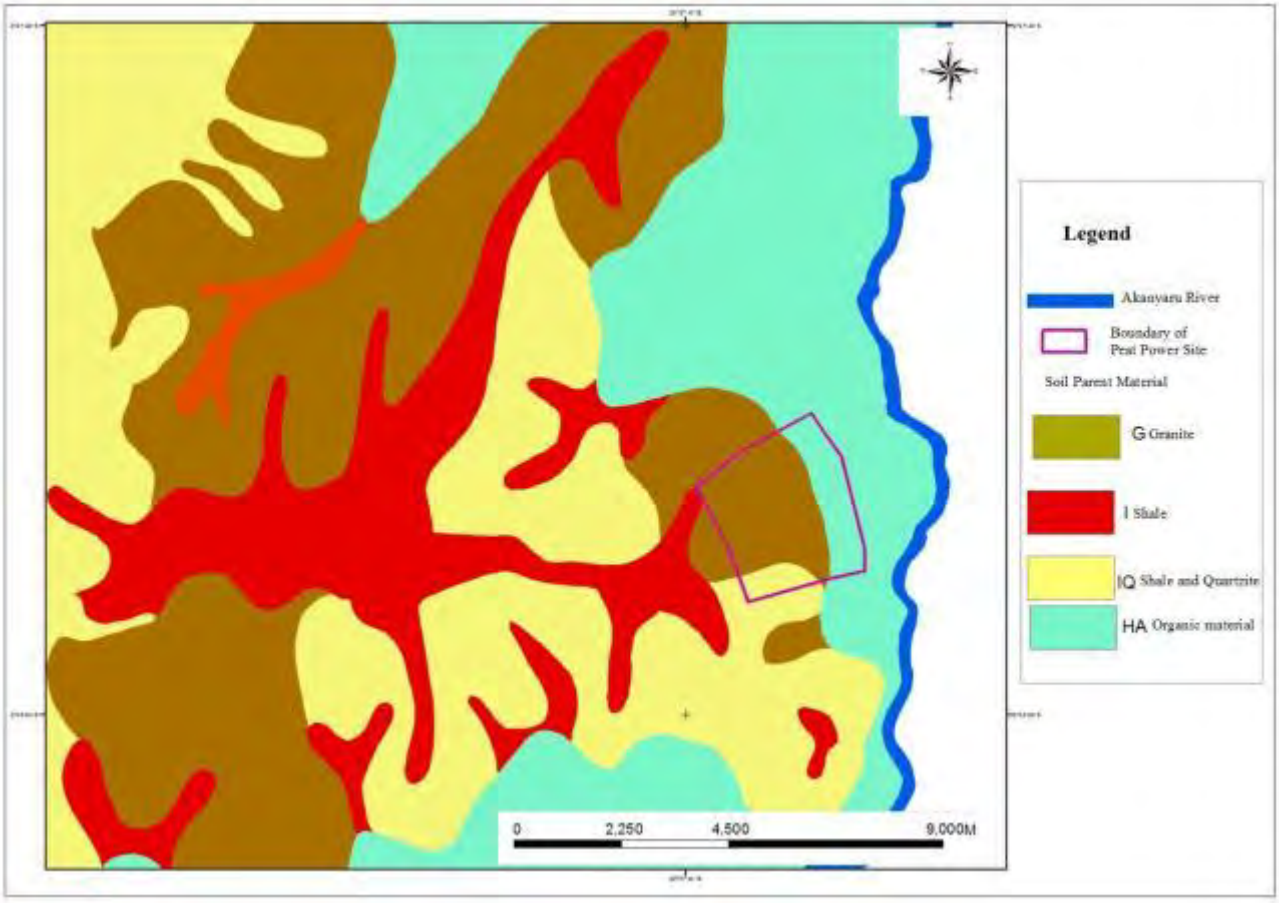
The bedrock of the drainage basin is Precambrian (Carte geologique, Burundi 1981, Carte geologique du Rwanda 1991). The lower part of the Akanyaru valley has been paludified for a distance of approximately 90 km. The area covered by the swamp complex is approximately 25 900 ha, comprising the valley of the main river and the lower parts of the tributary valleys.

The project will be implemented in an area of schists and quartzites. In this zone, alterations are well developed on the schists. These faded schists then become very soft and very rich in clay and have a very low permeability. The subjacent schists can nevertheless have a low flow in so far as they are fissured. The quartzites not fissured are impermeable. The significant tectonic movements in the area have often fractured and fissured the quartzites which become very permeable and constitute aquifers of good quality with significant flows.

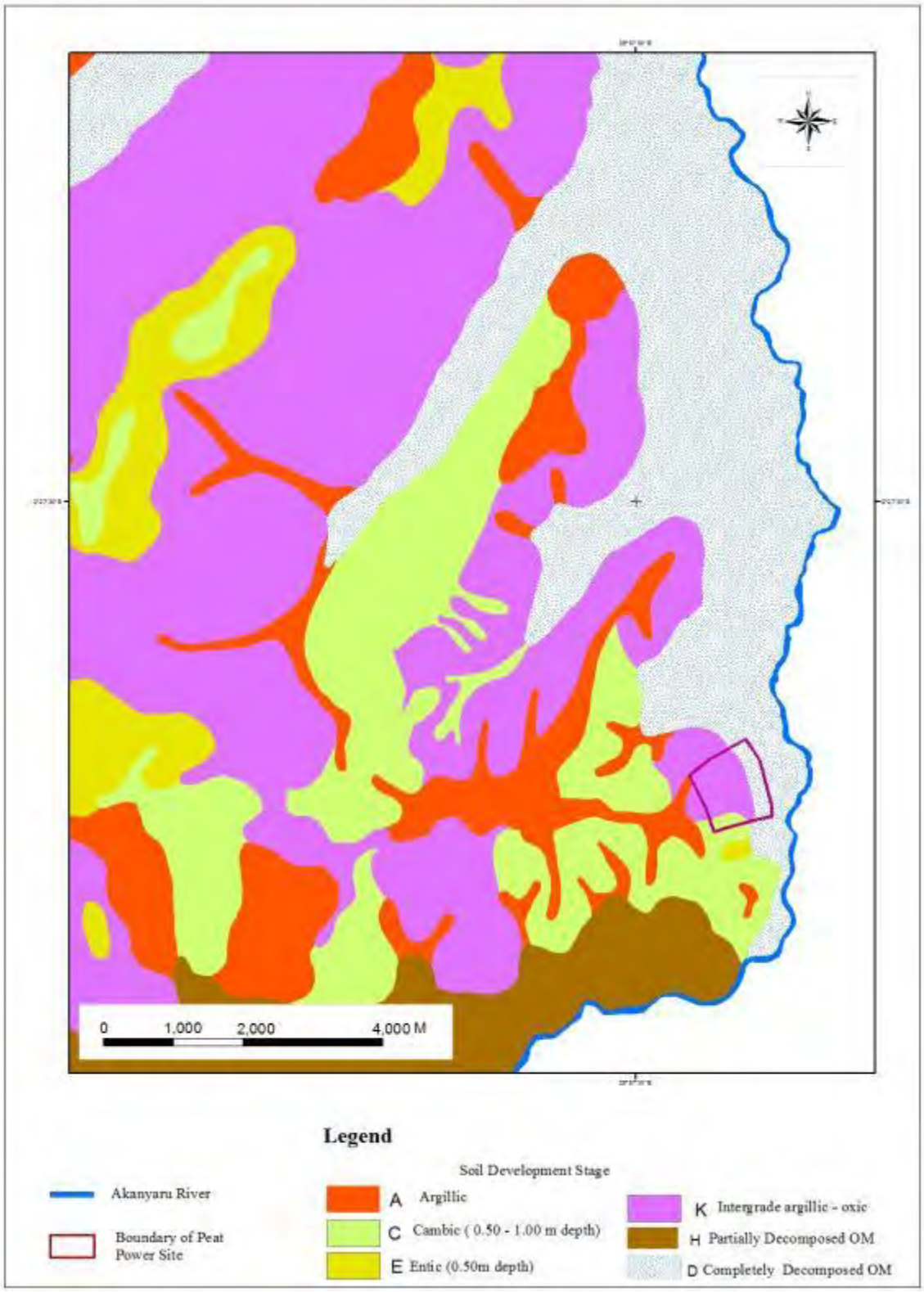
III.3.1.3. Soil

The soils-cap is strongly variable. Rock outcrops characterize the hill tops. Humus-rich, gravelly soils are found on the upper slopes, while the younger soils of the foot slopes generally have a higher productivity. The geomorphology of the area is mainly composed with rounded hills (Verdoot and van Ranst, 2003). The slope ranges from 6 to 13% in general but in the valley around Akanyaru River, it ranges from 0 to 2%.

Map-1 shows parent material of soil within the project area and *Map-2* shows the development stages of soil in project area, while *Map 3* shows the sampling points by the Study Team.



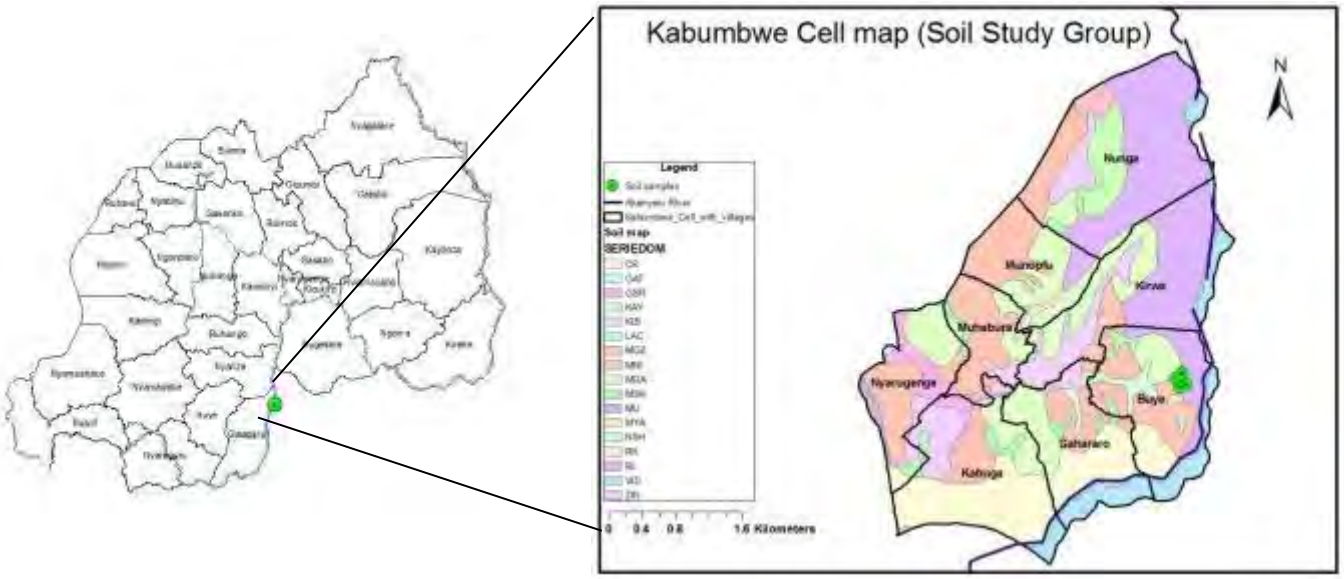
Map 1 : Soil parent material in the project zone



Map 2: Soil development stages in the project zone

Dominant soil series in Buye village, Kabumbwe cell where the power plant will be built are: Rukeli (RL) Typic Troposaprist in USDA or Fibric Histosols in the FAO system, Mugozi (MGZ) Typical Humitropept in the USDA system or Humic Dystric Cambisols in FAO, Murama (MRA) Tropeptic Umbriorthox in USDA or Umbric Ferralsols in FAO, and Masaka (MSK) Oxic Tropudalf in USDA or Chromic Luvisols in FAO.

Soils were sampled (Ap horizon: top 30cm) on the site where the power plant will be installed and taken to the soil laboratory at the National University of Rwanda for analyses. The results of the soil analysis are presented in Appendix 2-2. The soil may be classified as calcareous and relatively rich in N.



Map 3: Kabumbwe cell map with villages and soil sample points (Source: Author)

III.3.1.3.1. Soil classification

Soils in Rwanda are classified according to USDA (1975) which was nearly translated to FAO (1976). The soils were investigated by means of auger observation at grid spacing of 100 x 100m and to a depth of 1m. The soils were described and checked for the accuracy of the Rwanda soil map. Dominant soil series in the study area were identified and mapped.

III.3.1.3.2. Land capability classification

The capability of the Rwandan land to sustain different forms of agricultural land use primarily depends on the possibilities for mechanization and management strategies to reduce the risk for erosion. Consequently, depending on the slope gradient, the land units have been classified as arable land and pasture, forest and wildlife habitats. Within the gently sloping areas, soil depth determines the possibilities for terracing and the rootable depth for the cultivation of crops. Shallow land units that can't be terraced should be used as pasture land. The capability of the arable land further depends on the availability of water, oxygen and nutrients. Important parameters influencing these land qualities are water holding capacity, aeration, nutrient retention capacity, and nutrient supply capacity (Verdoot and van Ranst, 2003). These parameters have been assessed through an evaluation of soil depth and stoniness, parent material, risk for flooding, internal drainage, development stage and Base Saturation.

Capability classes 1 to 4 have been designed to classify the arable land according to its potential for the cultivation of different upland crops and according to the management techniques that are required to ensure sustainable production. The slope gradient of these units should be 25 % or less. With increasing capability class, the number of crops that can be cultivated decreases, and the level of management increases from ordinary techniques to very careful management strategies. Capability class 5 groups those land units that are located in valleys with an impeded drainage, with organic materials, or with a serious risk for flooding. These land units might be suitable for the production of lowland crops, after the application of very careful to exceptional management techniques. Capability classes 6, 7 and 8 group land units that are actually not to be used as arable land, due to the shallow soil depth and/or very steep slopes (Verdoot and van Ranst, 2003). Criteria for land capability classification are summarized in *table 7*.

Table 7: Overview of the land characteristics defining the 8 land capability classes in Rwanda (Verdoot and Van Ranst, 2003)

Parameter	Capability classes							
	1	2	3	4	5	6	7	8
Risk for soil loss								
Slope gradient (%)	0-2	0-13	0-13	0-25	-	0-25	25-55	>55
Wetness control								
Flooding	No	no	No	no	yes	-	-	-
Internal drainage	Well	well	Well to imperfect	Well to imperfect	Moderate to very poor	-	-	-
Physical properties								
Parent Material	Only V-Bv-B	All except G,Q,H	All except H	All except H	All	-	-	-
Depth of stoniness(m)	>1.00	>1.00	>0.50	>0.00	>0.00	>0.00	-	-
Depth of contact (m)	>1.00	>1.00	>0.50	>0.50	>0.50	>0.00	-	-
Chemical properties								
Development stage[b]	E-C	E-A	E-O	E-O	-	-	-	-
Base saturation	>50	>35	>20	≥0	-	-	-	-

a V: volcanic material; Bv: basalt; B: basic material; G: granite; Q: quartzite; H: organic material

b E: entic; A: argillic; O: oxic

III.3.1.3.3. Soil erodibility classes

The erodibility of a soil is an expression of its inherent resistance to particle detachment (degradation) and transport by rainfall (erosion). The K factor was estimated in the Universal Soil Loss Equation (USLE) using the Wishmeier et al. (1969) method that takes into account silt content, very fine sand content, clay content and organic matter content, as well as the structure of the surface layer and the permeability of the profile. This equation was used here to generate the erodibility classes of soils to be disturbed by the project. The soil structure was described by five classes: crumbly, sub-polyhedral, polyhedral, coherent and single corn. The humus content was estimated from the darkness of the color of a horizon. The darker the color the more organic substance contains a soil (Reetsch, 2008). The definition of erodibility classes is shown in *table 8*.

Table 8: Definition of erodibility classes

	Class	**K factor** (t*ha/MJ*mm)
1	Negligible	< 0.020
2	Low	0.020 - 0.039
3	Moderate	0.039 - 0.053
4	High	0.053 - 0.066
5	Very high	≥ 0.066

Adapted from Presant and Acton (1984)

III.3.1.3.4. Soil analyses

Soil sampling was done on the site of power plant with an Eldelman auger at 0-30 cm for soil chemical analyzes. Five cores of soil samples were taken in $1m^2$ and bulked to one composite sample. The Z method was used to get a total of 5 samples (4 near corners of a rectangle and 1 in the middle) which are shown on the map (Figure 1). Soil samples were packed and labeled and taken to the soil laboratory at the National University of Rwanda. The following soil characteristics are being measured: Electric conductivity (EC), pH, total nitrogen, total P, available P, total Ca, K, Mn, Boron, Sodium and SAR. Other elements that will be measured include Sulphates (ppm), Iron (ppm), Copper (ppb), Cadmium (ppb), total Chromium (ppb), Lead (ppb). Total N will be determined by semi-microkjeldahl digestion and distillation techniques. P will be determined by colorimetry using Bray 1 method (Bray and Kurtz, 1945). The total contents of Ca, K, Mn, Boron, Na, Fe, Cu, Cd, Cr and Pb will be analyzed using the methods described by Okalebo et al., (2002) using Atomic adsorption spectrophotometer (AAS). The pH will be analyzed in deionized water and in 1N KCl using a pH electrode (Rhoades, 1982).

Analytical results are presented in Appendix 2-2, and will be the baseline data for the environment management plan, to be complied with by the contractor/operator of the plant.

III.3.1.3.5. Results from the surveyed site

Table 9: Characteristics of soils at the plant site and in the neighbourhood of Buye village, Kabumbwe cell, Mamba sector

Soil types (FAO) and fertility status at the plant site and in the neighborhood	Land Capability classes	Soil erodibility classes	Soil properties related to wetness	Possible impacts by the proposed operation/Mitigation
Fibric Histosols: Fertile but agriculturally productive when drained, limed and fertilized	-Class 5	-Negligible	Yes	-Fertility altered/Use of top soil to fertilize other farms poor in organic matter -Drainage will cause the oxidation of sulphidic minerals, which accumulated under anaerobic conditions/Liming of the soils
Humic Dystric Cambisols: moderately fertile	-Class 2	-Moderate	No	
Umbric Ferralsols: Less fertile though having good physical properties	-Class 2	-Low	No	
Chromic Luvisols: moderately fertile	-Class 3	-Low	No	

A) Fibric Histosols

Histosols generally comprise soils formed in organic materials. The Fibric Histosols found in the investigated site are member of the family of the "Euics, isohyperthermic Typic Troposaprists" (Soil Taxonomy, 1975). This soil series consists of soils developed in organic materials mixed to alluviums; they are imperfectly drained and present a saprist development. These soils are not limited by any gravel load. The histosols were identified next to Akanyaru river; in a pedoclimatic regime called aquic isohyperthermic. Most of the histosols were called fibric because they were having, after rubbing, two-thirds or more (by volume) of the organic material consisting of recognizable plant tissue within 100 cm of the soil surface.

B) Humic Dystric Cambisols

Cambisols generally combine soils with at least an incipient subsurface soil formation. The cambisol found on the site is a member of the family of "Loamy-skeletal, mixed, Typic isothermic. Humitropepts" (Soil Taxonomy, 1975). This soil series consists of soils developed in one derivative material of formations schisto-quartzitic; they are sandy, yellow loamy-clayish-sand, well drained and present a moderate and fairly deep change as well as a cambic development. These soils are limited before 50 cm of depth, by a mixture of quartzitic materials and of rocky remnant transported based on

the saprolithe and the mother rock. They were found mainly in a pedoclimatic regime called udic isothermic. The described cambisols were termed humic since they were enriched in organic carbon contents in the fine earth fraction. It is also a dystric cambisol based on its base saturation (by 1 M NH4OAc) of less than 50 percent in the major part between 20 and 100 cm from the soil surface.

C) Umbric Ferralsols

Ferralsols generally represent the classical, deeply weathered, red or yellow soils of the humid tropics. These soils have diffuse horizon boundaries, a clay assemblage dominated by low activity clays (mainly kaolinite) and a high content of sesquioxides. The ferralsol found on the site is a member of the family of "Clayey over clayey-skeletal, mixed, isothermic, Tropeptic Umbriorthox" (Soil Taxonomy). This series consists of soils developed in one derivative material of acidic rocks (granite); they are clayey, red, well drained and present an advanced and deep change as well as a development of clay-intergrade-oxic; these soils are limited between 50 and 100 cm of depth, by a mixture of granitic arena and quartzitic materials. The Umbric Ferralsols were mainly identified in a regime of pedoclimatic udic isothermic. This ferralsols is termed umbric since it has an umbric horizon (from Latin *umbra*, shade) which is a thick, dark-coloured, base-depleted surface horizon rich in organic matter.

D) Chromic Luvisols

Luvisols are generally soils that have a higher clay content in the subsoil than in the topsoil as a result of pedogenetic processes (especially clay migration) leading to an argic subsoil horizon. They have high-activity clays throughout the argic horizon and a high base saturation at certain depths. The Luvisol found on the site is a member of the family of "Fine, kaolinitic, Oxic isohyperthermic, Tropudalfs" (Soil Taxonomy). These soils are developed in a material drifted of schistose formations; they are heavy clayey, red, well drained, and deep as well as an argilic development. These soils are not limited by any gravel load. They were mainly found in a regime called pedoclimatic udic isohyperthermic. The Luvisol found on the site was termed chromic given that it had within 150 cm of the soil surface a subsurface layer, 30 cm or thicker, that had a Munsell hue redder than 7.5 YR.

III.3.1.4. Climate

The project zone has a tropical climate with almost uniformly high temperatures and humidity, and moderate rainfall. Seasonal variations in temperature are slight. Although the temperature never gets dangerously high, the combination of heat and humidity can at times seem oppressive. The annual average temperature in the area of Akanyaru swamp complex is about 20-21°C.

The meteorological data collected in the years 1983 and 1984 show an average temperature of 21 °C. The daily temperature varied on an average 20°C, the average maximum being 32°C and the minimum 12°C. The daily variation is at its greatest during the dry season, when the minimum temperatures generally drop below 10°C.

Figure 2 shows the minimum, maximum and average temperatures of Cyili, the nearby rice marshland from 1984 to 1989

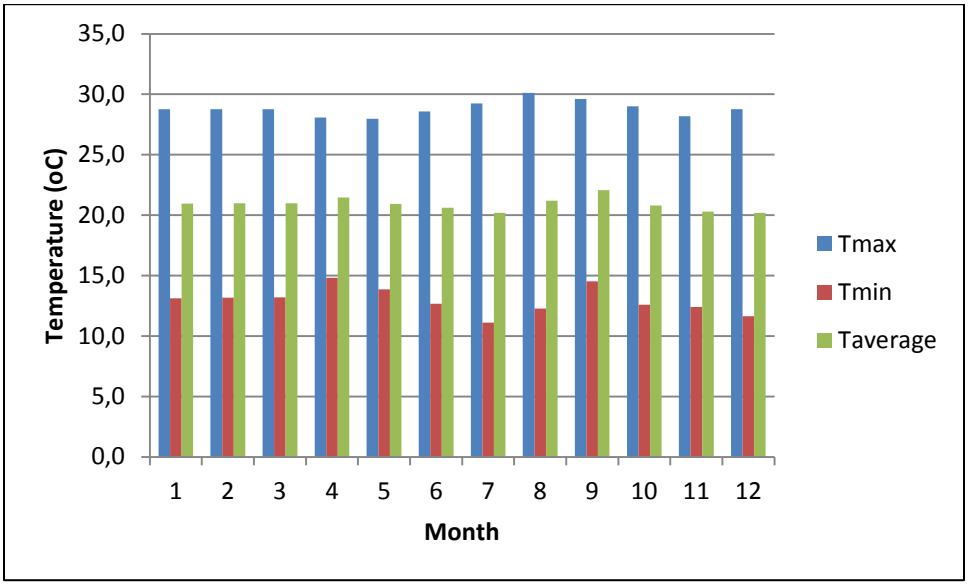


Figure 2: Minimum , maximum and average temperatures of Cyili from 1984 to 1989

III.3.1.5. Rainfall

The precipitation amount varies according to the different parts of the area, being approximately 1200 mm a-I in the southern part and 800 mm a-I in the northern part (Atlas du Burundi 1979, Atlas du Rwanda 1981). The precipitation amount and its variations in the drainage basin control the hydrology of the rivers. Along with the local climatic conditions it thus has a marked effect on the development of the river valley swamps. The drainage basin of Akanyaru extends in the west to the drainage divide between the Nile and the Zaire. Towards the west the precipitation amount increases while the dry season becomes shorter.

The precipitation amounts on the swamp correspond to the average values of the area, although the annual variations may be significant. During the years examined, it rained 1370 to 1030 mm. In 1983 the precipitation amount was only a little greater than the evaporation from open water (1340 mm).

The evapotranspiration of natural mires is due to shading smaller than the evaporation from open water (e.g. Gaudet, 1979). The difference between precipitation amount and evaporation reflects mainly the amount of water available for the vegetation of mineral soils. The vegetation of limnogenic river valley swamps, on the other hand, is dependent on the water flowing from the drainage basin.

The annual precipitation amount is divided into two rainy seasons and two dry seasons.

- Long rainy –from mid-March to mid-June. This period receive about 40-60% of the total annual precipitation;
- Long dry- from mid-June to mid-September;
- Short rainy-from September to late December; and
- Short dry from late December to mid-March

The graph in *Figure 3* shows the monthly average precipitation at Gakoma from 1971 to 1990

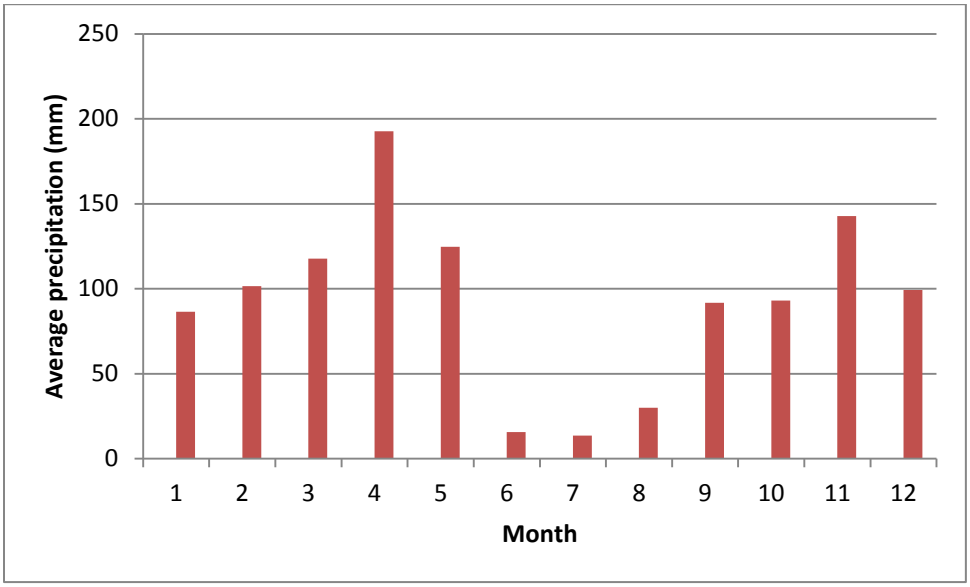
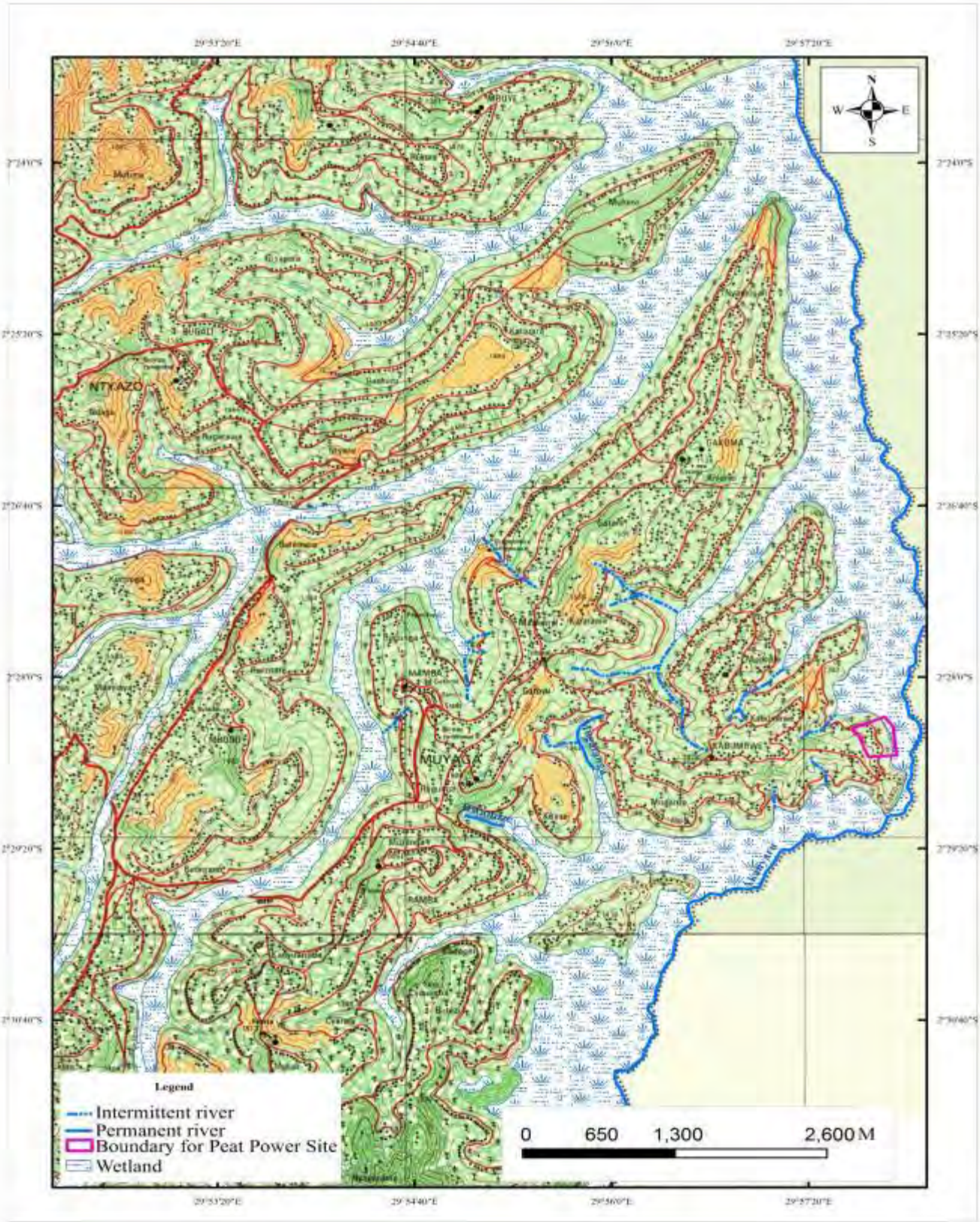


Figure 3: Monthly average precipitation at Gakoma (1971-1990)

III.3.1.6. Hydrology and Water Resources

The project zone is characterized by a drained landscape. It is bordered by Akanyaru valley, and Rwamisenga, Mugatanga and Kinamba rivers that are tributary of Akanyaru River. There are other small and intermittent rivers that drain the zone during the rainy season and which are also the tributary of Akanyaru.

The main hydrographic features of the project zone are presented on *Map 4*.



Map 4: Hydrographic features of the project zone on the topographic map

The main river is Akanyaru which is one of the upper tributaries of Kagera. It begins at the main drainage divide between the Nile and the Congo at 2500 m a.s.l., and joins Nyabarongo at 1350 m a.s.l. and its average discharge is 21 $m^3 s^{-1}$, based on measurements from a monitoring weir between 1957 and 1985.The discharge follows the seasonality of precipitation and is highest in April (29 $m^3 s^{-1}$) and lowest in August (16 $m^3 s^{-1}$).

