ENVIRONMENTAL AND SOCIAL AUDIT

NTARUKA HYDROPOWER PLANT

FINAL REVISED REPORT

prepared by

Green Growth Solutions Ltd

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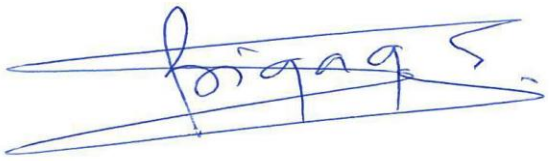

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This report was prepared by an independent Auditors Firm with no previous involvement in the activities mentioned. Responsibility for the content and presentation of findings and recommendations rests with the study team. The views and opinions expressed in the report do not necessarily correspond to the views of REG/EDCL.

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II. ACRONYMS

BCEOM	Bureau Central d'Etudes pour les Equippements d'Outre Mer
EA	Environmental Audit
EAQIP	Energy Access and Quality Improvement Project
EDCL	Electricity Development Corporation Limited
EIA	Environmental Impact assessment
EMP	Environmental Management Plan
ESA	Environmental and Social Audit
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management plan
ESSs	Environmental Social Safeguards
EUCL	Energy Utility Corporation Limited
GGS	Green Growth Solutions
GoR	Government of Rwanda
HPP	Hydropower Plant
IAPs	Interested and Affected Parties
IPM	Integrated Pest Management
MHPPs	Micro Hydropower Plant Projects
MINAGRI	Ministry of Agriculture and Animal Husbandry
MINALOC	Ministry of Local Governance
MINEMA	Ministry Of Emergency Management
MININFRA	Ministry of Infrastructure
MW	Megawatts
NHPP	Ntaruka Hydropower plant
REG	Rwanda Energy Group
REG/EDCL	RWANDA Energy Group
REMA	Rwanda Environment Management Authority
REMA	Rwanda Environmental Management Authority
RNRA	Rwanda Natural Resources Authority
RSB	Rwanda Bureau of standards
RURA	Rwanda Utilities Regulatory Agency
RWA	RWANDA
SIMPACTS	Simplified Approach for Estimating Impacts of Electricity Generation model
ToRs	Terms of Reference
WB	World Bank
WBG	World Bank Group

II. EXECUTIVE SUMMARY

The Government of Rwanda (GoR) through REG/EDCL under the oversight of the Ministry of Infrastructure (MININFRA) envisages increasing access to electricity and diversifying energy sources countrywide, and has set a target of increasing the installed capacity from 224 MW to 556 MW by 2024. It is in this regard, the project titled "**Rwanda - Energy Access and Quality Improvement Project (EAQIP)**" is being developed with World Bank support to improve access to energy and efficiency of energy service delivery to households, businesses and public institutions in Rwanda. As part of its key activities, the Project will undertake the rehabilitation of the Ntaruka Hydropower Plant (HPP), to contribute to the security of renewable energy generation in Rwanda, and to improve the operation characteristics of power generation plants in the country.

Environmental and Social Audit Methodology

This Environmental and Social Audit (ESA) is prepared as part of the **Rwanda Energy Access and Quality Improvement Project (P172594)** for Ntaruka HPP with a view to meeting Rwanda and International Environmental and Social Safeguards, Procedures and Guidelines. This ESA consisted of a systematic literature review and key stakeholder consultations including REG staff and a sampling of communities in the project area. The implementation period reviewed by this audit is 60 years i.e. from 1959 to June 2020.

The scope of the ESA of the Ntaruka HPP Project included a review against national and international environmental and social performance standards, and also against relevant legislation and policies. Audit criteria were agreed with the client during the pre-audit meeting, to form a 'compliance check' on which verification of the extent to which the various monitoring and mitigation measures have been implemented to date. Physical field checks, allowed the audit team to comment on the efficiency of the various measures.

Based on the agreed audit criteria, checklists for the functional areas of the audit were developed to guide the collection of information and evidence by the various auditors. The audit considered the assessment of current Ntaruka HPP project area, the overall environmental management status, social issues, and risks and impacts of the plant with reference to the requirements of GoR's laws and regulations, and the World Bank Environmental and Social Standards, and the World Bank Group general EHS guidelines.

Audit Findings and Summary of Proposed Mitigation

Baseline Information on project site revealed information as follows: -

1. Though Ntaruka HPP has been in operation for 60 years, there are no industries in the neighbourhood, thus suggesting that the general site's chemical contamination hazard is low.
2. There was no evidence of flooding observed during site reconnaissance. With most of the power plant components located on the hillside, the potential effects of flooding on the foundations of the existing project structures are insignificant.
3. The project area is prone to landslides and slope failures as was observed during the site reconnaissance. However, it appears that appropriate landslide remedial action was taken into consideration during construction of each power plant component. This remedial action includes the use of protection for the slope cuts, which are stable and are in good condition. No signs of ground subsidence were observed on the site and its neighbourhood.

4. The audit revealed that a comprehensive environmental and social impact assessment process has not been undertaken for Ntaruka HPP Project prior to its development and the associated environmental and social monitoring and management programs are not well mainstreamed in its operation. Noting that EIA became mandatory for constructed facilities after 2005 in Rwanda. Given that the social and economic impacts of the Ntaruka HPP were not initially quantified, a full Environmental and Social Impact Assessment is recommended before the implementation of the rehabilitation project.

Dam Safety

1. The natural reservoir for Ntaruka HPP is Lake Burera on which was constructed a small weir type dam of 5.5 m of height and a crest length of 28 meters. Though the dam has been in operation for more than 60 years, there were no safety issues and cases historically recorded. that are associated with the dam and power plant. Applying the World Bank criteria, the dam risk is categorized as low, considering its dimension and location. Release of water from the spillway is controlled, and its failure or disoperation can result in no probable loss of human life. In the event of dam failure, the water would flow into the lower lake through a natural channel.
2. The terrain downstream of dam is steep mountain sides. By applying SIMPACTS (Simplified Approach for Estimating Impacts of Electricity Generation Model), it showed that the inundated area is small. Therefore, there is no risk of loss of life for any dam failure except for low economic and/or environmental losses i.e. destruction of unpaved road.
3. **Regarding Dam safety plans**: at time of site visit, the auditors found that only an operation and maintenance (O&M) plan was available. This O&M plan included only subsystem/equipment to be maintained, activity, long-term maintenance schedule and risks associated on the maintenance. The O&M plan did not set out details of the organizational structure, staffing, technical expertise and training required, and equipment and facilities needed to operate and maintain the dam. O&M procedures were not clearly described, nor are arrangements for funding O&M. The O&M plan also doesn't reflect changes in the dam's structure or in the nature of the impounded material that may be expected over a period of years.
4. No Construction Supervision and Quality Assurance Plan and Instrumentation Plan were found on project site. Dam instrumentation is necessary during the rehabilitation project, and after rehabilitation, instrumentation and monitoring of dam and of the reservoir and the Rugezi-Burera-Ruhondo catchment area should be implemented.
5. No emergency preparedness plan was found. This key plan would ideally include, i.) clear statements on the responsibility for decision making relating to dam operations and for the related emergency communications, ii.) maps outlining inundation levels for various emergency conditions, iii.) warning system characteristics, and iv.) procedures for evacuating threatened areas and mobilizing emergency services and equipment.
6. Therefore, we recommend that the plant owner, i.) Develops and complies with an Emergency Preparedness Plan, an Evacuation Plan, Instrumentation Plan for the dam and the catchment area; ii.) Develops and complies with a comprehensive O&M plan after project rehabilitation; iii.) Develops dam safety programs which include periodic safety inspections of the dam after project rehabilitation, and implementation of measures required in addressing safety issues.

Occupational Health and Safety

7. Some employees are not trained in first-aid. Additionally, there is need to enhance signage to show proper PPE usage, hazardous areas, location of first aid boxes, and location of fire extinguishers. The company should conduct risk assessment as a basis for the development of a comprehensive Emergency Response Plan, and also implement OSH training including

regular fire and emergency evacuation drills. The noisy diesel generator installed in the staff residential camp also requires an acoustic enclosure Noise muffler).

Waste Management

8. Some hazardous products are used on site (turbine, generator and transformer oil). Additionally, rehabilitation and operation stages of the plant will generate wastes including Wastes will generated during the rehabilitation and operation phase of the plant. Solid wastes will include paint containers, dead plant material, waste cement, old parts that will be replaced with new ones, such as the old grill wire mesh covering the surge tank, old ladders, etc.
9. This ESA recommends the development and implementation of a robust Waste Management Plan.

Ecological Flow

10. Water from the Rugezi Wetlands flows downstream first into Lake Burera supplying Ntaruka HPP nearly half of its inflow and then into Lake Ruhondo. Before the construction of the power plant, Lake Burera and Ruhondo were connected by the Ntaruka stream. By the time of the plant construction, the river was dammed and its water channelled into the head race tunnel towards the surge tank, to finally reach the powerhouse via a penstock.
11. The auditors recommend that, the ecosystem of the Rugezi-Burera-Ruhondo catchment should be regularly monitored.

Energy Management (Key Issues)

12. Though Ntaruka HPP equipment is regularly checked, some parts are not changed or repaired when needed, example of burnt circuit breakers in switching gear.
13. During the site visit, the water level recorded was 1862.2m. The lake is allowed to operate between 1859.7m and 1864.0m giving a live storage volume of 201 mill.m^3. The average annual inflow is given as 4.95m3/s giving a total inflow of 156.1 mill.m^3. With an installed turbine discharge capacity of close to 3 times the average annual inflow, the recommendation is to raise the lake level to have a minimum average water level of 1863.2m which would result in a 1% increase in annual energy production.

Air Emissions Management

14. Apart from emissions generated by employees cars and power backup equipment which work only a few minutes a day, hydroelectric power plants do not generate a lot of specific emissions.

Noise Emissions

15. We would recommend that noise emission levels are properly assessed inside the power plants and appropriate PPE (ear muffs) should be provided for the personnel exposed to elevated noise levels.

Fire Protection

16. The auditors found the cabling of firefighting equipment to be in a satisfactory condition. There are three 50 kg ABC dry powder extinguisher; thirteen 5 kg CO2 extinguishers, and two 2 kg CO2 extinguishers installed in total. The auditors recommends that the number are increased to 5, 20 and 10, 50 kg ABC dry powder, 5 kg CO_2 and 2 kg CO_2 extinguishers respectively. These extinguishers must be checked on regularly and site personal must be trained on their

use. Additionally, automatic fire extinguishing systems (sprinklers) must be kept in good working condition.

Bearing Lube Oil Cooling System

17. The cooling piping has depreciated and allows ingress of water into the oil. This can cause corrosion damage. The auditors recommend immediate replacement of oil cooling tubes to avoid further oil contamination and damage on the generator and turbine bearings and shaft.

Penstock Environmental Condition

18. The entire length of the penstock is free of water leakage, but the following minor defects were noted. i.) visible external corrosion of the penstock pipe exhibited some damage at the road crossing, ii.) some expansion box fasteners were corroded, iii.) some corrosion of the paint along the length of the penstock given that it is moderately old, and iv.)the penstock drainage pipe and valve in the powerhouse was severely corroded.
19. It is recommended that the following are measures are instituted, i.) repairs to seal cracks in the penstock foundations, ii.) rehabilitation of the penstock expansion boxes by sand blasting and painting, iii.) sand blasting and painting of the exterior of the penstock, and iv.) the damaged penstock pipe is repaired.

Geotechnical hazard considerations

20. The project area are free chemical contamination. There were no signs of ground subsidence on the site and neighbourhood that were observed during visual inspection. Since the site has been used for power production for over 60 years and has had no legacy of industries, the audit team concludes that its contamination hazard is low.

Status of the Substation

21. The existing evacuation lines are good enough to sustain the power generated from the power plant.

Regarding Organisation (observation)

22. To date, environmental management principles have not been fully internalised at the plant. It is recommended that a training program (Environmental Management System) is implemented in collaboration with the environmental staff for environmental compliance, and that the safety & prevention unit carries out regular monitoring activities to address any pertinent issues.

Planned rehabilitation project

23. The audit further considered the assessment of potential environmental and social issues, risk and impacts associated with the planned rehabilitation works including, i.) the potential impacts of the proposed rehabilitation, and ii.) the ability of the proposed rehabilitation project to meet the environmental and social requirements of the GoR laws and regulations, and the World Bank ESS, and WBG EHS Guidelines.
24. Special attention has been given, but not limited to, effects on the hydrological regime, power generation, water quality, effects on terrestrial habitats, health and safety, air pollution, and soil degradation. Since the rehabilitation is happening on the current footprint of the Ntaruka HPP, potential negative impacts from the project on the surrounding physical, biological and socio-economic environment, will be minor. For each of the potential negative impacts, mitigation measures were proposed to be further addressed with the implementation of rehabilitation activities in a full Environmental and Social Impact Assessment.

Effects on the Hydrological Regime

25. The operation of the Ntaruka HPP solely depends on water in its reservoir, that in turn relies on the health of its catchment area, and particularly on the Rugezi marsh. As the degradation of the marsh prior to 2007 has shown, lake levels reduced drastically with a resultant decrease in power generation. It is important that the plant extends its management efforts to catchment monitoring for a healthy hydrological regime.
26. **Recommended action:** For the purposes of ensuring that the status quo of the 2-lake system is maintained, the upstream catchment's health must be maintained to ensure the release of water at all times between the two lakes. The development of an Instrumentation Plan for monitoring both the reservoir lake and the catchment area will aid in ensuring a healthy hydrological regime.

Waste Generation, Characterisation and Management

27. Waste will be generated during the rehabilitation works as well as during the operation of the plant. This will include paint containers, dead plant material, waste cement, old parts that will be replaced with new ones, such as the old grill wire mesh covering the surge tank, old ladder, among other. This if not appropriately disposed of will result in soils, surface and ground water contamination, and subsequently affect the health of aquatic and terrestrial biodiversity particularly in the adjacent lakes, and humans.
28. **Recommended mitigation:** The development of a comprehensive Waste Management Plan during the detailed ESIA Phase, to specify designated waste collection point(s), sorting, and pick-up centre, and engage a licensed waste management company to handle all waste in accordance with the national and international legal provisions.

Water Quality

29. The main impact on water quality during the rehabilitation phase is anticipated to arise from minor inputs of suspended matter to the Ruhondo Lake as a result of rehabilitation activities and erosion of the banks of the lake channels by the higher velocity flows during diversion.

Effects on Land/ Terrestrial Habitats

30. The planned rehabilitation does not involve the construction of a new power station, but rather a rehabilitation with modern equipment of the existing power plant and same foot print, in order to improve the production and the distribution of electricity. REG does not require additional land thus, and respectively, no resettlement or displacement is envisaged.
31. The rehabilitation of Ntaruka hydropower plant is expected to have minimal impacts on the available fauna and flora. This will include loss of some vegetation from areas surrounding the penstock, dam, and surge tank when undertaking routing maintenance activities.