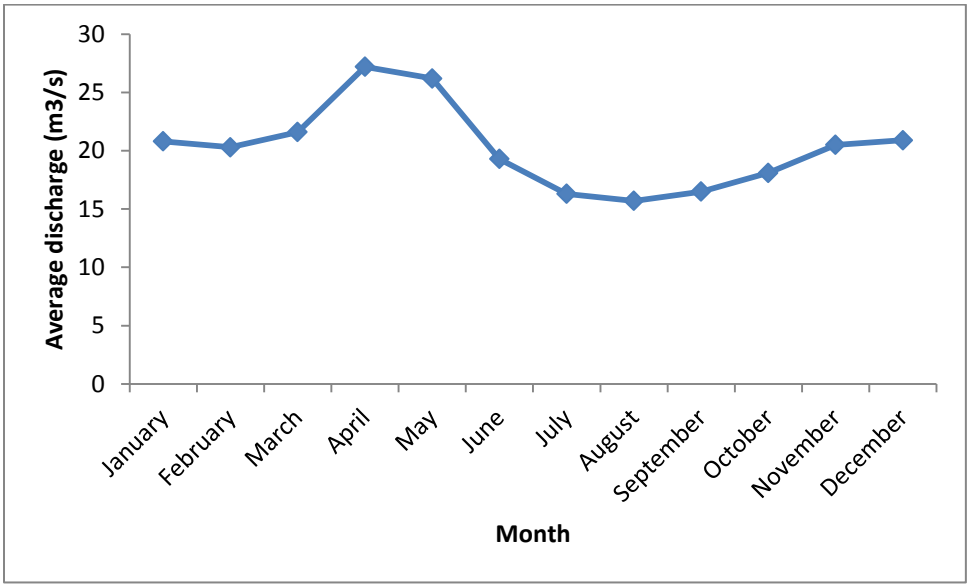


Figure 4: Akanyaru average monthly discharge (1957-1985)

Akanyaru surface water quality

The quality of surface water of Akanyaru river has been assessed during by analysing the following water quality parameters:

- Temperature
- Conductivity,
- Calcium,
- Turbidity,
- COD
- Dissolved Oxygen
- pH,
- Chloride,
- Fluoride,
- Ammonia Nitrogen
- Nitrate NO^-_3
- Nitrite NO^-_2,
- Potassium,
- Sodium,
- Sulfate as SO_4^{2-},

- cyanide
- copper
- Iron,
- Lead,
- Cadmium,
- Chromium,

Two samples have been taken twice upstream and downstream of the proposed location of the peat fired power plant. Water samples have been analysed at the National University of Rwanda (NUR), Faculty of science, in Kigali water laboratory and by ASL laboratory in Sweden. Analytical results are detailed in *Appendix-2-1* of this report. The most characteristic feature of the water quality is the high turbidity and colour, due to the high content of suspended solids from erosion of the upstream catchment areas.

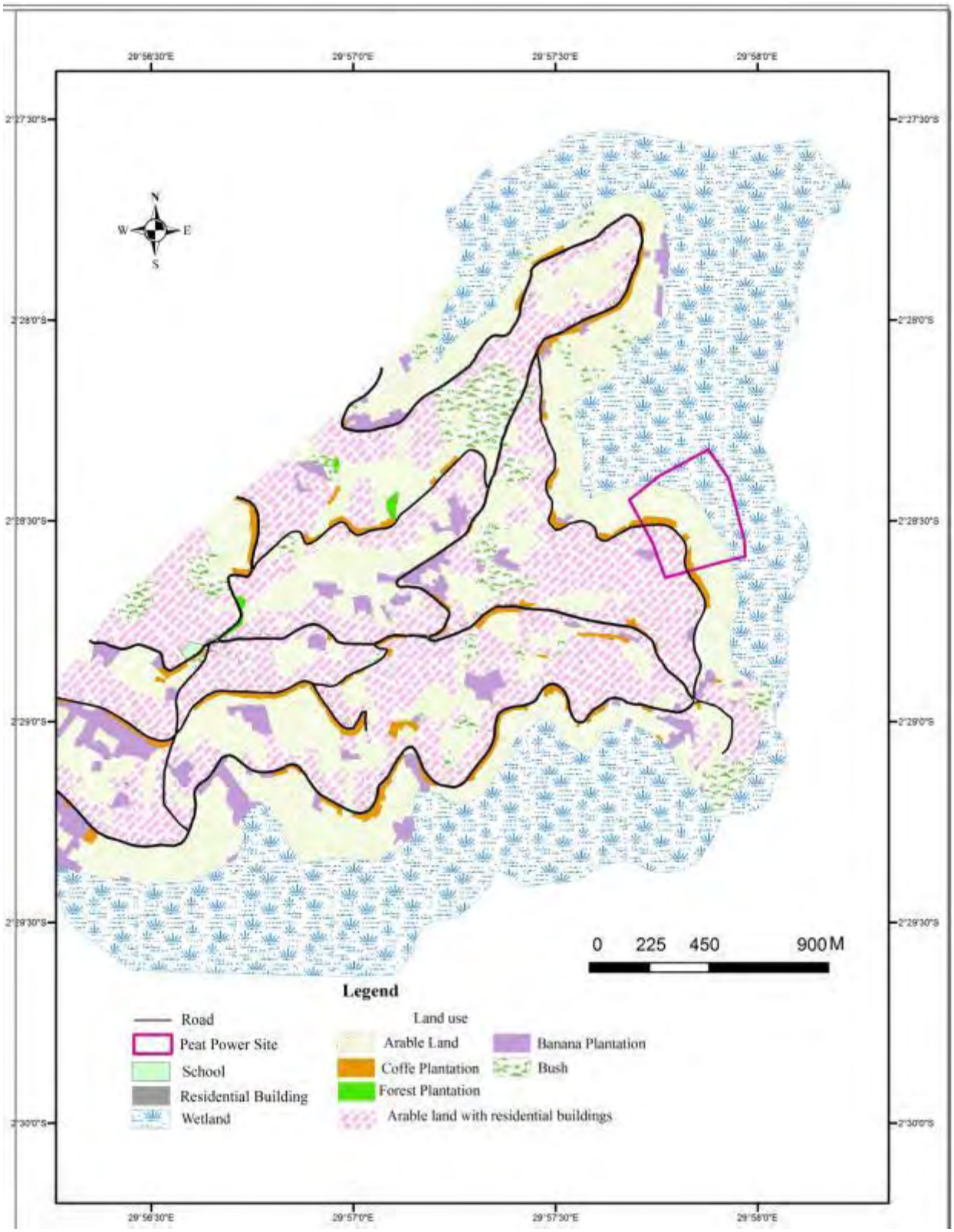
III.3.1.7. Land Uses

The Land Use map was generated based on aerial photographs representing the ecosystems of Mamba zone, in Gisagara District. The map was produced through digitization. The identification of land use units was based on the land cover map of Rwanda and field observations through which the land cover of the zone was analyzed.

Table 10: Classification of land use units around the peat fired power plant site

Land Use Class	Description	Area in hectares
Forest Plantation	Land covered by the trees like Eucalyptus, bush or shrubs and any other trees.	1.3
Bush	Land covered by bush or shrubs and any other small trees.	40.83
Arable land	Land used for agriculture purpose with seasonal crops (beans, sweet potatoes, maize, cassava,) and perennial crops like bananas. Banana plantation cover an area of 44,5 hectares	283.23
Arable land with residential buildings	Land used for agriculture purpose with seasonal crops, and perennial crops, with remarkable residential buildings that are scattered within the land	327.74
Coffee plantation	Land covered by coffees	22.7

The above table shows different types of land use units identified at Mamba, where the peat power plant will be developed. In general, the dominant land use in that zone is agriculture and the common plantations include seasonal crops like beans, maize, and sweet potatoes as illustrated on *Map 5.* Other crops are banana plantations, and coffees. Within the arable lands which are used for agricultural purposes are developed residential buildings that provide shelters for the inhabitants of the zones. Within the proposed site for the peat power plant land use is basically agriculture with seasonal and perennial crops (coffee).



Map 5: Land use of the project zone

III.3.2. Biological Environment

III.3.2.1. Flora

III.3.2.1.1. Introduction

In order to provide information on the potential impact of Akanyaru Peat Fired Power Plant project on the plant life in Akanyaru wetland, a survey of flora was undertaken. Inventory of plant species and their distribution in the project area were surveyed in March and April 2013. According to the classification of swamps in Rwanda by REMA (2008), the concession area belongs to Kanyaru-Nyabarongo and Akagera basins category where the characteristic vegetation was reported to be dominated by *Cyperus papyrus, Phoenix reclinata and Syzigium cordatum*. Due to human pressure in a significant part of Akanyaru wetland these natural plant species are progressively replaced by annual herbs or crops depending on the season. The concession riverine area is mainly cultivated and some relics of natural vegetation indicate that a savannah may have existed in the area in the past (ER1).

The flora survey was carried out in a part of Akanyaru basin between 1350-1420m of height. According to the Official Gazette n° 44 of 01/11/2010, this zone is located in the swamp n°25 (Akanyaru Nord) proposed as RAMSAR swamp. Its status implicates that it can be used only under specific conditions that is to say, it should be exploited upon completion of environmental impact assessment. No detailed flora inventory study in the peat concession has earlier been conducted in the Project area.

III.3.2.1.2. Scope of Work

The flora study aimed at determining the composition and structure of the vegetation and, to evaluate the potential threats of the project on the natural vegetation of the area. The main objectives were:

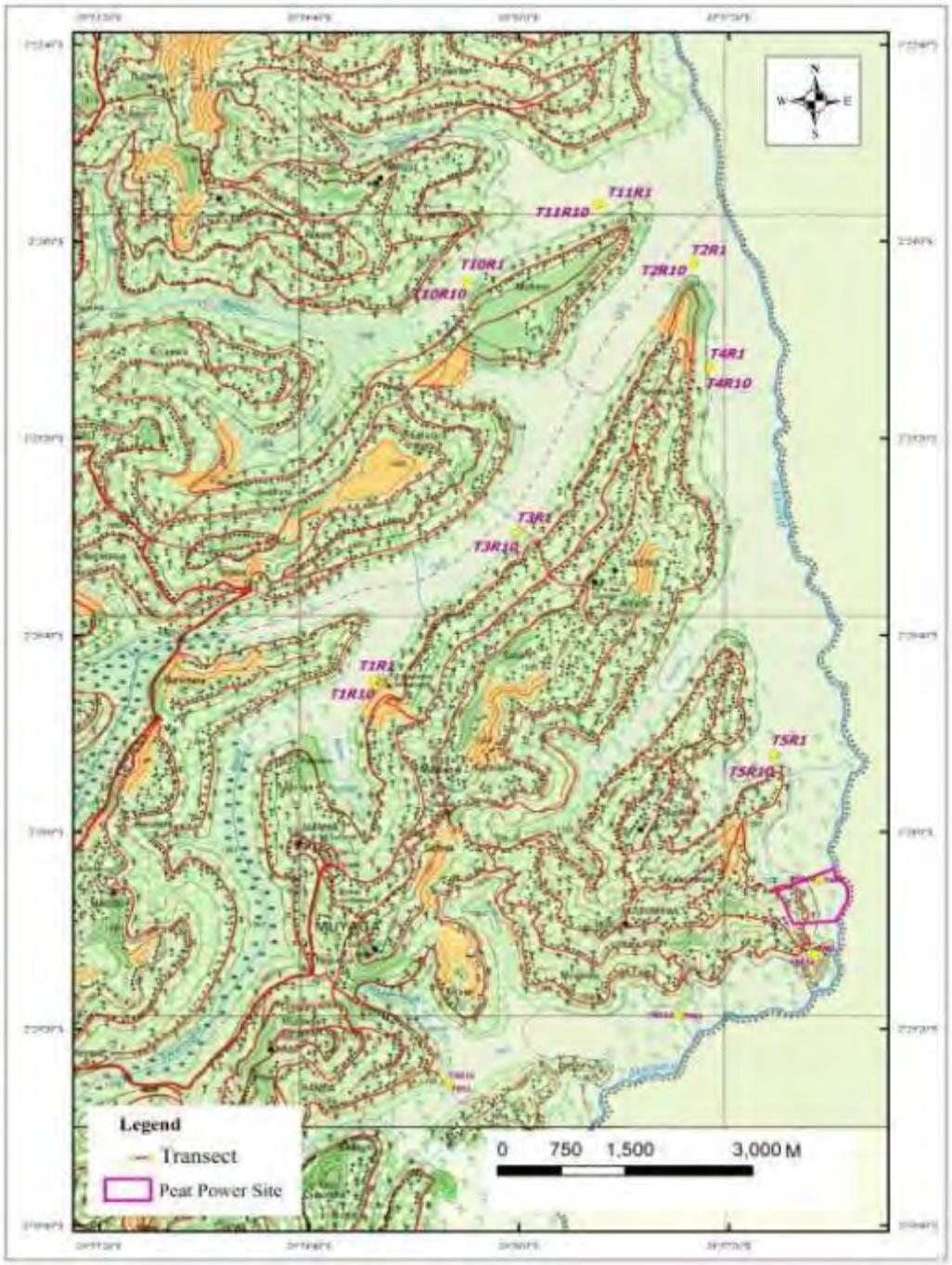
- To describe the regional vegetation;
- To identify dominant plant species;
- To identify endangered or rare species, intruder or exotic species;
- To illustrate the location and document the area of the various vegetation types that will be disturbed by the project.

III.3.2.1.3. Methodology

To determine the plant species to be found in Akanyaru peat concession and its vicinity a phyto-sociological study was conducted by using the transect method. Out of the 11 sites investigated (Karama, Ruhuha1, Ruhuha 2, Kivomo, Kirwa, Buye 1, Buye 2, Murambi, Gahararo, Muyenzi 1 and Muyenzi 2) 10 were located in the wetland and one was out of the concession (on the top of Buye hill) where the project plant was planned to be installed. For each site surveyed one transect, 50 m long was considered for inventory of plant species with 10 plots per transect (each plot covering 4m²), see *Map 6.* The abundance of each species in each plot was estimated according to the Braun-Blanquet cover-abundance scale (Troupin, 1966). Plant species diversity in the area was determined as the total number of species encountered during the survey. The flora list was prepared based on the reference mostly used for plant identification in Rwanda (Troupin, 1983; 1985; 1987; 1988). In order to analyse plant communities, the phyto-sociological parameters including presence, frequency, relative

frequency, relative dominance, frequency-dominance and performance index were calculated (Troupin, 1966) in each transect at every site. Plant species with higher performance indices in a given site were therefore considered as characteristic for that site.

To recognize the status of plant species the IUCN red list (ER2) and the list of protected plant species established by the Ministerial order N°007/2008 of 15/08/2008 were used. Photographs were taken with a digital camera (PANASONIC DCM –TZ30).



Map 6: Transects localisation

III.3.2.1.4. Results and discussion

Vegetation diversity in the area was determined as the total number of species encountered in the wetland and at Buye hill during the survey. In the eleven sites investigated 61 species were encountered in all the sampled plots and the corresponding flora list with respective performance indices is given in *Table 11*.

The distribution of plant species in the wetland is variable among sites. However, distinction can be made between wetland vegetation and the vegetation out of the wetland. In the wetland there was variation of plant distribution mostly due to disturbance by human activities. The species *Typha capensis* and *Cyperus spp.* including *Cyperus papyrus, Cyperus latifolius* and *Cyperus dives* were preferentially found in less disturbed sites. In disturbed sites the vegetation was dominated by annual herbs and grasses, see *Plate1 and 2*.

Plate 1: *Cyperus papyrus* and *Cyperus dives* in less disturbed wetland zone (Muyenzi site)

Plate 2: Common bean and soy bean crops in Murambi site

Table 11: List of plant species and their performance indices (%) in different transects

N°	Species name	Family	Local name	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Protection status	
															Rwanda*	IUCN*
1	*Asystasia gangetica*	Acanthaceae	IJOJWE							**65,0**						
2	*Thunbergia alata*	Acanthaceae	NKULIMWONGA							4,5						
3	*Aloe dawei*	Aloeaceae	IGIKAKARUBAMBA							19,0						
4	*Achyranthes aspera*	Amaranthaceae	UMUHURURA									2,1				
5	*Centella asiatica*	Apiaceae	GUTWIKUMWE								14,2					
6	*Colocasia esculenta*	Araceae	ITEKE								1,9					
7	*Asparagus flagellaris*	Asparagaceae	UMUSHABISHABI							4,6						
8	*Ageratum conyzoides*	Asteraceae	INKURUBA		8,9		9,2					18,9				
9	*Aspilia africana*	Asteraceae	ICYUMYA		17,2	4,2										
10	*Bidens pilosa*	Asteraceae	INYABARASANYA		16,5		17,3				2,3	1,7				
11	*Crassocephalum bumbense*	Asteraceae	IGIFURANINDI		10,9						8,5	8,4				
12	*Erigeron floribundus*	Asteraceae	BAMBUWA							4,5		4,2				
13	*Galinsoga parviflora*	Asteraceae	KIMARI				4,0									
14	*Guizotia scabra*	Asteraceae	ISHIKASHIKE								21,0					
15	*Gynura scandens*	Asteraceae	IKIZIMYAMURIRO			19,7					5,8	10,1	5,1	5,6		
16	*Helichrysum schimperi*	Asteraceae	MANAYEZE		2,0							3,5				
17	*Lactuca inermis*	Asteraceae	RURIRA							2,0						
18	*Tagetes minuta*	Asteraceae	MUNUKANABI							3,8		18,1				
19	*Vernonia amygdalina*	Asteraceae	UMUBIRIZI							8,9		1,8				
20	*Vernonia sp.*	Asteraceae			27,7		18,1				4,8					
21	*Commelina benghalensis*	Commelinaceae	INTEJA	18,8	8,5		**30,6**			1,9	13,3	2,1				
22	*Ipomoea batatas*	Convolvulaceae	UMUGOZI W'IBIJUMBA		10,5											
23	*Ipomoea cairica*	Convolvulaceae	UMUZENGA				1,9									
24	*Ipomoea rubens*	Convolvulaceae	UMURANDAGASHI				2,2									
25	*Cyperus distans*	Cyperaceae	URUKUTA					**40,4**	**88,5**							
26	*Cyperus dives*	Cyperaceae	URUGAGA	27,2			2,2						11,3	18,7		
27	*Cyperus latifolius*	Cyperaceae	URUKANGAGA	3,3		**34,9**							4,6			
28	*Cyperus papyrus*	Cyperaceae	URUFUNZO	3,3		17,8							25,9			

N°	Species name	Family	Local name	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Protection status	
															Rwanda*	IUCN*
29	*Mariscus luteus*	Cyperaceae	INTARATARE				2,2									
30	*Pycreus flavescens*	Cyperaceae	INTARATARE		2,0		8,5					2,1				
31	*Euphorbia grantii*	Euphorbiaceae	AMADWEDWE				2,2					5,2				
32	*Phyllanthus sp.*	Euphorbiaceae	URUHEZA													
33	*Acacia polyacantha*	Fabaceae	UMUGU							4,6						
34	*Ocimum urticifolium*	Lamiaceae	UMWENYA							5,1						
35	*Hibiscus aponeurus*	Malvaceae	UMUTOZO							12,0						
36	*Triumfetta cordifolia*	Malvaceae	UMUSHYIGURA		2,3					3,8		33,6				
37	*Eucalyptus globulus*	Myrtaceae	INTURUSU							14,6						
38	*Nymphaea caerulea*	Nymphaeaceae	AMAREBE								12,2		5,1	5,6		
41	*Ludwigia abyssinica*	Onagraceae	UMUZIGANGORE	5,0	6,6	**29,4**					7,2		15,1	8,1		
42	*Brachiaria decumbens*	Poaceae	IVUBWE	14,4	**34,5**	**32,3**	**47,3**	**83,1**	**87,1**	2,6	**58,6**	**56,3**	22,5	**54,7**		
43	*Cynodon dactylon*	Poaceae	UMUCACA							6,3						
44	*Cynodon nlemfuensis*	Poaceae	UMUCACA			8,4					2,3					
45	*Digitaria abyssinica*	Poaceae	URWIRI		11,7	2,4				15,7						
46	*Digitaria sp.*	Poaceae	URWIRI		4,3					1,9	4,8					
47	*Eulesine indica*	Poaceae	URUMAMPFU									3,8				
48	*Leersia hexandra*	Poaceae	URUKEMBA	11,6	2,3	14,2	6,4	20,1	4,2		7,2	3,8	2,6	**36,9**		
49	*Melinis minutiflora*	Poaceae	URUVUTERI									1,8				
50	*Panicum maximum*	Poaceae	UMUTSINA							6,3						
51	*Vetiveria nigritana*	Poaceae	VETIVERI							2,6						
52	*Polygonum pulchrum*	Polygonaceae	IGOROGONZO		21,8		**44,1**	22,1	11,9		**34,8**	22,6	14,2	23,6		
53	*Polygonum sp.*	Polygonaceae	IGOROGONZO	25,5		15,5	17,1	**34,3**	8,4		2,8			2,3		
54	*Pauridiantha dewevrei*	Rubiaceae	UMUSIBYA							4,5						
55	*Solanum incanum*	Solanaceae	UMUCUCU							4,5						
56	*Solanum tuberosum*	Solanaceae	IKIRAYI		2,0											
57	*Sida cordifolia*	Tiliaceae	UMUCUNDURA							2,6						
58	*Typha capensis*	Typhaceae	UMUBERANYA	1,7		12,7							**93,5**	**44,6**		
59	*Clerodendrum johnstonii*	Verbenaceae	UMUKONDOGORO							2,7						
60	*Clerodendrum myricoides*	Verbenaceae	UMUKUZANYANA							1,9						
61	*Lantana camara*	Verbenaceae	UMUHENGERI							26,8						

T1: Karama ; **T2**: Ruhuha 1 ; **T3**: Ruhuha 2 ; **T4** : Kivomo ; **T5** : Kirwa ; **T6** : Buye 1 ; **T7** : Buye 2 ; **T8** : Murambi ; **T9** : Gahararo ; **T10** : Muyenzi 1; **T11** : Muyenzi 2.

Protection status

Rwanda*: Ministerial order N°007/2008 of 15/08/2008 species

IUCN**: International Union for Conservation of Nature

The dominant species in these zones are *Polygonum spp., Brachiaria decumbens, Leersia hexandra, Ludwigia abyssinica* and *Commelina benghalensis.* No tree species was found in the investigated area.

Our interview with people living in the vicinity of the wetland showed that some of these plant species have significant economic importance for their daily life as they are used to manufacture items that are sold or used locally and to feed the cattle. These species are for instance:

- *Brachiaria decumbens* and *Leersia hexandra* which are used as feed;
- *Cyperus papyrus* used for handcrafting, to make roof, rope etc.
- *Cyperus dives, Cyperus latifolius, Typha capensis and Mariscus luteus* for handcrafting.

Though the survey study was not done in the agricultural season our observation and information from the local population indicate that several species are grown in that area and the production yield is higher than when grown out of the wetland area. The main crops grown the wetland are maize, sorghum, common bean, soy bean, Irish potato, sweet potato, taro and various vegetables.

The vegetation found out of the wetland zone (Buye 2 site with 26 plant species) comprises more plant species than the wetland area probably because it is not under flood disturbance but also it is more influenced by human activities.

III.3.2.1.5. Conclusion

The number of plant species found in the surveyed peat concession is relatively high considering the regular disturbances related to flooding and/or agricultural activities. Among the species recorded in the surveyed area none is classified under particular status to require specific protection. According to IUCN Red list (http://www.iucnredlist.org) and the list of protected plant species established by the Ministerial order N°007/2008 of 15/08/2008, there are no endangered plant species that were observed in the studied area (see *Table 11*). Therefore, exploitation of peat in the concession should have no adverse effects on endangered flora of Rwanda.

III.3.2.2. Fauna

III.3.2.2.1. Introduction

The baseline of the fauna survey of the part of Akanyaru floodplain where the peat will be extracted was conducted between 23rd March and 6th April 2013. In total 7 sites of the floodplain named after the riverine villages were surveyed. Six villages namely Karama, Ruhuha, Kivomo, Kirwa, Murambi, and Gahararo are within Mamba sector in Gisagara District while one village Muyenzi Nyakabingo is within Ntyazo sector in Nyanza District. The work was done qualitatively and dealt with the animals living or spotted

both in the riparian area and in the floodplains. The survey focused on fish, birds, mammals, reptiles, amphibians and invertebrates.

III.3.2.2.2. Scope of the work

The focus of the fauna study was to gather information about the current status of the wildlife in Akanyaru floodplains where peat production and a peat fired power plant (PFPP) will be constructed in Gisagara and Nyanza Districts in the Southern province.

Following items were carefully monitored during the field visits to the concerned concessions:

- ***An inventory of wildlife resources in the development area:*** This inventory collected information on the qualitative characterization of animal community i.e. species composition (presence or absence) and identification of the most abundant species. The latter was done by appreciating the probability of encountering species in each point of the floodplain bordered by a selected village and in all parts of the floodplain riparian to the seven selected villages.

- ***Rare or endangered species:*** Identified species were scrutinized in order to see if any of them was indicated on the IUCN red list or if it was protected by environmental regulations in Rwanda.

- ***Migration route and staging areas:*** Under this item, the consultant gathered information on whether the concessions were on the route of animal migration.

- ***Habitat evaluation, distribution, and utilization; critical habitat:*** Under this section, the status of the floodplain as a habitat for wild animal was studied. In addition threats that may lead to their fragmentation, destruction or disturbance were identified. This led to the identification of the type, location, quantity and capability of habitat that will be disturbed or lost as a result of the project.

- ***Sensitivity to disturbance***: The evaluation of the threats was accompanied by the identification of animal species that will be disturbed by the destruction or impairment of the floodplain.

- ***Regional and local significance of populations:*** This section dealt with the ecological services and functions of animal species colonizing the project zone.

III.3.2.2.3. Methodology

During this survey animals living in or in areas adjacent to the Akanyaru floodplains were surveyed. The fauna inventory dealt mainly with birds, mammals, reptiles, amphibians, fish and invertebrates. A qualitative and environmental friendly approach was used. Animals was caught if necessary, photographed and released afterwards. Data about animals was collected as follows:

Birds

A direct observation of birds foraging, flying in or near the floodplain was done. In addition elder local people were interviewed to name the birds they are used to see in the floodplains. Their scientific names were directly identified in the field or later in the office by consulting books and internet.

Mammals

As the number of mammals has declined in the area or due to the fact that they hide during the day time, names of mammals found in the area were obtained from the interviews that were held between the consultant and the elderly people of the area.

Reptiles

The area surrounding the floodplain is characterised by hot temperatures and is a good habitat for snakes. The inventory of snakes was done through the interview between the consultant and the elderly people. In addition moving snakes, especially in the afternoons were spotted and identified.

Fish

As part of the population living near the Akanyaru River earn their living through fishing, local names of the fish were got from them. A thorough inspection of their catch helped the consultant to distinguish different fish species inhabiting the Akanyaru River which also use its floodplains for spawning or foraging during the rainy season.

Amphibians

Amphibians were caught using an insect net by passing it through water filled canals that are scattered in the floodplain. They were photographed with a digital camera (Panasonic LumixDMC-TZ30), released back in the canals and were afterwards identified during analysis.

Invertebrates

Flying invertebrates were identified through direct observation. Aquatic ones were caught using an insect net that was passed in shallow water filled canals found either at the edge of the floodplain or in the floodplain where the water levels allowed easy

access. An interview about the baits used to trap fish also helped to identify the invertebrates of the place.

III.3.2.2.4. Results

Habitat assessment

Akanyaru River and its associated floodplains provide a human impacted habitat for animals. Akanyaru River as an aquatic habitat with high sediment loads harbour animals that are able to use atmospheric oxygen during respiration

Figure 1. Habitat state in PFPP project area.

Plate 3: Assessed aquatic habitat

The floodplains may be divided into two parts: a part reclaimed for crop production used mainly during the dry season but inaccessible during the rainy season and an area where natural wetland plant recolonized the area following inadequacy of the drainage system to counteract floods (Plates 4A, 4B and 4C). This type of vegetation is a suitable habitat for birds, aquatic and semi-aquatic mammals, reptiles and amphibians.

Plate 4: Natural revegetation recovery (A,B) and Crop production (C) in Akanyaru floodplains

Animal inventory

In total 70 species were identified in the project area, four species of fish, 30 species of birds, 9 species of mammals, 7 species of reptiles, three species of amphibians and 17

species of invertebrates (see *Table 12*). The birds showed the highest number of species followed by invertebrates while amphibians showed the lowest number of species.

Table 12: Identified animal species in the PFPP project area.

Species	English name	Vernacular name	Observation
Fish			
Clarias gariepinus	Cat fish	Kamongo (Inshonzi)	Abundant
Protopterus aethiopicus	African lungfish	Imamba	Abundant
Gnathonemus longibarbis	Longnose stonebasher		Abundant
Marcusenius graham		Nzeli	Abundant
Birds			
Milvus aegyptius	Yellow-billed Kite	Sakabaka	Rare
Falco tinnunculus	Common Kestrel	Agaca	Rare
Nettapus auritus	African Pygmy-goose	Igishuhe	Present
Scopus umbretta	Hamerkop	Sarumfuni	Present
Numida meleagris	Helmeted Guineafowl	Inkanga	Present
Bostrychia hagedash	Hadada Ibis	Nyirabarazana	Present
Ardea cinerea	Grey Heron	Uruyongoyongo	Present
Gallinula angulate	Lesser Moorhen	Inkoko yo mu mazi	Abundant
Ploceus baglafecht	Baglafecht weaver	Isandi	Abundant
Euplectes axillaris	Fan-tailed Widowbird	Ikijenjegeri	Present
Vidoua macroura	Pin-tailed whydah	Matene	Rare
Motacilla aguimp	African Pied Wagtail	Inyamanza	Rare
Pycnonotus barbatus	Common Bulbul	Isoryo	Rare
Colius striatus	Speckled mousebird	Umusure	Rare
Balearica regulorum	Grey Crowned Crane	Umusambi	Rare
Spermestes cucullatus	Bronze mannikin	Uduhuri	Abundant
Lagonostricta senegala	Red-billed Firefinch	Ifundi	Abundant
Streptopelia capicola	Ring-necked Dove	Inuma	Abundant
Egretta ardesiaca	Black Egret	Makoti	Rare
Pternistes afer	Red-necked Spurfowl	Inkware	Abundant
Cisticola ayresii	Wing-snapping Cisticola	Gungeri	Abundant
Turdoides jardineii	Arrow-marked Babbler	Ikijwangajwanga	Abundant
Psalidoprocne holomelas	Black-Saw-wing	Intashya	Present
Lanius collaris	Common fiscal	Ikibiribiri	Present
Ceryle rudis	Pied Kingfisher	Murobyi	Abundant
Dicrurus adsimilis	Fork-tailed Drongo	Umunoga	Abundant
Nectarinia purpureiventris	Purple-breasted Sunbird	Umununi	Abundant
Psalidoprocne holomelas	Black-Saw-wing	Intashya	Present
Bubulcus ibis	Cattle Egret	Inyange	Abundant

Species	English name	Vernacular name	Observation
Anastomus lamelligerus	African Open-billed Stork	Nyiramujongi (ikiragi)	Abundant
Mammals			
Hippopotamus amphibus	Hippopotamus	Imvubu	Rare
Canis adustus	Side-Striped Jackal	Nyiramuhari	Present
Lemniscomys barbarous	Striped Grass Mouse	Urumende	Abundant
Hydrictis tenuis	Otter	Inzibyi	Present
Leptailurus serval	Tiger bush cat	Imondo	Rare
Aonyx congica	African otter	Igihura	Present
Cephalophus natalensis	Natal duiker	Inzobe	Present
Felis aurata	Zool mongoose	Umukara (umutereri)	Abundant
Genetta servalina	Servaline genet	Urutoni	Rare
Reptiles			
Boulengerina annulata (Naja annulata)	Banded water cobra	Idubi	Present
Dendroaspis polylepis	Black Mamba	Insana	Present
Bitis arietans	Viper	Impiri	Present
Naja melonoleuca	Forest Cobra	Inshira kirezi	Present
Psammorphis philipsii	Olive grass snake	Imbarabara	Present
Philothamnus nitidus	Green bush snake	Insharwatsi	Abundant
Pelusios subniger	Black mud turtle	Akanyamasyo	Rare
Amphibians			
Ptychadena mascareniensis	Mascarene Rigded Frog	Umutubu	Abundant
Phrynobatrachus natalensis	Dwarf puddle frog	Intaruka	Abundant
Bufo regularis	Toad	Igikeri	Abundant
	Tadpoles	Umuhini	Abundant
Invertebrates			
Phalanta phalantha	Common Leopard Butterfly	Ikinyugunyugu	Abundant
Crocothermis sanguinolenta	Small scarlet	Kajugujugu	Abundant
Trithemis furva	Dark dropwing	Kajugujugu	Abundant
Orthetrum Julia	Julia skimmer	Kajugujugu	Abundant
Africallagma glaucum	Swamp bluet	Kajugujugu	Abundant
Apis mellifera	Honey Bee	Uruyuki	Abundant
Acrida acuminate	Common stick grasshopper	Igihori	Abundant
Hirudo medicinalis	Leech	Umusundwe	Abundant
Lumbricus terrestris	Earthworm	Umunyorogoto	Abundant
Cybister tripunctatus	Yellow-edge water beetle	Inyogaruzi	Present
Gyrinus sp	Whirligig beetle	Inyogaruzi	Present

Species	English name	Vernacular name	Observation
Chironomus formosipennis	Bloodworm	Isazi	Present
Biomphalaria spp	Snail	Ikinyamujongo	Abundant
Bulinus spp	Snail	Ikinyamujongo	Abundant
Diplonychus spp	Brooding water bugs		Rare
Dorylus helvolus	Red driver ant	Intozi	Abundant
Polistes fastidiotus	Paper wasp	Ivubi	Abundant

III.2.2.2.5. Discussion of survey results

Wetlands are parts of a larger landscape unit comprising a network of energy transfers and chemical interactions among organisms that are directly or indirectly dependent on the presence of surface water during some years or seasons. Akanyaru floodplain associated wetland is not an exception. This survey revealed that bird species are the most abundant in the area. They include wetland based species such as *Gallinula angulata* (Lesser Moorhen), *Arnea cinerea* (Grey heron), *Balearica regulorum* (Grey crowned crane), *Egretta ardesiaca* (Black egret), *Bubulcus ibis* (Cattle egret) and *Anastomus lamelligerus* (African open-billed stock). Others visit the wetland to forage as the major part has been drained for agricultural purposes but The Lesser Morhen occupies patches where the regeneration of plants is taking place following the incapacity of local people to control water levels.

The number of mammal species is low following the fact that the habitat has been destroyed due to agricultural activities and hunting in the 70s and 80s. However, most of the species are wetland dependent and some of them do not even dare to get out of water (eg. *Hydrictis tenuis*, otter) others migrated to Burundian side that possesses a natural reserve site.

The number of fish species is also low but the catch is important as the fish are big. Their species number is low because the waters of Akanyaru River are very turbid. Only species possessing accessory respiratory organs that allow them to use atmospheric oxygen survive under such conditions (e.g: African catfish, Lung fish). In addition the floodplains are good breeding sites for the *Clarias gariepinus* (the African catfish) especially breeds only during the flooding period. The latter being a trigger.

Amphibians, reptiles and invertebrate species are also present and in good numbers as wetlands are high productive and provide a good source of food and shelter. These animals also play an important ecological role in the food chain, nutrient cycling and pollination.

Among the animals identified one species, *Pelusios subniger* (Black mud turtle) is protected by the Convention in International Trade in Endangered Species of Wild fauna and flora (CITES).

Fourteen species are protected by Rwandan regulations under Ministerial order n° 007/2008 of 15/08/2008 establishing the list of protected animal and plant species in Rwanda.

The concerned species are *Nectarinia sp*p (sunbirds), *Scopus umbretta* (Hamerkop), *Ardea cinerea* (Grey Heron), *Balearica regulorum* (Grey crowned crane), *Turdoides jardineii* (Arrow-marked babbler), *Psalidoprocne holomelas* (Black-saw wing), *Bubulcus ibis* (Cattle egret), *Anastomus lamelligerus* (African open-billed stork), *Hippopotamus amphibus* (Hippopotamus), *Leptailus serval* (Tiger bush cat), *Cephalophus natalensis* (Natal duiker), *Felis aurata* (zool mangoose) and *Bitis arietans* (Viper).

To preserve this species during the project, the buffer zone of 50 meters (from Akanyaru River) that will be created and the safety zone may serve as refuge for the animals. The preservation of trees near the project area will enable the harmerkop to nest in the region. In addition creation of unexploited zone and a corridor will enable the connection between the project area and the rest of Akanyaru floodplains and Bugesera wetlands that will ease the movement of animals to safer zones.

The safety zone will serve as a buffer zone and fish will use it as a breeding zone. This zone may be used to restore natural vegetation and hence a natural habitat for the above species living in the area.

IV. PROJECT DESCRIPTION

IV.1. Objectives of the project

The project consists of harvesting of Akanyaru peat, the construction and the operation of a peat fired power plant of 70 MWe of total net capacity in a first phase and 35 MWe in a second phase. The peat fired power plant will be constructed at Mbuye village, Kabumbwe cell, Mamba Sector, Gisagara District, South province of Rwanda.

IV.2. Stages of the project

The present project will be implemented in four stages as described below.

IV.2.1. Stage 1: Pre-construction phase

Activities planned during this stage are project design, planning, land acquisition and project feasibility studies including this ESIA report.

IV.2.2. Stage 2: Construction phase

The activities planned in this phase are removal of soil and excavation works, landscaping and re-vegetation of exposed surfaces, acquiring construction materials, transportation of waste and materials, civil works, installation and assembling machines, Construction of ash landfill, etc.

IV.2.3. Stage 3: Project operation

Activities planned in this phase are mainly:

a) Peat harvesting
b) Peat drying, storage, transport and preparation;
c) Peat firing in the PFPP
d) PFPP Maintenance
e) Diesel and other hydrocarbon storage and handling
f) Liquid and solid wastes management & Management of non-hazardous and hazardous materials
g) Maintenance and rehabilitation of infrastructures and plant machines
h) General surface clean up

IV.2.4. Stage 4: Decommissioning/Closure and post-closure

The planned activities are:

(i) The Closure of peat harvesting;
(ii) Closure of peat fired power plant and other infrastructures (water and electricity sources, including halting of the pumping for lowering of the ground water);
(iii) Closure of storage sites;
(iv) Land reclamation, and
(vii) Revegetation.

IV.3. Evaluation of Different Harvesting Methods

Earlier studies of the areas of interest concluded that there would be problems to work in the area since during part of the year the river floods the peat area and the groundwater level is high. In the rainy season, it will probably be impossible to drain the area by gravity and therefore a lot of the peat would take a long time to dry before it would be able to harvest in the harvesting season. Another problem is the depth of the peat bogs; these vary between seven and 10 metres (sometimes even more) which means that a lot of the peat is below the groundwater level even during the dry period and therefore difficult to harvest.

Three methods of harvesting have been evaluated:

(i) Dry method
(ii) Digging method
(iii) Dredging method

Each of these three methods is a pre-production method and later includes the conventional mill- or sod peat method. A combination of the two conventional methods may be an alternative.

IV.3.1. Dry Method (recommended)

During the visit to the bogs, Sweco concluded that with the right actions it would be possible to harvest the peat bog in dry conditions. This would lead to lower production costs because conventional methods could be used.

A principle layout of the method is shown in *Figure 5*. The method uses the following steps:

- The peat bog is protected against flooding by two to three metres high walls built around the production area (*Figure 5* and *Figure 6*). The material of the walls is made from the vegetation, the surface soil and soil from canals that will be built. The wall will be reinforced with geotextiles to resist erosion. Fast growing grass will be sown. Parallel to and outside of the wall, a canal will be excavated where required; its water flow being diverted from the surrounding hills to the river. In some places, existing ditches will be gutted and used as canals.

- The bog will be built in a traditional way with small ditches, etc. but surrounded by large ditches (main ditches) near the inside of the walls. The small ditches (trenches) lower the groundwater level in the bog.

- Since the water cannot be drained by gravity, pumping stations will be installed in the main ditches approximately two kilometres apart. The pumps will pump the waters from the main ditches to the River via sedimentation basins.

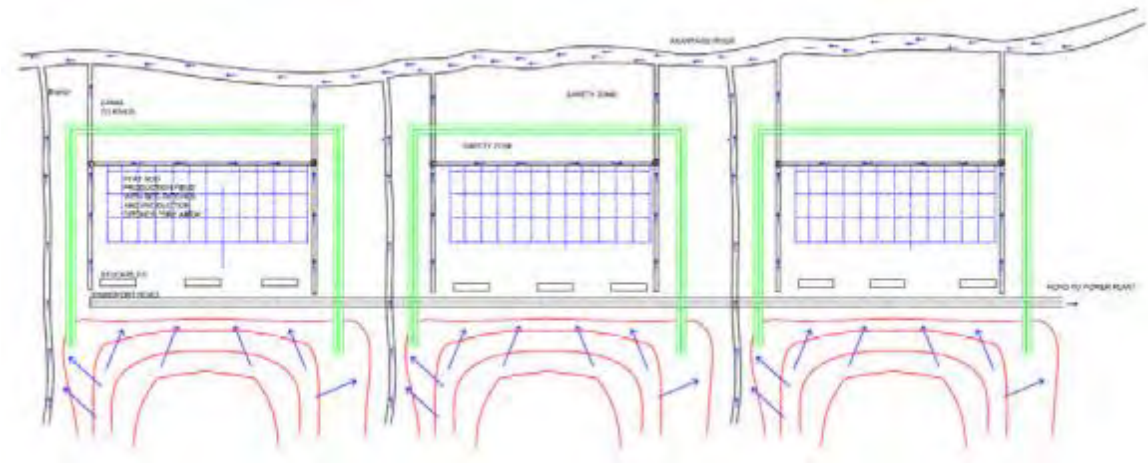


Figure 5: **Schematic of peat bog production area as seen from above. The picture is not to scale and the production areas are expecting to be much bigger compared with the roads and stockpiles**

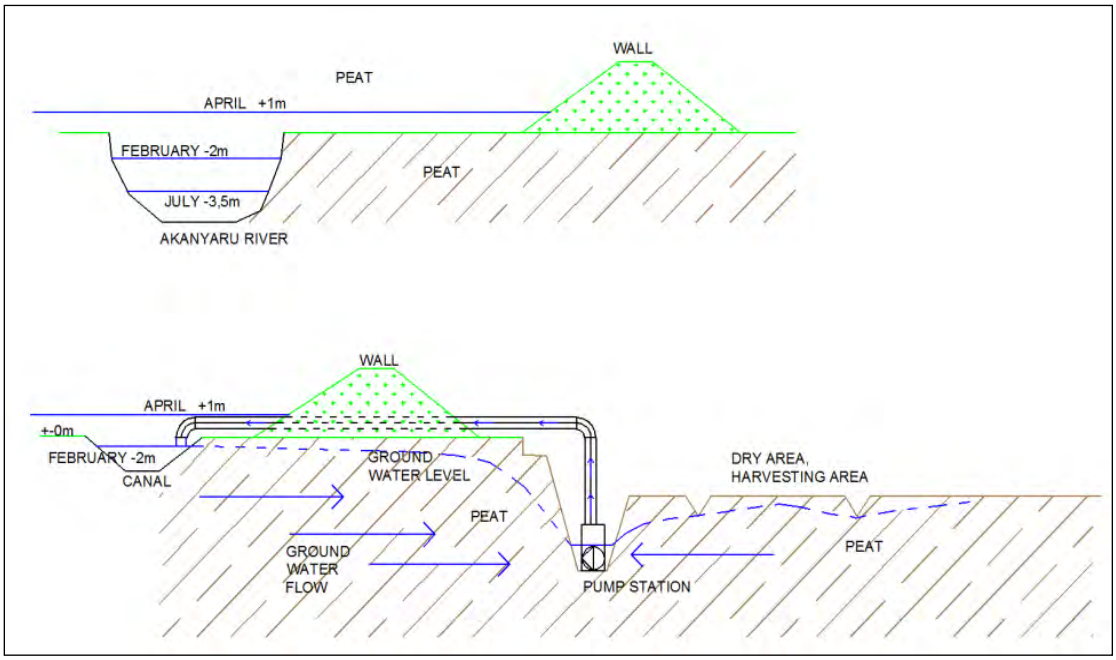


Figure 6: Illustration of how the walls protect the area from flooding and the pumps keep the ground water level under the production surface.

IV.3.2. Digging method

Although the bogs have a moisture content of 90% it is possible to walk on them during the dry season in several places but problems for the excavators can occur even if they use wide tracks

A principle layout of the method is shown in *Figure 7*. The following steps will be used:

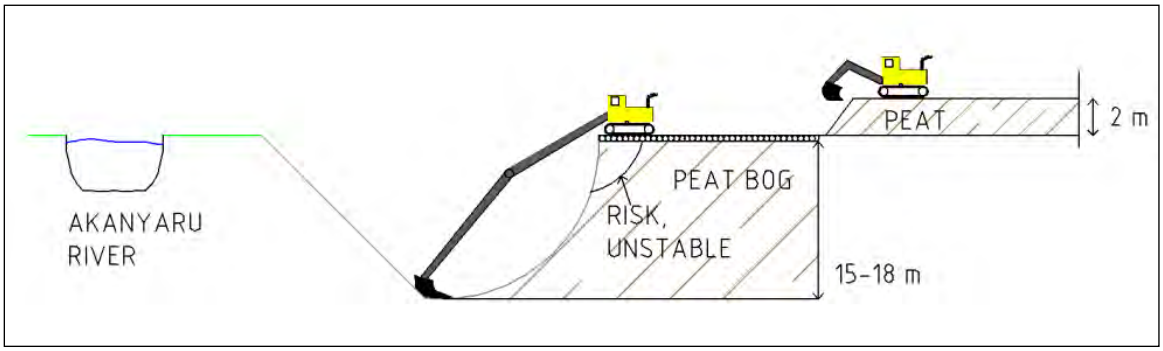


Figure 7: Principle of the digging method.

- The peat will be dug with an excavator with wide tracks and equipped with an approximately 20 metres long arm. Depths of 10 metres should not be problematic. Alternatively, a dragline bucket can be used.
- Another machine will take care of the excavated peat and spread it over a surface with a thickness of 2 to 2.5 metres. The peat is placed on dry ground that will not be flooded during the rainy season.
- On the new peat surface, traditional methods are used to prepare the bogs for harvesting.
- This method will be very energy-consuming and as the digging is under water, stirring will occur. This will lead to higher moisture content in the peat. Although the excavator has wide tracks, it has to be put on tracking mats when it works. Here there is a high risk with the stability of the ground and the edge can collapse. If this method should be used, the stability of the ground must be carefully examined.

IV.3.3. Dredging Method

The dredging method is described in Tractebel Engineering's report "Hakan - Rwanda Peat. Peatbog preparation and production planning" [3].

Sweco has been in contact with a Dutch dredging company to evaluate the dredging method and our conclusions are:

- Dredging peat with suction cutter method will be possible but a high amount of water will be added (10-15% in-situ peat m³ of mixture dredged material/water).
- The peat can easily be pumped over a distance of 10 kilometres so transport will be no problem if pipelines are used.
- Dredging organic material can cause release of lethal concentrations of H_2S.
- The dredging method is very expensive:

  - ✓ Investment costs for transport dredging equipment from Europe to Rwanda will be around US$ 18 million.

- ✓ Rough calculations made by the dredging company show US$ 13/m³ per in-situ peat.
- ✓ It should be noted that the method is unproven at industrial scale. Tests have been made in Finland and Sweden, which confirm the high costs and that it is not commercially attractive

IV.4. Peat Production

Peat production shall use the dry method and in this example, the milled peat method.

Plate 5a: Tractor preparing the ditches

Plate 5b: Rotary tiller (harvester)

IV.4.1. Milled Peat

The steps are carried out with tractor-drawn implements and the steps are the following:

- **First step: Milling/harrowing**: A 15 to 20 mm layer of moss is removed with so-called cam- or end mills or large modified harrows, which travel up to half of the checks (being the distance between the small ditches).

- **Second step: Drying**: For the peat to dry quickly it is turned one or more times with a gear called turner. After one day at the earliest, but normally three days after milling/ harrowing, the peat is dry enough to be towed.

Plate 6: A ridger

- **Third step: Towing:** This can be done by four main principles but only the Loader wagon principle will be discussed in this report since this is the method recommended by Sweco. The dry peat is scraped into one or more windrows on every check. After that, the peat is collected and transported to stock piles in trailers fitted with pater-noster works and large cargo space (15 to 30 m³).

Plate 7: A loader wagon

IV.4.2. Production Areas

The Tractebel Engineering assumption of one crop every day seems to be too optimistic and Sweco suggests every second day. The following calculations are therefore based on every second day of the dry season, =127 days.

This provides about 65 harvests per year. A yield based on an average milling depth of 15 mm and a peat amount of 75 kg DM/m³ of peat in-situ peat (about 90% moisture content) will provide 3.58 GWh/ha per year [3]. This consumes ca. 1 metre of peat per year which means that a peat depth of 10 metres provides ten years production.

The peat quality and volume needed for 30 year is calculated as follows:
To feed the power plant, approx. 7.4 million m³ of peat at 89% moisture (75 kg DM/m³) content per year will be needed. 30 years of operation of the PFPP will require a total amount of peat of circa 220 million m³.

There is a lot of uncertainty about the peat quality, etc. and therefore 30% extra surface requirement is included in reference [4]. Included in this 30%, for example, is an allowance for the peat containing 60 kg DM/m³ (based on samples from reference [7]) and not 75 kg DM/m³ as written above. This means that the required total surface could be as much as 1.3 x 2 200 + 660 = 3 520 ha or 352 million m^3. These numbers may change after the results are provided from the detailed sampling of the peat bogs in July – August 2013. The detailed sampling and analysis will comprise fuel, nutrient and trace element and geotechnical characteristics.

The effective peat production area is estimated to be 2.94 TWh/3.58 GWh per Ha = 820 Ha. Based on this conclusion, Sweco recommends to use the bogs HL-A, HL-B and IL-A (858 Ha in total, containing 85 million m³ of peat) for ten years production. For 30 years production, DL, EL, ER, HL-A/B, IL-A/B, JL and KL are also required.

The total area taken up by ditches, transport routes, stack, etc. increases the area by between 30 and 50%. The store area for the stock piles should be placed above the highest groundwater lever on mineral soil next to the production bogs. The stock piles dimension is suggested to about 20x7 metres (BxH) and need an area of about 100 ha.

IV.4.2.1. HL-A (Gakoma)

HL-A is about 3.9 km alongside the Akanyaru River and has an average width of about 750 m which provides an area of approximately 300 ha. The bog is bounded by streams in the north and south which flow into the Akanyaru River. These streams are used to take care of the water from the surrounding soil and the pumped water from the main ditches. Walls are needed in the north, east and south. The total length of the wall is estimated to about 7.8 kilometres.

IV.4.2.2. HL-B (Kabumbwe)

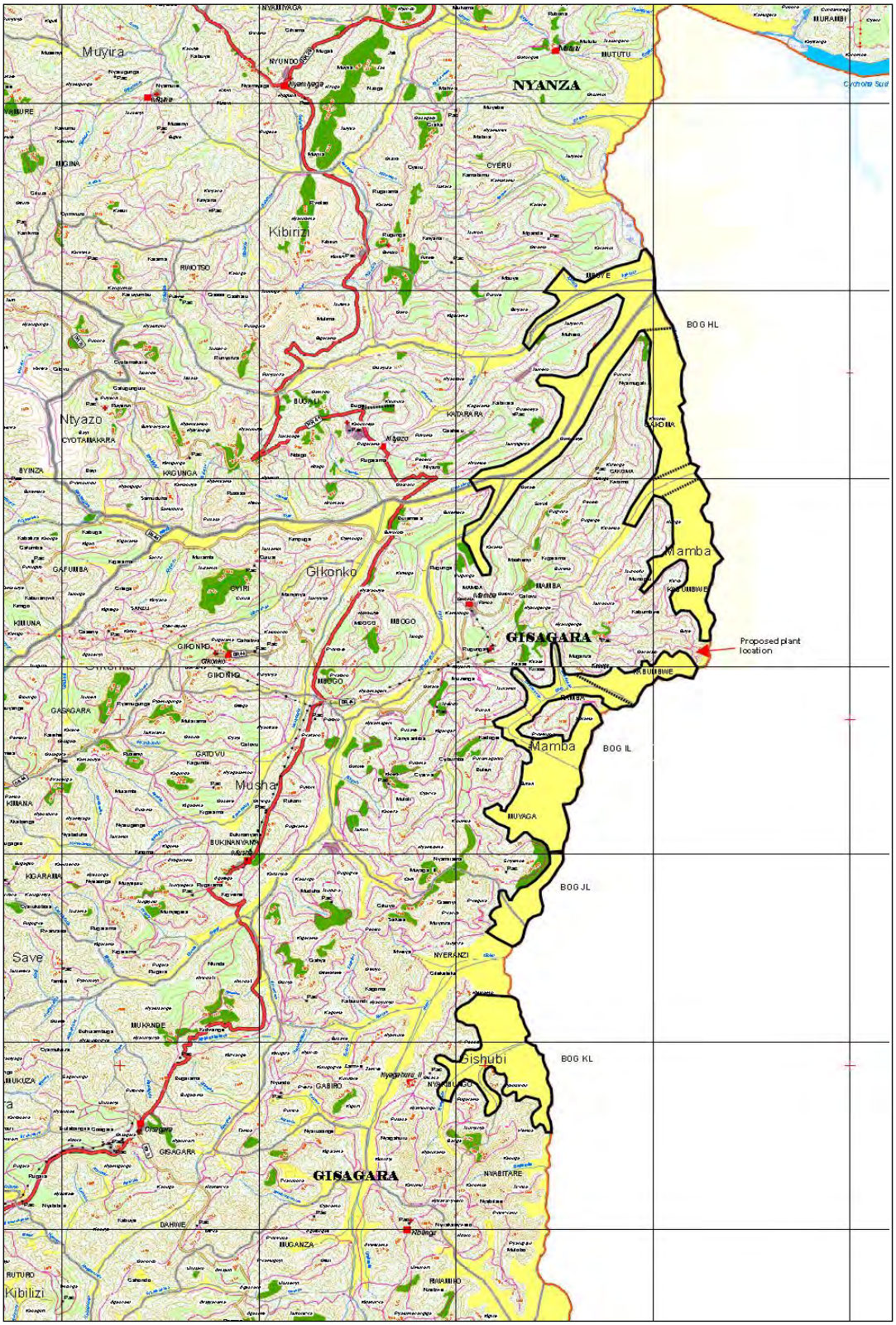
HL-B has a length of about 4.2 km along the river and an average width of about 900 m which provides an area of approximately 380 ha. The bog is bounded by a stream which flows north into the river and a headland in the south. The stream in the north should be used to take care of water from the surrounding soil and the main ditches. The south requires more study of the surface water. The need for walls is in the north, east and south. The length of the walls is estimated to be about 6.2 kilometres.

IV.4.2.3. IL-A (Ramba)

IL-A has a length of about 2.25 km along the river and an average width of about 750 m, which provides an area of approximately 380 ha. The bog is bounded by a stream in the south flowing into the river and a headland in the north. The river in the south is used to take care of the water from the surrounding soil and the main ditch inside the wall. The north requires more study of the surface water (see HL-B). Banks are needed in the north, east and south. The length of the walls is estimated to be about 5 km. The peat bogs and others to be used are indicated on *Map 7*.

The total required volume is specified below:

Peat Bog		**Peat Quantity (Mm^3)**
DL		69
EL		29
ER		37
HL-A		30
HL-B		38
IL-A		17
IL-B		68
JL		21
KL		53
Theoretical reserve		**362**
Losses due to roads, walls, buffer zone, storage etc.	30%	-66
Contingencies for uncertainty (DM-, ash content, depth)	30%	-66
Adjusted total volume / Equivalent years		**230/ 31 years**



Map 7: Location of the PFPP as proposed by Sweco relative to the location of the peat bogs to be exploited

IV.5. Peat Fired Power Plant Concept

IV.5.1. Design Basis

The approximate location of the Power plant is shown in *Figure 8a*, while its perceived components are presented in *Figure 8b.*

Figure 8a: Approximate location of the Power Plant.

IV.5.1.1. Ambient Conditions

The reference ambient air conditions for the PFPP design are:

- Ambient air temperature = 21°C.
- Ambient air relative humidity = 70%.
- Ambient air pressure = 860 mbar (at about 1 400 m above sea level).

IV.5.1.2. Main Features

Two alternative PFPP concepts were first considered:

- One 90 MWe (net output) unit.
- Two 45 MWe (net output) units, later changed to **35 MWe**.

The main features of the selected concepts are:

- Peat is expected to be close to milled peat nature used for e.g. in Finland/Sweden and Ireland (particle size, physical properties, etc.).

- Peat drying is done at the peat production area. Average moisture content of the peat received at the PFPP is expected to be ca. 50%.
- Intermediate storage of the peat is included at the site for one days' storage and for levelling out short-term quality variations.
- Circulating fluidised bed (CFB) boiler technology.
- Steam reheat system in 90 MWe (net output) unit.
- Single pressure in 45/35 MWe (net output) units.
- Conservative steam parameters used to avoid excessive boiler fouling and corrosion as a result of the peat's high ash- and alkaline contents.
- Wet cooling tower with mechanical draught selected. Make-up water from Akanyaru River is expected to be available.

The advantages of CFB technology over pulverised fuel burner technology in peat firing are:

- Fluidised beds are able to burn 40-60% moisture content peat without support firing. Pulverised fuel firing typically needs the fuel to be dried as well as have support firing to obtain stable combustion conditions throughout the boiler's operational range.
- Fluidised beds are less sensitive to peat moisture and quality variations since the fluidised bed's high heat capacity evens out short-term variations.
- Milled peat is not in a suitable form for burner firing and thus it has to be ground; this is also a maintenance issue.
- Peat from the Akanyaru valley has a high sulphur content and therefore some form of sulphur capture is required to meet the IFC emission limits. In the CFB boiler, sulphur reduction can be achieved easily through feeding limestone to the furnace and in some cases even the peat's inherent lime content will be utilised if it is in a reactive form. Pulverised fuel firing requires the use of a flue gas cleaning system in the cold end of the boiler.

Fluidised beds have basically no moving parts and thus they are more reliable in operation and have less maintenance issues than pulverised peat-fired burners. Note however that the refractory-covered areas of the CFB boiler do require regular maintenance.

For new peat-fired boilers in Scandinavia and Ireland, the fluidised bed boilers have more or less replaced pulverised peat-fired units. However, as with pulverised peat-fired units, the CFB boiler supplier needs to take into account the peat properties when designing the boiler.

IV.5.1.3. Power Plant Parameters

The PFPP is intended to operate as a base load unit with ca. 8 000 annual operating hours. Details of the Power Plant Options are specified in *table 13.*

Table 13: Power Plant parameters studied

Option (net output)		100 MWe	2 x 50 MWe	2 x 35.5 MWe
Type of peat		milled		
Moisture content of fuel delivered to gate	%	50	50	42
Type of boiler		CFB		
Operating mode		Base load, ca. 8 000 hrs/annum		
Steam system		reheat	single pressure	single pressure
Main steam pressure/ temperature	bar.a/°C	120/520	80/520	80/520
Reheat pressure/ temperature	bar.a/°C	33/520	-	-
Cooling system		Induced draught air-cooled wet condenser		
Plant estimated performance data				
Gross electrical output	MW	112	2 x 56	2 x 40
Net electrical output	MW	100	2 x 50	2 x 35.5
Net electrical efficiency	%	34.3	31.3	31.3
Boiler estimated mass balance				
Peat (NCV = 7.6 MJ/kg)	tonnes/hour	140	2 x 77	-
Peat (NCV = 9.2 MJ/kg)	tonnes/hour	-	-	2 x 44
Bottom ash	tonnes/hour	1.4	2 x 0.7	2 x 0.7
Fly ash	tonnes/hour	16.5	2 x 9.1	2 x 6.5
Peat	tonnes/annum	1 118 000	1 226 000	711 000
Bottom ash and fly ash	tonnes/annum	143 000	156 000	115 900
Emissions				
NOx	mg/Nm³	510	510	510
SO_2	mg/Nm³	900	900	900
Particulates	mg/Nm³	50	50	50
NOx	tonnes/annum	1 830	2 000	1 350
SO_2	tonnes/annum	3 220	3 540	2 400
Particulates	tonnes/annum	180	200	140

IV.5.1.4. Fuels

Peat from the Akanyaru marshland will be used as the main fuel, the quality as descried in *table 14*. Light fuel oil shall be used as start-up and auxiliary boiler fuel.
Major issues related to the combustion of Akanyaru peat are:

- Peat is considered suitable for fluidised bed combustion but as no references for burning Akanyaru peat exists further studies are recommended with relevant boiler suppliers.
- Peat is expected to be available at all times and no back-up fuel is required.
- Peat's high ash- and alkaline contents may cause fouling especially in the boiler superheater, thus conservative steam temperatures are recommended.
- Due to the peat's high sulphur content, limestone feeding to the furnace (for SO_2 emission control) is expected to be needed.
- Due to the peat's high sulphur content, high enough boiler flue gas exit temperature is recommended to avoid corrosion.
- Peat ash is expected to be fine material and mostly fly ash but is expected to form also bed material, possibly together with the limestone used for sulphur removal.
- Selected peat production method may impact peat size range and other physical/mechanical properties. This has to be taken into account in power plant equipment (peat handling and feeding).

Table 14: Peat main properties expected (as received at the power plant)

	Average	Range[1)]	unit
Moisture	42	40 – 55	%
Net calorific value	9.2	6 – 11	MJ/kg
Ash in dry fuel	19.4	10 – 22	%
Sulphur in dry fuel	1.3	0.8 – 1.8	%
Chlorine in dry fuel	0.04	0.03 – 0.06	%
Specific weight	340	250 – 400	kg/m^3

[1)] Range is intended for nominal boiler thermal output (not plant net output).

IV.5.1.5. Emission Requirements

The PFPP is intended to meet the IFC requirements for flue gas emissions. These requirements (reference condition of 6% O_2, dry flue gas) are specified in *table 15*.

Table 15: Emission requirements

NO_2	510	mg/Nm^3
SO_2	900	mg/Nm^3
Particles	50	mg/Nm^3

Limestone is expected to be needed for SO_2 control. Peat ash has a high alkaline content and is expected to inherently bind some sulphur in CFB boiler combustion conditions. However, fresh limestone is expected to be needed in order to meet IFC emission limits.

NO_2 emission is expected to be reached with primary measures (air staging and possibly flue gas recirculation, if needed).

Particulate matter emission is expected to be reached with electrostatic precipitator (ESP) or bag house if preferred.

IV.5.2. Power Plant Performance Data

IV.5.2.1. Mass and Energy Balances

Mass and energy balances data for this peat power plant are indicated in *table 16*.

Table 16: Mass and energy balances data of peat power plant

Plant estimated performance data			100 MWe unit	50 MWe unit	**35.5 MWe unit**
Gross electrical output		MW	112	56	40
Net electrical output		MW	100	50	35.5
Net electrical efficiency		%	34.3	31.3[2]	31.3
Gross electrical efficiency		%	38.1	34.8[3]	35.2
Gross heat rate of turbine plant		kJ/kWh	8 480	9 310[4]	9 260
Plant net heat rate in fuel		kJ/kWh	10 500	11 510[5]	11 500
Boiler estimated mass balance			100 MWe unit	50 MWe unit	35.5 MWe unit
Boiler steam output		MW	266	146	101
Expected NCV fuel efficiency		%	90	90[6]	90
Fuel input (NCV, 25°C)		MW	295	162	114
Fuel, air and limestone to the boiler		100 MWe unit	50 MWe unit	**35.5 MWe unit**	
Peat	t/h	140	77	-	50% moisture, 7.6 MJ/kg
Peat	t/h	-	-	44	42% moisture, 9.2 MJ/kg
Limestone	t/h	4.6	2.5	2.6	92% $CaCO_3$
Combustion air	t/h	504	277	185	
Flue gas and ash from the boiler					
Flue gas	t/h	630	345	224	
Bottom ash	t/h	1.4	0.7[7]	0.7	
Fly ash	t/h	16.5	9.1[8]	6.5	Including SO_2 retention products

[2] Net electrical efficiency = 31.3% = ca. 50 (Net electrical output) ÷ 162 (Fuel input, NCV, 25°C)
[3] Gross electrical efficiency = 34.8% = ca. 56 (Gross electrical output) ÷ 162 (Fuel input, NCV, 25°C)
[4] Gross heat rate of turbine plant = 9 310 kJ/kWh = ca. 3 600 x 146 (Boiler steam output) ÷ 56 (Gross electrical output)
[5] Plant net heat rate in fuel = 11 510 kJ/kWh = ca. 3600 x 162 (Fuel input, NCV, 25°C) ÷ ca. 50 (Net electrical output)
[6] Expected fuel efficiency = 90% = ca. 146 (Boiler steam output) ÷ 162 (Fuel input, NCV, 25°C)
[7] Ash in fuel = 19.4% (Ash in fuel, dry basis) x 77 (Fuel flow rate, tonnes/hr) x 50% = 7.5 tonnes/hr. Bottom ash = say 10% of fuel in ash = 0.7 tonnes/hr
[8] Ash in fuel = 7.5 tonnes/hr. Fly ash in flue gas = say 90% of fuel in ash = 6.8 tonnes/hr. $CaSO_4$ in flue gas = 2.3 tonnes/hr

IV.5.2.2. Other Major Consumables

Make-up water, e.g.:

- Wet cooling tower, ca.300 m³/h on average (purified and conditioned river water).
- Main steam cycle, ca. 150 m³/d on average (demineralized water).

Chemicals for water treatment, e.g.:

- For pH and oxygen control in main steam/water cycle.
- Conditioning cooling water cycle water quality.
- Waste water purifying.

Table 17: Estimated Annual Values for Consumables and Flue Gas Emissions

Estimated annual values (8 000 h/a)		**100 MWe unit**	**2 x 50 MWe unit**	**2 x 35.5 MWe unit**	**Notes**
Major consumables					
Peat consumption	t/a	1 118 000	1 226 000	-	50% moisture/ 7.6 MJ/kg
Peat consumption	t/a	-	-	711 000	42% moisture/ 9.2 MJ/kg
Limestone consumption	t/a	37 000	40 000[9]	42 000	
Raw water consumption	t/a	2 800 000	2 800 000	2 800 000	350 m³/h expected
Ash					
Bottom and fly ash to be landfilled[10]	t/a	143 000	156 000[11]	115 900	
Flue gas emissions from the stack(s)	mg/Nm³	t/a	t/a	t/a	
NO_2	510[12]	1 830	2 000	1 350	
SO_2	900	3 220	3 540	2 400	
Particulates	50	180	200	140	

IV.5.3. Main Process

The PFPP has the following main process areas:

- Peat handling.
- Boiler plant.
- Turbine/generator plant.
- BOP equipment.