Geology and Soils

32. As a result of this project, especially during construction when excavation activities will be conducted to rehabilitate the penstock foundation, staff landscape work, the soil and geology will be disturbed and to a given extent localized interference of the geology and soils will be experienced.
33. **Recommended mitigation:** Minimal disturbance of the soils and earth should be encouraged and promoted during the construction/rehabilitation period. The catchment of the reservoir should be reforested to prevent exposure to erosion. The proponent should establish tree nurseries at the village level to enable communities participate in reforestation programmes.

The communities should also be trained in soil and water conservation measures so as to provide them with the capacity to mitigate soil loss and siltation of the reservoir.

Dust Generation

34. Transport of materials to the site will generate dust along the unpaved access road, particularly during the dry season, a nuisance for residents and settlements along the road as well as workers at the project site.
35. **Recommended mitigation:** During dry conditions, unpaved access roads to site will be water-sprayed to minimize dust generation and trucks containing friable material will be covered.

Working condition, Hazards and Safety

36. Equipment weighing a minimum of 60 tonnes is expected to be transported to the project site. Additionally, there is an expected increase in traffic with the related potential safety risks (accidents and injuries) for road users. Potential injuries and accidents are also expected during the installation of new equipment and structures during the rehabilitation process.
37. **Recommended Remedial Actions:** Development of a Traffic Management Plan for the rehabilitation phase, specifying dedicated parking zones, speed limits, signage, etc. Workers should also undergo OSH training including first aid knowledge.

Summary of Environmental, Social, Health and Safety Requirements Against which the Audit is conducted

38. As of October 1, 2018, the ESF applies to all new World Bank investment project financing. The ESF enables the World Bank and Borrowers to better manage environmental and social risks of projects and to improve development outcomes. It was launched on October 1, 2018. The ESF makes important advances in areas such as transparency, non-discrimination, public participation, and accountability—including expanded roles for grievance mechanisms. It brings the World Bank's environmental and social protections into closer harmony with those of other development institutions.
39. With regard to the above, the environmental and social risk classification for the Ntaruka MHPP Project is substantial; and the relevant ESSs applicable to the project include ESS1, ESS2, ESS3, ESS4, ESS5, ESS6, ESS8, ESS10 as described below:
40. **ESS1 Assessment and Management of Environmental and Social Risks and Impacts** sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through Investment Project Financing (IPF), in order to achieve environmental and social outcomes consistent with the Environmental and Social Standards (ESSs).
41. **ESS2 Labour and Working Conditions** recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. Borrowers can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions.
42. **ESS3 Resource Efficiency and Pollution Prevention and Management** recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. This ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life-cycle.
43. **ESS4: Community Health and Safety** addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrowers

to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.

44. **ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement** - involuntary resettlement should be avoided. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons (and on host communities receiving displaced persons) will be carefully planned and implemented.
45. **ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources** recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. ESS6 also addresses sustainable management of primary production and harvesting of living natural resources, and recognizes the need to consider the livelihood of project-affected parties, including Indigenous Peoples, whose access to, or use of, biodiversity or living natural resources may be affected by a project.
46. **ESS8: Cultural Heritage** recognizes that cultural heritage provides continuity in tangible and intangible forms between the past, present and future. ESS8 sets out measures designed to protect cultural heritage throughout the project life-cycle.
47. **ESS10: Stakeholder Engagement and Information Disclosure** recognizes the importance of open and transparent engagement between the Borrower and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation.
48. The institutional framework for environmental management in Rwanda is currently set out in the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda, published in the Official Gazette RWA N° 9 of the 1st May 2005, particularly in Chapter III relating to the establishment of the institutions.
49. The Rwanda Environment Management Authority (REMA) is responsible for managing environmental issues in Rwanda and has a duty to implement policies and laws related to the environment. REMA was established under the Organic Law (No. 04/2005 of 08/04/2005) and given responsibility to oversee, co-ordinate and supervise the EA process in Rwanda.
50. According to the recent restructuring, governmental institutions involved directly or indirectly in environmental management include: Ministry of Emergency Management (MINEMA), Ministry of Local Governance (MINALOC) through provinces and decentralised entities (districts, sectors), Ministry of Agriculture and Animal Husbandry (MINAGRI), Rwanda Environment Management Authority (REMA), Rwanda Natural Resources Authority (RNRA), Rwanda Bureau of Standards (RBS), Rwanda Utilities Regulatory Agency (RURA) and Energy, Water and Sanitation Authority (REG/EDCL).
51. Relevant national laws for this Project include:
    - The Law on Land Use and Management (Organic Law N° 08/2005 of 14/07/2005).
    - The Law on Forestry (No 47/1988 of 5 December 1988).
    - The Water Law (Law N°62/2008 of 10/09/2008).
    - The Land Title and Registration Law (Ministerial order N°002/2008 of 01/4/2008).
    - Ministerial Order establishing the list of protected animal and plant species (Ministerial Order No 007/2008 of 15/08/2008).
    - Ministerial Order relating to the requirements and procedure for environmental impact assessment (ministerial order n° 003/2008of 15/08/2008).

- Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees (Ministerial Order N°01 of 17/05/2012).
- National Strategy on Climate Change and Low Carbon Development for Rwanda, (DOI 10.4210/SSEE.PBS.2011.0002).
- The National Land Policy, 2004.
- The Water and Sanitation Policy, 2004.
- The five-year strategic plan for the environment and natural resources 2009-2013.
- The Mines and Geology Policy, 2004.
- National Forestry Policy, May 2010.

52. Law No.62/2008 of 10/09/2008 elaborates the use, conservation, protection and management of water resources.
53. The National Policy for Water Resources Management (2011) is the latest development in Government's consistent and continuous efforts to strengthen the water resources management sub- sector. It replaces the 2004 policy whose revision became indispensable due to its ill-alignment with the Water Law No. 62/2008. The later embodies many modern and cutting-edge principles of sustainable water resources.
54. The development of the 2011 policy, in keeping with the ideals of stakeholder participation, included a process of consultations with experts, senior managers and opinion leaders from different agencies and walks of life in the water sector.
55. Labour Law No. 66/2018 of 30/08/2018 Law Regulating Labour in Rwanda repealed and replaced Law No. 13/2009 of 27/05/2009 Regulating Labour in Rwanda. The law regulates all employment matters for employees in the private sector, contractual staff in public sector, interns, apprenticeships, and self-employed persons but only in regard to occupational health and safety (Art 2). The new law was enacted to align it to International Labour Organization (ILO) conventions which Rwanda has ratified and also to address concerns and gaps which stakeholders had noted in the repealed law. The entire of Chapter V (Articles 77 – 82) is dedicated to occupational health and safety.

Conclusion

56. The evaluation of the impacts of the rehabilitation project are based on the operational knowledge gained from the Ntaruka HPP Project, together with the insights from the related environmental and social aspects of the Project. The ESA concludes that no major concerns, were observed and reported during the entire plant's operation period, and that the rehabilitation project will not have any major potential impacts either. The compliance level of the project has both positive aspects, and those aspects that need improvement.
57. A synopsis of the conclusions by way of key achievements so far and recommendations on the areas of improvement for Ntaruka HPP, and expected negative potential impacts of rehabilitation project across environment management, labour, health, safety and social aspects, are presented in this audit report. Further, the ESA provides corrective measures to reduce the highlighted potential negative impacts.
58. This ESA further recommends that an Environmental and Social Impact Assessment (ESIA) should be performed prior to project rehabilitation works and a qualified environmentalist is tasked to ensure compliance with the ESMP implementation.

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

Rwanda is located in Central/Eastern Africa with a population of more than 11.5 million and with a land area of 26,338 km^2. Approximately 5.3% of Rwanda's total area is occupied by water, comprising of Lake Kivu, Lake Muhazi, Lake Ihema, Lake Mugesera, Lake Burera and Lake Ruhondo. The Ntaruka Hydropower Project (HPP), located in the northern part of Rwanda, on the land mass separating the Lakes Burera and Ruhondo. Its water supply is from Burera Lake.

Rwanda is endowed with various natural resources for electricity generation, including hydropower, solar, methane, peat and biomass. Currently net installed capacity of power plants is 224.6 MW (46.3% from hydropower, 25.7% from diesel, 5.7% from solar PV, 13.4% from methane, 6.7% from peat, 0.0% from Biomass and 2.4% is imported from neighbouring Democratic Republic of Congo (DRC) and Uganda (Table 1).

Table 1: Current installed power capacity in Rwanda *(Source: REG, January 2019)*

Generation Mix (% Share/Technology)		
Technology	**Installed Cap(MW)**	**% Share**
Hydro	104.1	46.3%
Diesel	57.8	25.7%
Methane	30	13.4%
Peat	15	6.7%
Solar	12.23	5.4%
Biomass	0.07	0.0%
Imports	5.50	2.4%
Total	**224.7**	**100%**

As of April 2020, the cumulative connectivity rate is 54.5% of Rwandan households including 39.7% connected to the national grid and 14.8% accessing power through off-grid systems (mainly solar). Currently, the Government of Rwanda has set out plans to achieve 556 MW installed power generation capacity by 2023–2024 satisfying 100% universal electricity access i.e. 52% on grid and 48% off-grid.

Hydropower generation

Hydropower sector in Rwanda has shown good promise, because of the introduction of independent power producers (IPP) to the sector through private sector investment groups. Hydropower plants production record for Rwanda is shown in **Appendix 1**. Currently, many hydropower plants are operating either as on-grid or off-grid facilities, all to satisfy the electricity demand of the Rwandan population. In addition, other hydropower projects in the country are either commissioned, or under construction and/or development.

Energy from flowing water can be used to produce electricity through hydropower plants, utilizing power from water flow as captive energy for hydroelectricity production. Hydropower plants constructions require large land area, high initial cost, long payback periods, and environmental side effects like relocation of people and internal displacements, coupled with varying effects on biodiversity.

1. *Ntraruka HPP*

The Ntaruka HPP under study is an on-grid (running on river water) small 11.25 MW hydropower plant, whose water supply is from Burera Lake. It caters for 5% of total installed capacity in Rwanda. It was constructed in late 1950s and was designed to generate 22 GWh electricity annually. It is equipped with three generator units with Francis-type turbines. Net head is 102 m, diameter of penstock is 1.8 m, and diameter of head race is 2.5 m making this hydropower plant worthy of reappraisal, especially because of age, there is need to assess its current operational generation effectiveness. Aging also often leads to more equipment breakdowns, losses, down times, huge maintenance costs, and lower efficiency.

Based on its age and current performance, it has been found necessary to rehabilitate the Ntaruka HPP by upgrading to modern equipment, so as to bring the generation capacity back to the installed capacity level. The planned rehabilitation of Ntaruka HPP will be implemented by Energy Development Corporation Limited (EDCL), one of the two independent subsidiaries of REG.

It is against this background that an Environmental and Social Safeguards Audit (ESA) for the project has been prepared as part of the Rwanda Energy Access and Quality Improvement Project (P172594). Once the rehabilitation activities for Ntaruka HPP have been designed and agreed on, the Government of Rwanda will prepare environmental and social risk management instruments specific to the rehabilitation activities, including an **Environmental and Social Impact Assessment (ESIA)**, an **Environmental and Social Management Plan (ESMP)**, a **Stakeholder Engagement Plan (SEP)**, and a **Labour Management Plan (LMP)** in accordance with the World Bank's ESF, national laws and regulations, as well as the Project ESMF, SEP and LMP (not available for Ntaruka HPP and will be developed with the Ntaruka HPP planned Rehabilitation Project).

1.2 Objectives of the Environment and Social Audit

The main objectives of the audit was to identify the nature and extent of all environmental and social areas of concern at the existing Ntaruka HPP structural and operational components along with the dam/intake weir, and assess their current status as per the requirement of the GoR's environmental impact assessment, health, safety, labour, and biodiversity laws and regulations and the World Bank environmental and social standards; and to identify and justify appropriate measures and actions to mitigate the areas of concern and estimate the costs of the measures and actions for the rehabilitation of the HPP.

Specifically, the purpose of the ESA was to -

1. Help REG/EDCL to find out whether power generation by MHPP is complying with environmental standards and other statutory requirements through audit findings,
2. To help REG/EDCL conduct its activities without harming the people living in neighbourhood of the Hydropower plants,
3. To help in identifying operational defects in the projects in order to develop and implement corrective measures, and
4. To prepare for review and approval by REMA an EA report, and to develop an Action Plan to address audit findings according to national EA Guidelines and Regulations, 2010.

1.3 Scope of work

The scope of work for the audit included, amongst others, the determination of the application to-date of environmental and social safeguards based on the PAD, ESMF and WMP. It also

included the collection of relevant data on how the project is addressing relevant social issues, i.e. issues of inclusion/exclusion, targeted beneficiaries and discrimination.

Specific activities in the audit included: -

- Determination of the extent of the application of safeguards policies in relation to, environmental and & social issues relevant to the project at the national, district and local level.
- Determination of the environmental and social safeguards issues that arose in the course of project implementation and whether any of and/or all project activities have had or have cumulative environmental and social impacts.

Specifically, the following were covered in the audit:

a. A description of the Ntaruka HPP, and an audit of its equipment, facilities and operations, and an assessment of the safeguard operational constraints and concerns facing the project.
b. An assessment and evaluation of the safety status of the dam, its appurtenances, and its performance history.
c. Identification of Environmental and Social issues, risks and impacts of Ntaruka HPP, including dam safety issues, biodiversity conservation, pollution prevention and management issues, risks and impacts, risks and impacts associated with land and natural resource tenure and use, health and safety issues, cultural heritage, and grievance redress system,
d. A review and evaluation of the Ntaruka HPP's operation and maintenance procedures.
e. A review of relevant institutional, legislative and regulatory frameworks of Rwanda
f. overall environmental and social risks and impacts of the proposed project interventions in the current project ecosystems (lakes), current operation practices in the plan for health and safety, its environs monitoring plans and Associated Facilities
g. Conducted an Environmental and Social analysis for identification of environmental and social issues, impacts and risks of associated facilities,
h. Conducted Stakeholder Consultations, including an assessment of the feedback mechanisms put in place for receiving/hearing and effectively responding to grievances or any other feedback from stakeholders.
i. A presentation of proposed Environmental and Social Mitigation measures, and findings and recommendations for any remedial work and safety related measures necessary to rehabilitate the Plant and its intake weir/dam and related infrastructure to acceptable standards of safety.

1.4 Environmental and Social Audit methodology

1.4.1 Introduction

The ESA employed mixed methods to collect both qualitative and quantitative data. The qualitative component involved a review of documents, records and procedures used in the day-to-day running of Ntaruka HPP. Interviews were also conducted with the responsible personnel at the project site to capture operational and social issues. Interviews with relevant stakeholders were also conducted.

The quantitative component of the audit included, on-site assessment of occupational health and safety parameters and visual inspection of relevant structures, infrastructure and processes which were used to identify environmental, health and safety issues including social concerns. This was also used to assess compliance to pre-agreed procedures and instructions/guidelines such as WB/IFC ESS procedures, policies and standards.