[9] Limestone usage = 2 x 2.5 (limestone consumption, tonnes/hr) x 8 000 hours. Note: Ca in limestone = 2 500 (limestone consumption, kg/hr) x 92% ($CaCO_3$ content in limestone) x 40/100 (molecular weight of CA/ molecular weight of $CaCO_3$) = 920 kg/hr and S in fuel = 1.8% (S content in fuel, dry basis) x 50% x 77 000 (fuel flow rate, kg/hr) = 693 kg/hr. Therefore, Ca in limestone/S in fuel = 1.3. Note that the fuel inherent Ca/S ratio = ca. 1

[10] At this stage of the project, it is assumed that the fly ash from the PFPP will be sent to a landfill for final disposal

[11] Bottom and fly ash to be landfilled = 2 x (0.7 + 9.1* 99% = ESP efficiency) x 8 000 hours

[12] The NO_2 emission given is the limit from the IFC EHS guidelines; the actual value from the plant is expected to be lower than this maximum value as are also the actual SO_2- and particulate matter emissions

The main process areas are illustrated in *Figure 9.* The PFPP also includes electrical and automation systems and buildings for different equipment, operators, storage and maintenance works. Water and steam cycle connections are illustrated in *Figure 10* and *Figure 11.*

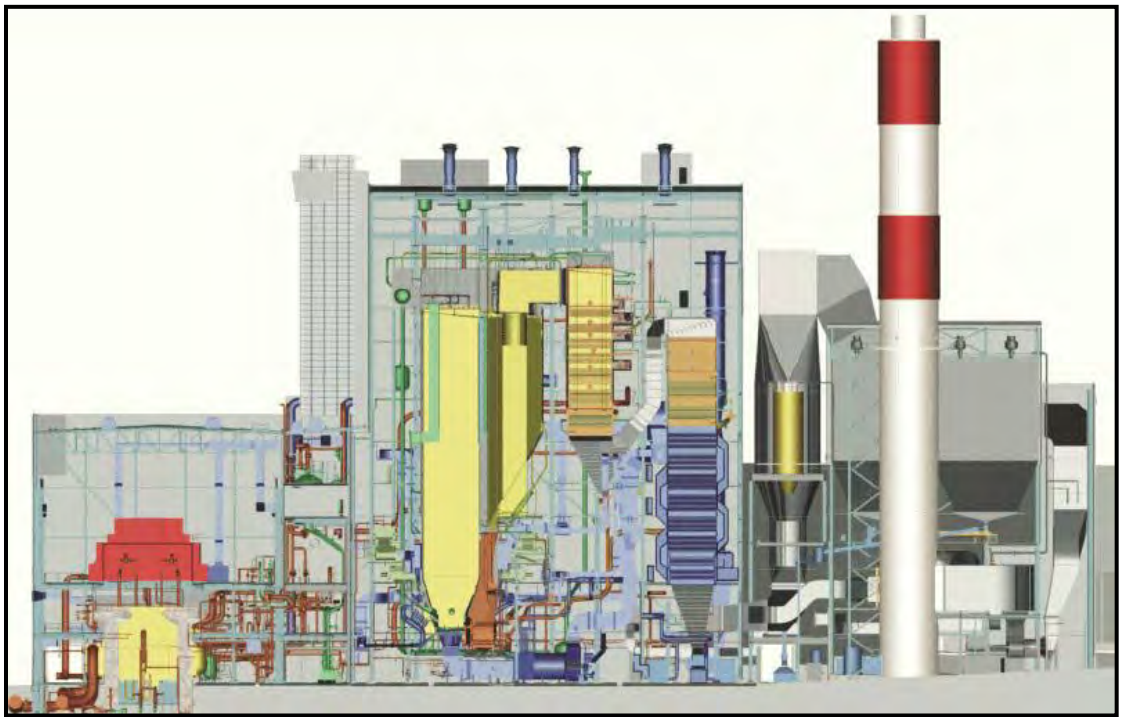


Figure 8b: **Modern PFPP in Ireland. Turbine plant and process equipment on the left, CFB boiler in the middle and flue gas cleaning on the right**

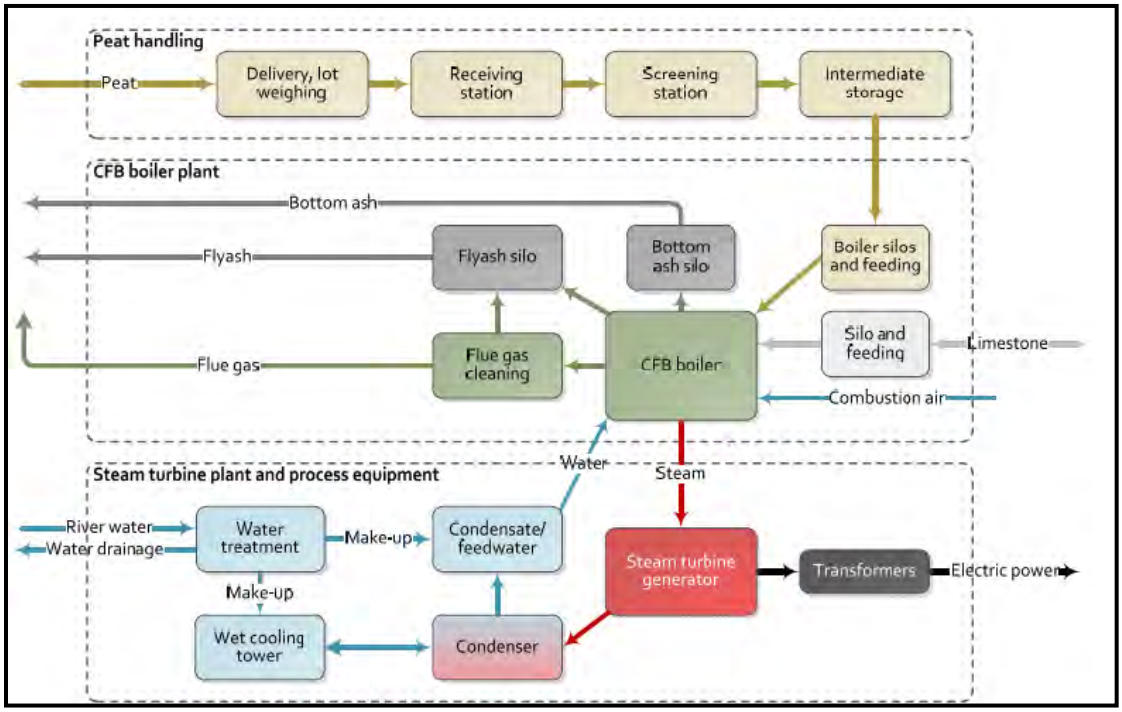


Figure 9: PFPP general block flow diagram

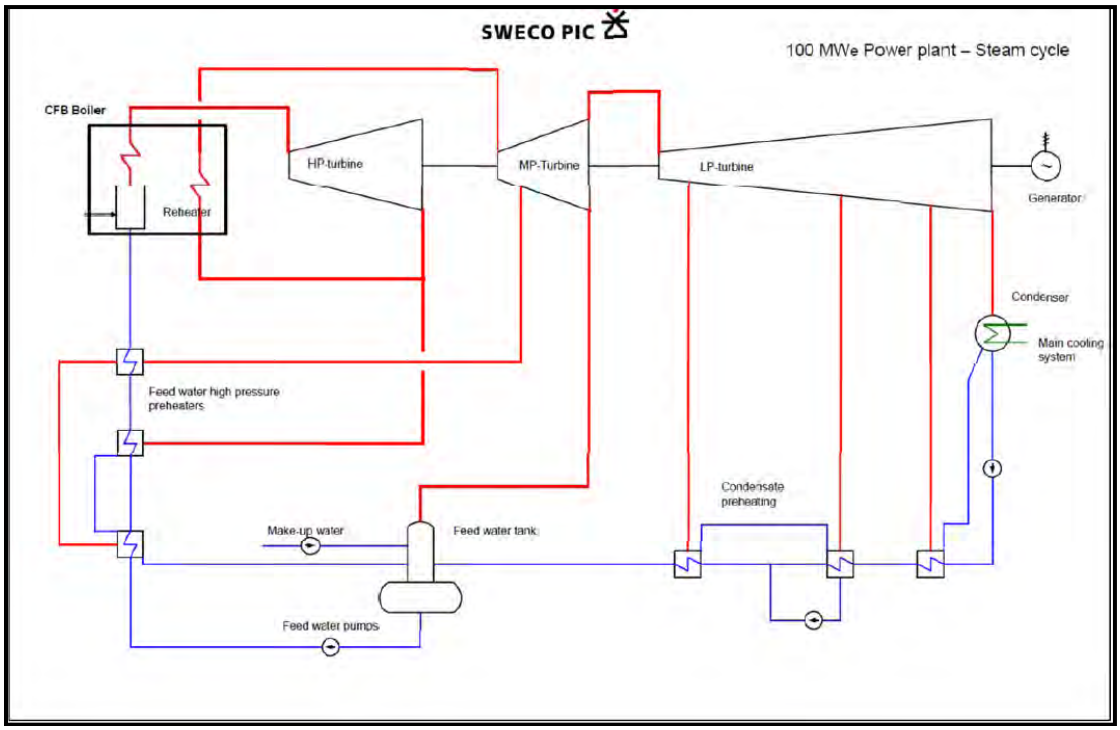


Figure 10: 90 MWe (net output) steam cycle diagram

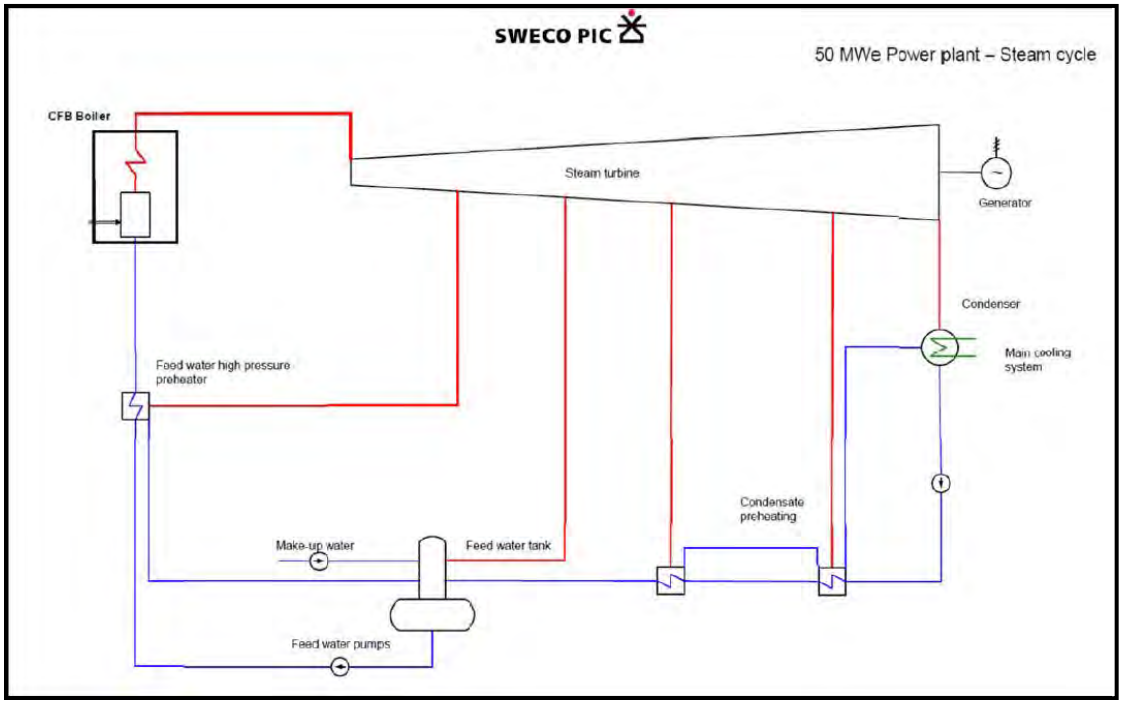


Figure 11: 35 and 50 MWe (net output) steam cycle diagram

IV.5.4. Description of Main Process Units

IV.5.4.1. Water and Steam Cycle

The main flow diagrams are illustrated in *Figure 10 and Figure 11*. The 90 MWe PFPP is with a steam reheat cycle and the 45/35MWe unit is a single pressure cycle.

The 90 MWe PFPP has seven water/condensate preheating stages and the 45/35 MWe PFPP has four.
The main cooling system in both size options is a wet cooling tower with mechanical draft. Water make-up is cleaned and conditioned Akanyaru river water.

IV.5.4.2 Peat Handling System

Peat is expected to be delivered continuously to the PFPP every day. No backup fuel is considered. The peat drying will be done at the peat production area and moisture content of the peat delivered to the PFPP is expected to be ca. 50%.

Moisture variations for different delivery lots should be minimised. Some blending and levelling of short-term quality variations will be achieved in the peat handling system, particularly in the intermediate storage.

The boiler(s) peat consumption with full load is expected to be ca. 450- 500 m^3/h (50% moisture, 300 kg/m^3).

Peat handling at the PFPP area comprises the following sections:

- Truck weighing system at PFPP entry.
- Truck unloading by tipping at peat receiving station. Peat receiving alternatively with a conveyor system.
- Conveyor(s) from receiving station to peat screening station.
- Peat screening station with crusher for oversized particles and a metal separator.
- Conveyors from screening station to covered intermediate storage.
- Intermediate storage.
- Conveyors from intermediate storage to boiler silos.

The capacity requirement from receiving station to boiler silos is expected to be ca. 1000 m^3/h. The intermediate silo volume is assumed to be sufficient for about 24 hours storage which equals about 11 000 m^3.

IV.5.4.3. CFB Boiler Plant

The CFB boiler is suitable for different quality fuels, including high moisture fuels such as Akanyaru peat. The CFB boiler can be designed to achieve full thermal output within a certain moisture range, e.g. 40 to 55%.

The boiler design shall take into account the properties of Akanyaru peat. High ash content, high alkaline and high sulphur shall all be considered as they have an impact on the design of the boiler. Since the fuel properties are of major importance, the boiler heating surface, etc. arrangements are recommended to be discussed with potential EPC suppliers.

Major concerns include the fouling and corrosion of superheaters (boiler hot area) and air preheaters (boiler cold area). The selected steam parameters (520°C) and flue gas exit temperature (≥ 160°C) are considered to be rather conservative and expected to be suitable for these peat properties but should be checked when designing the main steam cycle and the boiler.

The CFB boiler plant has the following main subsystems:

- Pressure parts, such as furnace evaporator, superheaters, economisers and reheaters.
- Cyclone (for recirculating fluidised bed material back to furnace).
- Fluidised bed grate.
- Fuel feeding equipment starting from feeding silos.
- Bed material make-up system.
- Limestone feeding system.
- Primary- and secondary air systems.
- Heating surface cleaning equipment (e.g. steam soot blowers).
- Combustion air preheating with flue gas.
- Combustion air preheating with steam.

- Internal piping, valves, etc.
- Instrumentation and boiler safety systems.
- Flue gas system with particulate separator (ESP), flue gas and recirculation gas fans, stack.
- Bottom ash and fly ash systems.
- Boiler house, stairs, platforms, etc., steel construction required.

IV.5.4.4.Turbine Plant

The turbine units include extractions as required for different feedwater and condensate preheating stages.
Exhaust steam is condensed in a turbine condenser, average pressure 66 mbar. Condenser cooling is executed with a wet cooling tower (average dry bulb air temperature = 21°C, relative moisture = 70%).

The turbine plant has the following main subsystems:

- Extraction-condensing turbine with auxiliaries.
- Generator with auxiliaries such as magnetizing, protection, measurement and synchronization systems.
- Gear (if any).
- Condenser.
- Instrumentation, control and protection equipment.
- Main valves, bypass system as required.
- Gland/sealing steam system.
- Vacuum system.
- Lube and control oil system

IV.5.4.5. Other Systems

IV.5.4.5.1. Power Supply

The PFPP generator will be connected to the national grid via a generator circuit breaker, main transformer and main switchyard.

IV.5.4.5.2. Electrical System

The PFPP electrification includes all necessary equipment and systems required for plant operations, e.g.:

- Generator.
- Generator circuit breaker.
- Main transformer.
- HV switchgear.
- MV bus duct between generator and main step-up transformer.
- Intermediate transformer(-s).
- MV switchgear.
- Power distribution transformers from MV to LV as necessary.

- MV/LV MCCs/panels.
- Emergency diesel generator.
- Auxiliary voltage systems.
- Process electrification.
- Building electrification.
- Earthing and lightning protection systems.

IV.5.4.5.3. Control and Instrumentation (C&I)

The PFPP will be controlled and monitored mainly via DCS (Distributed Control System) from the main control room. Local operating systems (PLCs, Programmable Logic Controller) and panels may also be used if local control turnouts to be necessary however all the operator controls should be possible from the DCS operator stations. Although automation of the plant is expected to be high, manual interventions to the process and equipment (e.g. peat handling area or normal maintenance) are also vital and necessary.

The main processes and equipment which will be connected to the DCS for monitoring and control include:

- Boiler plant.
- Steam turbine plant.
- Process equipment/BOP.
- Water treatment plant.
- Switchgear and medium voltage system.
- Peat handling system.
- Burner management system.
- Safety-related system.

IV.5.4.5.4. Earthworks, Civil and Buildings, including Internal Roads

The following contains a list of the anticipated buildings/civil structures in the PFPP:

- Boiler house.
- Steam turbine building.
- Control and electrical building.
- Air-cooled condenser.
- Flue gas cleaning (ESP).
- Flue gas and recirculation gas fan building.
- Stack.
- Fly ash and bottom ash silo/container discharge room.
- Main transformer and auxiliary transformer.
- Main switchgear structures.
- Water treatment plant.
- Demineralized water tank(-s).
- Raw water tank(-s).

- Fire water system.
- Administration building.
- Workshop and storage building.
- Peat receiving building.
- Peat screening building.
- Peat intermediate storage.
- Fuel oil unloading, storage tank and pumping.
- Internal roads, power plant yard.
- Auxiliary boiler.

V. ENVIRONMENTAL IMPACTS OF PEAT FIRED POWER PLANT PROJECT

V.1. Introduction

The objective of the assessment of impacts is to identify and assess all the significant impacts that may arise from the undertaking of an activity and findings used to inform the competent authority's decision as to whether the activity should be either authorized, authorized subject to conditions that will mitigate the impacts to within acceptable levels, or refused.

In this sense, impacts are defined as the changes in an environmental parameter that result from undertaking an activity. These changes are the difference between effects on an environmental parameter where the activity is undertaken compared to that where the activity is not undertaken, and occur over a specific period and within a defined area.

V.2. Impacts Types

Different types of impacts may occur from the implementation of this type of project, which may be positive or negative, and can be categorized as being either direct (primary), indirect (secondary) or cumulative.

Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity (for example, dust generation during peat harvesting). These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

Indirect impacts are induced changes that may occur as a result of the activity (for example the use of water from a natural source at the activity will reduce the capacity for supply to other users). These types of impacts include all the potential impacts that either do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity (Jain et al, 1993; Fuggle and Rabie, 1994).

Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities (for example, removal of vegetation may cause soil erosion, leading to excessive sediments in receiving stream, leading to reduced sunlight penetrating the water and thus reducing dissolved oxygen in the water and adversely affecting aquatic life and water quality). Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts (Jain et al, 1993).

V.3. Identification of Potential Impacts

In order to identify the potential impacts of this project, we used the matrix of identification which is an adaptation of the matrix of Leopold et al. (1971).

The matrix was designed for the assessment of impacts associated with almost any type of development project. Its main strength is as a checklist that incorporates qualitative information on cause-and-effect relationships. The Leopold system is an open-cell matrix containing project actions (sources of impacts) along the vertical axis and environmental 'characteristics' and 'conditions' along the horizontal axis (see *table 17*).

Also, the matrix of potential environmental impacts on the major components of peat land ecosystem associated with the different stages of peat harvesting is presented in *table 18*.

Table 18: Identification matrix of potential impacts of the peat fired power plant project

ENVIRONMENTAL COMPONENTS / SOURCE OF IMPACT			PHYSICAL ENVIRONMENT								BIOLOGICAL ENVIRONMENT				HUMAN ENVIRONMENT								
			Geology	Soil		Water			Air	Visual aesthetics	Flora		Fauna		Land use				Quality of life				
			Geological formation and composition	Quality of soil	Profile of soil	Surface water	Runoff and infiltration	Underground water	Air quality	Visual impacts	Floral species	Floral Succession	Faunal species	Faunal Habitat	Residential	Commercial	Agriculture/ Rangeland/ Forestry	Infrastructure and public utilities	Public health and safety	Income generation	Education/Training	Cultural and heritage sites	Noise
Project Phase	**#**	**Main Activity**																					
Pre-construction phase [PCP]	1	Project design, planning and land acquisition																					
	2	Feasibility study (including geotechnical studies and ESIA)																					
Construction Phase [CP]	3	Removal of soil and excavation works																					
	4	Installation of camp sites, offices and workshops and storage facilities																					
	5	Construction of peat fired power plant (2x35MWe)																					
	6	Provision of water and electricity																					
	7	Construction of ash landfill																					
	8	Construction of storage facilities																					
Operation Phase [OP]	9	Peat harvesting																					
	10	Peat production																					
	11	Peat firing in the PFPP																					
	12	PFPP Maintenance																					
	13	Diesel and other hydrocarbon storage and handling																					
	14	Liquid and solid wastes management & Management of non-hazardous and hazardous materials																					
	15	Maintenance and rehabilitation of infrastructures and plant machines																					
	16	General surface clean up																					
Decommissioning/Closure and Post-closure Phase [DP]	17	The Closure of peat harvesting																					
	18	Closure of peat fired power plant and other infrastructures (water and electricity sources)																					
	19	Land reclamation and revegetation																					
	Potential impacts																						

Table 19 presents the matrix of potential environmental impacts on the major components of peat land ecosystem associated with the different stages of peat harvesting.

Table 19: Potential environmental impacts on the major components of peat land ecosystem associated with peat harvesting

Environmental Impact \ Mining stages		Clearing	Draining	Facility construction	Mining	Processing	Restoration
Peat	Removal of non-renewable resource				X		
	Subsidence		X		X		
	Quality change		X		X	X	
	Dessication/ increase fire hazards		X		X		
Water quantity and Quality	Increase runoff	X	X	X	X		
	Increase water storage		X				
	Reduce peak runoff		X				
	Reduce interception	X					
	Reduce evapotranspiration	X	X	X			
	Lower water table		X				
	Change groundwater flow		X				
	Reduce infiltration of bare peat	X					
	Block drainage			X			X
	Impair water quality	X	X	X	X	X	X
Vegetation	Eliminate vegetation	X		X			
	Alter species composition		X	X			X
	Change vegetation structure		X	X			X
	Alter or eliminate vegetation pattern	X	X	X			
Wildlife	Eliminate wildlife habitat	X		X			
	Displace wildlife	X	X	X			
	Create wildlife barriers		X	X	X		
	Alter species composition	X	X	X			
	Change population level	X	X	X			

Environmental Impact \ Mining stages		Clearing	Draining	Facility construction	Mining	Processing	Restoration
	Alter aquatic life	X	X	X	X	X	X
Air quality	Increase fugitive dust	X		X	X	X	X
	Increase exhaust emissions	X	X	X	X	X	X
Non-consumptive use of values	Alter recreation potential	X	X	X	X		X
	Alter aesthetic or scenic value	X	X	X			
	Alter scientific/educational value	X	X	X	X		
	Alter historical/archeological values	X			X		
Other impacts	Alter surface landscape	X		X	X		X
	Noise creation	X	X	X	X	X	X
	Increase traffic			X	X	X	X
	Creation of solid wastes					X	

(X: Potential impact)

V.4. Impact Assessment Methodology

The methodology used for impact assessments in this report will relate to risk assessment (whereby certain impacts to the environment are identified), risk evaluation (by using a stipulated assessment criteria whereby impacts are given a rating or weighting and obtaining an overall rating or significance of an impact) and risk management (relating directly to applicable mitigation measures to be implemented to manage a risk of an impact in the best interest of a society; Schogren, 1990). The guideline criteria followed in this study are presented in *table 20*.

Table 20: Assessing criteria and ratings used for determining impact significance

Nature or Status of the Impact: The type of effect the activity would have on the environment		
Status		**Description**
Positive:		a benefit to the holistic environment
Negative:		a cost to the holistic environment
Neutral:		no cost or benefit
Duration of the Impact: The lifetime of the impact		
Score	**Duration**	**Description**
1	Short term	Less than 2 years
2	Short to medium term	2 – 5 years
3	Medium term	6 – 25 years
4	Long term	26 – 45 years
5	Permanent	46 years or more
Extent or Scale of the Impact: The distance from source that impacts may be experienced		
Score	**Extent**	**Description**
1	Site specific	Within the site boundary
2	Local	Affects immediate surrounding areas
3	Regional	Extends substantially beyond the site boundary
4	National	Affects country
5	International	Across international borders.
Reversibility of the Impact: To what degree its influence on the relevant environment can be negated.		
Score	**Reversibility**	**Description**
1	Completely reversible	Reverses with minimal rehabilitation & negligible residual affects
3	Reversible	Requires mitigation and rehabilitation to ensure reversibility
5	Irreversible	Cannot be rehabilitated completely/rehabilitation not viable
Intensity or Magnitude of the Impact: Severity of the negative and magnitude of positive impacts		
Score	**Severe/beneficial effect**	**Description**
1	Low	Little effect - negligible disturbance/benefit
2	Low to moderate	Effects observable - environmental impacts reversible with time
3	Moderate	Effects observable - impacts reversible with rehabilitation
4	Moderate to high	Extensive effects - irreversible alteration to the environment
5	High	Extensive permanent effects with irreversible alteration
The Probability of the Impact: Describes the likelihood of the impact actually occurring		
Score	**Rating**	**Description**
1	Unlikely	Less than 15% sure of an impact occurring
2	Possible	Between 15% and 40% sure of an impact occurring
3	Probable	Between 40% and 60% sure that the impact will occur
4	Highly Probable	Between 60% and 85% sure that the impact will occur
5	Definite	Over 85% sure that the impact will occur
The Consequence (C)		= Magnitude/Intensity (M/I) + Extent (E) + Duration (D) + Reversibility (R).
The Significance (S)		= Consequence (C) x Probability (P)

V.5. Determination of Significance

After assessment of an impact in accordance to the criteria described above, the significance of an impact can be determined. The various ratings as indicated above are accorded to these criteria. These ratings are then used to calculate a significance (S) rating and are formulated by adding the sum of ratings given to the extent (E), duration (D), Reversibility (R) and intensity (I) and then multiplying the sum with the probability (P) of an impact as follows:

- Significance (S) = (E+D+R+I) X P

The significance rating is described as follows:

Score out of 100	Significance
1 to 20	Low
21 to 39	Moderate to Low
40 to 60	Moderate
61 to 79	Moderate to high
80 to 100	High

V.6. Impact Assessment

All relevant impacts on the environment are rated and evaluated as set out in the preceding sections and presented via impact tables.

The peat fired power plant impacts are subdivided into the following four phases, from which impacting activities can be identified:

(i) Pre-construction phase [PCP]- all activities including design, planning and feasibility studies,
(ii) Construction phase [CP] – all activities on and off site, including the transport of material,
(iii) Operational phase [OP] – all activities, including operation and maintenance of structures,
(iv) Decommissioning/ rehabilitation (closure) phase [DP] – any activity related to the physical dismantling of the structures and/ or restoring of process/mining land to some degree of its former state.

Identified impacts for this peat fired power plant project are summarised in *table 21*.

Table 21: Presentation and significance of impacts of Akanyaru Peat fired power plant