1.4.2 Data Collection

Data for the Ntaruka HPP ESA audit was mainly acquired through Site Inspections and Public Consultations. Primary data was directly captured in the field through direct interviews, recordings, administration of questionnaires, parameters analysis, photographic capture, geographical mapping, and public consultation including focused group discussions. This was complimented with secondary data from literature review of documentation on the project, similar case studies, and national and international regulations and international best practice.

The following methodological steps were followed in conducting the ESS audit: -

1. Familiarization with project and Preliminary Document Review.
   Included discussions on REMA regulations and advice relevant to the audit scope. We also familiarised ourselves with the range of reports and documents provided by the Client. We sought briefings from REG/EDCL on the different sites and their backgrounds. This was achieved through reviews of documents and meetings with REG/EDCL, REMA and other key stakeholders.

2. Site Inspections and Public Consultations.
   A walk-through site inspection has been undertaken to give auditors a general overview of the project area and infrastructure. The study team undertaken rigorous public engagement in identifying and addressing the potential impacts of the hydropower activities.
   Focus group discussion (between 6 and 10 individuals) were used to gain information on views and experiences on hydropower activities. Discussions with stakeholders were focused on some of the following topics:
   - Main Economic Activities in the area,
   - Institutions in relation with hydropower activities in the area,
   - Perceptions and Awareness of the stakeholders about the project development activities,
   - Concerns/Risks/Fears of stakeholders about the implementation of hydropower activities in the area,
   - Opportunities and Weaknesses of the project activities in the area,
   - Interests, Influence and Importance of different stakeholders on the project activities in the area, and the level of participation of the stakeholders into these activities,
   - Assessment of expectations and benefits that are likely to result from the project implementation, and
   - Employment, Land use and ownership, Education, Human health, Rare and endangered species, Sustainability and community participation and ownership in the implementation of the project activities, Socio-cultural behaviour, and Gender issues.

3. Detailed Document Review,
   Review existing environmental site assessment and other project reports in relation to the project, to gauge their capacity to provide data sufficient to assess the risks to land, groundwater and indirectly to surface waters; a review of available hydro geological assessments to gauge whether sufficient information exists about the occurrence and movement and condition of water flow; an assessment of the water flow monitoring network; to ascertain whether it was appropriate for the assessment and monitoring of water flow; and a document review to check for compliance with REMA requirements.

4. Assessment of Risks to both to Physical and Socio-Economic Environment.
   All Ntaruka HPP equipment, facilities and operations were checked with a focus on (a) inspection and evaluation of the safety status of the dam and its accessories, and its

performance history; (b) reviewing and evaluation of the owner's operation and maintenance procedures in order to propose recommendations for any remedial work or safety related measures necessary to rehabilitate the Plant along with the intake weir/dam and related infrastructure to acceptable standards of safety. This task also included a review of the risk assessments to physical environment (Land, Water, Air, etc) as well as the risk to human health. The following risks are identified and assessed:

a. Physical risks including impacts on Geology and Soil, Hydrology, Catchment and Drainage, Environmental Flow (sediment transportation, soil erosion, vegetation change and adaptation among others), Inundation, Water Quality and Air Quality.
b. Biological risks including impacts on biological resources (forest resources, rare, threatened or endangered plant species, associated habitat requirements, and both terrestrial and aquatic wildlife resources).
c. Socio-economic risks including Local employment, Local Procurement, Local Services and Infrastructure, Education, Public Health and Safety, Demographic changes, Transportation, Water and sanitation, Resource Use Conflict, Land use, and Occupational Health and Safety.

   The risks were evaluated empirically and on three criteria:
   - Does the parameter being evaluated comply with required standards?
   - Has the finding been verified, and
   - Is there any existing, residual, inherent, contingent or potential environmental risk revealed by this finding?

   Impact Matrix used is given in Table 2, below.

Table 2: The criteria that have been used to evaluate the significance of risks

CRITERIA	**SIGNIFICANCE**			
Spatial Scale	Site specific	Local	Regional	National
Duration	Short Term	Medium Term	Long Term	Permanent
Intensity	Low	Medium Low	Medium High	High
Cumulative effects	None	Low	Medium	High
Probability of occurrence	Improbable	Possible	Highly Probable	Definite
Significance without mitigation	Low	Medium Low	Medium High	High
Significance with mitigation	Low	Medium Low	Medium High	High

5. Assessing how mitigation measures are implemented.
   An assessment of mitigations that have been implemented was undertaken, to gauge the need for remedial actions if any, for the Ntaruka HPP to continue in a sustainable manner. Mitigation measures were assessed for the following parameters: -
   - Environmental management programs,
   - Social and economic investment programs,
   - Technical design solutions,
   - Alternative approaches and methods to achieving an activity's objective,
   - Operational control procedures, and
   - Management systems approach.

6. Preparation of the Audit Report.
   The audit report consists of recommendations aimed at minimising environmental risk, ensuring compliance with environmental legislation and improving environmental management

procedures. Remedial actions have been recommended for each risk identified in a Remedial Action Plan. The measures also are designed to ensure that they are economically feasible, socially acceptable and environmentally sustainable.

2.0 NTARUKA HPP DETAILED DESCRIPTION

2.1 Project location

Ntaruka HPP is located in Northern Province of Rwanda, in Burera District between Burera and Ruhondo Lakes.

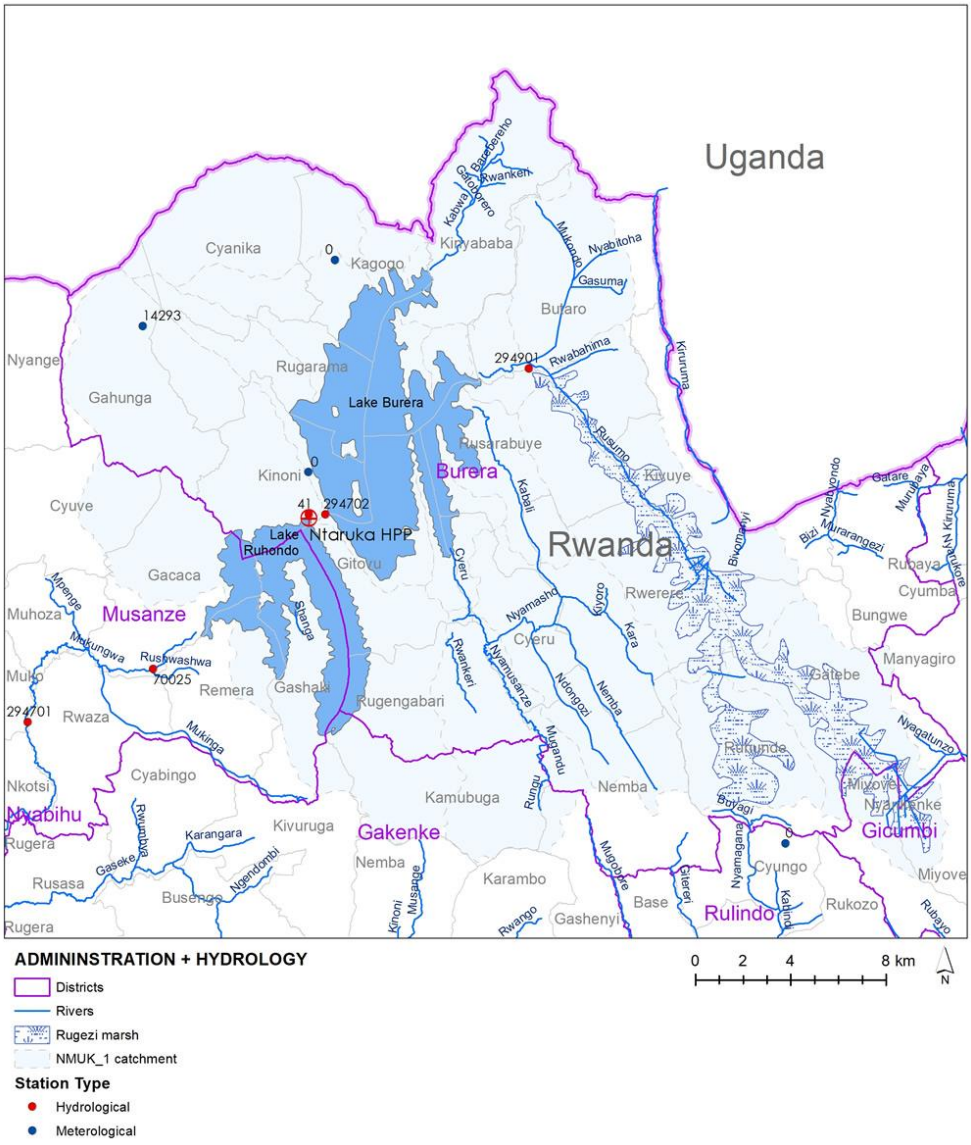

Fig. 1: Ntaruka HPP location

2.2 Ntaruka HPP History

Ntaruka HPP was commissioned by the Belgium Colonial Government, with the aim of supplying power the mineral rich areas in Rwanda, namely Gifurwe, Rutongo, Yanza, Ntunga, Bugambira, Rwinkwavu and Bugarama. Construction started in 1957, and the power plant was commissioned two years later (1959) with only two units operating alternatively. With increasing demand on the grid and being the only power plant in the country, the two units were later operated simultaneously to meet the demand.

In 1973 a third unit was installed increasing the installed capacity with the same site parameters (head and available water). In 1986 (after 26 years of operation), the power plant was rehabilitated where most of electro-mechanical equipment and control systems were replaced.

Since its realization, the power plant has been managed by different authorities, as listed below.

a. From 1957 to 1970, it belonged to "FORCES DE L'EST" Belge,
b. From 1970 to 1975, it was managed by "SNEL" of Zaire (DRC),
c. From 1975 to 1976, it was under the management of "REGIDESO" of Rwanda,
d. From 1976 to 2009, it was under the management of ELECTROGAZ,
e. From 2009 to 2011, it was under management of RECO-RWASCO,
f. From 2011 to 2014, it was under management of EWSA, and
g. From 2014 to date, the power plant is under the management of REG/EUCL.

It should be noted that in 1986 the power plant was rehabilitated by a GRICHTING & VALTERIO, a Swiss consortium on the account of ELECTROGAZ which gave the power plant a new look in terms of operation and efficiency. Its old manual production and operating system was completely refurbished and replaced by a new automatic system, including a governor control system and excitation, and ACEC alternators by B.B.C.

In 1993 during the Rwandan civil war, the power plant was severely damaged, with damages to key components including the Power Transformer, Generator Unit No3, Control Board and Intake among spoiled. The plant stopped operating until 1995 when KFW provided funds to rehabilitate the power plant whereby, a French GEC ALSTHOM NEYRPIC in a joint venture with a Germany company SAG were hired to repair the power plant.

The first unit was then brought on grid in 1995, the second unit in 1996, and the third unit in 1997, albeit with limited generation capacity as compared to its design rating.

2.3 Technical Details about the Equipment and their Current Status

2.3.1 River Headwork

A. River Bank Training Work.

Minor defects were observed on the river bank training works at both side (i.e. left and right).

On the right bank, the following was observed,

Vertical movement on the foundation of the river training stone pitching for slope protection, Slope stones pitching foundation have numerous cracks and few stones pitching fragments are seen as washed-out to the lake bottom.

On the left bank, the following was observed:

Vertical movement on the foundation of the river training stone pitching for slope protection, Slope stones pitching foundation showed some appreciable damage and cracks and few stones pitching fragments are seen as washed out to the lake bottom.

B. Intake Dam.

The foundation and body of the intake dam was checked against concrete cracks, leakage, concrete reinforcement cover and concrete carbonation/weathering. Furthermore, the alkalinity test result at the intake dam was related to the compressive strength of fresh concrete. The findings on intake dam are summarized as below:

- There were no signs of leakage through the dam foundation and body. During this field assessment against leakage, the water level in reservoir/lake was at 1862.2m amsl, which is at 1.5m from the crest of the spillway. This shows that when the plant is operating at normal/full reservoir level, the dam is not susceptible to leakage.
- The entire body of the dam had a concrete cover of more than 60mm. It is important to note that for most countries, the standard concrete cover against seawater and/or aggressive chemical environment for components completely or partially submerged in sea water and/or components in saturated salt air with aggressive industrial atmospheres and/or water and earth faces is 50mm. As such, the concrete cover on the body of the dam is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in the concrete.
- The entire surface weathering of the concrete cover on the dam was limited to 3 -5mm, which is good. The current weathering depth is insignificant when compared with the current available concrete cover of 60-70mm, which is sufficient to protect reinforcement from corrosion and provide fire resistance to the reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on the body of the dam was found to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).
- The entire body of the dam was found to be free of surface and subsurface discontinuities except the walkway on top of the dam which has minor surface discontinuities.
- Significant concrete damage was not observed on the dam foundation and body except for minor plastering fractures on top of the spillway crest at right hand bank.
- Erosion on the concrete face of the dam body and spillway was not observed.
- No observations of any signs of vertical movement or settlement of the dam foundation and body. However, the dam is missing equipment for recording vertical and horizontal settlement.
- The downstream face of the dam was found to be covered in fungus and algae.
- Generally, the body and foundation of the Ntaruka intake dam is in good structural condition and can be used for many more years to come with minor maintenance work.

2.3.2 Power Waterways

The power waterway system comprises one independent intake structure, penstocks, and turbine and discharging tailrace.

A. Intake Structure

Each of the steel and concrete components of the intake were checked using the checks on steel and concrete described in section 5.1. The findings on the concrete structures of the intake are summarized below:

- The intake control floor area was found to have minor surface discontinuities and foliation which were limited to surface plastering.
- The intake control floor concrete cover was found to be in the range of 55mm to 65mm and is sufficient to protect the slab reinforcement from corrosion and to provide fire resistance to reinforcement bars embedded in the concrete.
- Weathering on the concrete cover of the gate control slab was limited to 5mm. This depth of weathering is insignificant when compared with the current available worst condition concrete cover of 55mm, which is sufficient to protect reinforcement from corrosion and provide fire resistance to reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on the intake control floor was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).

- No observation of any signs of vertical movement or settlement of the intake control floor.

B. **Headrace Tunnel/ Pipe.**

The water directed from Lake Burera through the intake is conveyed through a tunnel up to the surge tank. Ntaruka power plant comprises one headrace tunnel which is concrete lined, 463m long and 2.25m in diameter. The entire length of the penstock was checked for surface and subsurface discontinuities, lining weathering, leakage, ponding of water and erosion.

The assessment against the above mentioned parameters summarized as below:

- The head loss in the headrace tunnel is 0.7m is equivalent to a Manning coefficient of 0.017. This shows that the head loss in the concrete lined headrace tunnel is within the acceptable limit and it is almost the same head loss that is expected in a power plant that was commissioned over 67 years ago.
- The entire length of the tunnel lining is free of discontinuities and leakage,
- Weathering on the concrete lining ranges between 2mm to 5mm. This depth of weathering is insignificant when compared with the design thickness of 150mm for the outer upper tunnel lining.
- The entire length of the tunnel is not subjected to any ponding of water and excessive erosion.
- Few fungi and algae were observed on the walls of the tunnel.

C. **Surge Tank**

Ntaruka hydropower plant has a surge tank at end of the headrace tunnel for regulating the water flow during load reduction and sudden increase in the load on the hydro generator (water flow transients in penstock) and thus reducing the pressure on the penstock.

This surge tank is 17m high and 6m in diameter. Detailed assessment of surge tank is summarized as below:

- The surge tank wall was found to be free of major surface and subsurface discontinuities which cause leakage.
- The entire surface of the surge tank foundation and wall was found not to have major damage and/or erosion.
- The concrete cover on surge tank wall ranges from 55mm to 63mm, and is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in concrete.
- In most countries comparatively, a concrete cover of 50mm is recommended for protection against seawater and/or aggressive chemical environment for completely or partially submerged components in sea water and/or components in saturated salt air with aggressive industrial atmospheres and/or water and earth.
- The concrete cover weathering ranges between 3mm and 4mm. As such, the current available concrete cover is sufficient to protect reinforcement from corrosion and provide fire resistance to the reinforcement bars embedded in concrete without any further improvement work.
- The compressive strength of the concrete on walls of the surge tank was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).
- There were no signs of vertical movement or settlement of the surge tank's foundation. This shows that the foundation of the surge tank set on firm ground.
- Most of the surge tank access ladders are completely covered with rust and few are broken.
- The top grill beams are in good status, but some of the mesh wires were damaged.
- Few fungi and algae were found on the walls of the surge tank.

D. **Penstock Steel Structure.**

Ntaruka hydropower plant has a 120m long steel penstock which, at the time of commissioning had an internal diameter of 1800mm and a steel plate thickness of 16mm. The extent of internal and external corrosion was determined using a digital ultrasonic flaw detector and following the procedure described in SE-213 (ASTM E 213-83) - "Standard Practice for Ultrasonic Inspection of Metal Pipe and Tubing". By obtaining the internal and external corrosion, We (Consultant) was able to deduce the effective plate thickness remaining after the wear and tear due to corrosion. The finding of the ultrasonic test on the penstock indicates that the internal and external corrosion at all points tested is below 1mm, leaving an effective plate thickness of at least 14.42mm. Given that no more than 9.875% of the plate has been lost to corrosion over the last 58 years, it is concluded that the penstock is still in good condition and can serve for another 30 years.

E. **Penstock Foundation.**

Ntaruka hydropower plant's penstock is an exposed above ground surface type penstock & supported on piers.

Both the steel and concrete foundation supports were tested using a PROCEQ Profometer 3 reinforcement bar detector and locator and a cover meter. We (Consultant) also performed a test for alkalinity.

The findings of these tests are summarized as below:

- All foundations were free from erosion.
- All the penstock anchor blocks and supports for the foundations were found to be free from vertical and horizontal movement, except a minor horizontal movement on one support block foundation.
- Only a few of the anchor and support blocks were not clean.
- All anchor and support blocks were free of major surface discontinuities, except minor crack on one support block.
- All foundation of anchor and support blocks were free of concrete damage and erosion.
- The concrete cover on all anchor and support blocks was found to be above 55mm, which is adequate to protect the reinforcement and anchor bolt from corrosion and to provide fire resistance to bars and anchor bolts embedded in concrete,
- The weathering of the concrete cover on all anchor and support blocks was limited to 5mm. As such, the remaining concrete cover was found to be sufficient to protect reinforcement and anchor bolts from corrosion and provide fire resistance to reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on all anchor and support blocks was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).

F. **Tailrace System.**

The tailrace system of Ntaruka hydropower scheme consists of one reinforced concrete open channel that joins Lake Ruhondo.

The results of the non-destructive tests and visual inspection of the tailrace canal are summarized as below:

- There were signs of vertical movement and cracks on both sides of the bank stone pitching works of the tailrace canal and on the foundation.
- The tailrace water level raiser/seal structure was decayed and
- Some of the stone pitching fragments had been washed-out and there was some grass and trees growing out of the stone pitching.

2.3.3 Powerhouse Structure and Landscape

Ntaruka power plant powerhouse is a surface power house constructed from reinforced concrete and structural steel, and located on a lean bank. The powerhouse accommodates a loading/service bay, overhead gantry crane, three units of Francis turbines, a control block and offices.

The current status of the powerhouse civil structures is summarized as below:

- Both the windows glazing the air vent have some damages.
- A few fragments of slope retaining stone pitching are missing.
- Some trees and grass were observed on slope rating structure wall.
- The entire slope stability retaining structure work and powerhouse walls were free of excessive cracks.
- All anchor and support blocks were free of major surface discontinuities, except for a minor crack on one of the support blocks.
- The foundation works for the retaining structure and power house were free from concrete damage and erosion.
- The weathering of the concrete cover on the slope retaining structure and power house was limited to 5mm and 2mm respectively, Hence the remaining concrete cover is sufficient to protect reinforcement and anchor bolts from corrosion and fire.
- The compressive strength of the concrete on slope retaining work and power house was estimated to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).

2.3.4 Current Status of the Electromechanical Components

A. Turbine and draft tube.

There are three turbines installed at Ntaruka hydro power plant between 1959 (unit 1 and 2) and 1976 (Unit No3) respectively.

The installed turbines have the following characteristics:

- Type: horizontal FRANCIS
- Model:
- Unit 1: SULZER ESCHER WYSS – ACEC
- Unit 2: BOUSSANT and
- Unit 3: Georges FISCHER.
- Q: 5,5 m3/s
- Net head: 102 m
- Power: 5300 CV
- Rated speed: 1000 t/m
- The runner is made of stainless steel material and runners for all machine were found to be in good condition**.** Spiral Casing were also in good condition.
- The turbine shafts have been severely affected by cavitation pitting which could be felt with the hand.
- The draft tube pipes were also severely cavitated immediately after the stainless steel throat ring, covering an area of about 25% of the draft tube circumference (10 to 30 cm W x 40 cm L).
- The paint in the draft tube lining is generally intact.
- Some corrosion and leakages were observed on the spiral casing also excessive water leakages were observed as the generators were in operation at high load. This excessive water leakage was observed from one of the turbine shaft gland stuffing boxes on the generator and guide vane regulating ring side of unit 1 at 3.57MW and was most probably due to damaged

seals and poor shaft surface condition. Additionally, minor leakage from the guide vanes stems from the damaged seals.
- Unit 2 had moderate water leakage from the two shaft gland stuffing boxes due to old seals.

B. Main Inlet valve and Hydraulic Systems.
- G1 and G3 spherical valves use pressurized water for the operation of servomotors which open and close the valves. The control valves have internal leakage which affects their effectiveness in operation.
- The water leakage noise on G1 could be heard on the machine floor and G3 has slight water leakage at the bottom area.
- The valves exhibit poor sealing. Sealing surfaces need to be dressed up and seals renewed.
- G2 has new valve and operated by pressure oil servomotor.
- G2 has a problem of high oil temperature due to the absence of a cooling system and the poor location of the oil pressure unit.
- No free air circulation to cool the surrounding environment.
- The MVI and guide vanes opening with speed regulators hence output power and frequency of turbine is controlled by MIPREG 520s Electronic Controller.
- Electronic Controller of machine 2 has opening time problems where setting and output do not match accurately.
- The turbine vacuum breaker system has a cock valve that has been set to such a position as to allow air flow all the time. Therefore, there are continuous air bubbles at the turbine discharge in the tailrace when the turbine is in operation. The air admission ports in the draft tube are located 58cm from the runner vanes. The air pipe is painted dark blue which is not correct colour coding. This requires correct colour coding for easy identification of the system.

2.3.5 Generator control & Protection Systems and Power House Ancillary

Ntaruka hydro power plant is equipped with three generators. Each unit has an installed capacity of 5000 KVA at a designed power factor of 0.75, 6.6 KV, 437.4 Amp, 50Hz, a rotor at 38 Volts, 635 Amps and speed of 1000rpm. The insulation for the stator is class F while the rotor is class B.

A. **Physical and operating condition of generator.**

On 29 May 2020, an audit to conduct both physical inspection and running tests on three generators for seven hours was carried out.

Gauges indicated that temperature stabilize at temperatures below alarms and trip values which are respectively set at 60 and 65^{o}C.

The results of temperature and pressure monitoring show that the pressure gauges are malfunctioning and temperature gauges require calibration so as to obtain accurate temperature values.

Visual inspection of the generator winding and rotor was done on all units.

Depending on conducted assessment the following were noticed:
- There were carbon deposits on stator core and stator windings.
- Stator winding insulation measurement results indicated low polarization index.
- Unit 1 end cover cracked and deformed (Thermo mechanical damage).
- Partial discharges.
- Corona discharge (Signs of white deposits).
- Rotor poles insulation was low.
- Stator winding connections was sound but rotor connection require improvement
- It was observed that stator core lamination and slots are tight, stator winding biding were in good condition.

- No any sign of thermal ageing, mechanical stress, electromagnetic stress nor field pole looseness. Carbon brushes were long enough and maintenance carried out at regular intervals depending on machine running hours and their actual status.

B. Excitation System.
As per the conducted assessment, future improvement can involve sophisticated computer programs to manage the safe operations of the excitation system.
If the list of spares contains obsolete parts, the best recommendation is replacement of the entire excitation system.

C. Programmable Controllers.
There is need to replace all obsolete systems without spares before complete failures to mitigate untimely outages.
The management of the power plant should prioritize the worst situations and schedule their replacement according to the rehabilitation plans. This system uses the old DOS system yet spares for such systems are obsolete.

D. Medium voltage 6.6kV SF6 Metal-enclosed Switchgear and Control Gear Assembly.
This is a double busbar Merlin-Gerin ten-way panel, manufactured 1986, comprising SF6 circuit breakers, and associated control, protection (IEE relays) and indication equipment. There are feeder cables from the Nos. 1, 2 & 3 alternators supplying to the three generator and transformers 1, 2 & 3 supply to two auxiliary transformers, a coupling bay which also facilitates protection and measurements. There is also a spare bay. It was observed that one of the circuit breakers developed a fault (got burnt) some time back and there are no replacement spares.

E. Auxiliary power supply system Equipment and Accessories.
These include two (200 and 250) kVA 3-phase auxiliary supply transformers 48V and 110V DC battery systems and chargers, a 65kVA 400/230kVA 3-phase standby generator and auxiliary supplies panels. This equipment supplies power that is required for daily and continuous operation of the power plant. Two 3-phase auxiliary transformers, AGECELEC ONAM (6,6kV/400V- 250kVA) and the other one VALTRANSFO 85146 (6,6kV/400V- 200kVA) are connected to the 6,6kV bus bar and to the low voltage internal supply circuits. They are automatically interchanged between them and between them and the emergency generator when there is a power failure.

F. Metering, Protection and Control Panels within the Control Room.
Old originally installed equipment/panels for metering, protection indication, alarms and control are found in the control room. They are still functioning although with a number of issues. For example, at the time of the site visit, abnormal trips of machine were observed and it was not easy to identify which panel trigged the trip and what was the cause. Additionally, it is reported that some recorders and other accessories do not work and need to be replaced.

G. Power House Crane
Despite earlier complaints about the mal-operation of the power house crane, no failures were registered during the inspection. However, the installed engine does not function properly although there was no failure witnessed. Usually, electrical component functional failures do not occur every time one is operating the equipment. We consider the complaints from the plant operators to be genuine and recommend part replacement of the powerhouse crane.

H. Lighting Inside and Outside the Power House.

Lighting of the facilities in a power station including galleries and outside areas like roads, substation, intake dam, etc. is crucial especially when it involves handling emergencies at night. The power house building needs more lighting points to be installed in case of emergency activities at night time. This must include all panels, galleries, substation roads and the intake dam.

I. Fire Protection.
The firefighting equipment must be kept adequate at all times in case of fire and most workers must be trained to handle incidences in case of fire. Automation of firefighting equipment can be a nuisance especially during mal-operation of carbon dioxide banks. This situation is fatal if the operators are not trained and advised properly.

Most power plants are manually handled during firefighting emergencies. Mistakes cannot be avoided but can be rectified in time. Once appropriately trained personnel at the power plant can decide correctly by using the recommended equipment for a particular type of fire. It was however, noticed that the cabling were in a satisfactory condition.

2.3.6 Current Status of the Substation
From the available information the original three initially, 3 x 5MVA transformers (and associated substation switchgears) were uprated and replaced as recently as 1996 2 x 10MVA; 1 x 15MVA (more recently in year 2016) and there is adequate evacuation capacity for the current and even any slightly increased generation.

A visual inspection of the existing equipment within the substation was conducted and it was found out that the equipment age and physical status basing upon information received from the plants' operator regarding historical performance.

Fig. 2: Part of the Outdoor Substation/switch yard "three outdoor transformers" at Ntaruka.

Within the outdoor substation, the generated power at 6.6kV is stepped up to 30kV and 110kV for onward transmission to supply the grid.

A. 15MVA, 6.6/30kV Transformer; ONAN/ONAF ((No. 3).

- Make: CHINT
- Year of manufacture: 2016

The output from this transformer supplies two separate feeders, Cyanika and Ruhengeri at 30kV. Each feeder is controlled by an SF6 breaker, make GEC Alstom (year 1996); the circuit also incorporates a load break switch, current transformer, surge arresters and an earthing switches for the outgoing lines.

From the available information, the 15MVA transformer was installed in 2016 to replace the original 5MVA one and at the time. All the other remaining interconnection equipment were maintained the same. At the time of the visit there were plans by the client (REG) to install additional equipment which included a circuit breaker for transformer as well as all associated protection gears, CTs, etc., with a view to improve upon the system protection and stability.

Fig. 3: Deteriorated Silica Gel.

It was noted that the quality of the silica gel had deteriorated, resulting in accumulated moisture levels (Fig. 3 above). The transformer however, does not exhibit any signs of distress and is devoid of any tell-tale signs of leakage and other associated effects of deterioration.

B. 30kV Bus bars and Outgoing Feeders.

As already noted, the output from this transformer supplies two separate feeders, Cyanika and Ruhengeri at 30kV. Each feeder is controlled by an SF6 breaker, make GEC Alstom. The circuit also incorporates a load break switch, current transformer, surge arresters and an earthing switch for the outgoing line. There is, however, no direct 30kV outgoing transformer circuit breaker and this may under certain conditions be a constraint that compromises protection and/or system flexibility in its operations.

It was also noted that the CTs had deteriorated over time especially the ones on the Ruhengeri circuit/feeder. One is cracked at the top as well as an oil seepage on another CT.

Fig. 4: Cracked CT for one of the Outgoing 30kV Feeders.

Fig. 5: Oil Seepage on a CT for one of the Outgoing 30kV Feeders.