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
PRE-CONSTRUCTION PHASE										
ACTIVITY 1: Project Design, Planning and land acquisition										
	Loss of land and resettlement	Negative	4	2	5	3	14	4	56	Y
Quality of life	Job creation	Positive	2	3	1	1	7	4	28	N
ACTIVITY 2: Feasibility studies (including geotechnical studies)										
Geology	Alteration of the geology	Negative	1	1	2	3	7	3	21	Y
Soil	Risk of soil erosion	Negative	1	1	1	1	4	4	16	Y
Surface water	Risk of surface water pollution	Negative	2	2	1	1	6	4	24	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	3	12	Y
Air quality	Risk of dust generation and emission	Negative	2	1	1	1	5	4	20	Y
Noise	Increase of noise levels	Negative	1	2	1	1	5	4	20	Y
Flora and Fauna	Adversely affect local fauna and flora	Negative	4	1	1	5	11	4	44	Y
Land use	Risk of loss of crop production	Negative	1	1	1	1	4	3	12	Y
Quality of life	Jobs creation	Positive	3	2	1	3	9	4	36	N
	Risk of accidents	Negative	2	1	1	3	7	3	21	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
CONSTRUCTION PHASE [CP]										
ACTIVITY 3: Removal of soil and excavation works										
Soil	Risk of soil erosion	Negative	1	2	1	3	7	4	28	Y
Surface water	Risk of surface water pollution and siltation	Negative	3	2	1	1	7	4	28	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	3	12	Y
Air quality	Risk of dust generation and emission	Negative	2	1	1	1	5	4	20	Y
Noise	Increase of noise levels	Negative	1	2	1	1	5	4	20	Y
Flora and Fauna	Adversely affect local fauna and flora	Negative	3	1	1	5	10	4	40	Y
Land use	Risk of loss of crop production	Negative	1	1	1	1	4	3	12	Y
Quality of life	Jobs creation	Positive	3	2	1	3	9	4	36	N
	Risk of accidents	Negative	2	1	1	3	7	3	21	Y
ACTIVITY 4: Installation of camp sites, offices, workshops and storage facilities										
Soil	Risk of soil erosion and compaction	Negative	1	1	1	3	6	3	18	Y
Surface water	Risk of surface water pollution	Negative	1	2	1	1	5	3	15	Y
Air quality	Dust generation and emission	Negative	1	1	1	1	4	3	12	Y
Noise	Increase of noise levels	Negative	1	2	1	1	5	3	15	Y
Flora and fauna	Loss of Biodiversity	Negative	4	1	2	3	10	4	40	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Land use	Loss of forest and /or farmer land	Negative	1	1	3	3	8	3	24	Y
Quality of life	Job creation	Positive	4	4	2	3	13	4	52	N
	Health effects (risk of accidents)	Negative	2	1	2	5	10	4	40	Y
ACTIVITY 5: Construction of peat fired power plant (2x45MWe)										
Soil	Risk of soil erosion	Negative	1	1	2	3	7	3	21	Y
Surface water	Risk of surface water pollution	Negative	2	2	1	3	8	3	24	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	3	12	Y
Air quality	Risk of dust generation and emission	Negative	2	2	1	3	8	4	32	Y
Noise	Increase of noise levels	Negative	3	2	2	3	10	4	40	Y
Flora and fauna	Adversely affect local fauna and flora	Negative	3	1	2	3	9	4	36	Y
Quality of life	Health effects	Negative	3	2	2	5	12	4	48	Y
	Job creation	Positive	4	4	2	3	13	4	52	N
ACTIVITY 6: Provision of water and electricity										
Soil	Risk of soil erosion	Negative	1	1	2	3	7	3	21	Y
Surface water	Risk of reduction of surface water	Negative	2	2	1	3	8	3	24	Y
Ground water	Risk of reduction of ground water	Negative	1	1	1	1	4	3	12	Y
Air quality	Risk of dust generation and emission	Negative	2	2	1	3	8	4	32	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Flora and fauna	Adversely affect local fauna and flora	Negative	3	1	2	3	9	4	36	Y
Quality of life	Health effects	Negative	5	2	3	3	13	3	39	Y
	Improvement of quality of life	Positive	4	2	3	3	12	4	48	Y
	Education and Employment	Positive	4	2	3	3	12	4	48	Y
ACTIVITY 7: Construction of ash landfill										
Soil	Risk of soil erosion	Negative	1	1	2	3	7	3	21	Y
Surface water	Risk of surface water pollution	Negative	2	2	1	3	8	3	24	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	3	12	Y
Air quality	Risk of dust generation and emission	Negative	2	2	1	3	8	4	32	Y
Noise	Increase of noise levels	Negative	3	2	2	3	10	4	40	Y
Flora and fauna	Adversely affect local fauna and flora	Negative	3	1	2	3	9	4	36	Y
Quality of life	Health effects	Negative	3	2	2	5	12	4	48	Y
	Job creation	Positive	4	4	2	3	13	4	52	N
Activity 8: Construction of storage facilities										
Soil	Risk of soil erosion	Negative	1	1	2	3	7	3	21	Y
Surface water	Risk of surface water pollution	Negative	2	2	1	3	8	3	24	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	3	12	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Air quality	Risk of dust generation and emission	Negative	2	2	1	3	8	4	32	Y
Noise	Increase of noise levels	Negative	3	2	2	3	10	4	40	Y
Flora and fauna	Adversely affect local fauna and flora	Negative	3	1	2	3	9	4	36	Y
Quality of life	Health effects	Negative	3	2	2	5	12	4	48	Y
	Job creation	Positive	4	4	2	3	13	4	52	N
Operation Phase [OP]										
Activity 9: Peat harvesting										
Soil	Soil alteration and compaction	Negative	4	2	3	3	12	4	48	Y
Peat	Removal of non-renewable resource	Negative	4	4	3	5	16	5	80	Y
	Subsidence	Negative	2	2	3	3	10	4	40	Y
	Quality change	Negative	3	2	3	3	11	4	44	Y
	Desiccation/ increase fire hazards	Negative	2	2	2	3	9	3	27	Y
Water quantity and Quality	Increase runoff	Negative	3	2	2	3	10	4	40	Y
	Water storage	Negative	2	2	3	3	10	3	30	Y
	Peak runoff	Negative	2	2	2	1	7	3	21	Y
	Reduce interception	Negative	3	2	2	3	10	3	30	Y
	Reduce evapotranspiration	Negative	2	2	2	3	9	3	27	Y
	Lower water table	Negative	4	2	3	3	12	4	48	Y
	Change groundwater flow	Negative	4	2	3	3	12	4	48	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
	Infiltration of bare peat	Negative	3	2	2	1	8	3	24	Y
	Block drainage	Negative	3	2	2	1	8	3	24	Y
	Impair water quality	Negative	4	2	3	3	11	4	44	Y
Vegetation	Eliminate vegetation	Negative	5	2	2	3	12	4	48	Y
	Alter species composition	Negative	4	2	2	3	11	4	44	Y
	Change vegetation structure	Negative	4	2	2	3	11	4	44	Y
	Alter or eliminate vegetation pattern	Negative	4	2	2	1	9	3	27	Y
Wildlife	Eliminate wildlife habitat	Negative	4	3	2	3	12	4	48	Y
	Displace wildlife	Negative	5	3	2	3	13	4	52	Y
	Create wildlife barriers	Negative	3	2	2	1	8	3	24	Y
	Alter species composition	Negative	4	2	2	1	9	3	27	Y
	Change population level	Negative	3	2	2	1	8	3	24	Y
	Alter aquatic life	Negative	4	3	2	3	12	4	48	Y
Air quality	Increase fugitive dust	Negative	5	2	2	3	12	5	60	Y
	Increase exhaust emissions	Negative	4	2	2	1	9	4	36	Y
Noise	Noise creation	Negative	3	2	2	1	8	3	24	Y
Solid wastes	Creation of solid wastes	Negative	3	2	2	1	8	3	24	Y
Quality of life	Employment	Negative	4	5	3	1	13	4	52	Y
Activity 10: Peat production										
Soil	Soil compaction	Negative	4	1	3	3	11	3	33	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Surface water	Risk of surface water pollution	Negative	5	2	5	3	15	5	75	Y
Ground water	Risk of ground water pollution	Negative	2	1	3	1	7	2	14	Y
Air quality	Risk of dust generation and emission	Negative	4	2	3	3	12	4	48	Y
Noise	Increase of noise levels	Negative	3	2	3	1	9	3	27	Y
Quality of life	Employment	Positive	5	4	3	3	15	5	75	N
	Risk of accidents	Negative	3	1	3	5	12	3	36	Y
	Health effects	Negative	3	2	3	5	13	4	52	Y
Activity 11: Peat firing in the PFPP										
Surface water	Risk of surface water pollution	Negative	3	2	3	3	11	3	33	Y
Ground water	Risk of ground water pollution	Negative	1	2	3	1	7	3	21	Y
Air quality	Risk of generation and emission of ash, SO_2, NO_2 and Particles	Negative	5	2	3	3	13	4	52	Y
Noise	Increase of noise levels	Negative	3	2	3	3	11	4	44	Y
Quality of life	Employment	Positive	5	3	3	3	14	5	70	N
	Safe water supply to nearby village	Positive	5	3	3	3	14	5	70	N
	Risk of accidents	Negative	4	1	3	5	13	4	52	Y
	Health effects	Negative	4	2	3	5	14	4	56	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
ACTIVITY 12: PFPP Maintenance										
Surface water	Risk of surface water pollution	Negative	1	2	1	1	5	3	15	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	2	8	Y
Air quality	Risk of dust generation and emission	Negative	1	2	1	1	5	3	15	Y
Noise	Increase of noise levels	Negative	2	2	1	1	6	2	12	Y
Flora and fauna	Adversely affect fauna and flora	Negative	1	1	1	3	6	2	12	Y
Quality of life	Employment	Positive	3	4	1	3	11	4	44	N
	Risk of accidents	Negative	2	2	1	5	10	3	30	Y
	Health effects	Negative	2	2	1	5	10	3	30	Y
ACTIVITY 13: Diesel and other hydrocarbon storage and handling										
Soil	Potential hydrocarbon contamination washing off into surrounding soils	Negative	3	1	3	3	10	3	30	Y
Surface water	Potential hydrocarbon contamination washing off into rivers	Negative	4	2	3	1	10	4	40	Y
Ground water	Potential hydrocarbon contamination leeching into the water table	Negative	4	1	3	3	11	4	44	Y
ACTIVITY 14: Liquid and solid wastes management & Management of non-hazardous and hazardous materials										
Soil	Soil erosion and compaction	Negative	3	1	3	3	10	3	30	Y
Surface water	Reduction of surface water pollution, provision of water supply	Positive	4	2	3	1	10	4	40	N
Ground water	Reduction of ground water pollution, provision of water supply	Positive	4	1	3	1	9	4	36	N

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Visual aspects	Visual impacts	Negative	3	2	3	3	11	3	33	Y
Air quality	Dust generation and emission through waste transport and disposal	Negative	2	2	2	3	9	2	18	Y
Raw Material	Potential for secondary industry to utilise the ashes	Positive	3	2	4	3	12	3	36	
Noise	Increase of noise levels	Negative	2	2	2	3	9	2	18	Y
Flora and fauna	Positively affect fauna and flora	Positive	3	2	3	1	9	3	27	N
Quality of life	Employment	Positive	4	4	3	3	14	3	52	N
	Risk of accidents	Negative	3	1	3	3	10	3	30	Y
	Health effects	Negative	3	2	4	3	12	3	36	Y
ACTIVITY 15: Maintenance and rehabilitation of infrastructure and plant machines										
Surface water	Risk of surface water pollution	Negative	1	2	1	1	5	3	15	Y
Ground water	Risk of ground water pollution	Negative	1	1	1	1	4	2	8	Y
Air quality	Risk of dust generation and emission	Negative	1	2	1	1	5	3	15	Y
Noise	Increase of noise levels	Negative	2	2	1	1	6	2	12	Y
Flora and fauna	Adversely affect fauna and flora	Negative	1	1	1	3	6	2	12	Y
Quality of life	Employment	Positive	3	4	1	3	11	4	44	N
	Risk of accidents	Negative	2	2	1	5	10	3	30	Y
	Health effects	Negative	2	2	1	5	10	3	30	Y

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Infrastructures	Rehabilitation and maintenance of infrastructure	Positive	4	1	1	3	9	4	36	N
ACTIVITY 16: General surface clean up										
Soil	Soil erosion and compaction	Negative	3	1	3	3	10	3	30	Y
Surface water	Reduction of surface water pollution	Positive	4	2	3	1	10	3	30	N
Ground water	Reduction of ground water pollution	Positive	4	1	3	1	9	4	36	N
Visual aspects	Visual impacts	Negative	3	2	3	3	11	3	33	Y
Air quality	Risk of dust generation and emission	Positive	2	2	2	3	9	2	18	N
Noise	Increase of noise levels	Negative	2	2	2	3	9	2	18	Y
Flora and fauna	Positively affect fauna and flora	Positive	3	2	3	1	9	3	27	N
Quality of life	Employment	Positive	4	4	3	3	14	3	42	N
	Risk of accidents	Negative	3	1	3	3	10	3	30	N
DECOMMISSIONING/CLOSURE AND POST-CLOSURE PHASE [DP]										
ACTIVITY 17: The Closure of peat harvesting										
Soil	Possibility to the soil to revert to its pre-mining conditions	Positive	1	1	4	3	9	3	27	N
Surface & Gr. Water	Rebounding of hydrological regime to baseline levels	Positive	2	2	4	1	9	2	18	N
Air quality	Improvement of air quality due to the site rehabilitation	Positive	1	3	4	1	9	4	36	N
Fauna and Flora	Vegetation cover and proliferation of fauna habitats	Positive	2	1	4	1	8	3	24	N

Impacted Aspect	Impact	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Consequence (C)	Probability (P)	SIGNIFICANCE (S)	Mitigation
Public safety	Risk accidents	Negative	1	1	1	5	8	3	24	Y
Land use	Fish farming development on the site	Positive	2	1	3	3	9	3	27	N
Visual aspects	Improvement of the beauty of the area	Positive	3	2	4	3	12	3	36	N
ACTIVITY 18: Closure of peat fired power plant and other infrastructures										
Soil	Soil contamination	Negative	2	1	2	3	8	2	16	Y
Surface and ground water	Risk of surface and ground water pollution	Negative	2	2	2	3	9	2	18	Y
Noise	Increase of noise levels	Negative	2	2	2	3	9	2	18	Y
Visual	Improvement of the beauty of the area	Positive	3	2	4	3	12	3	36	N
Public safety	Risk of accidents	Negative	2	1	2	5	10	2	20	Y
ACTIVITY 19: Land reclamation and re-vegetation										
Soil	Soil structure and texture improvement	Positive	3	1	3	1	8	3	24	N
Flora and Fauna	Vegetation cover and proliferation of fauna habitats	Positive	4	1	3	1	9	4	36	N
Surface & gr. water	Improvement of surface and ground water quality	Positive	3	2	2	3	10	3	30	N
Land use	Availability of land for agriculture	Positive	3	2	3	1	9	3	27	N
Quality of life	Job creation	Positive	3	2	2	3	10	3	30	N

V.7. Positive Socio-Economic Impacts

The development of the peat fired power plant project is likely to engender substantial positive socio-cultural and economic impacts in the area. Obvious positive impacts are the provision of employment and infrastructure in the local community, and the multiplier effects of regional investment from the project.

The following section highlights the potential social-cultural and economic impacts of the peat fired power plant project.

V.7.1. Local Employment

The implementation of this peat fired power plant will create job opportunities for the local population, e.g. as tractor drivers, support staff at the power plant and other direct services. The use of local labourers and skilled workers will improve the skill resource base in the project area through the implementation of training and development programmes. These are both positive outcomes of the project and for the local population. However, there will be an influx of people looking for work from around Gisagara and Rwanda in general. If not carefully managed, this strain may be a negative impact.

During the public consultation all the persons met solicited the access to the job. The project would therefore have a positive impact which is permanent to job and the revenues of the population of the zone.

These revenues will be distributed through the creation of temporary or permanent jobs for the local personnel or the supplying material at different sources together with the compensation which will be distributed. Referring to concrete impact, the mass of money which will be distributed with the zone of the project, will contribute to the improvement of the quality of life, the accessibility to health treatments and to opportunities of trade.

V.7.2. Contractor Employment

The use of local contractors will increase the capability of local contractors to carry out their work competently. There will also be an influx of skilled contractors to Gisagara District related to various fields of the economy. This will help to set up economic diversification.

V.7.3.Rural electrification

One of the most anticipated positive impact by the Government of Rwanda and the population is the increased power supply to the community and household.

The production of 70 MWe of electricity will have a considerable impact on the electricity access for the whole country and even for the region through the Regional

Interconnection Project. This will have many indirect impacts on the public health, education, business proliferation, etc.

V.7.4. Local Business Enhancement

The business environment of Gisagara District (Mamba Sector) and the country in in general, will continue to improve as the economy expands and unemployment is reduced, having affects through levels of the population through multiplier effects.

The increase in the demand for goods and services (supplies for construction and operation of the plant, supply of food and lodging, etc.), required during the project activities will stimulate local and regional trade.

V.7.5. Economic Diversification

The economic expansion in Gisagara District and in Rwanda in general, aided by improved electricity supply will enable alternative businesses and economic activities to develop. Also, increased earnings by staff will most likely be spent locally further supporting already established businesses in the area, as well as potential new businesses that may emerge.

V.7.6. Healthcare for Employees

Employees and their immediate families of the Akanyaru Peat fired power plant project will be provided with basic healthcare. This will benefit the overall health of the local population. HIV/AIDS information will be dispersed to employees to prevent the spread of the disease amongst the project employees and their families.

V.7.7. Possibility of Savings for the Employees

The increase of the project's employee's revenue will lead to the possibility of savings in local banks and micro-finances.

V.7.8. Tax Payments

Due to the operation of the peat fired power plant, Hakan as well as the employees of the plant will pay taxes to the local and central government.

V.8. Potential negative socio-economic impacts

V.8.1. Housing and Resettlement

About 20 houses at and close to the location of peat fired power plant will have to be demolished and people will have to be resettled. A resettlement and compensation procedure will have to be set up. Since less than 200 persons in the vicinity of the Project are expected to be subject to relocation a simplified Resettlement Action Plan will be required.

V.8.2. Land acquisition and loss of production

The construction of Akanyaru peat fired power plant will require a land acquisition of about 20 Ha leading to the expropriation of some people of the project zone.

As the Akanyaru marshland has being used for agriculture and grazing, the implementation of this project will lead also to the risk of production loss (crops and livestock) for the population of the project zone.

V.8.3.Traffic congestion

The frequency and number of truck movement loading and offloading construction materials and peat fuel may cause traffic congestion and noise/exhausts on the project access roads.

V.8.4. Risk of increase of HIV/AIDS and other Sexually Transmitted Diseases

Due to the increase of people from outside of the project zone, there is a risk of increase of HIV/AIDS and other sexual transmitted diseases.

V.8.5. Construction accident/ injuries

Accidents or injuries resulting from sharp objects, workers falling off scaffoldings, electric shocks are expected to happen under such project implementation.

V.9. Environmental Impacts

The Project adverse impacts during project phases (pre-construction, construction, operation and decommissioning phases) are described in this section. The significance and probability of occurrence of each impact can be reduced through the application of environmental preventive and mitigation measures. Potential environmental issues associated with this project, which may require management, are discussed below.

V.9.1.Geological Alteration

By the very nature of the activity, peat harvesting will impact detrimentally on the physical composition of the geological environment. The removal of peat will change the geological formation at the harvesting site permanently. The removal of this material

will result in the depletion of the geological resource of the area which will also have potential impacts on the hydro-geological regime.

V.9.2. Soil Damage and Erosion

Soil damage includes compaction and disturbance of the profile. Soil erosion involves transport of the soil downslope by running water or, more rarely but still a significant factor, away from the site by wind.

Soil compaction and disturbance, usually accompanied by vegetation and litter layer damage, are preconditions for accelerated soil erosion.

Most soil damage occurs as the result of movement of machine, trucking, and to some extent through felling of trees in the preparation of access roads.

Soil erosion depends not only on soil damage but also soil type, rainfall, slope and length of slope.

Without adequate water management on site, soil erosion will persist and result in loss of soil and sedimentation of Akanyaru River, affecting river characteristics as well as aquatic ecology.

Contamination of soil may occur from the spillage of oils and lubricants during construction and operation activities.

Degradation of the surrounding soil will affect flora and fauna and may restrict the future land use.

V.9.3. Water Use and Quality

Management of water use and quality, in and around the project site, will be a critical and significant issue due to the proximity of Akanyaru River and other steams draining the area. Potential contamination of water sources may occur at the peat lands during the peat harvesting stage and many factors including indirect impacts can result in negative impacts to water quality.

Reduction of surface and groundwater availability is also a concern at the local level and for communities in the vicinity of the project site because the project will use Akanyaru river water for its operation. Therefore this may result in the reduction of groundwater and surface water availability. Thus, there is necessity for mitigation measures for water-related issues and impacts, e.g. construction of sedimentation basins for the reduction of suspended peat particles to reach the Akanyeru River.

V.9.3.1. Water Use

As mentioned before, the plant will use large quantities of water, mostly in processing phase and related activities (cooling) but also for dust suppression among other uses. The project will need to focus on the appropriate management of their water balance (for example through reclamation, reuse and recycling of their process water).

The need for treated water for the Power Plant will give a good potential to furnish nearby population with clean water supply.

V.9.3.2. Storm Water

Key issues associated with management of storm water include separation of clean and dirty water, minimizing run-off, avoiding erosion of exposed ground surfaces, avoiding sedimentation of drainage systems and minimizing exposure of polluted areas to storm water.

V.9.4. General Waste

Much of the general waste (paper, plastic, cardboard etc.) is separated and incinerated on site due to lack of formal waste collection and lack of recycling vendors. Secondly, the peat storages may require cover with plastic sheeting to avoid unsuitable moisture of the stored peat. These plastic sheets need to be subject to proper waste management. This will impact on air quality, but could also result in poor quality leachate which could affect soil, surface water and groundwater if such waste is incinerated on site. A waste management plan must be devised and followed on site and a proper incineration/landfill system be implemented.

V.9.5. Land Use

The existing land use such as agriculture and settlement (close to peat power plant location) will be lost during peat harvesting and project operation. This will affect the income of the local population in the project zone.

V.9.6. Biodiversity

Habitat alteration is one of the most significant potential threats to biodiversity associated with this project. Habitat alteration may occur during any stage of this project cycle with the greatest potential for temporary or permanent alteration of terrestrial and aquatic habitats occurring during construction and operational activities. Peat harvesting, site clearing are expected to destroy the existing vegetation of the project zone. Impacts due to peat harvesting include loss of ground cover and the associated of wildlife habitat and existing vegetation. The significance on terrestrial flora

in this case is considered moderate to high as in some area of the project, the vegetation natural (papyrus).

V.9.7. Hydrological impacts

Potential hydrological impacts of peat harvesting include alteration or disruption of surface water flow patterns and changes in groundwater elevations. The impact of cooling water intake is assessed in *APPENDIX 8*, and shows that the required flow is less than 1% of the 1:100 years low flow in the Akanyeru River. Effluents produced from the drainage of the wetland will often contain a high level of suspended solids, which will be mitigated by sedimentation basins. The loss of absorbency of a peat may also increase the danger of flooding.

V.9.8. Air Quality

Management of ambient air quality at peat harvesting and processing sites is important. The harvesting activities (trucking, drying, earth disturbance, etc.) will contribute dust (particulates) to the atmosphere. The dust is expected mainly to contribute locally, since the normal wind speed at the site is low.

Peat harvesting and combustion will result in ash and others particulates creation and dispersion problems. The magnitude and chemical composition will be different over the bogs, transportation, and storage areas.

The primary emissions to air from the combustion of Peat are sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), carbon monoxide (CO), and greenhouse gases, such as carbon dioxide (CO_2). Other substances such as heavy metals (i.e., mercury, arsenic, cadmium, vanadium, nickel, etc.), halide compounds (including hydrogen fluoride), unburned hydrocarbons and other volatile organic compounds (VOCs) may be emitted in smaller quantities, but may have a significant influence on the environment due to their toxicity and/or persistence. Sulfur dioxide and nitrogen oxide are also implicated in long-range and trans-boundary acid deposition.

A dispersion model for the atmospheric contribution and dispersion of the air born pollutants is enclosed in *APPENDIX 3.* The results of the modeling for SO_x, NO_x and particulate matter, PM_{10}, has been compared with East African Guidelines, presented in *table 22*. Separate comparison with the IFC guidelines is also made.

Table 22. i) Ambient Air Quality Tolerance Limits in East African Community and ii) WHO Ambient Air Quality Guidelines

Pollutant	Time weighted Average				Test methods
		Industrial area	Residential, Rural & Other area	Controlled areas***	
Sulphur oxides (SO_x):	Annual Average*	80 µg/m³	60 µg/m³	15 µg/m³	IS0 4221-1980
	24 hours**	125 µg/m³	80 µg/m³	30 µg/m³	
	Annual Average		0.019 ppm/50µg/m³		
	Month Average				
	24 Hours		0.048ppm /125µg/m³		
	One Hour				
	Instant Peak		500 µg/m³		
	Instant Peak (10 min)		0.191 ppm		
Oxides of Nitrogen (NO_x):	Annual Average*	80 µg/m³	60 µg/m³	15 µg/m³	ISO7996: 1985
	24 hours**	150 µg/m³	80 µg/m³	30 µg/m³	
	8 hours				
	Annual Average		0.2 ppm		
	Month Average		0.3 ppm		
	24 Hours		0.4 ppm		
	One Hour		0.8 ppm		
	Instant Peak		1.4 ppm		
Nitrogen Dioxide	Annual Average	150 µg/m³	0.06 ppm		IS0 6768:1998
	Month Average		0.08 ppm		
	24 Hours	100 µg/m³	0.1 ppm		
	One Hour		0.2 ppm		
	Instant Peak		0.6 ppm		
Suspended particulate matter (SPM)	Annual Average*	360 µg/m³	140 µg/m³	70 µg/m³	ISO 9835:1993
	24 hours**	500 µg/m³	200 µg/m³	100 µg/m³	
		Industrial area	Residential, Rural & Other area	Controlled areas***	
	mg/Kg				
	Annual		100 µg/m³		

i) EAC

	Averaging Period	Guideline value in µg/m³
Sulfur dioxide (SO_2)	24-hour 10 minute	125 (Interim target-1) 50 (Interim target-2) 20 (guideline) 500 (guideline)
Nitrogen dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter PM_{10}	1-year 24-hour	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline) 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year 24-hour	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline) 75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

ii) WHO

Figures 12 - 15 presents the output from the model for NO_2, while *Figures 16 – 18* presents SO_2 values and *Figures 19 - 20* the PM_{10} results.

The figures representing the model results are presented for 100, 2*50 and 2*45 MWe power generation. All model results show that the emissions would be lower than the EAC Air Quality Tolerance Limits. Moreover, the amended Power Plant size to 35MWe would also be lower than the tolerance limits, and a new modeling run is thus not considered necessary.

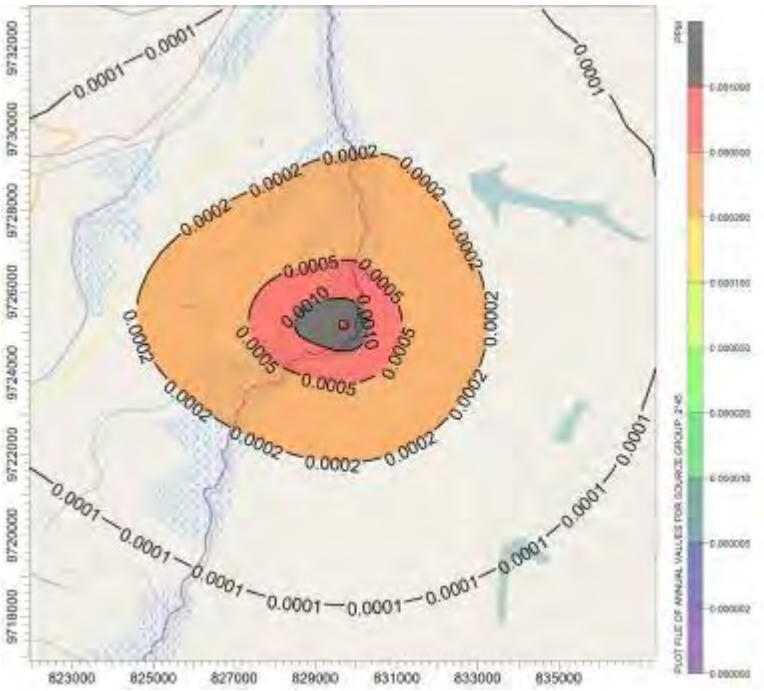


Figure 12. Annual Nitrogen dioxide NO_2 average from PP with 2*45 MWe

The model shows that the highest calculated value is lower than 0.002 ppm, the tolerance limit value is 0.05 ppm.

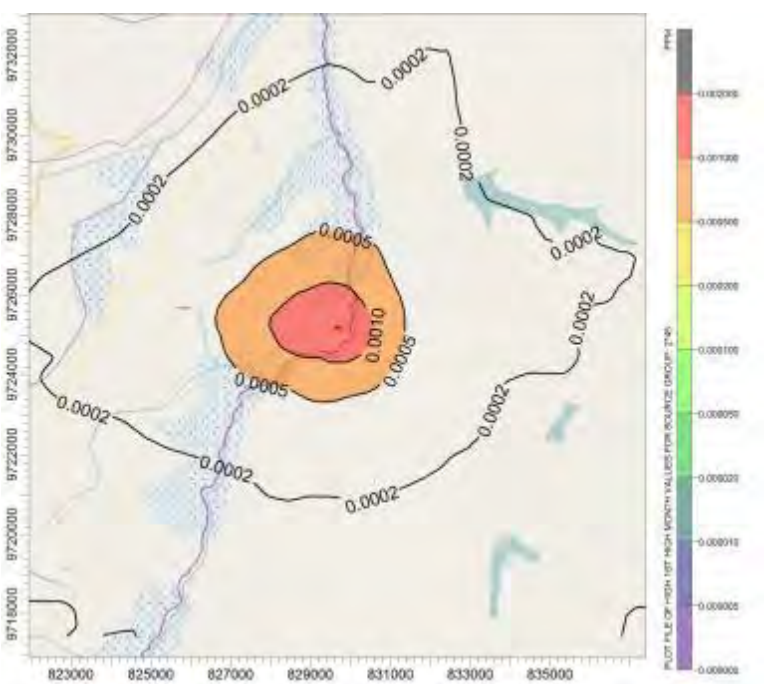


Figure 13. Maximum month average of NO_2 from PP with 2*45 MWe

The highest calculated value is lower than 0.002 ppm, the tolerance limit value is 0.08 ppm.

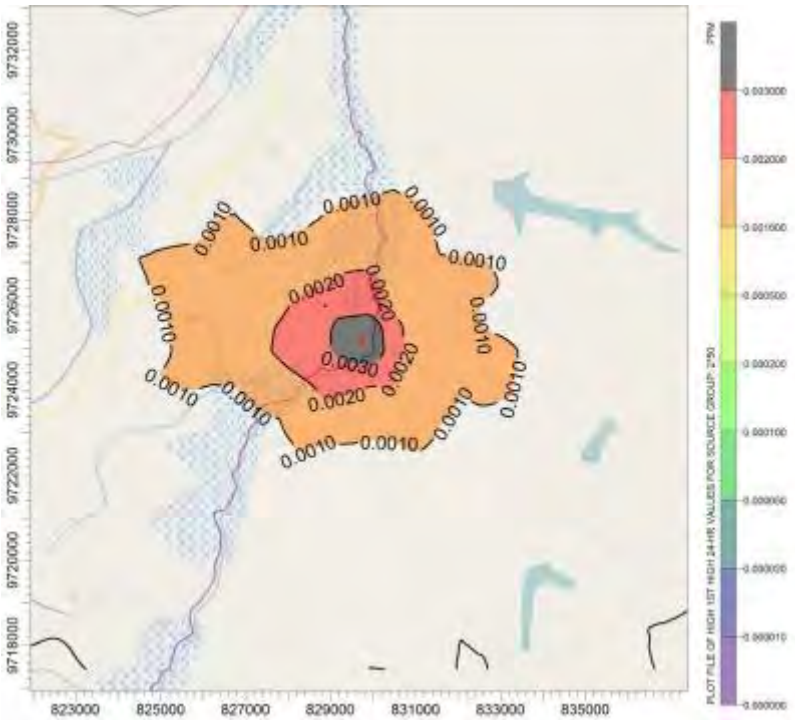


Figure 14. Daily NO_2 maximum values from PP with 2*45 MWe

The highest calculated value is lower than 0.006 ppm, the tolerance limit value is 0.1 ppm.

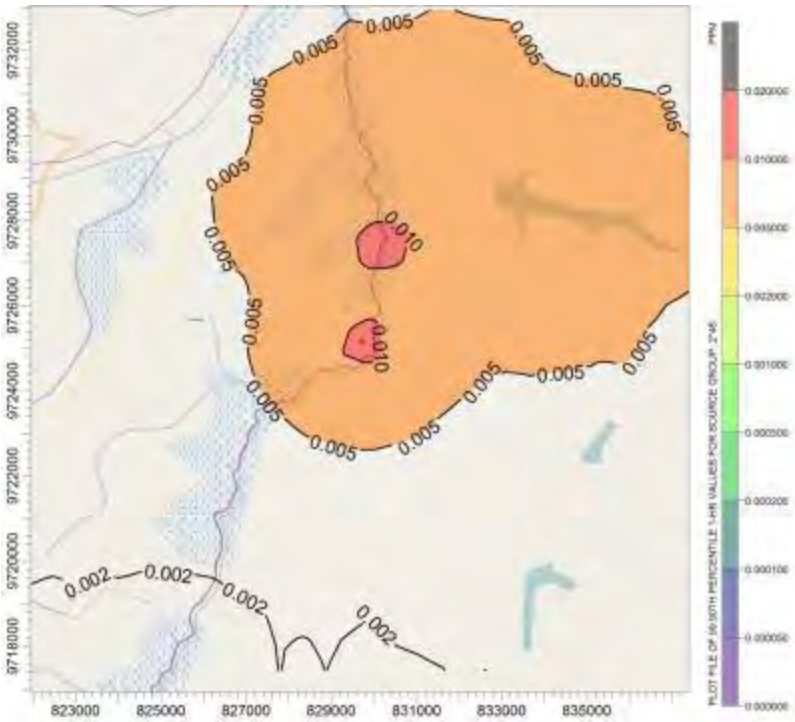


Figure 15. One hour maximum NO_2 values from PP with 2*45 MWe

The highest calculated value is lower than 0.02 ppm, the tolerance limit value is 0.2 ppm.

Below the model results for sulfur dioxide is shown for annual, daily and hourly means.

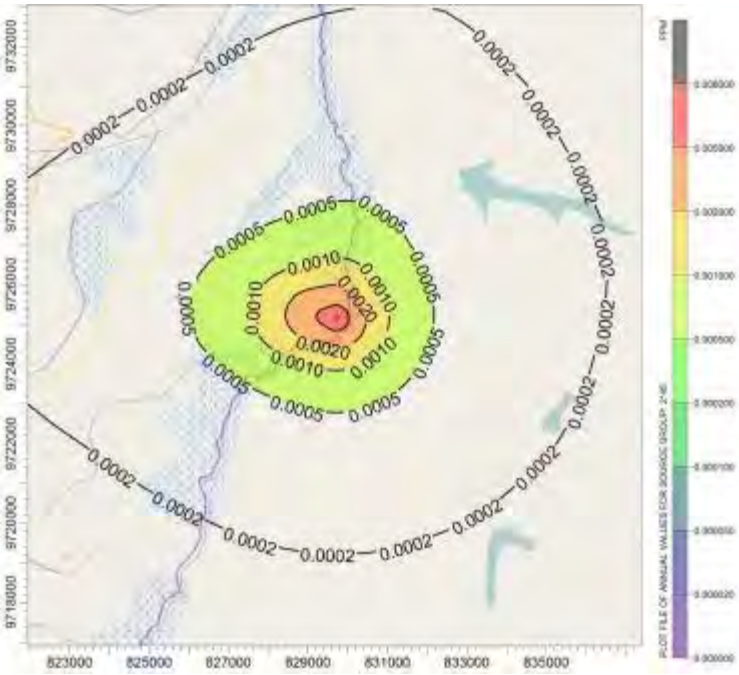


Figure 16. Annual SO_2 average from PP with 2*45 MWe

The highest calculated value is lower than 0.008 ppm, the tolerance limit value is 0.019 ppm.

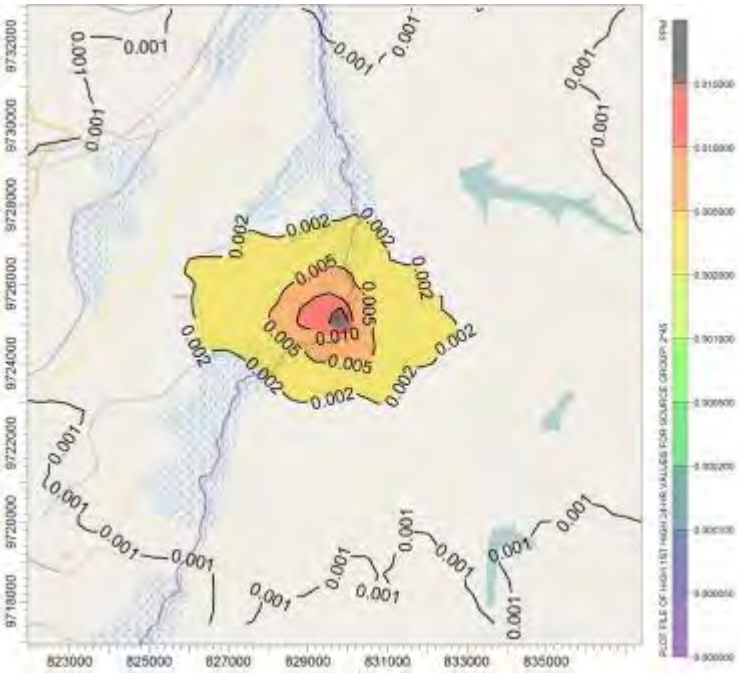


Figure 17. Daily maximum SO_2 values from PP with 2*45 MWe

The highest calculated value is lower than 0.03 ppm, the tolerance limit value is 0.048 ppm.