The Red phase CT on the outgoing Ruhengeri 30kV feeder is cracked at the top and is bound to be hazardous. Also, the Blue phase surge arrester on the same feeder was shattered/broken and disconnected.

C. 10MVA, 6.6/110kV Transformer; ONAN (No. 2).

Make: SGB (STARKSTROM-GERATEBAU GmbH)

- Year of manufacture: 1996
- The output circuit from this transformer connects through surge arresters and an 110kV circuit breaker (SF6 GCB)

- Make AEG;
- Year of manufacture: 1996.
- Associated connected equipment include Capacitor VTs,
- Make: HAEFELY-TRENCH,
- Year of manufacture: 1996.
- A disconnector switch (with earth) connects to the substation 110kV bus bars.

As appears with transformer No.3, the silica gel is severely deteriorated and excessive moisture accumulation is evident. It was also reported that the transformers occasionally present a fleeting fault oil and occasionally buchholz level alarm.
The transformer does not exhibit any signs of distress and is devoid of any tell-tale signs of leakage and other associated effects of deterioration. Proper monitoring and maintenance will increase the transformer life span.

D. 10MVA, 6.6/110kV Transformer; ONAN (No. 1).
- Make: SGB (STARKSTROM-GERATEBAU GmbH)
- Year of manufacture: 1996
- This transformer has similar connections to those of No.2. The output circuit connects through surge arresters and a 110kV circuit breaker, (SF6 GCB)
- Make: AEG and
- Year of manufacture: 1996.
- Associated connected equipment include Capacitor VTs,
- Make: HAEFELY-TRENCH and
- Year of manufacture: 1996.
- A disconnector switch (with earth) connects to the substation 110kV bus bars.

As appeared with transformer No. 3 and No. 2, the silica gel for No. 1 is much deteriorated and excessive moisture accumulation is evident. The transformers occasionally present a fleeting fault oil and occasionally buchholz level alarm.
It also bears similar issues of not exhibiting any signs of distress and is devoid of any tell-tale signs of leakage and other associated effects of deterioration. Yet when properly monitored and maintained it would increase its life span.

E. 110kV Bus bars and Outgoing Feeder
As has been indicated above, transformers No.2 and No.3 feed into the 110kV bus bars located within the upper part of the substation. The outgoing 110kV feeder connects to the bus bars through a bus bar disconnector switch together with a 110kV circuit breaker, (SF6 GCB);
- Make: AREVA and
- Year of manufacture: 2010).

Other associated equipment include a line disconnector switch (with earth) and CTs; of GEC-Alstom brand as well as capacitor VTs for measurement purposes of the 110kV bus bars functionalities whereas a CVT is connected to the bars through a disconnector switch.

2.3.7 Other Permanent Structures
A. Staff Houses.
Ntaruka hydropower plant complex comprises three different staff residence houses. The condition of these houses was also evaluated and the results are summarized as below:
- The entire landscape work around the resident area is washed out due to erosion.

- Some of the roofing sheets have rust and leak while part of the ceilings are damaged.
- Most of window glazing's are damaged and most of the doors are not properly functional while others are damaged.
- The entire sanitary system is old and not in good condition.
- Most of the electrical installation systems are old and in bad condition.
- Paint is peeling off on some of the walls and in several parts of the ceiling and some sections of the floor are cracked.

B. Access Roads.

Ntaruka hydropower plant has reliable access road to the project site and areas which is passable under all weather conditions for efficient and timely operation and maintenance of the plant. Generally, the access road is in good condition and does not need any major works.

2.3.8 Structural Diagram of the Dam and Power House

Fig. 6 shows a diagrammatic representation of the dam and power plant in relation to the two lakes.

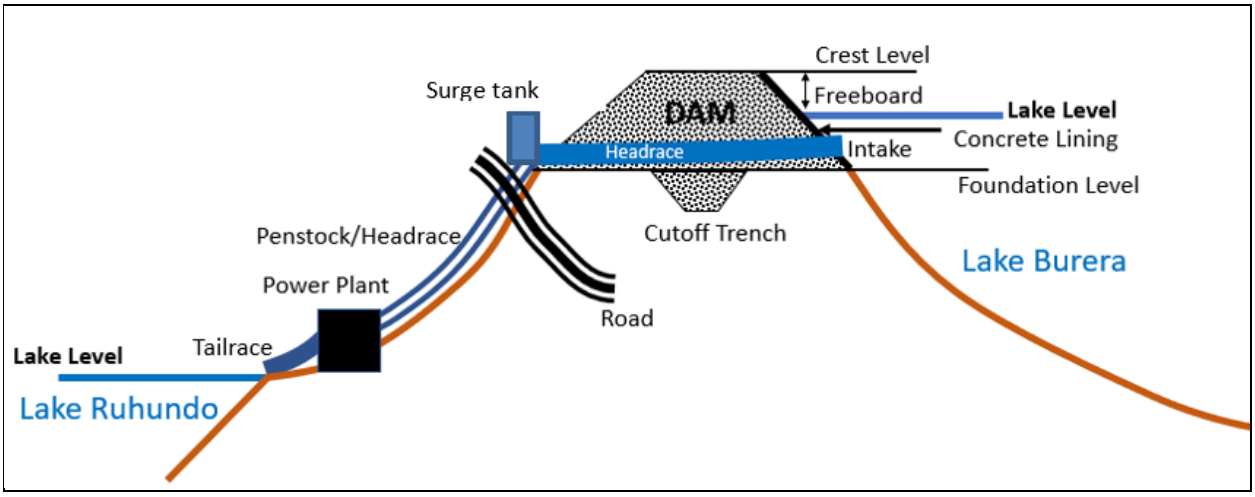

Fig. 6: Structural Diagram of the Dam and Power House

A description of the dam and power plant components is given in Table 3 as follows.-

Table 3: Ntaruka dam and power plant components

S/n	Element	Description
1	Lake Burera	- Area: 47 km - Maximum altitude before construction of Ntaruka project: 1861m - Allowed working range: 1859.7 to1864m - Live storage: 121Million m^3
2	Foundation level	- Altitude: 1855 - Height: varies between 0.50 to 0.90 m
3	Intake structure	- Altitude: 1856.50 to1861m
4	Headrace opening	- Between 1856.50 and 1861 - Slope: 1% - Diameter: 2.2m - Length of headrace: 463m (through the mountain)
5	Surge chamber	- Connect headrace to the penstock

S/n	Element	Description
		- Concrete material - Diameter: 6m - Height: 17m
6	Penstock	- Diameter: 1.8m - Length: 183m - Different slop between anchor blocks (see details in following sections)
7	Power house	- 44.8x10.4x9.1m - Hosts 3 turbine-Generator sets, control and command systems, auxiliaries and control room
8	Tailrace	- Altitude: 1759.8
9	Ruhondo Lake	- At Ntaruka Tailrace: 1757 - At Mukungwa river outlet: 1756 to 759.2

In the power house, a turbine bypass mechanism composed of valve and a 0.65 m diameter pipe is connected to the penstock near the Main Inlet Valve of each turbine. This system bypasses the turbine and is used to empty the penstock before carrying out maintenance activity on turbine, penstock and headrace canal.

2.4 Technical Details on the Dam and Intake Structure

This section gives a brief introduction of the technical aspects of the dam and intake structures. Detailed information is given in **Annex 6** – **Dam Safety Report.**

Diversion dam

Ntaruka main dam structure is located on river Ntaruka, 2.23m high above the foundation grade and has a length of 25.7m at the top. The dam is a weir type made of concrete structure constructed across the original river bed. The dam is equipped with features to allow for normal flow from the upper Lake Burera to downstream Lake Ruhondo through the original river bed in case the power plant stops operating for a long time due to any reason i.e. maintenance or rehabilitation activities, breakdown, etc.

Intake

The water is conveyed to the turbine through an intake arrangement that controls water flow into the headrace channel and then to the penstock. The intake is made of concrete, and has a trash rack with a height of 4.5m that prevents debris from entering the conduit, and two intake gates one after another whose are dimension are 2.2x2.5m. The lowest base of trash rack is situated at 1,856.5m level. The slope of the water channel from trash rack to the headrace channel through headrace gates is 1%.

Headrace Tunnel

Water directed from Lake Burera through the intake and conveyed through a tunnel up to the surge tank. Ntaruka HPP comprises of one headrace tunnel, a concrete-lined 463m long and 2.25m diameter tunnel buried in the hill.

Surge Tank

Ntaruka HPP has a surge tank at the end of the headrace tunnel for regulating the water flow during load reduction and / or load increase on the hydro generator (water flow transients in

penstock) and thus reducing the pressure on the penstock. Ntarukra hydropower plant's surge tank is 17m high and 6m in diameter.

Penstock Steel Structure
Ntaruka hydropower plant has a 120m long steel penstock which, during the time of commissioning, had an internal diameter of 1800mm and a steel plate thickness of 16mm. It is supported by anchor blocks at different points and has variable slopes at different points of its length.

Tailrace System
The tailrace system for Ntaruka hydropower scheme consists of one reinforced concrete open channel that joins Lake Ruhondo.

2.5 Lake Burera - Water reservoir for Ntaruka HPP

Ntaruka HPP has been designed to utilize the optimum potential of a specific stretch of water for generation of electric power. This project utilizes the water from Lake Burera whose inflow is from three rivers, namely Rusumo falls, which is also an outlet of Rugezi wetland lying within the Districts of Burera and Gicumbi, and the other two being Rivers Cyeru and Kabwa.

Lake Burera has a catchment area of 580 km^2 and a surface area of 55km^2, 8.5% of it is comprising of islands.

A clear look at the intake and dam design revealed that water can be stored in the reservoir up to 1,864m before over-flowing. The dam design recommend that water can be used up to 1,859.7m. This dam has a working height of the 4.3m and a storage capacity 202.1million m^3 of water.

2.6 Lake Water Level and Energy Production

After the development of Ntaruka hydropower plant, it is clear that the level of the lake in almost fully controlled by the production of the power plant. The less production of the power plant the higher the water level increases in the lake and less water volume flow to the lake Ruhondo.

Fig. 7 shows the relationship between Lake Burera water level variation and electricity production. The lake level started in 1996 with overflow at the dam spilling water as the power station had been out of operation since the 1994 war. The average lake level in the period is 1862.16m. There has been no spill of water and the "overuse" of water compared to the inflow is equivalent to 1.8m in this period.

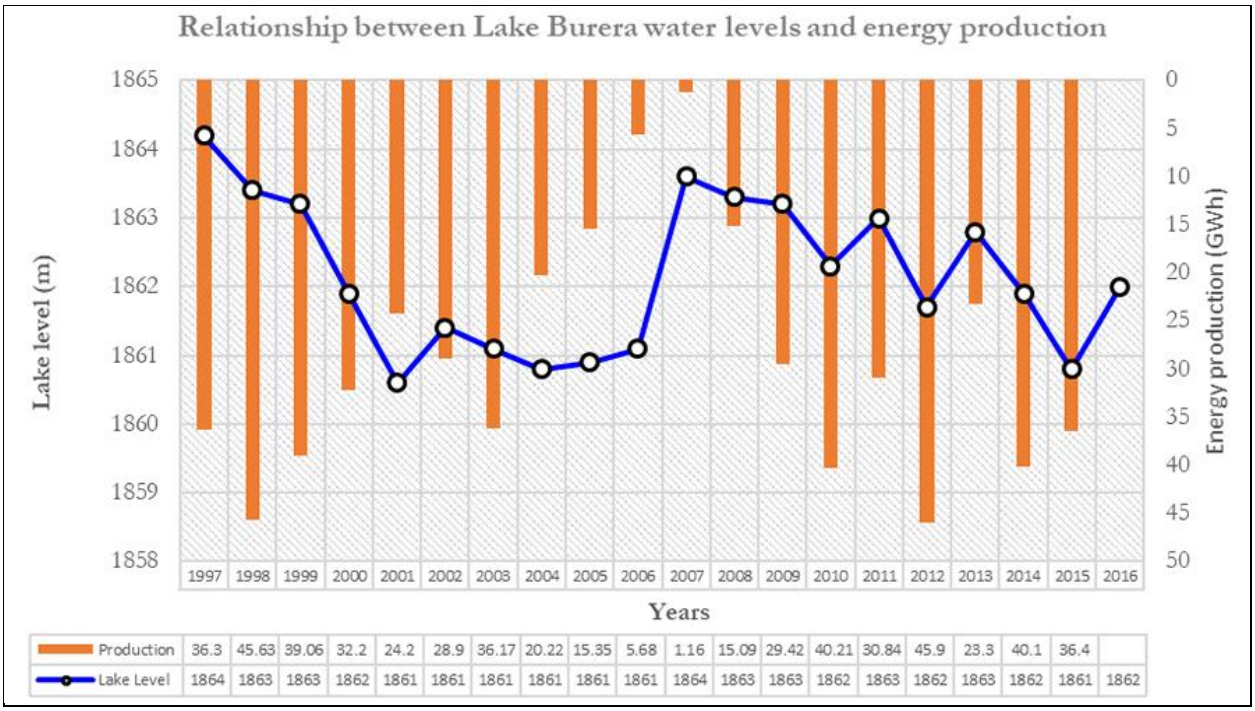

Fig. 7: Lake Burera water level and energy production relationship
(There were no available data until 2020 at the time of this survey)

The highest level of 1863.60m was recorded in 2007 after stopping almost all energy production for two years to raise the water level. Despite good rainfall in the period after 2007, the lake has been operated at levels lower than the one raised to in 2007. During the site visit, the water level recorded was **1,862.2m.**

Daily records of water level indicate that when the plant is stopped in rainy season the level sometime increases even by 3cm a day or remain the same if the plant is running. During the dry season the level remains the same even when the plant does not run. It decreases by more than 2 cm a day when the power plant is running at full capacity during periods of small rainfall.

2.6.1 Lake Burera water levels, inflow and water balance

The Auditor obtained a dataset of the direct measurement of the water levels at Lake Burera and used this data to calculate the average water level and energy production from 1997 to 2016 (**Fig. 7).**

The power station had been out of operation since the 1994 war, with dam water overflowing. Operations were restarted in 1996. The average lake level in the period was 1,862.16m. There has been no dam spill / overflow of water since then and the "overuse" of water compared to the inflow is equivalent to 1.8m in this period. The highest dam water level (1,863.60m) was recorded in 2007 after stopping almost all energy production was halted for two years to raise the dam water level. Despite good rainfall in the period after 2007, the lake has been operating at levels lower than the one raised to in 2007.

During the site visit, the water level recorded was 1,862.2m. The lake is allowed to operate between 1,864.0m and 1,859.7m to maintain a live storage volume of 201 mill.m^3. The average annual inflow is given as 4.95m^3/s giving a total inflow of 156.1 million m^3. With an installed turbine

discharge capacity of close to 3 times the average annual inflow it is recommended to raise the lake level to have a minimum average water level of 1,863.2m, which would result in a corresponding 1% increase in annual energy production.

The average annual lake evaporation of 780mm in the period (calculated using the Meyer formula) is equivalent to a total volume of 35.7 mill.m^3. Raising the lake level will only have a marginal impact on this figure.