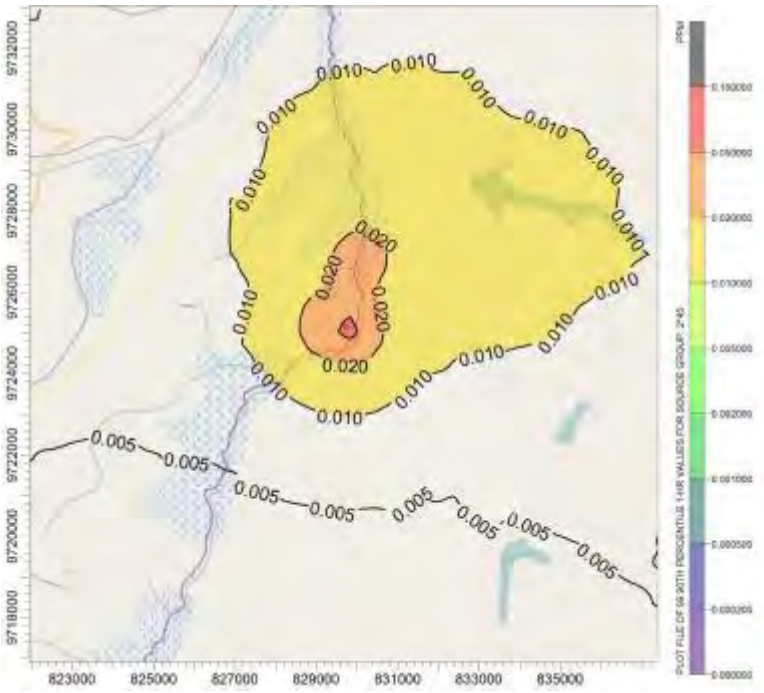


Figure 18. One hour maximum SO_2 values from PP with 2*45 MWe

The highest calculated value is lower than 0.1 ppm, the tolerance limit value is 0.19 ppm.

Particulate matter PM_{10} model results are presented below as annual and daily figures.

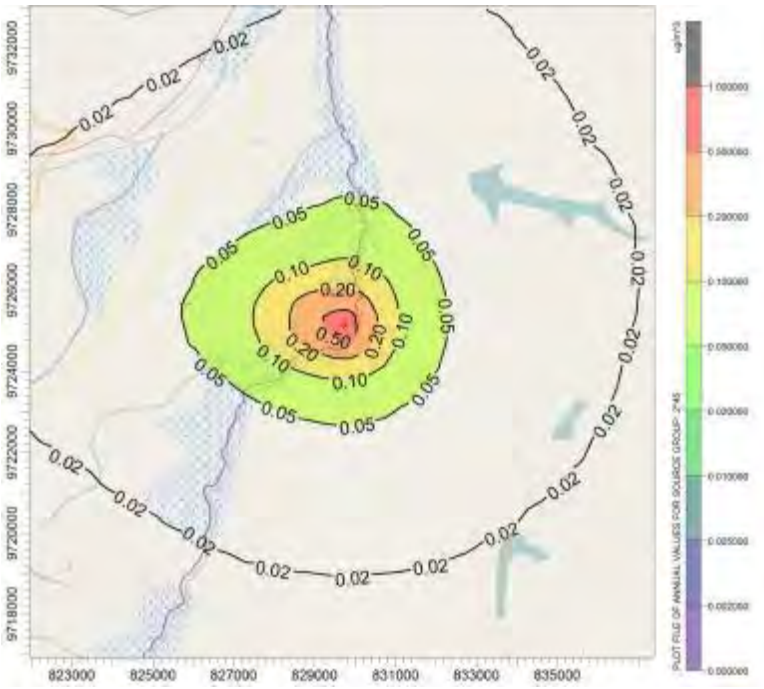


Figure 19. Annual average of PM_{10} from PP with 2*45 MWe

The highest calculated value is lower than 1 µg/m^3, the tolerance limit value is 50 µg/m^3.

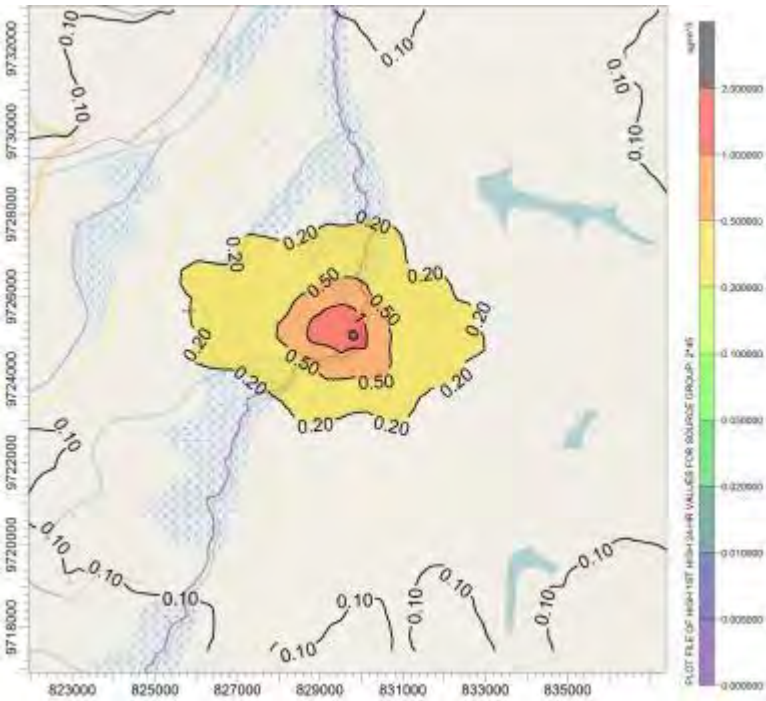


Figure 20.Daily maximum values of PM_{10} from PP with 2*45 MWe

The highest calculated value is lower than 4 µg/m^3; the tolerance limit value is 100 µg/m^3.

As presented in the figures, all data are well below the tolerance limit values. The EMP and the tender documents will specify the requirements on the equipment to be installed in in the Power Plant.

V.9.9. Energy Efficiency and GHG Emissions

Carbon dioxide, one of the major greenhouse gases (GHGs) under the UN Framework Convention on Climate Change, is emitted from the combustion of peat for electricity generation and appropriate mitigation measures will be required. *APPENDIX 4* presents the current research status on CHG emissions from peat bogs and peat harvesting.

Based on Swedish and Finnish studies (with emissions of 1000 CO_2 g m-2 yr-1), a peat production area of 800 ha would induce emissions of about 8 000 ton CO_2 g m-2 yr-1. Measurements from emissions of CH4 in summer during peat production reach to levels of 0,3-9,1 g CH4 m-2 yr-1. The assumed emissions of N2O is about 0,1-0,5 g m-2 yr-1. However, the estimates from the Nordic countries may not be representative for the Akanyeru valley, and research results from tropical areas are rare.

V.9.10. Water Consumption and Aquatic Habitat Alteration

Steam turbines used with boilers require a cooling system to condense steam used to generate electricity.
Water is also required for boiler makeup, auxiliary station equipment and ash handling systems.

The withdrawal of such large quantities of water has the potential to compete with other important water uses such as agricultural irrigation or drinking water sources. Withdrawal and discharge with elevated temperature and chemical contaminants such as biocides or other additives, if used, may affect aquatic organisms, including phytoplankton, zooplankton, fish, crustaceans and many other forms of aquatic life.

However, the make-up water required for the cooling system is only expected to be 300 $m^{3/}$hour or 0,9% of the minimum flow of the Akanyeru River at a recurrent period of 1:100 years. To allow for other water usage at the nearby plant, the withdrawal would be maximum 1% of the 1:100 years low flow.

Aquatic organisms drawn into cooling water intake structures are either impinged on components of the cooling water intake structure or entrained in the cooling water system itself. In the case of either impingement or entrainment, aquatic organisms may be killed or subjected to significant harm. In some cases, organisms are entrapped in the intake canals.

There may be special concerns about the potential impacts of cooling water intake structures located in or near habitat areas that support threatened, endangered, or other protected species or where local fishery is active.

Conventional intake structures include traveling screens with relative high through-screen velocities and no fish handling or return system. Measures to prevent, minimize, and control environmental impacts associated with water withdrawal should be established.

V.9.11. Effluents

Effluents from thermal power plants include thermal discharges, wastewater effluents and sanitary wastewater.

V.9.11.1. Thermal Discharges

In general, thermal discharge should be designed to ensure that discharge water temperature does not result in exceeding relevant ambient water quality temperature standards outside a scientifically established mixing zone. The mixing zone is typically defined as the zone where initial dilution of a discharge takes place within which relevant water quality. Since the cooling system is designed for evaporative cooling no temperature impact on the Akanyeru River will occur.

V.9.11.2. Liquid Waste

The wastewater streams include cooling tower blowdown; ash handling wastewater; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from ion exchange boiler water purification units.

The characteristics of the wastewaters generated depend on the ways in which the water has been used. Contamination arises from demineralizers; lubricating and auxiliary fuel oils; trace contaminants in the fuel (introduced through the ash-handling wastewater); and chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems.

V.9.11.3. Sanitary Wastewater

Sewage and other wastewater generated from washrooms, etc., are similar to domestic wastewater. This wastewater will be treated before discharge to the receiving river.

V.9.12. Solid Wastes

Akanyaru peat-fired power plants will generate a large amount of solid wastes due to the relatively high percentage of ash in the fuel. The large-volume peat combustion wastes (PCW) are fly ash, bottom ash and boiler slag.

Bottom ash includes slag and particles that are coarser and heavier than fly ash. Due to the presence of sorbent material, the wastes have a higher content of calcium and sulfate and a lower content of silica and alumina than conventional combustion wastes.

V.9.13. Hazardous Materials and Oil

Hazardous materials stored and used at combustion facilities include solid, liquid, and gaseous waste-based fuels; air, water, and wastewater treatment chemicals; and equipment and facility maintenance chemicals (e.g., paint certain types of lubricants, and cleaners).

V.9.14. Noise

Principal sources of noise include the turbine generators and auxiliaries; boilers and auxiliaries, such as peat pulverisers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers and cooling system.

Modelling of the noise point sources at the Power plant and the Peat Production is presented in *APPENDIX 5*. The figure below shows the sound level distribution from the Power Plant. Other sound sources are the transport vehicles from the peat storage areas to the power plant, calculated at ca. 12 return trips per day. The sound from tractors operating at the peat production is substantially reduced by the peat bog itself, and standard noise prevention equipment will be sufficient to reach acceptable sound levels in the surroundings. The requirements for noise prevention will be specified in the Tender Documents for the Contractors and in the EMP.

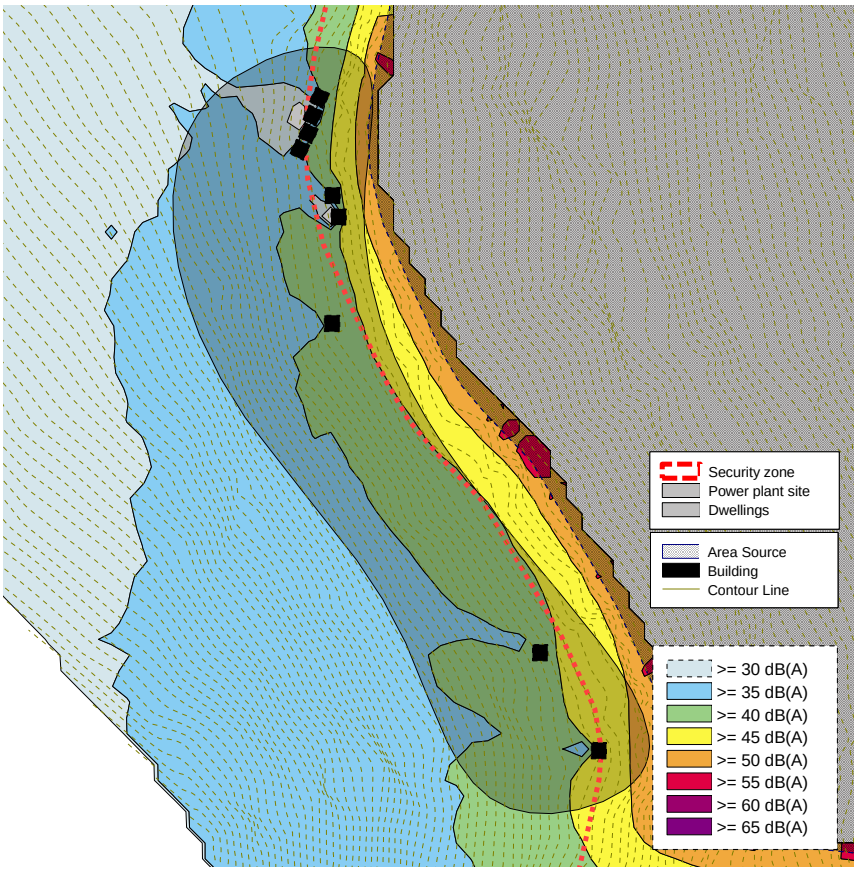


Figure 21. Power plant modelled as an area source 2 m above ground with a sound power level of 90 dB(A) Coloured fields represent equivalent sound level 2 m above ground

Good practice in the prevention and control of noise sources should be established based on the prevailing land use and the proximity of noise receptors such as communities or community use areas.

V.10. Occupational Health and Safety

Occupational health and safety risks during construction, operation, and decommissioning of this project will depend on the type of activity and on the location.

In addition to the risk of accident and injuries during the peat harvesting and preparation, the following health and safety impacts are of particular concern during operation of the power plant:

- Non-ionizing radiation
- Heat
- Noise
- Confined spaces
- Electrical hazards
- Fire and explosion hazards
- Chemical hazards
- Dust

V.10.1. Non-ionizing radiation

Combustion facility workers may have a higher exposure to electric and magnetic fields (EMF) than the general public due to working in proximity to electric power generators, equipment, and connecting high-voltage transmission lines. Occupational EMF exposure should be prevented or minimized through the preparation and implementation of an EMF safety program.

V.10.2. Heat

Occupational exposure to heat will occur during operation and maintenance of combustion units, pipes, and related hot equipment.

V.10.3. Noise

Noise sources in the Power Plant include the turbine generators and auxiliaries; boilers and auxiliaries, such as pulverisers; diesel engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling systems etc.

V.10.4. Confined Spaces

Specific areas for confined space entry may include peat ash containers, turbines, condensers, and cooling water towers (during maintenance activities).

V.10.5. Fire and Explosion Hazards

The Akanyaru peat fired power plant will store, transfer, and use large quantities of peat and fuels; therefore, careful handling is necessary to mitigate fire and explosion risks. In particular, fire and explosion hazards increase as the particle size of peat is reduced.

Particle sizes of peat that can fuel a propagating explosion occur within thermal dryers, cyclones, bag houses, pulverized-fuel systems, grinding mills, and other process or conveyance equipment.

V.10.6. Chemical Hazards

The peat fired power plant project will use hazardous materials, including ammonia for NO_X control systems, and chlorine and other chemical for treatment of cooling tower and boiler water.

V.10.7. Dust

Dust is generated during handing solid fuels, additives, and solid wastes (e.g., ash). Dust may contain silica (associated with silicosis), arsenic (skin and lung cancer), peat dust (black lung), and other potentially harmful substances. Dust management should be done in appropriate way.

VI. MITIGATION MEASURES OF ADVERSE IMPACTS

VI.1. General Environmental Management Conditions

HAKAN/YUMN and the Contractors to be hired for the implementation of the Project shall implement all measures necessary to avoid undesirable adverse environmental and social impacts wherever possible, restore work sites to acceptable standards, and abide by any environmental performance requirements specified in an Environmental and Social Management Plan. In general these measures shall include but not be limited to:

- Minimize the effect of dust on the surrounding environment resulting from peat harvesting, preparation, combustion and other earth works on the sites, vibrating equipment, temporary access roads, etc. to ensure safety, health and the protection of workers and communities living in the vicinity of dust producing activities.
- Ensure that noise levels emanating from machinery, vehicles and noisy construction activities (e.g. excavation) are kept to a minimum for the safety, health and protection of workers within the vicinity of high noise levels and nearby communities.
- Ensure that existing water flow regimes in rivers, streams and other natural or irrigation channels is maintained and/or re-established where they were/are disrupted due to works being carried out.
- Prevent oils, lubricants and waste water used or produced during the execution of works from entering into rivers, streams, irrigation channels and other natural water bodies/reservoirs, and also ensure that stagnant water in uncovered borrow pits is treated in the best way to avoid creating possible breeding grounds for mosquitoes and other water-related pathogens which may be harmful to humans.
- Prevent and minimize the impacts of peat harvesting, earth borrowing, piling and building of temporary construction camps and internal access roads on the biophysical environment including protected areas and arable lands, local communities and their settlements. In as much as possible restore/rehabilitate all sites to acceptable standards.
- Upon discovery of ancient heritage sites/artefacts, relics or anything that might or is believed to be of archaeological or historical importance during the execution of works, immediately report such findings to the local authorities, so that measures aimed at protecting such historical or archaeological resources can be taken.

- Discourage construction workers from engaging in any activity that might have a negative impact on the social and economic welfare of the local communities.
- Implement soil erosion control measures in order to avoid surface run off and prevents siltation.
- Ensure that garbage, sanitation and drinking water facilities are provided in construction workers camp; and as far as practicable, to the nearby population.
- Ensure that as much as possible, local materials are used to avoid importation of foreign material and long distance transportation.
- Ensure public safety, and meet traffic safety requirements for the operation to avoid accidents.
- HAKAN/YUMN shall indicate the period within which it shall maintain status on site after completion of civil works to ensure that significant adverse impacts arising from such works have been appropriately addressed.
- The machines used will have to be of the size and design adapted to the nature of the work. The noisy machines will have to be as sound-proof as possible to comply with relevant industrial noise and ambient noise guidelines.
- As far as it is possible, the recruitment of unspecialized manpower should benefit the population of the area of the project and thus contribute to poverty reduction.
- Appropriate safety measures will be installed on the working sites and in the areas to ensure the safety of the workers and the neighbouring population.
- The entirety of solid and liquid wastes generated by the building site, including packages, food waste, will have to be collected and removed to an adequate dumping place. A proper incinerator/landfill facility should be established to reduce impacts on air quality through emissions.
- Drained oils will be carefully collected in water tight containers and deposited in places where they will not threaten the environment and will not under any circumstances be poured into ditches or other areas not specifically designed for containment of hydrocarbons.
- Adequate installations of temporary drainage will be designed and constructed to prevent the effect of excessive water runoff.

Appendix-1 indicates the **Environmental Guidelines** for Contractors who will be undertaking some activities of Akanyaru Peat fired power plant project.

VI.2. Specific Mitigation Measures

VI.2.1. Mitigation measures of negative impacts on human environment

Suggested mitigation measures to avoid/reduce negative impacts on human environment during construction and operation phases of Akanyaru peat production and fired power plant project are summarized below.

VI.2.1.1. Expropriation

HAKAN/YUMN in collaboration with local authorities will inform at an appropriate time the concerned population and it will be necessary to proceed to their compensation before the beginning of the works in order to avoid all kinds of conflicts. The affected persons should have a priority of job during the recruitment in the beginning of project activities.

VI.2.1.2.Traffic congestion management

The incidence of road accidents involving project vehicles during construction and operation of Akanyaru peat fired power plant project should be minimized through a combination of education and awareness-raising. Prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those who are most vulnerable to road traffic accidents. Provision of traffic signs and humps where needed for speed reduction will be necessary.

VI.2.1.3. Dealing with noise pollution

During peat harvesting, construction and decommissioning activities, noise and vibration may be caused by the operation of pile drivers, earth moving and excavation equipment, concrete mixers, cranes and the transportation of equipment, materials and people. Some recommended noise reduction and control strategies to consider in areas close to community areas include:

- Planning activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance,
- Avoiding or minimizing project transportation through community areas.

VI.2.1.4. Dealing with sexually-transmitted diseases (STDs)

Communicable diseases due to labor mobility are sexually-transmitted diseases (STDs), such as HIV/AIDS. Recognizing that no single measure is likely to be effective in the long term, successful initiatives typically involve a combination of behavioral and environmental modifications. Recommended interventions at the project level include:

- Providing surveillance and active screening and treatment of workers,
- Preventing illness among workers in local communities by:

(i) Undertaking health awareness and education initiatives, for example, by implementing an information strategy to reinforce person-to-person counseling addressing systemic factors that can influence individual behavior as well as promoting individual protection, and protecting others from infection, by encouraging condom use,

(ii) Training health workers in disease treatment,

(iii) Conducting immunization programs for workers in local communities to improve health and guard against infection,

(iv) Providing health services,

(v) Providing treatment through standard case management in on-site or community health care facilities.

(vi) Ensuring ready access to medical treatment, confidentiality and appropriate care, particularly with respect to migrant workers

(vii) Promoting collaboration with local authorities to enhance access of workers families and the community to public health services and promote immunization

VI.2.1.5. Construction accident/ injuries

Suggested measures to prevent and/or to minimize that type of impacts include:

- Providing all workers with appropriate personnel protecting equipment (PPE) e.g. dust masks, rubber boots, gloves, safety glasses and helmets.
- Training the workers and make sure they always use the PPE
- A functional first aid box should be kept on site and a standby ambulance in place to rush any injured to the nearby health units;

VI.2.1.6. Loss of production

The population which exploited the fields located in the area of the project activities will have to be compensated according to the national expropriation law.

VI.2.2. Mitigation measures of negative environmental impacts

VI.2.2.1. Geological Alteration

The removal of peat and alteration of geological composition at the harvesting site cannot be mitigated. However as peat harvesting progresses, it should be feasible to convert the peat mined area into basins for fish farming or bird refuges.

Depending on the size of the peat harvest area, the suggested mitigation measure for this impact is the implementation of a properly engineered rehabilitation strategy.

VI.2.2.2. Soil

A soil monitoring programme will be implemented to evaluate the level of soil contamination on site. Materials handling and storage areas will be constructed and plans developed to ensure the proper handling and storage of all onsite materials to minimise the risk to the environment.

Soil handling procedures will include removing all useable soils from construction areas and stockpiling these onto clean areas so as to prevent contamination to these soils. Long-term stockpiles should be seeded with local indigenous plants to stabilize these and reduce risk of erosion.

The topsoil that will be removed from the upper 0,5-1 m of the peat bogs will primarily be utilised for preparation of dykes. Excess soil may be provided to nearby farmland to improve the organic content of the soils, and its texture.

In order to reduce the soil compaction, the use of machines on the bogs themselves which have the potential for minimizing soil damage, due to their high surface area.

VI.2.2.3.Water Use and Quality

Water Use

For Akanyaru peat fired power plant project, recommended practices for water use management include:

- Establishing a water balance for the whole project, also taking into account the water needs for the nearby population and use this to improve the infrastructure of water management;
- Developing a Sustainable Water Supply Management Plan to minimize impact to natural systems by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users;
- Minimizing the amount of make-up water and recycle power plant water as far as possible;
- Consider reuse, recycling, and treatment of process water where feasible;
- Use water on site conservatively and responsibly and create awareness amongst staff on responsible water use practices; and
- Provide treated water supply to nearby residents.

Water Quality

Recommended practices to manage impacts to water quality include:

- The quality and quantity of PFPP project effluents discharged to the environment, including storm water, process effluents, and overall peat harvesting works drainage should be managed and treated to meet the applicable effluent discharge guideline values;
- In addition, discharges to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria outside a scientifically established mixing zone. Receiving water-body use and assimilative capacity, including the impact of other sources of discharges to the receiving water, should be considered with respect to acceptable contaminant loadings and effluent discharge quality;
- Efficient oil and grease traps or sumps should be installed and maintained at refuelling facilities, workshops, fuel storage depots, and containment areas, and spill kits should be available with emergency response plans;
- Sedimentation basins need to be provided to avoid that suspended peat particles would reach the Akanyeru River, design criteria proposed to be $5m^2$ per ha;
- Water quality in open storage systems should be based on the results of a site specific risk assessment with appropriate control measures put in place to mitigate the risk and meet the effluent guideline values;
- Sanitary wastewater should be managed via reuse or routing into septic or surface treatment; and
- Water that does not meet the effluent guideline values will be contained on site and evaporated or reused or treated to acceptable standards prior to release into the environment. Effluent criteria are presented in *table 22.*

Storm Water

Key issues associated with management of storm water include separation of clean and dirty water, minimizing run-off, avoiding erosion of exposed ground surfaces, avoiding sedimentation of drainage systems and minimizing exposure of polluted areas to storm water.

Table 22: Effluent Guidelines[13]

Pollutants	Units	Guideline value
Total Suspended Solids	mg/L	50
pH	-	6-9
COD	mg/L	150
DBO5	mg/L	50
Oil and grease	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.05
Chromium (VI)	mg/L	0.1
Copper	mg/L	0.3
Iron (total)	mg/L	2.0
Lead	mg/L	0.1

For Akanyaru PFPP project, recommended storm water management strategies have been broadly categorized into phases of operation (although several measures span more than one phase including the decommissioning and closure phase).

VI.2.2.4. Land and Biodiversity Protection

The protection and conservation of biodiversity is fundamental to sustainable development. Integrating conservation needs and development priorities in a way that meets the land use needs of local communities is often a critical issue for this kind of project.

Temporary and permanent terrestrial habitat alteration should be minimized to the extent feasible and be consistent with the requirement to protect and preserve critical habitat. Recommended strategies include consideration of the following:

- Siting access internal routes and facilities in locations that avoid impacts to critical terrestrial habitat, and planning construction activities to avoid sensitive times of the year;
- Minimizing disturbance to vegetation and soils;
- Implementation of mitigation measures appropriate for the type of habitat and potential impacts including, for example, post-operation restoration

[13] Source: United Nations Environment Programme (UNEP) Mineral Resources Forum {http://www.uneptie.org/pc/mining/mrfvision.htm}

(which may include baseline inventories, evaluations, and eventual rescue of species), offset of losses, or compensation of direct users;

- Avoiding or minimizing the creation of barriers to wildlife movement, or threats to migratory species (such as birds) and providing alternative migration routes when the creation of barriers cannot be avoided;
- Planning and avoiding sensitive areas and implementing buffer zones around such areas;
- Conducting activities such that the risk of landslides, debris or mud flows, and bank or alluvial fan destabilization is minimized;
- Implementing soil conservation measures as discussed under soils above;
- Topsoil management should include maintenance of soil integrity in readiness for future use;
- Conserving the quality and composition of growth medium for use (e.g. for capping) during site reclamation and closure activities;
- Ensuring that the growth medium is sufficient to support native plant species appropriate for the local climate and consistent with proposed future land uses.
- Overall thickness of the growth medium should be consistent with surrounding undisturbed areas and future land use; and
- Manage vegetation growth along access roads and at permanent above-ground facilities. Remove invasive plant species and replant native species. Vegetation control should employ biological, mechanical and thermal vegetation control measures and avoid the use of chemical herbicides as much as possible. Invasive species should not be removed while seeding, and if this is unavoidable should be conducted carefully so as not to distribute seeds.

VI.2.2.5. Mitigation measures of hydrological impacts

Suggested mitigation measures of potential hydrological impacts of peat harvesting are indicated in *table 23.*

Table 23: Potential hydrological impacts of peat harvesting and the suggested mitigation measures

Impacts	Mitigation Measures
1. **Removal of ground cover**	
• Loss of existing land use	• Development of detailed for post-harvesting land development
• Loss or disruption of rare or endangered plant species	• Conduct botanical survey to determine extent of rare or

Impacts	Mitigation Measures
	endangered plant species; • Plan site to avoid these areas where possible; • Attempt to transfer to similar habitat.
• Loss or disruption of wildlife habitat	• Conduct survey to determine presence of wildlife habitat at harvesting site; avoid habitat areas where possible and keep site size to a minimum.
2. Disruption of existing surface and ground waters	
• Modification of ground water elevation due to loss of water-holding peat	• Construct holding basins to mimic water detention functions of peat land.
• Increased floodwater flow	• Use holding basins and gradually pumping of excess water from the site.
• Modification of nearby water flow patterns	• Assess the impact of altered water flow patterns on local land use and; if the impacts are undesired, use holding ponds to collect excess water.
3. Changes in water quality	
• Discharge of acidic waters	• Holding ponds where run-off treated to restore pH levels prior to release from the site; • Buffer zone around the site
• Increased BOD/COD	• Holding ponds where BOD/COD normalized through natural aeration and biological and chemical oxidation. • Buffer zone around the site.
• Increased discharge of colloidal, nutrients and settleable solids and heavy metals	• Holding ponds where wastewater will settle and unwanted substances can be removed and treated. • Buffer zone around the site.

VI.2.2.6. Air Quality

Management of ambient air quality at the project sites is important due to the nature of this project (peat harvesting and peat fired power plant).

Recommended measures to prevent, minimize, and control air emissions include:

- Considering beneficiation to reduce ash content,
- Watering and compaction of ash landfill for dust prevention,
- Selection of the best power generation technology for the peat to balance the environmental and economic benefits.

Pollutant-specific control recommendations are provided below.

A) Sulfur Dioxide

Recommended measures to prevent, minimize, and control SO_2 emissions include:

- Use of lime or limestone ($CaCO_3$) in fluidized bed combustion boilers to have integrated desulfurization which can achieve a removal efficiency of up to 80-90 % through use of Fluidized Bed Combustion

B) Nitrogen Oxides

Formation of nitrogen oxides can be controlled by modifying operational and design parameters of the combustion process (primary measures). Additional treatment of NO_X from the flue gas (secondary measures) may be required. Measures to prevent, minimize, and control NO_X emissions should be included

C) Particulate Matter (Ash)

Particulate matter is emitted from the combustion process. The proven technologies for particulate removal in power plants are fabric filters and electrostatic precipitators (ESPs).

Particulate matter can also be released during transfer and storage of peat and additives, such as lime. Recommendations to prevent, minimize, and control particulate matter emissions include:

- Installation of dust controls capable of over 99% removal efficiency, such as ESPs or Fabric Filters (bag houses). The advanced control for particulates is a wet ESP, which further increases the removal efficiency and also collects condensables (e.g. sulfuric acid mist) that are not effectively captured by an ESP or a fabric filter;
- Use of water spray systems to reduce the formation of fugitive dust from peat storage;
- Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust;
- Design and operate transport systems to minimize the generation and transport of dust on site;
- Storage of lime or limestone in silos with well designed, extraction and filtration equipment;

- Use of wind fences / covers in open storage of peat or use of enclosed storage structures to minimize fugitive dust emissions where necessary, applying special ventilation systems in enclosed storage to avoid dust explosions (e.g., use of cyclone separators at peat transfer points).
- Ash disposal in landfill as the peat ash may be suitable for road construction or/and as a soil conditioner and fertilizer. This opportunity will be investigated.

VI.2.2.7. Energy Efficiency and GHG Emissions

Carbon dioxide, one of the major greenhouse gases (GHGs) under the UN Framework Convention on Climate Change, is also emitted from the combustion of peat in peat fired power plant.

Recommendations to avoid, minimize, and offset emissions of carbon dioxide from thermal power plants include, among others:

- Use of higher energy conversion efficiency technology,
- Use of high performance monitoring and process control techniques, good design and maintenance of the combustion system so that initially designed efficiency performance can be maintained;

VI.2.2.8. Water Consumption and Aquatic Habitat Alteration

Recommended management measures to prevent or control impacts to water resources and aquatic habitats include:

1. Conserving water resources by:
   - Use of a closed-cycle, recirculating cooling water system (e.g., natural or forced draft cooling tower), or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts.
   - Use of dry scrubbers in situations where these controls are also required.
   - Use of air-cooled systems.

2. Reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets (seasonal or year-round), fish handling and return systems, fine mesh screens, wedge wire screens, and aquatic filter barrier systems.

VI.2.2.9. Effluents management

A) <u>Management of Thermal Discharges</u>

Thermal discharges should be designed to prevent negative impacts to the receiving water taking into account the following criteria:

- The elevated temperature areas because of thermal discharge from the project should not impair the integrity of the water body as a whole or endanger sensitive areas (such as recreational areas, breeding grounds, or areas with sensitive biota);

- There should be no lethality or significant impact to breeding and feeding habits of organisms passing through the elevated temperature areas;
- There should be no significant risk to human health or the environment due to the elevated temperature or residual levels of water treatment chemicals.

Recommendations to prevent, minimize, and control thermal discharges include:

- Use of multi-port diffusers;
- Adjustment of the discharge temperature, flow, outfall location, and outfall design to minimize impacts to acceptable level (i.e., extend length of discharge channel before reaching the surface water body for pre-cooling or change location of discharge point to minimize the elevated temperature areas);
- Use of a closed-cycle, recirculating cooling water system, or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts.

Since the PP would be constructed with evaporative cooling, no temperature impact on Akanyeru River will occur.

B) *Liquid Wastes Management*

Recommended measures to prevent, minimize, and control wastewater effluents from thermal power plants include:

- Collection of fly ash in dry form and bottom ash in drag chain conveyor systems;
- Use of infiltration and runoff control measures such as compacted soils, protective liners, and sedimentation basins and other controls for runoff from peat piles;
- Spraying of peat piles, possibly with anionic detergents to inhibit bacterial growth and minimize acidity of leachate
- Treatment of low-volume wastewater streams that are typically collected in the boiler and turbine room sumps in conventional oil-water separators before discharge;
- Treatment of acidic low-volume wastewater streams, such as those associated with the regeneration of makeup demineralizer and deep-bed condensate polishing systems, by chemical neutralization in-situ before discharge;
- Elimination of metals such as chromium and zinc from chemical additives used to control scaling and corrosion in cooling towers;
- Use the minimum required quantities of chlorinated biocides in place of brominated biocides or alternatively apply intermittent shock dosing of chlorine as opposed to continuous low level feed.

VI.2.2.10. Solid Wastes Management

Recommended measures to prevent, minimize, and control the volume of solid wastes from peat fired power plant include:

- Dry handling of the peat combustion wastes, in particular fly ash. Dry handling methods do not involve surface impoundments and, therefore, do not present the ecological risks identified for impoundments;
- Management of ash disposal and reclamation so as to minimize environmental impacts – especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff due to seasonal precipitation and flooding. In particular, construction, operation, and maintenance of surface impoundments should be conducted in accordance with internationally recognized standards, and dust control.
- Landfilling of the ashes will be proposed to occupy an area sufficient for 8 years of ash disposal. No coverage of the ashes is expected to be required, since the physical and chemical properties do not enhance leaching from the waste. Secondly, any secondary industry that would use the ashes as raw material for road or any other construction activities would be prevented if the ashes are to be covered by mineral soil or the like. A principal layout and proposed location of the landfill is enclosed in *APPENDIX 6.* The ashes shall be watered and possibly compacted to prevent and minimise dust generation ad spreading.

VI.2.2.11. Management of Hazardous Materials and Oil

Recommended measures to prevent, minimize, and control hazards associated with hazardous materials storage and handling for this project include spill prevention, the use of double-walled, underground pressurized tanks for storage of pure liquefied ammonia (e.g., for use as reagent for SCR) in quantities over 100 m^3; tanks of lesser capacity should be manufactured using annealing processes (EC 2006).

Working areas should be provided with adequate ventilation and dust/fume extraction systems to ensure that inhalation exposure levels for potentially corrosive, oxidizing, reactive or siliceous substances are maintained and managed at safe levels. In addition eye wash and emergency shower systems should be provided in areas where there exists the possibility of chemical contamination of workers and the need for rapid treatment.

VI.2.2.12. Occupational Health and Safety

For this project, as a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of Non-ionizing radiation, Heat, Noise, Confined spaces, Electrical hazards, Fire and explosion hazards, Chemical hazards and Dust.

(i) **Non-ionizing radiation***:* Occupational EMF exposure should be prevented or minimized through the preparation and implementation of an EMF safety program including the following components:

- Identification of potential exposure levels in the workplace, including surveys of exposure levels and the use of personal monitors during working activities;
- Training of workers in the identification of occupational EMF levels and hazards;
- Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers;
- Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non- Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE). Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent).
- Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials.

(ii) ***Heat:*** Recommended prevention and control measures to address heat exposure at peat fired power plants include:

- Regular inspection and maintenance of pressure vessels and piping;
- Provision of adequate ventilation in work areas to reduce heat and humidity;
- Reducing the time required for work in elevated temperature environments and ensuring access to drinking water;
- Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc;
- Use of warning signs near high temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.

(iii) ***Noise:*** *R*ecommendations to prevent, minimize, and control occupational noise exposures for this project include:

- Provision of sound-insulated control rooms with noise levels below 60 dBA;
- Design of generators to meet applicable occupational noise levels;

- Identify and mark high noise areas and require that personal noise protecting gear is used all the time when working in such high noise areas (typically areas with noise levels >85dBA)

(iv) **<u>Confined Spaces</u>:** Recommended management approaches include:

- Engineering measures should be implemented to eliminate, to the degree feasible, the existence and adverse character of confined spaces.
- Permit-required confined spaces should be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible. The area adjoining an access to a confined space should provide ample room for emergency and rescue operations,
- Prior to entry into a permit-required confined space:
  - Process or feed lines into the space should be disconnected or drained, and blanked and locked-out.
  - Mechanical equipment in the space should be disconnected, de-energized, locked-out, and braced, as appropriate.
  - The atmosphere within the confined space should be tested to assure the oxygen content is between 19.5 percent and 23 percent, and that the presence of any flammable gas or vapor does not exceed 25 percent of its respective Lower Explosive Limit (LEL).
  - If the atmospheric conditions are not met, the confined space should be ventilated until the target safe atmosphere is achieved, or entry is only to be undertaken with appropriate and additional PPE.
- Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary PPE, as well as the serviceability and integrity of the PPE should be verified.

(v) ***Electrical Hazards:*** Recommended measures to prevent, minimize, and control electrical hazards at thermal include:

- Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energisation;
- Use of voltage sensors prior to and during workers' entrance into enclosures containing electrical components;
- Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them;
- Provision of specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training should include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification,

proper use of PPE, proper lockout/tagout procedures, first aid including CPR, and proper rescue procedures. Provisions should be made for periodic retraining as necessary.

(vi) **Fire and Explosion Hazards:** Recommended measures to prevent, minimize, and control fire and explosion hazards include:

- Use of automated combustion and safety controls;
- Proper maintenance of boiler safety controls;
- Implementation of startup and shutdown procedures to minimize the risk of suspending hot peat particles (e.g., in the pulveriser, mill, and cyclone) during startup;
- Regular cleaning of the facility to prevent accumulation of peat dust (e.g., on floors, ledges, beams, and equipment);
- Removal of hot spots from the peat stockpile (caused by spontaneous combustion) and spread until cooled, never loading hot peat into the pulverized fuel system;
- Use of automated systems such as temperature gauges or carbon monoxide sensors to survey peat storage areas to detect fires caused by self-ignition and to identify risk points.

(vii) **Chemical Hazards:** Chemical hazards can most effectively be prevented through a hierarchical approach that includes:

- Replacement of the hazardous substance with a less hazardous substitute
- Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits
- Keeping the number of employees exposed, or likely to become exposed to a minimum,
- Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel,
- Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE,

(viii) ***Dust:*** Recommended measures to prevent, minimize, and control occupational exposure to dust in thermal power plants include:

- Use of dust controls (e.g. exhaust ventilation) to keep dust below applicable guidelines,

- Storage for dusty materials should be enclosed or operated with efficient dust suppressing measures;
- Loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and use of dust suppression spray systems should be considered; and
- Conveyor systems for dusty materials should be covered and equipped with measures for cleaning return belts.

VI.2.2.13. Visual Impacts

HAKAN/YUMN and Contractors should prevent and minimize negative visual impacts through consultation with national (MINIRENA, RNRA, REMA) and local authorities (Gisagara and Nyanza districts) about potential post-closure land use, incorporating visual impact assessment into the peat mine reclamation process. Reclaimed lands should, to the extent feasible, conform to the visual aspects of the surrounding landscape. The reclamation design and procedures should take into consideration the proximity to public viewpoints and the visual impact within the context of the viewing distance.

VI.2.2.14. Water Storage Dams (WSD) and Sedimentation Ponds (SP)

Water storage dams and sedimentation ponds can potentially create and change the existing pattern of vector breeding sites. In areas where malaria is common, the shorelines of the WSD and SP may create a mosquito breeding site because of the presence of a large, shallow and vegetated shoreline. In addition, the WSD and SP may also create a new breeding site for the snail host of schistosomiasis. Recommended mitigation measures include ***Specific Vector Control and Prevention Strategies*** *by* reducing the impact of vector-borne disease (e.g. malaria) on the long- term health of workers and in local communities, which are best accomplished through implementation of an integrated set of interventions aimed at eliminating the factors that lead to disease. Therefore, there are significant roles for both project engineering and medical staff. HAKAN/YUMN, in close collaboration with community health authorities, should implement an integrated control strategy for mosquito and other arthropod-borne diseases that should generally involve:

- Increase malaria awareness in the project zone and community.
- Implementation of an integrated vector control program;
- Engineering design reviews including careful scrutiny of water storage and control facilities and surface water management strategies; and

- Collaboration and exchange of in-kind services with other control programs in the project area to maximize beneficial effects, particularly distribution of treated bed nets.

VI.2.2.15. Peat harvesting site Security and Public Safety

There will be a restricted zone around the peat harvesting sites. No unauthorised person will be allowed to enter the sites. HAKAN/YUMN will keep the community informed regarding peat harvesting operations and social and environmental issues and seek to discuss future plans with Government and local authorities.

All hazardous areas will be sign posted and fenced off if necessary and the public informed of the associated dangers of inadvertent peat harvesting site access after closure through the company's on-going public consultation programme.

VII. ANALYSIS OF ALTERNATIVES

This section analyses the possible alternatives of this project in particular the project site selection, peat harvesting methods, zero scenario, and peat firing technology.

VII.1. Project Site

The project site selection has been based on availability of raw material (peat and water).

The location of different infrastructures (peat fired power plant, internal access roads, and other facilities) is in function of peat location, topography and the main project access road.

VII.2. Peat harvesting Method

Three methods have been considered: dry method, digging method and dredging method. Project feasibility study has recommended the dry method which uses the following steps:

- The peat bog is protected against flooding by two to three metres high walls built around the production area. The material of the walls is made from the vegetation, the surface soil and soil from canals that will be built. The wall will be strengthened with geotextiles to resist erosion. Fast growing grass will be sown. Parallel to and outside of the wall, a canal will be excavated where required; its water flow being from the surrounding hills to the river. In some places, existing ditches will be gutted and used as canals.
- The bog will be built in a traditional way with small ditches, spaced at a ca. 20m distance, and surrounded by large ditches (main ditches) near the inside of the walls. The small ditches (trenches) lower the groundwater level within the production field.
- Since the water cannot flow by gravity, pumping stations will be installed in the main ditches approximately two kilometres apart. The pumps will pump the waters from the main ditches to the canals outside the walls. Since the discharged water is filtered through peat, no sedimentation ponds are expected.

VII.3. Peat power plant technology

This peat fired power plant will use Circulating Fluidised Bed (CFB) boiler technology which has the following advantages over pulverised fuel burner technology in peat firing:

- ✓ Fluidised beds are able to burn 40-60% moisture content peat without support firing. Pulverised fuel firing typically needs the fuel to be dried as well as have support firing to obtain stable combustion conditions throughout the boiler's operational range.
- ✓ Fluidised beds are less sensitive to peat moisture and quality variations since the fluidised bed's high heat capacity evens out short-term variations.

- ✓ Peat from the Akanyaru valley has a high sulphur content and therefore some form of sulphur capture is required to meet the IFC emission limits. In the CFB boiler, sulphur reduction can be achieved easily through feeding limestone to the furnace and in some cases even the peat's inherent lime content will be utilised if it is in a reactive form. Pulverised fuel firing requires the use of a flue gas cleaning system in the cold end of the boiler.

Fluidised beds have basically no moving parts and thus they are more reliable in operation and have less maintenance issues than pulverised peat-fired burners. Note however that the refractory-covered areas of the CFB boiler do require regular maintenance.

For new peat-fired boilers in Scandinavia and Ireland, the fluidised bed boilers have more or less replaced pulverised peat-fired units. However, as with pulverised peat-fired units, the CFB boiler supplier needs to take into account the peat properties when designing the boiler.

VII.4. No Project Option

The implementation of this project will result in extensive physical disturbance of the part of Akanyaru marshland due to the peat harvesting, which for the most part is permanent. The physical environmental impacts, as a result of peat harvesting and peat firing for power generation are expected to happen during the project operational phase.

However, if well managed and appropriate reclamation measures are implemented, the identified impacts can be reduced and the whole project activities will eventually have minimal public health or safety risks and no long-term effects on adjacent biophysical environment.

If the Akanyaru peat fired power plant would not be established, there will be no disturbance of the environment due to peat harvesting and peat firing for electricity generation but this no project option must also be weighed up against the loss of a multi-million dollar long-term investment for this project and the anticipated socio-economic impacts of this project for Gisagara district and for the Rwandan economy as a whole.

This project will employ several hundred people (directly and indirectly) during the implementation. There will be numerous multiplier effects for the local, regional and national communities. Additional jobs will be created in the service sector due to additional 70MWe of electricity which will be generated by this project.

HAKAN/YUMN is committed to local employment, the use of local contractors and the promotion of independent sustainable socio-economic development in the project zone area.

The no-project option would be a major setback for regional and national economic development.

In brief, with this option, all the positive impacts envisaged will be eliminated and this alternative does not have any advantage in business development and poverty alleviation.

VIII. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

This section addresses mitigation measures, monitoring and institutional arrangements for the environmental and social management of Akanyaru Peat fired power plant project.

VIII.1. Proposed Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) aims to make this project conform with the applicable environmental legal requirements and also to help all stakeholders to find their role and responsibility in the environmental preservation during the implementation of the present project.

This Environmental Management Plan completes the information given for the environmental impacts and the specific mitigation measures proposed in the previous sections. It proposes the institutional responsibilities for the implementation of the mitigation measures, the implementation indicators, the time frame for monitoring and follow-up and also the estimated cost for the implementation of various activities. The EMP, as specified in *table 24* will be integrated in the Tender Documents for the Contractors-

Table 24: Environmental Management Plan (EMP) for Akanyaru Peat fired power plant project

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
CONSTRUCTION, OPERATION PHASES AND DECOMMISSIONING PHASES						
Overall environmental management	- Appoint an Environmental Supervisor to oversee environmental management, environmental training, and the implementation of environmental policies; - Appoint Environmental Technicians to assist with sampling, monitoring and daily environmental compliance; - Establish an Environmental policy which must be signed off by Management; and - Provide environmental training to all employees.	Project site	HAKAN/YUMN	Self-monitoring by HAKAN/ YUMN	Operational: $5000 per month: Staff $200 per session: Training	Prior to construction phase
Occupational health and Safety (OHS)	- Ensure all employees have health insurance; - The Akanyaru peat fired power plant project should have a health and safety management plan; - A health and safety officer should be appointed; - Provide workers and visitors with the necessary personal protective	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA MIFOTRA Self-monitoring	Operational: $2000 per month: Staff $200 per session: Safety training:	Prior to operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	equipment (PPE); and - Implement project policies for supply, materials, recycling and reuse, energy uses etc. - Adoption of a systematic and structured approach for prevention and control of Non-ionizing radiation, Heat, Noise, Confined spaces, Electrical hazards, Fire and explosion hazards, Chemical hazards and Dust.			by HAKAN /YUMN		
Electrical safety and isolation	- Development of electrical competency standards and safe work procedures for all electrical work; - Use of electrical safety devices on all final distribution circuits, and appropriate testing schedules applied to such safety systems; and - All sources of hazardous energy or hazardous substances should have written procedures for isolation.	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA MIFOTRA Self-monitoring by HAKAN / YUMN	Operational costs	During pre-construction phase
Fitness for work	- Review of shift management systems to minimise risk of fatigue among employees.	Project site	HAKAN/YUMN	MIFOTRA Self-monitoring	Operational costs	Prior to operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
				by HAKAN / YUMN		
Geological alteration	- Implementation of a properly engineered rehabilitation strategy.	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational costs and peat harvesting area closure cost	
Impacts on soil	- A soil monitoring programme will be implemented to evaluate the level of soil contamination on site. - Materials handling and storage areas will be constructed and plans developed to ensure the proper handling and storage of all onsite materials to minimise the risk to the environment	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN / YUMN	Operational costs	During pre-construction phase
Water supply and liquid	- All waste water must be contained on	Project	HAKAN/YUMN	MINIRENA	Operational:	During pre-construction

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
waste management	site; - Consider reuse, recycling, and treatment of process water where feasible - The quality and quantity of plant effluent streams discharged to the environment, including storm water, process effluents, and overall works drainage should be managed and monitored and be of adequate quality prior to release;	site		REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	$4000: Biannual water monitoring.	phase
Loss of land and biodiversity	- Minimising disturbance to vegetation and soils; - Avoiding or minimising the creation of barriers to wildlife movement, or threats to migratory species; - Implementing soil conservation measures; - Where topsoil is pre-stripped, it should be stored for future site rehabilitation activities. Manage vegetation growth along access roads and at permanent above-ground facilities; - Remove invasive plant species and replant native species; and	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational costs: Environmental supervision and training. Environmental technician/supervisors responsibility.	During construction phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	- Sites rehabilitation and/or reconversion after harvesting operations.					
Hydrological impacts	- Development of detailed for post-harvesting land development, - Construct holding basins to mimic water detention functions of peatland, - Use holding basins and gradually pumping of excess water from the site, - Holding ponds where BOD/COD normalized through natural aeration and biological and chemical oxidation, - Buffer zone around the site, - Holding ponds where wastewater will settle and unwanted substances can be removed and treated.	Peat harvesting sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational costs	During pre-construction phase
Air Quality Management	- Use dust suppression techniques; - Conveyor systems for dusty materials should be covered and equipped with measures for reducing dust; - Develop a policy on air quality; and - Develop a dust-monitoring programme. - Considering beneficiation to reduce	Project sites	HAKAN/YUMN	MINIRENA, REMA, Gisagara and Nyanza Districts, RNRA, Self-monitoring by HAKAN/ YUMN	Operational costs	During construction and operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	ash content, - Selection of the best power generation technology for the peat to balance the environmental and economic benefits. - Implementation of recommended measures to prevent, minimize, and control of SO_2 , NO_X, Particulate matters (ash) emissions (section VI2.2.6)					
Energy Efficiency and GHG Emissions	- Use of higher energy conversion efficiency technology, - Use of high performance monitoring and process control techniques, good design and maintenance of the combustion system so that initially designed efficiency performance can be maintained;	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational costs	During pre-construction phase
Water Consumption and Aquatic Habitat Alteration	- Conserving water resources by: (i) Use of a closed-cycle, recirculating cooling water system (ii) Use of dry scrubbers in situations where these controls are also required or recycling of	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts	Operational cost: 10,000 $ per year for new technologies	During pre-construction and construction phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	wastewater in plants for use as FGD makeup (iii) Use of air-cooled systems. - Reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets, fish handling and return systems, fine mesh screens, wedge wire screens, and aquatic filter barrier systems.			RNRA Self-monitoring by HAKAN/ YUMN		
Solid waste management	- Dry handling of the peat combustion wastes, in particular fly ash. - Management of ash disposal and reclamation so as to minimize environmental impacts – especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff due to seasonal precipitation and flooding. In particular, construction, operation, and maintenance of surface impoundments should be conducted in accordance with internationally	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN / YUMN	5,000 $ per year for solid wastes transportation	During pre-construction and construction phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	recognized standards. - Landfilling of ashes is proposed to be available for 8 years to make utilization as road material and the like					
Non-Hazardous Waste	- Non-hazardous solid waste should be collected for recycling or disposal at an approved sanitary landfill, if possible; - Waste separation must be conducted on site; - Develop policies and programmes for waste management, storage, recycling and minimization; - Conduct waste management audits; and - Look at an incineration/landfill facility for the disposal of different wastes types.	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational: $1000/year. Waste collection at	During pre-construction, construction and operation phase
Management of Hazardous Materials and Oil	- Hazardous wastes management according the General Environmental Health and Safety Guidelines; - Waste separation must be conducted on site; - Develop policies and programmes for	Project site	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA	Capital: $10 000: Build concrete bunded areas for hazardous	During and construction and operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
	waste management, storage, recycling and minimisation; - Dedicated concrete bunded areas must be constructed for hazardous waste and materials storage;			Self-monitoring by HAKAN/ YUMN	wastes storage:	
Transport	- Develop a maintenance programme/inventory for all vehicles and machinery; and - Develop a policy on spill management/prevention.	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	$1,500/month	During and construction and operation phase
Emergency response	- Develop an emergency response procedure	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts, RNRA Self-monitoring by HAKAN/ YUMN	No additional costs	During and construction and operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
Visual Impacts	- Prevent and minimize negative visual impacts through consultation with national and local authorities (Gisagara and Nyanza districts) about potential post-closure land use, incorporating visual impact assessment into the peat mine reclamation process. - Reclaimed lands should, to the extent feasible, conform to the visual aspects of the surrounding landscape. The reclamation design and procedures should take into consideration the proximity to public viewpoints and the visual impact within the context of the viewing distance	Project sites	HAKAN/YUMN	REMA, Gisagara and Nyanza Districts, RNRA, Self-monitoring by HAKAN/ YUMN	Operational: $5 000/ha Environmental supervision and training.	During and construction and operation phase
Water storage dams(WSD) and Sedimentation ponds (holding basins)	- Adopt the Specific Vector Control and Prevention Strategies by reducing the impact of vector-borne disease (e.g. malaria) on the long- term health of workers and in local communities.	Project sites	HAKAN/YUMN	MINISANTE REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational : $1000/month	During and construction and operation phase

Environmental concerns	Suggested Mitigation Measures	Location	Responsible	Monitoring	Estimated cost	Timing
Peat harvesting sites rehabilitation	- Rehabilitation programmes, designs and policies must be developed and implemented; - Rehabilitation must be on-going through the life of peat bogs; and - Regular monitoring and maintenance must be undertaken on all rehabilitated areas.	Peat harvesting sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Operational: $10 000/ha Monitoring: Environmental technician/supervisors responsibility	During and construction and operation phase
Post Closure and Peat harvesting sites Rehabilitation	- Ensure the safety of surrounding communities - Return the land to conditions capable of supporting the former land use or where this is not practical or feasible, an alternative sustainable land use, e.g. conversion of peat production areas to fish ponds or bird refuges; and - Prevent potential significant adverse effects on adjacent water resources (groundwater and surface water)	Project sites	HAKAN/YUMN	MINIRENA REMA Gisagara and Nyanza Districts RNRA Self-monitoring by HAKAN/ YUMN	Post closure budget to determined	During and construction and operation phase

VIII.2. Social Management Plan (SMP)

The main objectives of the social management plan are to:

- Wherever possible and economically feasible, preferentially maximise the use of local and provincial employment and business opportunities;
- Encourage the diversification of local businesses due to the presence of this project; and
- HAKAN/YUMN policies on environmental issues to the community and wider public, via public consultation processes during the project implementation.

The proposed socio-economic and cultural impact mitigation measures are described below.

VIII.2.1. Maximising Local Employment and Economic Opportunities

- HAKAN/YUMN will maximise local employment during the project life by implementing a strategy that focuses on the employment of people from Gisagara and Nyanza districts. The company is an 'equal opportunity' employer and in practice, the best applicant for the position will be offered employment. Local people will be given priority in employment subject to their experience and qualifications.
- HAKAN/YUMN will offer employees' salaries and conditions of service commensurate with other power plant projects. HAKAN/YUMN will also implement training and development programmes for employees so that they can acquire transferable skills that can be used elsewhere after project closure.
- HAKAN/YUMN will implement a contractor engagement strategy that ensures local contractors are employed in preference to foreign contractors, subject to their ability to carry out the work. This action will improve contractor competency and managerial capacity of local contractors.
- HAKAN/YUMN will outline the safety standards and conditions that employees and contractors will have to comply with so as to promote a safer working environment. These conditions will include an HIV/AIDS awareness and prevention campaign.
- HAKAN/YUMN will implement a retrenchment-training programme for its employees and also implement a counseling plan for workers going through retrenchment. This will aim at promoting sustainable livelihoods.

VII.2.2. Local and Regional Economic Growth

HAKAN/YUMN will implement a local procurement strategy that supports local economic development. The Company will distribute information material through its procurement

office explaining the procedures for doing business with HAKAN/YUMN supplies and contracts. This will improve business multipliers and reduce unemployment.

HAKAN/YUMN will liaise with relevant local government ministries and departments, non-governmental organisations ("NGO's") and donor agencies to encourage the development of an Economic Diversification and Development Plan based on diversification away from the peat harvesting and energy generation sectors.

VII.2.3. Land Use and Settlement

- HAKAN/YUMN will liaise with the Government, local authorities and local community to establish safe pathways around the project sites and to ensure that these pathways are made known to local people. This will prevent inadvertent access into dangerous/hazardous areas of the project sites.
- The mine site boundaries will be clearly demarcated and HAKAN/YUMN's land use and settlement policy clearly communicated to local communities and stakeholders.
- The boundaries will be marked on-site with beacons and the use of signposts. They will be shown on all plans. This will discourage the encroachment of local population onto the demarcated area. The local communities will be discouraged from using the project sites for settlement or their livelihoods.
- HAKAN/YUMN will engage in natural resource management at the local community level to assist in the conservation of trees. This will involve the prevention and discouragement of further deforestation in accordance with HAKANA's Environmental Policy. The programme will be conducted with the Forestry Department of Rwanda Natural Resources Authority (RNRA).
- HAKAN/YUMN will ensure that all project sites hazards are mapped and clearly marked on the sites. They will raise awareness and provide general information on the project site hazards through public consultation.
- HAKAN/YUMN will promote awareness of the water quality in its effluent stream and the risks associated with its consumption as drinking water. Signs in local languages/symbols will be erected alerting the public of drowning, sickness etc. The aim will be to discourage the use of non-treated surface water by local communities.

VIII.2.4. Health Plan

HAKAN/YUMN will ensure all employees have health insurance. The Company will implement an HIV/AIDS awareness and prevention programme in consultation with local HIV/AIDS organizations and government initiatives. HAKAN/YUMN will also conduct malaria awareness at the project site and nearby areas.

VIII.2.5. Public Consultation

HAKAN/YUMN will continue the public consultation process throughout the life of the project and hold consultative meetings with stakeholders at regular intervals. This will aid in the development of friendly and trusting relationships between HAKAN/YUMN and the local population.

VIII.3. Responsibility of Institutions in Implementing the Environmental and Social Management Plan

HAKAN/YUMN remains the key responsible institution for undertaking the mitigation measures proposed as well as the monitoring activities/measures associated with this mitigation plan.

Specifically in Monitoring and Evaluation, the following institutions will play the roles discussed below.

VIII.3.1.Roles of Rwanda Environment Management Authority (REMA)

VIII.3.1.1. 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.

VIII.3.1.2. 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 regular site visits to inspect and verify for themselves the extent to which the mitigation measures proposed in this EMP and SMP are being complied with or vice versa. They will then be expected to make viable recommendations based on their findings to HAKAN/YUMN.

VIII.3.1.3. Periodic Reports

REMA will prepare periodic environmental consolidated reports on the monitoring progress of the Akanyaru Peat fired power plant project.

VIII.3.2. Role of HAKAN/YUMN

HAKAN/YUMN will remain the sole institution that will fundamentally be responsible for undertaking monitoring throughout the project life cycle. HAKAN/YUMN will be expected to ensure self-monitoring throughout the project phases.

VIII.3.3. Role of the Rwanda Natural Resources Authority (RNRA)

The Rwanda Natural Resources Authority will have the role to ensure that HAKAN/YUMN is operating in compliance with the law N° 37/2008 of 11/08/2008 on mining and quarry exploitation in Rwanda.

VIII.4. Social and Environmental Risk Management

HAKAN/YUMN shall be obliged to appoint a Site Environmental Officer (SEO) to enforce both environmental mitigation and Occupational Health & Safety Policy (OH & Safety Policy).

VIII.5. Monitoring

Environmental monitoring is an essential component of project implementation. A general monitoring plan as indicated in *Table* should be implemented on site. It facilitates and ensures the follow-up of the implementation of the proposed mitigation measures. It helps to anticipate possible environmental hazards and/or detect unpredicted impacts over time. Monitoring includes:

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

Environmental monitoring programs for this project should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents and resource use. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. The timeframes indicated in this EMP will be adapted as necessary and as indicated through initial monitoring results. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analysed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Inspection and monitoring registers should be kept on site indicating that the inspection activity was carried out, date on which it was carried out, any issues observed, the relevant actions taken and follow-up on whether the implemented actions have been successful. Environmental monitoring data should be recorded on various spread sheets retained on site and at least annual reports should be compiled and monitoring programmes, mitigation and management measures updated/changed as needed depending on findings. Changes to on-site management should be communicated to the relevant local authorities to ensure on-going communication with these departments.

Table 25: General environmental monitoring schedule and action plan

Frequency	Monitoring & inspection	Responsible person	Proposed actions
Daily	Inspect peat harvesting and transportation	Site managers	Any spilled peat will be cleared from roads daily.
Weekly	Inspect bunded areas and any other areas where hazardous materials are stored to ensure no leaks from these areas.	Site managers	Bunded areas must be fitted with an outlet valve that must remain closed and locked and only be opened under controlled circumstances. Water released from storage areas should be diverted through an oil separator in areas where oils are stored or handled. All water from such areas must be released to the settling dams and contained on site.
Weekly	Inspect progress of all new activities on site & ensure that they are carried out in designated areas only.	Site managers	Activity will be ceased and placed back on track if any activity has occurred in undesignated areas. Proceeding with the activity in a well-planned and responsible manner by only removing species in areas designated for activity and not disturbing surrounding areas will limit the extent of the impact and retain biodiversity.
Weekly	Inspect power-related infrastructure to ensure fences are not damaged & no illegal connections have been added to lines	Electrical engineer/technician.	Ensure all power lines and related infrastructures are within specifications. Ensure that all power-related structures are adequately marked with relevant signs and warnings and fenced off with access control. Repair any damage done.
Weekly	Inspect water management features and check for breaches in berms or trenches and for any obstructions in trenches. Ensure no major leaks in any water-related infrastructure. Ensure dams have adequate capacity, monitor visually for seepage, check all pumps and pipelines are operating adequately and have no leaks, check for breaches in berms.	Site managers	Ensure water management facilities are operating adequately. Water should not accumulate in trenches and should flow to containment facilities. Silt build-up in trenches and any other obstructions should be cleared regularly from trenches and placed on the rock dumps. It is advisable to erect silt traps before water drains into dams to allow for easier silt management and clearance.
Weekly	Inspect all potable water works for leaks. Monitor water use. Inspect toilets and	Site managers	Saving water initiatives will be implemented. Repair any leaks detected as soon as possible. Use of such facilities will

Frequency	Monitoring & inspection	Responsible person	Proposed actions
	related piping for leaks		discontinue until such time that the repairs are made.
Weekly	Inspect water management around workshop and wash bay facilities and inspect oil traps.	Site managers	Ensure oils are cleared from oil traps into sealed containers for disposal to a registered disposal site. This should be conducted regularly to prevent overflow and leaks.
Monthly	Regularly inspect service logs and ensure service plans are maintained for all machinery and vehicles on site.	Site managers	Use of any equipment that has excessive leaking, emissions or noise will be discontinued until relevant repairs are made. Where equipment and machinery cannot be serviced, these will be replaced.
Monthly	Occupational noise monitoring in areas of high noise generation.	Site managers	Any equipment which becomes excessively noisy will be serviced and repaired or replaced if necessary. Staff will be given appropriate PEE where they are exposed to noisy (at the least noise greater than 85dB) equipment.
Weekly	Dust sample should be evaluated for at least chromium and cadmium and if levels are within WHO standards then frequency can drop off. Regular PM10 and dust monitoring should be implemented at major areas of dust generation.	Environmental manager / coordinator	Dust is not expected to be a major nuisance due to the regular rains; however any exceedance must be investigated and air quality mitigation measures as described in this report will be applied on site immediately in areas at the mines with high dust generation.
Quarterly	Groundwater monitoring and surface water will be monitored including bacterial counts for any samples from water sources used for potable use.	Environmental technicians	Where water monitoring indicates excessive spikes in constituents, then these will be further investigated and mitigation measures must be reassessed in order to manage the activity sourcing the contamination. Specialist will be consulted if necessary.
Quarterly	Environmental noise monitoring should be conducted at least at sensitive receptors near to the Peat fired power plant. Noise at these receptors should be within the World Bank day and night time limits.	Environmental manager / coordinator	Noise mitigation measures will be assessed and applied to any nearby noise generators which may be responsible for excessive noise at sensitive receptors. Consideration should also be given to moving noisy equipment away from sensitive receptors where possible.