2.6.2 Relationship between Lake Burera water levels and precipitation

The highest rainfall measurements are observed in March, April May, September, October and November. For a representative year these measurements were found to be of 9.38mm, 9.9mm, 9.50mm, 8.65mm, 9.77mm, and 7.41mm respectively.

The figure below represents all the daily water inflow that usually falls in the catchment of the Lake Burera. The graph indicates an average medium rainfall income in the catchment since the annual rainfall over the catchment is approximately 1,163 mm.

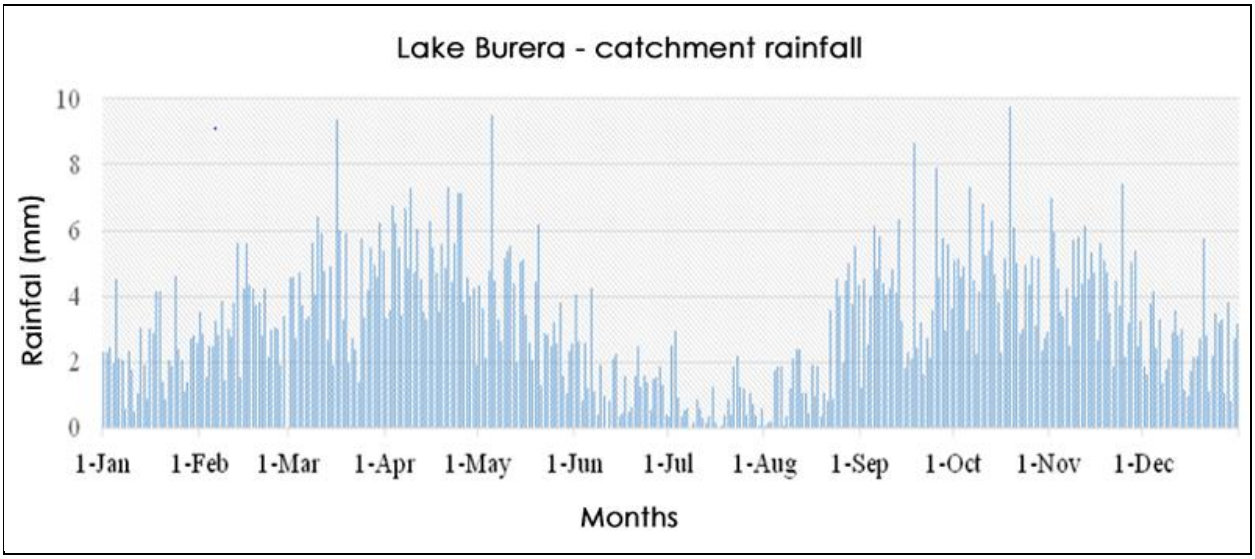

Fig. 7: Rainfall in Burera lake Catchment area

(From Hirwa, 2017)

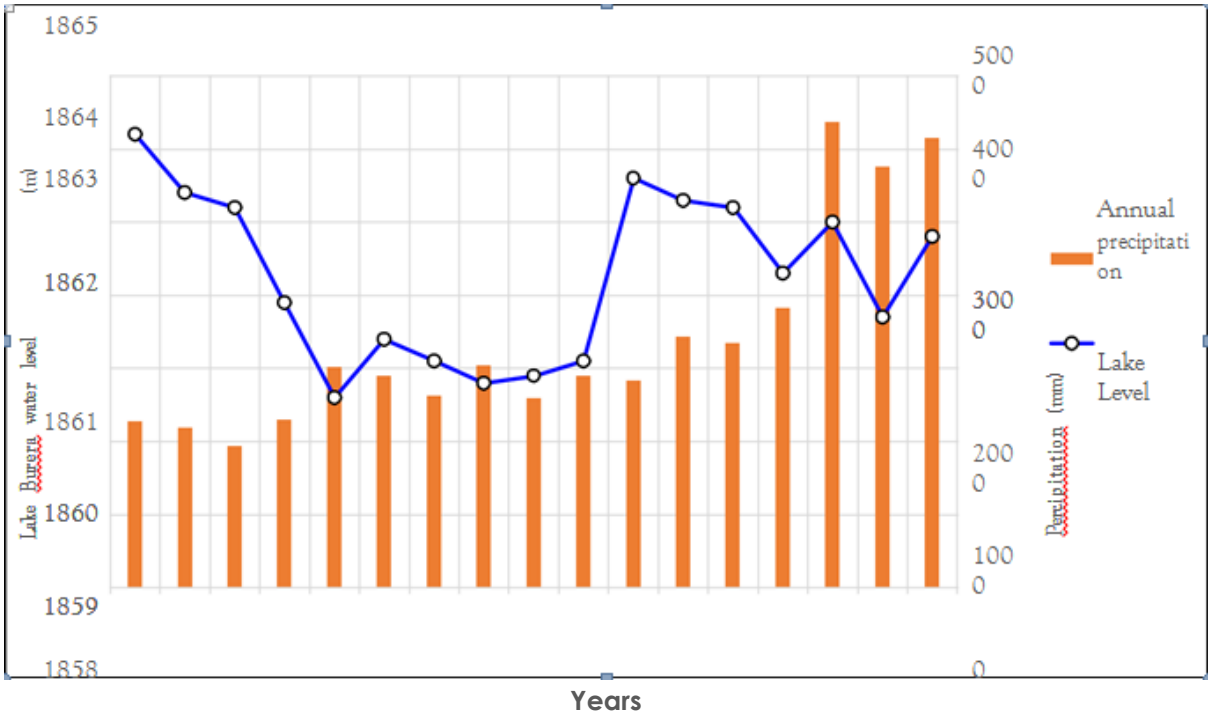

Fig. 8: Relationship between Lake Burera water levels and precipitation

The figure clearly shows 2 separate rainy seasons with daily peaks varying around 10 mm of rainfall. Before construction of Ntaruka power plant was in the lake was apparently stable at the level of 1860m (altitude) and water flow in the Ntaruka steam fluctuated seasonally from as much as less than 1.5m³/s to near 10m3/s as indicated in the bellow flow duration curve.

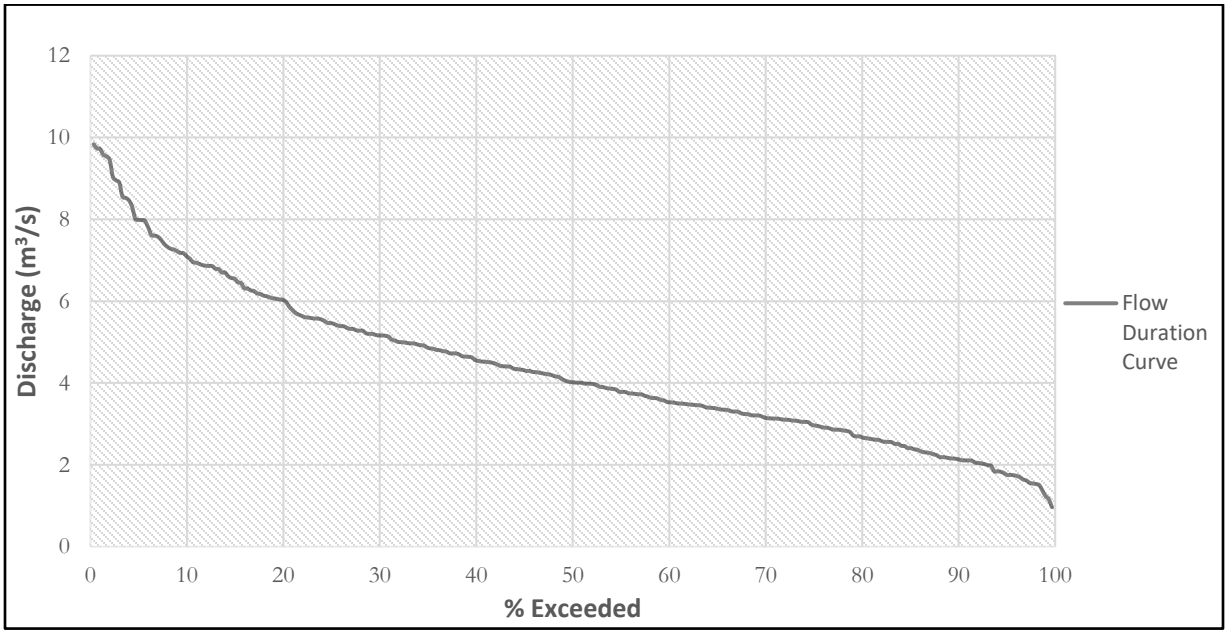

Fig. 9: Flow Duration Curve (source: New Plan 2017)

It is worth noting that in the project area like in other regions of Rwanda are four main seasons. The heavy rainy (March-April-May) and short rainy (September-October-November) seasons alternate with long dry (June-July-August) and short dry seasons (December-January-February).

2.6.3 Energy Production

The recorded average annual energy production in the period 1997-2016 is 28.74 GWh. Corrected for the additional drawdown of the lake of 1.8m from reduced inflow from evaporation gives an average production of 27.65 GWh. The potential energy production using the Plant Data Sheet using the stated average inflow of 4.95m^3/s and with no evaporation losses would have been 35.09 GWh. If the difference of 7.44 GWh from the obtained average annual energy production is due only to evaporation losses and corresponds to a volume of 33.1 mill.m^3 or 703mm. This figure is 10% lower than the average of 780mm calculated by the Meyer formula with data from station 14293. The lower figure can probably be explained by a higher inflow than average which is also supported by the recorded higher rainfalls compared to the normal in the period.

Data from the Ruhengeri Aero station shows an evaporation of 61.6 mill.m^3 corresponding to an energy loss of 13.85 GWh, and inflow to the lake of 5.6m^3/s instead of the stated inflow of 4.95m^3/s. The Plant Data Sheet presents an average annual energy production of 22GWh. However, the recorded energy production in the period is 27.65GWh (corrected for overuse of reservoir) and is 26% higher. Any variation in the evaporation will not change this production figure and there is nothing to be done to alter the evaporation from the lake.

Generally, considering the average inflow of 4.95m^3/s which is stated on plant data sheet and evaporation losses equivalent to 1.90m^3/s, the net available flow becomes 3.05 m^3/s which results in Ntaruka HPP having an annual energy production of 23GWh.

2.6.4 Plant Efficiency and Capacity

Head losses were recorded at different locations in the waterway while running turbines 1 and 2 with an output of 3.1MW each. Unfortunately, no pressure manometers at the turbine inlet were operational so the head loss in the penstock was calculated by using experienced roughness coefficients in penstocks of the similar environment. The concrete lined tunnel with longitudinal shuttering works is estimated to have a Manning figure of 60 due to its age giving a turbine flow of 7.14m^3/s. Further calculations give an efficiency of 87.7% for the turbines and generators combined. It is important to note that generators of this size are having an efficiency of around 96% giving an expected turbine efficiency of 91-91.5%. Using the A-lab program for turbine performance, the maximum rated turbine discharge of 4.63m^3/s and combined turbine/generator efficiency of around 88%, an output of around 3.9MW per unit is achieved.

The overall plant output of 11.7MW with plant efficiency 82.4% including waterway head losses. It is expected that after rehabilitation of the plant, the maximum output achieved will be in the order of 11.5-12MW. The surge chamber height is marginal if the turbine discharge is increased to 13.5m^3/s. This can be resolved by reducing the dimension of the throttle opening as the plant initially seems to accommodate the higher pressures introduced. Alternatively, the height of the tank can be raised slightly.

All civil work structures are generally of good quality and only minor repair work is required. The waterway, except the surge chamber, could accommodate a larger installation. The powerhouse layout, width/height/crane/submergence/etc., are explicitly designed for twin turbine equipment and replacement with new larger equipment with the same design would only give a marginal

increased capacity. If the plant is to be run mainly as a peaking power station, one new unit with single turbine giving a higher capacity could replace the three existing units. This would require reconstruction of the powerhouse with deeper submergence, larger width, new machine hall crane etc. The energy production can be increased by 1-2% due to higher efficiency of new equipment.

The existing equipment can be rehabilitated to a satisfactory level for long term continued operation. Replacement of all machinery within the same structural environment will only marginally increase the capacity and reliability. Increased capacity requires reconstruction of the powerhouse and will have to be justified by a concrete high value of every additional kW installed. The conclusion at this stage of the study is to rehabilitate the existing equipment.

2.6.5 Noise from Power Plant

Generally, external noise pollution from Hydroelectric Power Plants is not a hazard to community noise levels. However, because of the amount of machinery, such as turbines, air compressors and rotors associated to each generating unit, noise production is high inside the power plants. [1]Studies have shown that this makes the work environment unsuitable for the workers regarding occupational health. Equivalent continuous sound level in dB(A) from 125 Hz to 8.000 Hz have been recorded in powerplants.

The draft Rwandan Noise [2]Standards, DRS 236 on Acoustics, Noise Pollution and Tolerance limits, specifies noise exposure levels as follows: -
No person shall be exposed to sound levels exceeding:
a. 70 dB of continuous levels in any one way,
b. 85 dB of reasonably constant level for 8 h continuously in any one day,
c. 135 dB as measured with an instrument set as 'fast' in any one day; and
d. 150 dB in case of impulse as measured with an instrument set at 'fast' in any day.

All work areas where people may be exposed to sound levels exceeding the limits specified in the standard shall be identified as ear protection areas and shall be suitably condoned off.

2.7 Dam Safety Assessment

Ntaruka HPP Dam reservoir has a live storage capacity of 202.1million m^3 of water. Historical records indicate that the since 1997, the available water in the Dam has been always far lesser than the maximum storage. This is because the average inflow water from the catchment is less than the water that the plant requires to run continuously at full capacity. The plant operator informed the auditor that the plant operated at peak levels to meet daily and seasonal demand peaks.

An assessment of the Dam safety was conducted as part of the ESA, and a Safety Risk Assessment for Ntaruka HPP is highlighted in **Annex 6** The dam safety assessment covered two distinct issues:

[1] Noise Evaluation of Hydroelectric Power Plants. Maria Luiza de U. Carvalhoa, Wagner Leroyb, Rodrigo J. Calixtoc and Cynthia I. R. Borgesd. In Environmental Noise Control. The 2005 Congress and Exposition on Noise Control Engineering. 07-10 August 2005. Rio de Janeiro, Brazil
[2] Draft Rwanda Standard - DRS 256. Acoustics, Noise Pollution, Tolernce limit.

the likelihood of the dam failing; and what would happen if the dam failed. The observations made by auditor are summarized as follows.

- Ntaruka Dam is still robust enough to serve for several years; only minor repair works on embankment and weir top are required to restore it to its full and original integrity. Intakes gates should be refurbished to solve the issue of leakage through seals to allow for full closure of gates and safe inspection of headrace channel.
- Risk of abrupt rupture due to overflow and earthquakes is very low. There is no habitation between Dam and power house, and in case the dam fails the risk of death is very low.
- Risk of rupture (piping and erosive breaches) is very low (no seepage detected) but a clear warning sign should be installed to prevent large vehicles from passing through the road under the penstock to avoid accidental damage to the penstock.
- Anchor block with minor damages/sliding need to be repaired to ensure penstock is well supported and stable. Signage should be installed, indicating the height of vehicles that are allowed to pass under the penstock.
- Risk of failure in associated structures is moderate due to deteriorated pipes in the power house; this risk would be reduced to very low by rehabilitation works and installation of new pipes.
- Instrumentation for measurement of pressure and flow in the penstock are not functional and should be restored to ensure close monitoring. Appropriate equipment should be installed for monitoring of water level and earthquake recorder should be installed near the dam.
- Currently there is no Emergency Action Plan, Inspection Reports and/or Safety Assessments identified. These should be established and systematic inspection of the dam carried out. EDCL should put in place a clear Operations and Maintenance (OM) Plan to be implemented by Dam Operator.
- There was not proof that the power plant O&M team includes a trained Dam engineer, therefore owner should include in rehabilitation scope the training of a good number of dam engineer.

3.0 BASELINE INFORMATION

3.1 Introduction

The Ntaruka HPP is designed to utilize water from Lake Burera, located in the Rugezi-Burera-Ruhondo Catchment. This section covers the baseline aspects of the project area, including the Rugezi-Burera-Ruhondo catchment and its hydrological features.

3.2 Hydrology

The Ntaruka HPP utilizes the water from Lake Burera whose inflow is from three rivers, the Rusumo falls, which is the outlet of the Rugezi wetland lying within the Districts of Burera and Gicumbi, and the rivers Cyeru and Kabwa. The catchment of Lake Burera and the watershed for the contributing rivers shown in **Fig. 10**.

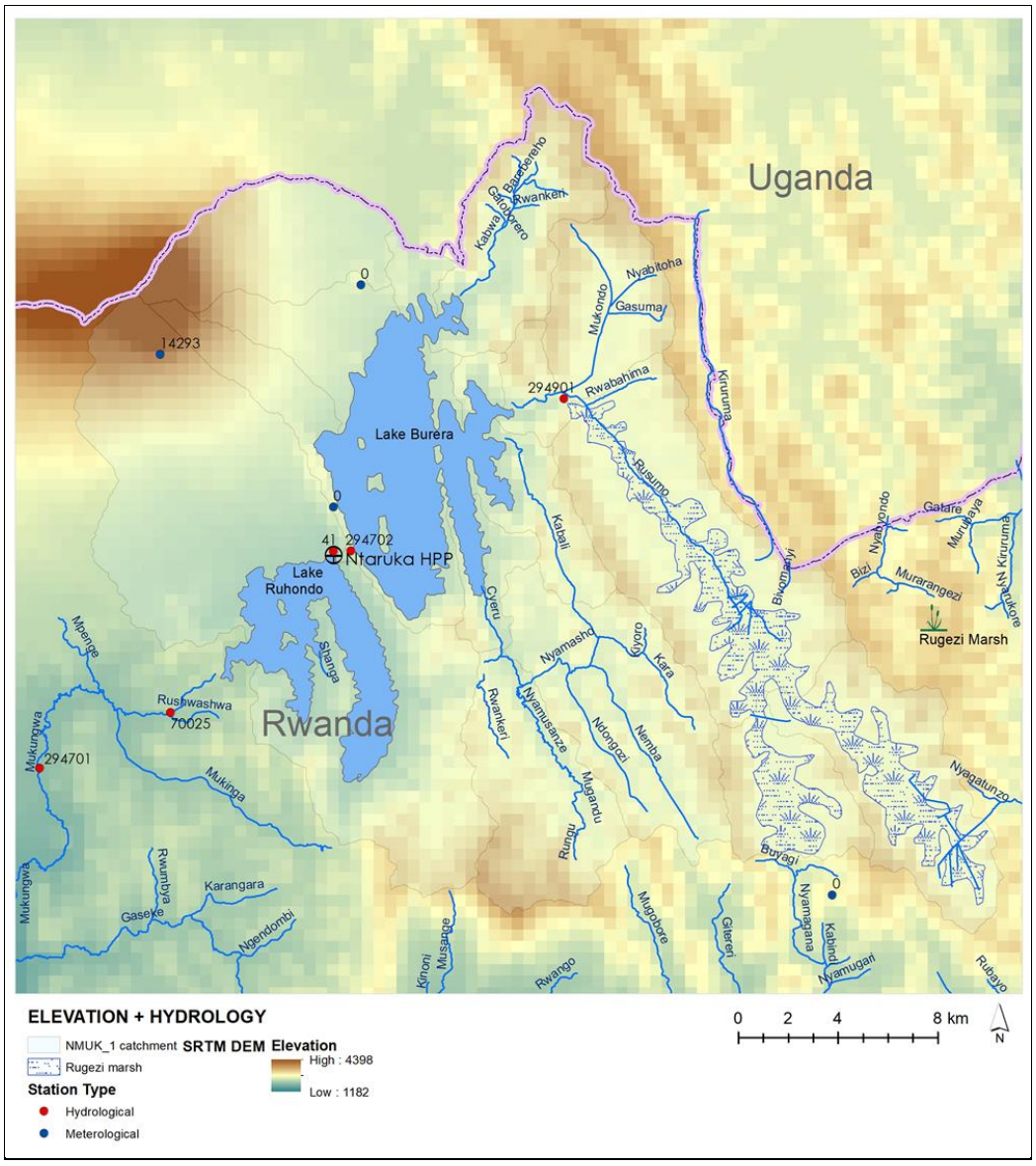

Fig. 10: Lake Burera and its catchment area

Fig. 10 shows [3]Rwanda L3 catchment (NMUK_1 - Mutungwa), [4]Africover, [5]RCMRD rivers and [6]GADM data and data stations which are referred to in the report overlaid on [7]NASA SRTM DEM.

3.2.1 Catchment Area

The three rivers cover about 430km^2 out of 580 km^2 catchment area of Lake Burera. Rugezi wetland has a catchment of 298.62km^2, and rivers Cyeru and Kabwa have a catchment of 109.91km^2 and 21.44 km^2 respectively.

Lake Burera occupies approximately 47 km^2 the 580 km^2 Burera catchment area. Lake Burera is located at latitude -1^{0}26'49.33'' and longitude 29^{0}44'28.91''. Lake Burera is curved out from heavily eroded hills composed of older metamorphic rocks (Hategekimana and Twarabamenye, 2007). Its catchment is located in the Northern Province, in Burera District. The existing bathymetric survey of the lake indicates an approximate depth of 169 meters with a number of underground caves.

The Ntaruka HPP is located in the middle of the twin lakes of Burera and Ruhondo (Aerial view – **Fig. 11**). The outflow of Lake Burera to Lake Ruhondo is controlled by the hydropower plant tailrace outflow, as well as the pipe arrangement at the power plant intake, that can allow release of flow when the plant is stopped. Burera lake lies to the SE of its twin Lake Ruhondo, emptying via a stream called Ntaruka, a 600m long stream. Burera is almost twice as large as Lake Ruhondo and despite only being 600 meters apart, the two lakes are separated by a dramatic drop in altitude of 100m. This dramatic drop is utilized for hydroelectric power generation, and produces 11.25 MW.

[3] Rwanda Level 3 Catchments. https://www.arcgis.com/home/item.html?id=d98ec9cde35b4e13838fd01c2d30de43
[4] Multipurpose Landcover Database for Rwanda – AFRICOVER. http://www.fao.org/geonetwork/srv/en/metadata.show?id=38100&currTab=simple
[5] Rwanda Rivers. RCMRD Geoportal. http://geoportal.rcmrd.org/layers/servir%3Arwanda_rivers
[6] Global administrative Areas (GADM). https://gadm.org/data.html
[7] NASA Shuttle Radar Topography Mission (SRTM) Version 3.0. https://earthdata.nasa.gov/search?q=srtm

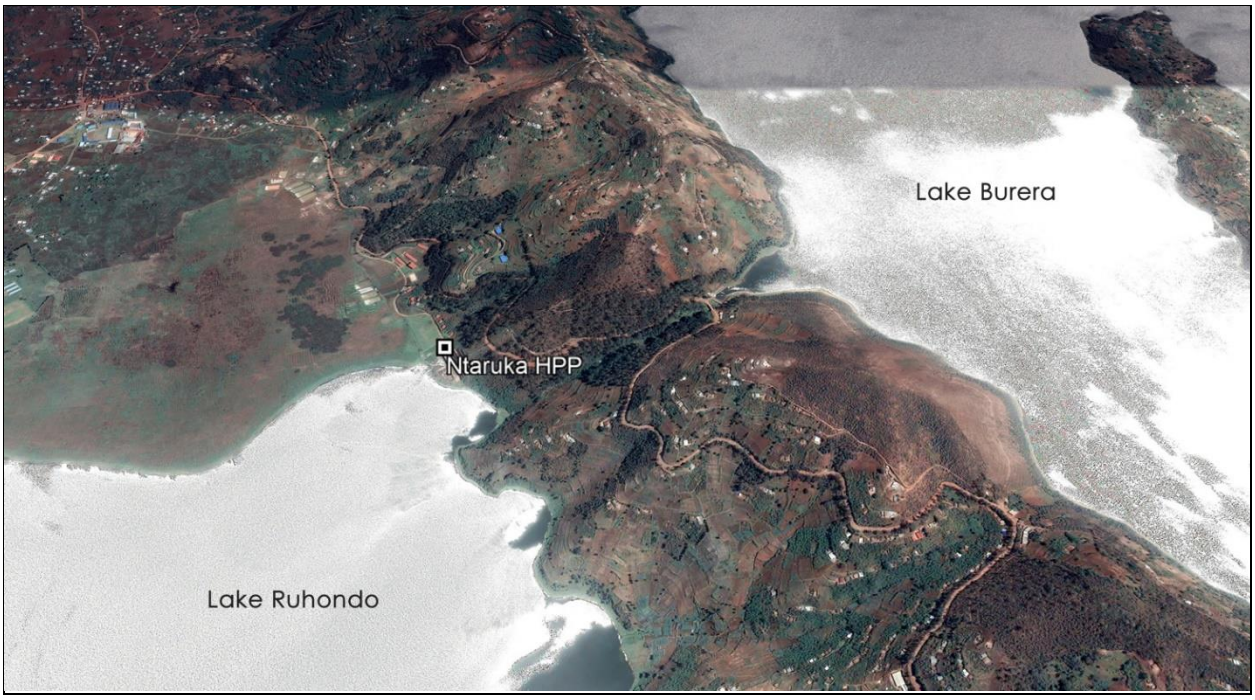

Fig. 11: The twin lakes of Burera and Ruhondo

The lake is allowed to operate between 1864.0m and 1859.7m levels, giving a live storage volume of 201 mill.m^3, 55% of which is attributed to the construction of weir across Ntaruka River that raised the maximum height of the Burera Lake by 2.23 m.

The average annual inflow is given as 4.95m^3/s giving a total inflow of 156.1 mill.m^3. Inflow variations occur due to climate change, land cover and land uses change or other reasons. The mean flow was not stable over different periods (New plan 2017).

3.2.2 Rainfall

Weather conditions in Rwanda are characterized by an alternation of four seasons, two wet and the two dry. Rwandan rainfall is generally well distributed throughout the year, despite some irregularities. Eastern and South Eastern regions (Umutara, Kibungo, Bugesera, Mayaga) are more affected by prolonged droughts while the northern and western regions (Ruhengeri, Gisenyi, Gikongoro and Byumba) experience abundant rainfall that usually causes erosion, flooding, and landslides.

Three rainfall gauging stations were considered for rainfall distribution and pattern analysis (i.e. Lake Burera gauging station (294702), Ntaruka Gauging station (41) and Station 14293. Burera catchment rainfall is generally well distributed throughout the year. The annual average rainfall from 1979 up to 2013 is about 2,035 mm at Station 14293, and 1,182 mm and 1262mm for Lake Burera and Ntaruka Gauging stations respectively (**Table 4**). While the rainfall dataset for Station 14293 gives weather prediction results and trend analysis from the National Centre for Environmental Prediction (NCEP), Lake Burera and Ntaruka Gauging stations offer hydrological analysis data.

Data from the stations is summarised as below:

- Monthly average precipitation is 169.6mm for Station 14293, 98.5mm for Lake Burera gauging station, and 105.2 mm for Ntaruka Gauging station, which varies between 310mm and 22.0mm. Note that station 14293 is located on the much higher (relief) area to the NW of Ntaruka HPP.
- Annual average precipitation is 2,035mm for Station 14293, 1,182.2mm for Lake Burera gauging station, and 1,262.2mm for Ntaruka Gauging stations, which varies between 4,998mm and 1027.6mm.
- The annual precipitation trend from station 14293 from 1997 up to 2013 increased by 83.3% when compared with the trend from 1979 up to 1996, which is a favourable condition for Ntaruka Hydropower Plant.

Table 4: Average Mean Monthly Rainfall in the project area, 1979-2013

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Station 14293	193.8	204.9	310	266.4	141.8	61.1	28.1	41.3	98.0	153.1	266.7	270.0
Burera Lake	65.9	98.3	134.2	152.0	114.7	48.0	22.3	62.6	124.4	145.6	135.6	78.0
Ntaruka	34.0	95.3	195.7	122.0	125.9	27.8	22.0	58.1	146.3	179.1	184.3	71.9

3.2.3 Evaporation

Two evaporation gauging station datasets are considered in this analysis, which are Station 14293 are and Ruhengeri Aero station (located about 15 kms to the west of Ntaruka HPP). Lake Burera evaporation is determined using Meyer's (1915) formula from the meteorological dataset from Station 14293 and the evaporation dataset obtained from Rwanda Meteorology Agency at Ruhengeri Aero station. **Table 5** presents the average monthly evaporation values for the two stations.

Table 5: Mean Monthly Evaporation

Station	Mean Monthly Evaporation (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Station 14293	72.9	73.9	61.8	41.7	49.4	78.5	121.4	134.6	116.4	76.5	42.8	50.4
Ruhengeri Aero	113.4	128	123.7	99.5	92.3	95.9	122.4	124.7	94.8	113	100.8	103.3

In **Table 5** and **Fig. 12** below, a difference in the amount of evaporation at Ruhengeri Aero and Station 14293 is observed. This difference is due to the type of measurements employed. At Ruhengeri Aero station, evaporation is a direct measurement from pan evaporation, while Station 14293 is not a direct measurement, but is calculated using empirical formula from weather parameters (i.e. temperature, wind speed and humidity).