Frequency	Monitoring & inspection	Responsible person	Proposed actions
After major rainfall	Inspect all hazardous storage areas and water containment facilities to ensure no flooding and overflow from these areas.	Site managers	Any water from such areas should be released under controlled circumstances into on-site containment facilities that have adequate capacity. Water should only be released into the environment under extreme flood situations. In such instances it is expected that qualities will be largely acceptable due to dilution.
Every 6 months depending on species	Establish alien invasive monitoring programme	Environmental manager / coordinator	Eradicate and control all alien invasive species on site. Rehabilitate and revegetate all areas where alien invasive species were removed. Replace alien species removed with indigenous species.
Annually in rehabilitated areas for a period of 3 to 5 years depending on outcomes.	Soil survey and soil quality and depth monitoring	Environmental manager / coordinator	Specialists must be contracted to complete these assessments and their recommendations should be applied to site.
Annually in rehabilitated areas for a period of 3 to 5 years depending on outcomes.	Floral surveys need to be conducted to monitor cover abundance, plant succession and community structure	Environmental manager / coordinator	Specialists must be contracted to complete these assessments and their recommendations should be applied to site.
As required	Ensure adequate communication channels with the communities in the area and ensure complaints are attended to in collaboration with the communities.	Social manager / coordinator	Follow up and action as per the EMP/SMP report
As required	Health and medical inspections to be carried out as needed and described under mitigation measures.	Medical practitioner	Action will be dependent on findings

Environmental monitoring of the following parameters is also recommended for the Akanyaru peat fired power plant:

VIII.5.1. Jobs and Construction Procurement

The construction and operational phases of the present project will provide local benefits to communities. It is therefore recommended to monitor local job creation. The SEO will have to keep a record of employees residence and hours worked and also of all the materials (stone, sand, etc.) and services bought on a local basis.

VIII.5.2. Water Quality Monitoring

Construction and operation phases of this kind of project are often a source of significant surface and groundwater pollution if not managed and sited properly. It is recommended therefore that HAKAN/YUMN undertake monitoring of groundwater and any effluent or wastewater discharged from the Akanyaru peat fired power plant activities.

The analytical parameters to be monitored quarterly are: Conductivity, Total dissolved solids (TDS), Turbidity, Total Suspended Solids (TSS), Dissolved Oxygen, BOD, COD, pH, Calcium, Chloride, Fluoride, Magnesium, Nitrate $NO^{-}_{3,}$ Sulphate as SO_4^{2-}, Total Alkalinity, Aluminium, Iron, Lead, Cadmium, Chromium, Arsenic and Manganese.

VIII.5.3. Noise Level Monitoring

Periodic monitoring of HAKAN/YUMN equipment and generally around the project sites should be undertaken. Noise level monitoring could be supplemented by consulting with Project Affected People to identify the level of monitoring and impact of noise.

VIII.5.4.Monitoring of Accidents/Health

HAKAN/YUMN must make sure that appropriate signs are posted at appropriate locations/positions to minimise/eliminate risk of accidents. In addition, health inspectors should make sure that:

- Measures to create awareness regarding sexually transmitted diseases, primarily HIV/AIDS, and other diseases such as malaria and schistosomiasis are taken;
- Preventive measures to reduce/eliminate malarial and schistosomal infections where/whenever appropriate are put in place; and
- Periodic health surveys are carried out in the project zone.

The following parameters could be used as indicators:

- Level of awareness of communities pertaining to dangers/risks associated with the project; and

- Accident reports: records on actual accidents associated with the project.

VIII.5.5. Monitoring of Social Impacts

The monitoring of the social impacts of the project is based on the experience of the communities and households. Through survey and/or focus-group information gathering techniques the following impacts should be monitored with the help of local authorities and households.

- **Employment and procurement:** impact on the community of the jobs offered and material bought locally by HAKAN/YUMN.
- **Quality of life:** impact of noise, vibration, dust, etc. related to Akanyaru peat fired power plant project on the daily life of households.
- **Community relationship:** impact of arrival of workers in the community on relationships in the community and with the workers.

VIII.6. Training and Capacity Building

Employees of HAKAN/YUMN will receive specific training for accident prevention and hazards precautions and procedures for the safe storage, handling, transport and use of potentially harmful materials that are relevant to each employee's job task and work area.

The training provided will include key information from the Material Safety Data Sheets ("MSDS's") for potentially harmful material and substances.

Employees will also receive training regarding safety, health and environmental matters including accident prevention, safe lifting practices, correct use of MSDS's, safe chemical handling practices, and proper control and maintenance of equipment and facilities. This will aid in the prevention of accidents or chemical spills.

Training will also be given on emergency response systems and procedures including the location and proper use of emergency equipment, use of personal protective equipment, procedures for raising the alarm and notifying emergency response teams, and the proper response actions for each foreseeable emergency situation.

Daily safety and environment briefings including inspections of personal protective equipment will be conducted by relevant supervisors or shift bosses.

A safety and environmental induction will be carried out for new employees and for any person arriving on site after a break exceeding two weeks or any contractor arriving on site. The safety induction will cover: the use of personal protective devices, dangerous areas, appropriate conduct, emergency response procedures and waste management.

HAKAN/YUMN will ensure that safety and fire control is a priority in the project sites.

IX.PUBLIC CONSULTATION

The public was well engaged in a dialogue concerning the project early on in the EMP process. Public consultation was thorough, transparent, and well distributed. Public consultation and disclosure procedures have been, and will continue to be carried out in an on-going, transparent, consistent, up-to-date and equitable manner. The GoR's Environmental Impact Assessment Regulations (2005) set out the minimum requirements for stakeholder consultation and engagement.

IX.1. Description of Stakeholders

The following provides a summary description of the stakeholders most affected by the Akanyaru peat fired power plant project, which includes: Vulnerable Groups, Local Villages & PAPs.

IX.1.1. Vulnerable Groups

Vulnerable groups were identified as women, the elderly, children (particularly orphans) and people with disabilities. It was expected that there would not be significant effects on vulnerable groups as a result of the physical development of this project.

IX.1.2. Local Villages & Project Affected Persons (PAPs)

The groups of stakeholders most affected by the project include particularly people who are living in the zones close to the location of the peat fired power plant. The following presents a summary of the socio-economic conditions of the Project Affected Persons (PAPs):

- Most of the inhabitants in the region could be described as small plot peasant farmers that may supplement their income through cash crops and other income generating activities (e.g. trade, livestock, fishing, etc.);
- The majority of the population in the project zone are farmers involved in crops production (cassava, banana, beans, sweat potatoes, maize, coffee, etc.
- Housing is constructed mainly in family compounds. Buildings are either 'temporary' (built with traditional materials), 'semi-permanent' (with traditional walls and corrugated iron roofs/ or tiles) or 'permanent' (with brick or concrete walls). The majority of housing is owner-occupied;
- Agriculture is practiced as a labour intensive, intercropping system with both cash crops and subsistence crops.

IX.1.3. Stakeholder Engagement

The consultation and disclosure programme was designed and implemented so as to foster community awareness of the proposed project and Environmental and Social Management Plan and to provide opportunities for community input and involvement. Careful attention was made to the various national and international principles/policies/guidelines as they relate to consultation.

Methods of public consultation that were applied during the course of the project included:

- Targeted briefings;
- Interviews with key people;
- Site visits;
- Informal at-home meetings;
- Surveys; and
- Focus group discussions.

The Public Participation Process (PPP) for this project was initiated in February 2013. HAKAN/YUMN in conjunction with Environmental Specialists of SWECO & WES initiated an open and transparent process of communication during the EIA phases of the project.

Authorities meetings were seen as essential in initiating the project, thus the following authorities meetings were held. These included the Minster of Natural Resources and the State Minister of mining, Director General of REMA, Mayor of Gisagara district, Officials and analysts from RDB, EWSA and REMA, Executive Secretaries of Mamba and Gishubi sectors and Gisagara District.

Other interested and affected parties have also been consulted during a socio-economic survey in the project zone.

Formal meetings with PAPs have been also held at Kabumbwe and Gakoma cells of Mamba sector, Gisagara district.

Plate 8: Public consultation at Gakoma cell

Plate 9: Public consultation at Kabumbwe cell

Table 26: Population Concerns and expectations vis-à-vis the Project

Issues	Indicators	Findings from survey	Comments and observations
Awareness	• People awareness on PFPP project • Source of info	90% indicated to be aware of PFPP project and among them 96% were informed by neighbours and only 6% informed by local leaders.	Generally the population is aware of the project through various channels. Most the local population indicated that they have been observing different scoping missions by the company's experts.
Expectation from PFPP project	• Job creation • Personal and general welfare • Business activities facilitation • Facilitate business activities • Easy access to medical services • Access to elctricity	• 100% expect the project to be a source of jobs creation which will impact on their welfare through income generation • 90% confirmed that business activities will be facilitated especially small and medium enterprises while 10% believe that prices of basic commodities may rise very high • 77% believe that the project will ease access to education however, some people fears that young people may choose to work than going to school • Finally, all surveyed HHs believe that the Peat project will allow them full access to electricity.	Promotion of small business through SMEs (restaurants, milk selling, hairs and beauty salons, etc) Employment creation for increased monetary income generation For the youth, they expect the decrease of Rural Exodus though employments and SMEs Women feels that education and performance of their children will be enhanced through home lighting Improved transportation though improved road network Support and promote descent housing and organised settlement ''Umudugudu'' though income generated from employment.
Fear on PFPP project	• Expectation on the Project to affect owned asset	• 81% of the surveyed expressed the fear to lose their own houses which will be relocated, 62 % the loose of agriculture land, 38% the loose of forest, 47% fear to loose grass for animal feeding from marshland and 12% losing the water sources located in the marshland.	**Relocation of some Households** in the project area and losses of agriculture land and crops, especially at the site of the plant as follow: The estimated houses to be relocated are 17 up road mainly at the Power Plant Site (Buye village). There is need for compensation and resettlement measures for 13 families. 31 houses located download are also likely to be destroyed and relocation and compensation measures should be further analysed as they are located in prohibited zone for construction (50 meters according to environment law and regulations) In regards to land losses, the inventory conducted estirmated about 69,728.97 Square Meters. For the crops loss, they are diversified and the project should be interested more in the perennial crops (coffee,

Issues	Indicators	Findings from survey	Comments and observations
			banana, etc..). More details on losses of land, houses and crops are indicated in the annex of the report. **Losses of agriculture production in the project marshland:** despite the fact that marshland belongs to government, the local population have been exploiting the marshland as source of livelihood and have been farming agriculture commodities including Maize, Beans, horticulture (mainly vegetable) and sweat potatoes, especially during the season C (dry season or ''Ishagasha'' in Kinyarwanda). Some population practices artisanal fishing, especially during the high raining season of April. The estimated cultivated surface area is 600 Ha. In order to optimally exploit the marshland, small farmers, men and women were organised in cooperative called *''Cooperative Jya Mbere Muhinzi or COJAMUGI''* and It is comprised of about 4080 members. The estimated total production, which is likely to be lost, in the marshland only for improved seeds of Maize in the last season, is 200 tones, equivalent to 80,000,000 RFW (200000 kgsX400 frw) of production, according to local leaders and president of COJAMUGI Cooperative. Other product that are likely to be affected in marshland is vegetation for animal feeding as well as papyrus which has been serving as roofing material as well as handcraft raw material (possibility to use for Basket waving, etc..) Other risks (negative impact): see Environmental impact assessment

X. CONCLUSION AND RECOMMENDATIONS

X.1. Conclusion

The project consists in the harvesting of Akanyaru peat, the construction and the operation of peat fired power plant of 70 MWe of total net capacity.

This project has many obvious benefits from the socio-economic point of view. The impact assessment process carried out has indicated the existence of a number of negative environmental impacts that may arise from implementation of this project. These have guided the formulation of the proposed management plan as reported above.

The mitigation measures for different negative impacts have been proposed and an environmental and social management plan has been established. Therefore, implementation of this project will be a success if the environmental management plan proposed is followed by all stakeholders directly or indirectly involved.

The project is viable and no fatal flaws were identified. The identified impacts can be mitigated through the implementation of the proposed Environmental and Social Management Plan. It is therefore the consultants' opinion that the present project is acceptable as long as the developer is responsible and takes all possible complementary arrangements as required by the authorities and the proposed mitigation measures in order to protect the environment.

X.2. Recommendations for Environment protection

Based on the nature of the project activities, biophysical conditions of the project area and the potential negative impacts, it is imperative that the following be given serious consideration and attention in order to preserve the environment:

- Environmental monitoring programs for this project should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during construction, operation and decommissioning phases. Speedy and appropriate actions must be taken on any issues arising through the monitoring plan/ indicated through monitoring results.
- Occupational health and safety performance should be evaluated against national /or international standards.

- HAKAN/YUMN should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities.
- The working environment should be monitored for occupational hazards relevant to this project.
- The safety (buffer) zone of 50m from Akanyaru River should be respected for security and environment protection.

X.3. Recommended Actions to mitigate gender and Vulnerability effects.

- Support the Establishment of Handcraft Centre for women in project area to the level of export especially for Papyrus available in the marshland
- Develop strategy to promote Fishing and aquaculture project in Akanyaru River and around the project area
- Take advantage of EAC under common market protocol to develop Business opportunities through cross border trade between Rwanda and Burundi neighbouring zones by constructing a modern bridge between Rwanda and Burundi and by establishing formal boarder.
- Establish partnership with MFIs institutions to bring banks and introduce the Micro-credits scheme in the project area
- Mechanism to support vulnerable groups and poor HH (mostly women headed and eldery) to get free agriculture inputs especially during period following the resettlement in project area
- Establish a gender responsive agriculture service delivery Program in project area which will support mainly women and landless youth to access agriculture inputs, extension services, commercialisation of fertilisers, veterinary services, and accessing capacity building/trainings program related to improvement and modernization of agriculture (from subsistence to a market oriented agriculture).
- Put in place of project that we support the citizen to efficiently use the Top Soil that will be excavated from the peat extraction in the marshland.
- Establish Project on agriculture infrastructure targeting feeder roads and rural modern markets to facilitate transportation and commercialisation of agriculture produces (mainly for women).
- Due to high migration of population to the Power Plant site , the risk for HIV infection becomes high and there is need to put in place Special sensitization program targeting workers at the site and surrounding community (especially women and young girls) by the project management including installing condom distribution points.
- Construction of a modern health centre in the project zone.

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APPENDICES

APPENDIX-1: Environmental guidelines for contractors of Akanyaru peat fired power plant

General Environmental Management Conditions

1. In addition to these general conditions, the Contractor shall comply with any specific Environmental Management Plan (EMP) for the works he is responsible for. The Contractor shall inform himself about such an EMP, and prepare his work strategy and plan to fully take into account relevant provisions of that EMP. If the Contractor fails to implement the approved EMP after written instruction by the Site environmental officer to fulfil his obligation within the requested time, the developer reserves the right to arrange for execution of the missing action by a third party on account of the Contractor.
2. Notwithstanding the Contractor's obligation under the above clause, the Contractor shall implement all measures necessary to avoid undesirable adverse environmental and social impacts wherever possible, restore work sites to acceptable standards, and abide by any environmental performance Requirements specified in an EMP. In general these measures shall include but not be limited to:

    a. Minimize the effect of dust on the surrounding environment resulting from earth mixing sites, vibrating equipment, temporary access roads, etc. to ensure safety, health and the protection of workers and communities living in the vicinity dust producing activities.

    b. Ensure that noise levels emanating from machinery, vehicles and noisy construction activities (e.g. excavation, blasting) are kept at a minimum for the safety, health and protection of workers within the vicinity of high noise levels and nearby communities.
    c. Ensure that existing water flow regimes in rivers, streams and other natural or irrigation channels is maintained and/or re-established where they are disrupted due to works being carried out.
    d. Prevent oils, lubricants and waste water used or produced during the execution of works from entering into rivers, streams, irrigation channels and other natural water bodies/reservoirs, and also ensure that stagnant water in uncovered borrow pits is treated in the best way to avoid creating possible breeding grounds for mosquitoes.
    e. Prevent and minimize the impacts of quarrying, earth borrowing, piling and building of temporary construction camps and access roads on the biophysical environment including protected areas and arable lands; local communities and their settlements. In as much as possible restore/rehabilitate all sites to acceptable standards.
    f. Upon discovery of ancient heritage, relics or anything that might or believed to be of archaeological or historical importance during the execution of works, immediately

report such findings to the Site environmental officer so that the appropriate authorities may be expeditiously contacted for fulfilment of the measures aimed at protecting such historical or archaeological resources.

g. Discourage construction workers from engaging in the exploitation of natural resources such as hunting and collection of forest products or any other activity that might have a negative impact on the social and economic welfare of the local communities.
h. Implement soil erosion control measures in order to avoid surface run off and prevents siltation, etc.
i. Ensure that garbage, sanitation and drinking water facilities are provided in construction workers camps.
j. Ensure that, in as much as possible, local materials are used to avoid importation of foreign material and long distance transportation.
k. Ensure public safety, and meet traffic safety requirements for the operation of work to avoid accidents.

3. The Contractor shall indicate the period within which he/she shall maintain status on site after completion of civil works to ensure that significant adverse impacts arising from such works have been appropriately addressed.
4. The Contractor shall adhere to the proposed activity implementation schedule and the monitoring plan/strategy to ensure effective feedback of monitoring information to project management so that Impact management can be implemented properly, and if necessary, adapt to changing and unforeseen conditions.
5. Besides the regular inspection of the sites by the Site environmental officer for adherence to the Contract conditions and specifications, the Owner may appoint an Inspector to oversee the compliance with these environmental conditions and any proposed mitigation measures. State environmental authorities may carry out similar inspection duties. In all cases, as directed by the Site environmental officer, the Contractor shall comply with directives from such inspectors to implement measures required to ensure the adequacy rehabilitation measures carried out on the bio-physical environment and compensation for socio-economic disruption resulting from implementation of any works.

Work site/Campsite Waste Management

6. All vessels (drums, containers, bags, etc.) containing oil/fuel/surfacing materials and other hazardous chemicals shall be bonded in order to contain spillage. All waste containers, litter and any other waste generated during the construction shall be collected and disposed of at designated disposal sites in line with applicable government waste management regulations.
7. All drainage and effluent from storage areas, workshops and camp sites shall be captured and treated before being discharged into the drainage system in line with applicable government water pollution control regulations.
8. Used oil from maintenance shall be collected and disposed of appropriately at designated sites or be re-used or sold for re-use locally.

9. Entry of runoff to the site shall be restricted by constructing diversion channels or holding structures such as banks, drains, dams, etc. to reduce the potential of soil erosion and water pollution.
10. Construction waste shall not be left in stockpiles along the road, but removed and reused or disposed of on a daily basis.
11. If disposal sites for clean spoil are necessary, they shall be located in areas, approved by the Site environmental officer, of low land use value and where they will not result in material being easily washed into drainage channels. Whenever possible, spoil materials should be placed in low-lying areas and should be compacted and planted with species indigenous to the locality.

Material Excavation and Deposit

12. The Contractor shall obtain appropriate licenses/permits from relevant authorities to operate quarries or borrow areas.
13. The location of quarries and borrow areas shall be subject to approval by relevant local and national authorities, including traditional authorities if the land on which the quarry or borrow areas fall in traditional land.
14. New extraction sites:

    a) Shall not be located in the vicinity of settlement areas, cultural sites, wetlands or any other valued ecosystem component, or on high or steep ground or in areas of high scenic value, and shall not be located less than 1km from such areas.

    b) Shall not be located adjacent to stream channels wherever possible to avoid siltation of river channels. Where they are located near water sources, borrow pits and perimeter drains shall surround quarry sites.

    c) Shall not be located in archaeological areas. Excavations in the vicinity of such areas shall proceed with great care and shall be done in the presence of government authorities having a mandate for their protection.

    d) Shall not be located in forest reserves. However, where there are no other alternatives, permission shall be obtained from the appropriate authorities and an environmental impact study shall be conducted.

    e) Shall be easily rehabilitated. Areas with minimal vegetation cover such as flat and bare ground, or areas covered with grass only or covered with shrubs less than 1.5m in height, are preferred.

    f) Shall have clearly demarcated and marked boundaries to minimize vegetation clearing.

15. Vegetation clearing shall be restricted to the area required for safe operation of construction work. Vegetation clearing shall not be done more than two months in advance of operations.

16. Stockpile areas shall be located in areas where trees can act as buffers to prevent dust pollution. Perimeter drains shall be built around stockpile areas. Sediment and other pollutant traps shall be located at drainage exits from workings.
17. The Contractor shall deposit any excess material in accordance with the principles of these general conditions, and any applicable EMP, in areas approved by local authorities and/or the Site environmental officer.
18. Areas for depositing hazardous materials such as contaminated liquid and solid materials shall be approved by the Site environmental officer and appropriate local and/or national authorities before the commencement of work. Use of existing, approved sites shall be preferred over the establishment of new sites.

Rehabilitation and Soil Erosion Prevention

19. To the extent practicable, the Contractor shall rehabilitate the site progressively so that the rate of rehabilitation is similar to the rate of construction.
20. Always remove and retain topsoil for subsequent rehabilitation. Soils shall not be stripped when they are wet as this can lead to soil compaction and loss of structure.
21. Topsoil shall not be stored in large heaps. Low mounds of no more than 1 to 2m high are recommended.
22. Revegetate stockpiles to protect the soil from erosion, discourage weeds and maintain an active population of beneficial soil microbes.
23. Locate stockpiles where they will not be disturbed by future construction activities.
24. To the extent practicable, reinstate natural drainage patterns where they have been altered or impaired.
25. Remove toxic materials and dispose of them in designated sites. Backfill excavated areas with soils or overburden that is free of foreign material that could pollute groundwater and soil.
26. Identify potentially toxic overburden and screen with suitable material to prevent mobilization of toxins.
27. Ensure reshaped land is formed so as to be inherently stable, adequately drained and suitable for the desired long-term land use, and allow natural regeneration of vegetation.
28. Minimize the long-term visual impact by creating landforms that are compatible with the adjacent landscape.
29. Minimize erosion by wind and water both during and after the process of reinstatement.
30. Compacted surfaces shall be deep ripped to relieve compaction unless subsurface conditions dictate otherwise.
31. Revegetate with plant species that will control erosion, provide vegetative diversity and, through succession, contribute to a resilient ecosystem. The choice of plant species for rehabilitation shall be done in consultation with local research institutions, forest department of Rwanda Natural Resource Authority (RNRA) and the local people.

Water Resources Management

32. The Contractor shall at all costs avoid conflicting with water demands of local communities.

33. Abstraction of both surface and underground water shall only be done with the consultation of the local community and after obtaining a permit from the relevant Water Authority.
34. Abstraction of water from wetlands shall be avoided. Where necessary, authority has to be obtained from relevant authorities.
35. Temporary damming of streams and rivers shall be done in such a way avoids disrupting water supplies to communities downstream, and maintains the ecological balance of the river system.
36. No construction water containing spoils or site effluent, especially cement and oil, shall be allowed to flow into natural water drainage courses.
37. Wash water from washing out of equipment shall not be discharged into water courses or road drains.
38. Site spoils and temporary stockpiles shall be located away from the drainage system, and surface run off shall be directed away from stockpiles to prevent erosion.

Traffic Management

39. Location of access roads/detours shall be done in consultation with the local community especially in important or sensitive environments. Access roads shall not traverse wetland areas.
40. Upon the completion of civil works, all access roads shall be ripped and rehabilitated.
41. Access roads shall be sprinkled with water at least five times a day in settled areas, and three times in unsettled areas, to suppress dust emissions.

Disposal of Unusable Elements

42. Unusable materials and construction will be disposed of in a manner approved by the Site environmental officer.
43. As far as possible, abandoned pipelines shall remain in place. Where for any reason no alternative alignment for the new pipeline is possible, the old pipes shall be safely removed and stored at a safe place to be agreed upon with the Site environmental officer and the local authorities concerned.

Health and Safety

44. In advance of the construction work, the Contractor shall mount an awareness and hygiene campaign. Workers and local residents shall be sensitized on health risks particularly of AIDS.
45. Adequate road signs to warn pedestrians and motorists of construction activities, diversions, etc. shall be provided at appropriate points.

Repair of Private Property

46. Should the Contractor, deliberately or accidentally, damage private property, he shall repair the property to the owner's satisfaction and at his own cost. For each repair, the Contractor shall obtain from the owner a certificate that the damage has been made good satisfactorily in order to indemnify the Client from subsequent claims.

47. In cases where compensation for inconveniences, damage of crops etc. are claimed by the owner, the Client has to be informed by the Contractor through the Site environmental officer. This compensation is in general settled under the responsibility of the Client before signing the Contract. In unforeseeable cases, the respective administrative entities of the Client will take care of compensation.

Contractor's Environment, Health and Safety Management Plan (EHS-MP)

48. Within 6 weeks of signing the Contract, the Contractor shall prepare an EHS-MP to ensure the adequate management of the health, safety, environmental and social aspects of the works, including implementation of the requirements of these general conditions and any specific requirements of an EMP for the works. The Contractor's EHS-MP will serve two main purposes:

    a. For the Contractor, for internal purposes, to ensure that all measures are in place for adequate EHS management, and as an operational manual for his staff.

    b. For the Client, supported where necessary by a Site environmental officer, to ensure that the Contractor is fully prepared for the adequate management of the EHS aspects of the project, and as a basis for monitoring of the Contractor's EHS performance.

49. The Contractor's EHS-MP shall provide at least:

    a. A description of procedures and methods for complying with these general environmental management conditions, and any specific conditions specified in an EMP;

    b. A description of specific mitigation measures that will be implemented in order to minimize adverse impacts;

    c. A description of all planned monitoring activities (e.g. sediment discharges from borrow areas) and the reporting thereof; and

    d. The internal organizational, management and reporting mechanisms put in place for such.

50. The Contractor's EHS-MP will be reviewed and approved by the Client before start of the works. This review should demonstrate if the Contractor's EHS-MP covers all of the identified impacts, and has defined appropriate measures to counteract any potential impacts.

EHS Reporting

51. The Contractor shall prepare bi-weekly progress reports to the Site environmental officer on compliance with these general conditions, the project EMP if any, and his own EHS-MP. It is expected that the Contractor's reports will include information on:
    a. EHS management actions/measures taken, including approvals sought from local or national authorities;
    b. Problems encountered in relation to EHS aspects (incidents, including delays, cost consequences, etc. as a result thereof);
    c. Lack of compliance with contract requirements on the part of the Contractor;
    d. Changes of assumptions, conditions, measures, designs and actual works in relation to EHS aspects; and
    e. Observations, concerns raised and/or decisions taken with regard to EHS management during site meetings.
52. It is advisable that reporting of significant EHS incidents be done "as soon as practicable". Such incident reporting shall therefore be done individually. Also, it is advisable that the Contractor keeps his own records on health, safety and welfare of persons, and damage to property. It is advisable to include such records, as well as copies of incident reports, as appendixes to the bi-weekly reports.
    a. Details of EHS performance will be reported to the Client through the Site environmental officer reports to the Client.

Training of Contractor's Personnel

53. The Contractor shall provide sufficient training to his own personnel to ensure that they are all aware of the relevant aspects of these general conditions, any project EMP, and his own EHS-MP, and are able to fulfil their expected roles and functions. Specific training should be provided to those employees that have particular responsibilities associated with the implementation of the EHS-MP.

General topics should be:

- EHS in general (working procedures);
- Emergency procedures; and
- Social and cultural aspects (awareness rising on social issues).

APPENDIX-2: Akanyaru water and soil analysis reports

2-1 Water analysis reports

National University of Rwanda
Université Nationale du Rwanda

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WATER ANALYSIS REPORT

WES CONSULT ltd

Sampling site : Akanyaru River
Sampling date: : 15 – 05 - 2013
Analysis date : started 16 – 05 - 2013

	Parameters analyzed	Unit	Results	
	Sampling name		Akanyaru Upstream	Akanyaru Downstream
1.	Temperature	°C	23.56	23.33
2.	pH		6.40	6.34
3.	Conductivity	µS/cm	54	60
4.	Dissolved Oxygen	mg/l	7.88	7.67
5.	Calcium	mg/l Ca^{2+}	11.2	12
6.	COD	mg/l	190	156
7.	Ammonia Nitrogen	mg/l	0.69	0.66
8.	Nitrites Nitrogen (NO_2-N)	mg/l	0.001	0.002
9.	Nitrates Nitrogen (NO_3-N)	mg/l	0.2	0.1
10.	Phosphates	mg/l	0.07	0.09
11.	Fluoride (F^-)	mg/l	0.07	0.08
12.	Chloride (Cl^-)	mg/l	7.8	8.3
13.	Sulfates (SO_4^{2-})	mg/l	1	2
14.	Iron (Fe)	mg/l	2.52	2.38
15.	Manganese (Mn)	mg/l	0.137	0.140
16.	Cyanide	mg/l	0.003	0.003
17.	Potassium	mg/l	2.052	2.391
18.	Sodium	mg/l	1.196	1.352
19.	Copper	mg/l	0.086	0.095
20.	Cadmium	mg/l	Not detected	Not detected
21.	Chromium	mg/l	Not detected	Not detected
22.	Lead	mg/l	Not detected	Not detected

BIRORI Mardochée
Head of laboratory
29.05.2013

Excellence in Education and Service to the People

Rapport

Sida 1 (5)

T1306661

1W2AL9RAKDK

Projekt
Bestnr 1989562000
Registrerad 2013-05-07
Utfärdad 2013-05-21

SWECO Environment AB
Per Olof Seman

Gjörwellsgatan 22
100 26 Stockholm

Ordernumber: T1306661 (1989562000;)			
Report created: 2013-05-21 by Maria.Bigner			
ELEMENT	**SAMPLE**	**2 downtream 2013-04-26**	**4 upstream 2013-04-26**
Ca	mg/l	6,11	4,56
Mg	mg/l	2,97	2,43
Na	mg/l	5,51	2,93
K	mg/l	1,1	1,16
Fe	mg/l	3,29	3,08
Cu	µg/l	1,5	2,18
Mn	µg/l	294	139
total hardnes	°dH	1,54	1,2
turbidity	FNU	81	130
colour	mgPt/l	290	320
conduktivity	mS/m	9	6,8
pH		6,5	6,5
nitrite	mg/l	0,07	<0.01
alkalinity	mg HCO3/l	29	20
CODMn	mg/l	9,4	6,6
ammonia	mg/l	0,086	<0.050
fosfate	mg/l	<0.040	<0.040
nitrate	mg/l	<0.50	1,91
fluoride	mg/l	<0.20	<0.20
chloride	mg/l	3,64	1,8
sulfate	mg/l	5,05	3,65

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Dokumentet är godkänt och digitalt signerat av

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2013-05-21 10:44:00
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2-2 Soil Analysis Report

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Huye 19th of June, 2013

Soil laboratory analysis for the Peat Power Plant project

Sample ID	pH (water)	pH(KCl)	EC (µS/cm)	N (ppm)	P avail. (ppm)	$SO4^{2-}$ (ppm)	B (ppm)	P tot. (ppm)	Cr tot. (ppb)
Buye-367	5.57	4.66	36.6	1764.45	1.71	35.8	0.07	394.99	228240
Cassava	5.49	4.57	38	1705.63	1.93	37.7	0.07	390.22	215130
Buye-368	5.41	4.55	28.5	1548.79	2.77	278.4	0.11	530.65	231540
Sorghum	5.5	4.56	27	1529.19	2.72	300	0.14	533.12	243270
Buye-369	5.21	4.24	31.8	1803.66	3.9	33.6	0.19	418.15	97000
	5.16	4.22	31.5	1764.45	3.69	39.5	0.17	417.03	89130
Buye-370	6.12	5.23	58.2	1725.24	2.22	36.3	0.16	520.18	51380
Maize+beans	6.18	5.25	59	1744.84	2.43	38	0.18	522.13	54190
Buye-371	5.87	4.75	36.2	1607.61	1.19	298.3	0.23	559.04	74440
	5.78	4.75	36.4	1646.82	1.28	283.3	0.23	558.14	76220

Sample ID	K tot. (ppm)	Na tot. (ppm)	SAR	Ca tot. (ppm)	Mn tot. (ppm)	Fe tot. (ppm)	Cu tot. (ppb)	Pb tot. (ppb)	Cd tot. (ppb)
Buye-367	2938.09	1899.98	0.040	1509.98	645.05	27771.3	139220	-	-
Cassava	2986.16	1913.84	0.037	1588.12	631.12	27732.4	148010		
Buye-368	3466.02	2633.3	0.045	1533.31	252.61	12982.1	46800	-	-
Sorghum	3482.1	2621.42	0.041	1549.27	267.14	13000.4	44300		
Buye-369	3592.48	2466.64	0.060	1633.32	225.15	11812.6	29740	-	-
	3531	2452.2	0.062	1682.13	226.12	11784.1	27130		
Buye-370	4910.1	2366.64	0.069	1766.64	434.27	16402.6	66520	-	-
Maize+beans	4943.3	2371.3	0.077	1798.45	439.16	16378	69310		
Buye-371	3960.74	1499.98	0.058	1399.98	535.89	31606.1	112780	-	-
	3976.14	1482.1	0.063	1423.56	541.83	31652.5	108240		

- : *Below detectable values*

Head of soil laboratory: CHIRAGAGA Dieudonné

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