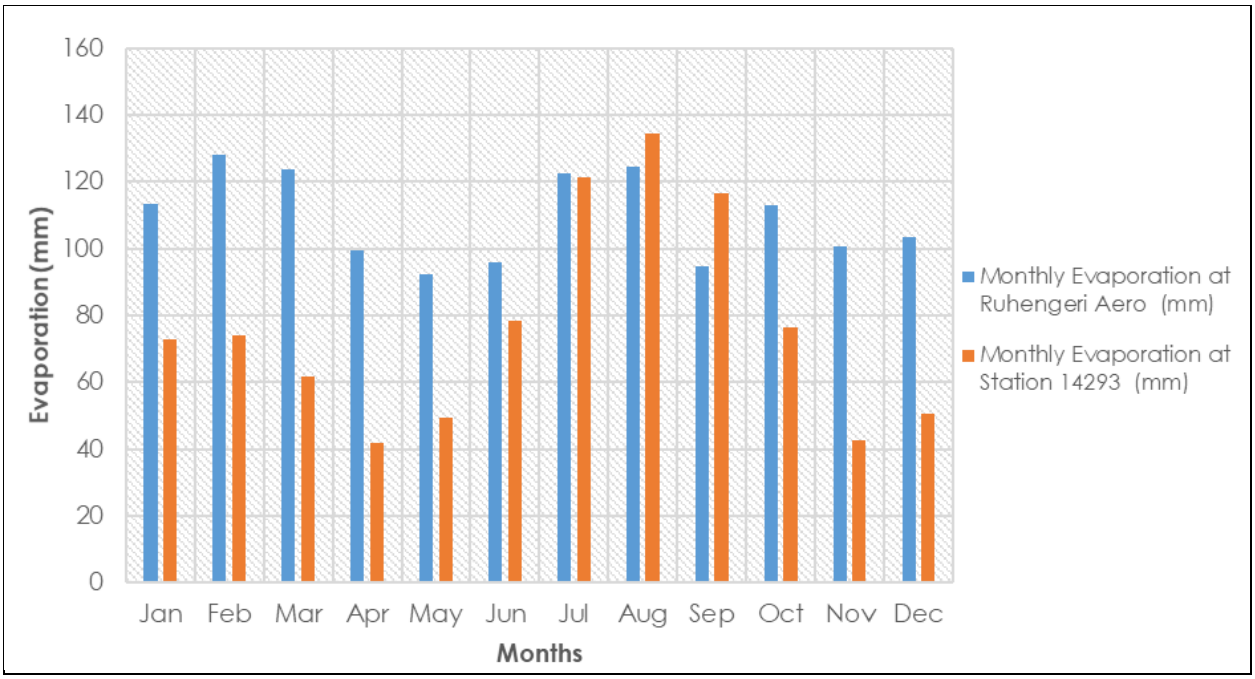

Fig. 12: Monthly evaporation at Station 14293 and Ruhengeri Aero

The monthly Lake Burera evaporation averages are estimated to range from 41.7 to 134.6 mm, with the both gauging stations showing that the rate of evaporation is decreasing in the project area as portrayed by long-term monthly lake evaporation trends (**Figures 13** and **14)**.

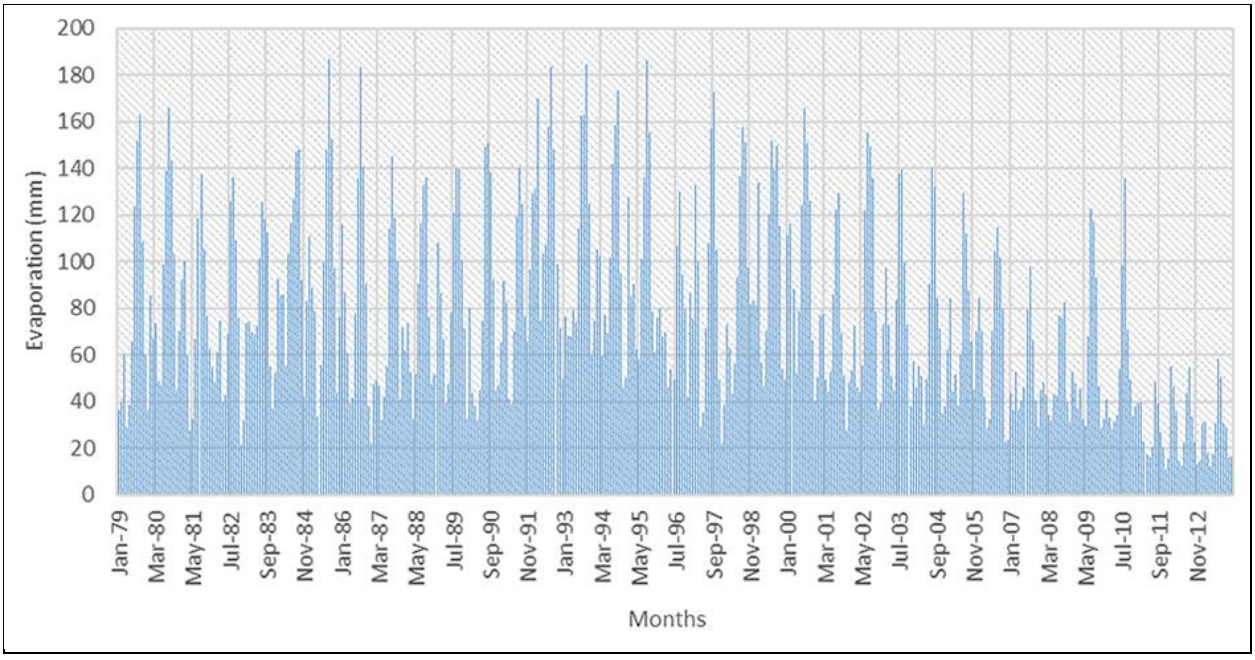

Fig. 13: Monthly evaporation trend at Station 14293 from 1979 – 2013

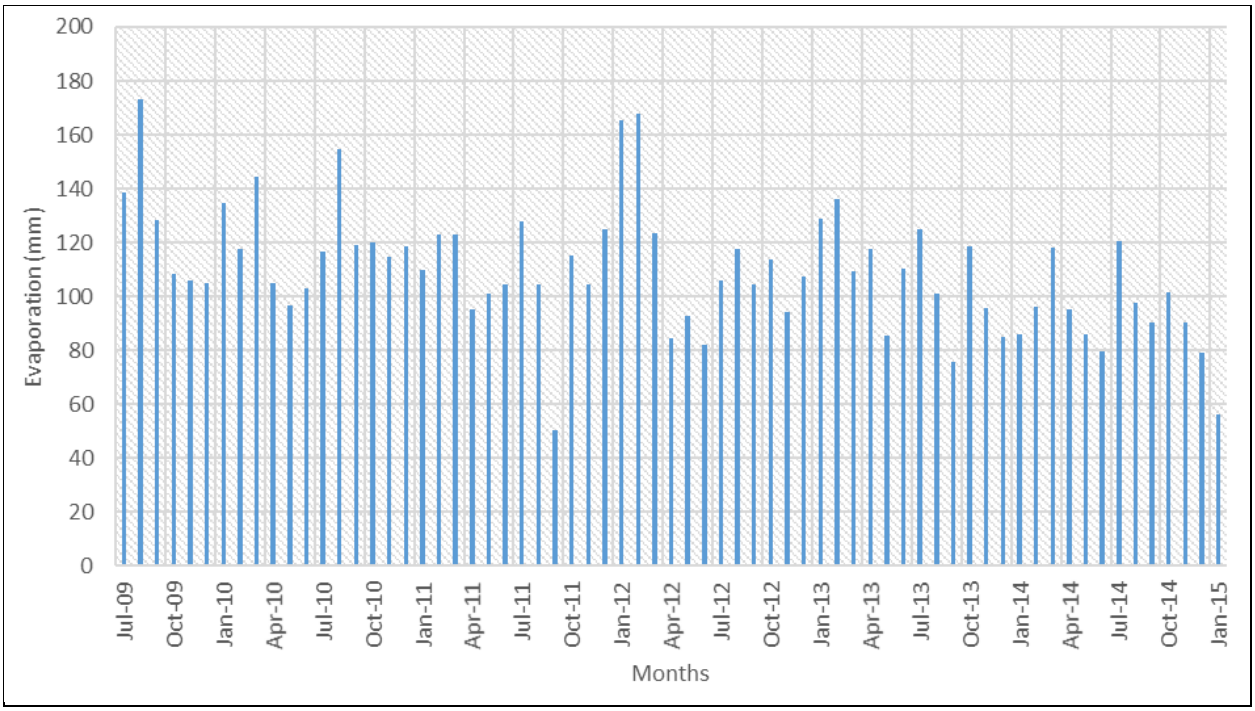

Fig. 14: Monthly evaporation trend at Ruhengeri Aero Station from 2009 – 2014

From **Fig. 13**, the annual lake evaporation trend from 1997 up to 2013 is reduced by 25.3% when compared with the trend from 1979 up to 1996, which is a favourable condition for Ntaruka Hydropower Plant. This helps Lake Burera to save about 12.46Mm^3 of water annually due to the reduced evaporation loss.

3.2.4 Burera Outlet and Lake Ruhondo

The out flow of Burera Lake (**Fig. 15**) reaches Ruhondo Lake either through the power plant (Ntaruka) or the original stream. Ntaruka stream caters for about 50% of the total inflow of Ruhondo Lake, therefore the net inflow to the lake Ruhondo is dependent on, and somehow controlled by the operation of Ntaruka power plant.

Fig. 15: Outlet of Ntaruka Hydro power plant into Ruhondo Lake

Similar to the Lake Burera, water level in Lake Ruhondo continuously fluctuates between minimum and maximum levels, depending on the weather and operation of Mukungwa I power plant that if fed by Ruhondo River (Mukungwa River) with an estimated average flow of 6m^3/s.

3.2.5 Effects of Domestic and Economic Activities on Inflow to the Lake Burera

Rugezi River is one of three main tributaries that feed Lake Burera. It originates from the Rugezi Marsh located in the Northern Province of Rwanda, spanning Gicumbi and Burera Districts, and extending between latitudes 1°21'30''and 1°36'11'' south, and longitudes 29°49'59''and 29°59'50'' east. It covers an area of 6,735 ha.

Rugezi marsh appears as a large flooded valley surrounded by a quartzitic ridge. In its natural state, the Rugezi Marsh formed a dense mat over floating peat formation in its deeper waters (Hategekimana, 2005). From its hydrological aspects, this complex plays major role in the regulation of water flow to Lakes Burera and Ruhondo and Mukungwa River.

With the passing years, the marsh was degraded by diverse activities including agriculture, fire, and plants species overexploitation. By the year 2005, it had been affected by reduced water level and sedimentation ,with the drying of downstream and central parts of the marsh. Demographic pressure and the related conversion to agricultural and pastoral lands had a huge implication on the water resources management. Climate change further exacerbated the degradation of the swamp during that period. The same pressure was observed in the Lakes Burera and Ruhondo catchments.

Following the crisis related to marshland, the GoR has put into place different laws and regulations aimed at restoration and protection of rivers, marshlands and lakes. In 2008 the Government also declared the Rugezi Wetlands a protected area). Creation of buffer zones, and other restoration activities have shown positive impact in restoring the essential hydrological, and socio economic functions played by Rugezi Marsh in Lake Burera and Ruhondo catchment. The use of water in domestic activities does not show any considerable effect on the water variation in the lake Burera and Ruhondo. The instituted initiatives, together with current existing stream flow trends, favour Ntaruka HPP production.

3.2.6 Installed Capacity, Annual Production and Available Flow at the Project Site

A hydro power plant is a generating station which utilizes the potential energy of water for the generation of electrical energy. The installed capacity basically depends on available water and head. Other factors such as investment and O&M cost, the national grid peak demand, and demand partner may also be decisive factors in selecting installed capacity at a given site.

Ntaruka has an installed capacity of 11.25MW. The plant data sheet indicated an annual average production of 22,000Mwh. With an installed turbine discharge capacity of close to 3 times the average annual inflow, the plant is currently operated as a peaking power plant with plant factor of around 23% to meet the peak demand and especially during dry season. This strategy of addresses concerns raised in Hirwa's study that suggested the outflow through the Ntaruka Dam in greater than the inflow into lake Burera, causing Ntaruka to periodically shut down to allow the water level of lake Burera to increase, particularly during the dry season.

3.2.7 Upstream Water Consumption

The Ntaruka project utilises water from Lake Burera whose inflow is from three rivers, namely, the Rusumo falls, which is the outlet of the Rugezi wetland lying within the Districts of Burera and Gicumbi, and the rivers Cyeru and Kabwa. Together, the three rivers cover about 430km^2 of the 580 km^2 Lake Burera catchment. Rugezi wetland has a catchment of 298.62km^2, Rivers Cyeru and Kabwa have a catchment of 109.91km^2 and 21.44 km^2 respectively. Lake Burera occupies approximately 47km^2 of the 580 km^2 Burera catchment area.

A report by RNRA indicated that in 2014, Rwanda used only 2.23% of its available water resources. This means that Rwanda loses almost all of its water resources through evaporation or runoff to other downstream countries. Of the water it does use, irrigation is the main use, accounting for 1.57% of available water and 80-90% of all water consumed in the country.

The report shows that Mukungwa catchment (1,586 km^2) has total consumptive use of 3,659,000m^3 out of 905,000,000 m^3 available in the catchment. The total water consumption is basically for potable water supply use while irrigation water use takes 0% of the total consumed water in the catchment. Ntaruka catchment accounts for 36% of Mukungwa catchment. This means, that total use of water upstream of Ntaruka Dam may be estimated at 0.40%. The fact that the water use for irrigation in Ntaruka catchment is null is justified by climate characteristic where Burera district profits from regular precipitations of more than 1.400 mm/year to develop its agriculture sector without relying on irrigation (RNRA, 2015).

3.3 Topography, Geology and Geotechnical Baseline of Burera Lake

The District of Burera belongs to the agro-bio-climatic zone of highlands of BUBERUKA, lava highlands with an average altitude of 2,100 meters. Relief is characterized by steeply sloping hills connected either by steep sided valleys or by flooded marshes. Annual precipitations reaches 1,400 mm, and temperatures vary between 9^{0}C and 29^{0}C. According to the Burera District Development Plan 2013-2018, all these characteristics mean that, the District can develop its agriculture sector with no need to irrigate, but with negative impacts such as erosion and landslides.

3.3.1.Geology

The geology of Rwanda generally is made up of sandstones alternating with shales, which are all assigned to the Mesoproterozoic Burundian Super group, sometimes intercalated by granitic intrusions. In the east of the country predominate older granites and gneisses. Neogene volcanic are found in the northwest and southwest parts of the country. Young alluvials and lake sediments occur along the rivers and lakes.

According to the geological map of the area presented in **Fig. 16**, adopted from Geological map of Rwanda (Modified after Baudin et al, 1984 and Theunissen et al 1991), the project site is underlain by Paleoproterozoic rocks. The Paleoproterozoic rocks include Quartzites of the lower series B. Quartz Sandstone and Schist were observed on the access road undercut at the project site. No major rock outcrops were observed apart from sandstone and schist boulders.

Burera Lake is situated between a zone of undifferentiated rock of the lower series A to the east and quartziles of the Miyove series A at the west part.

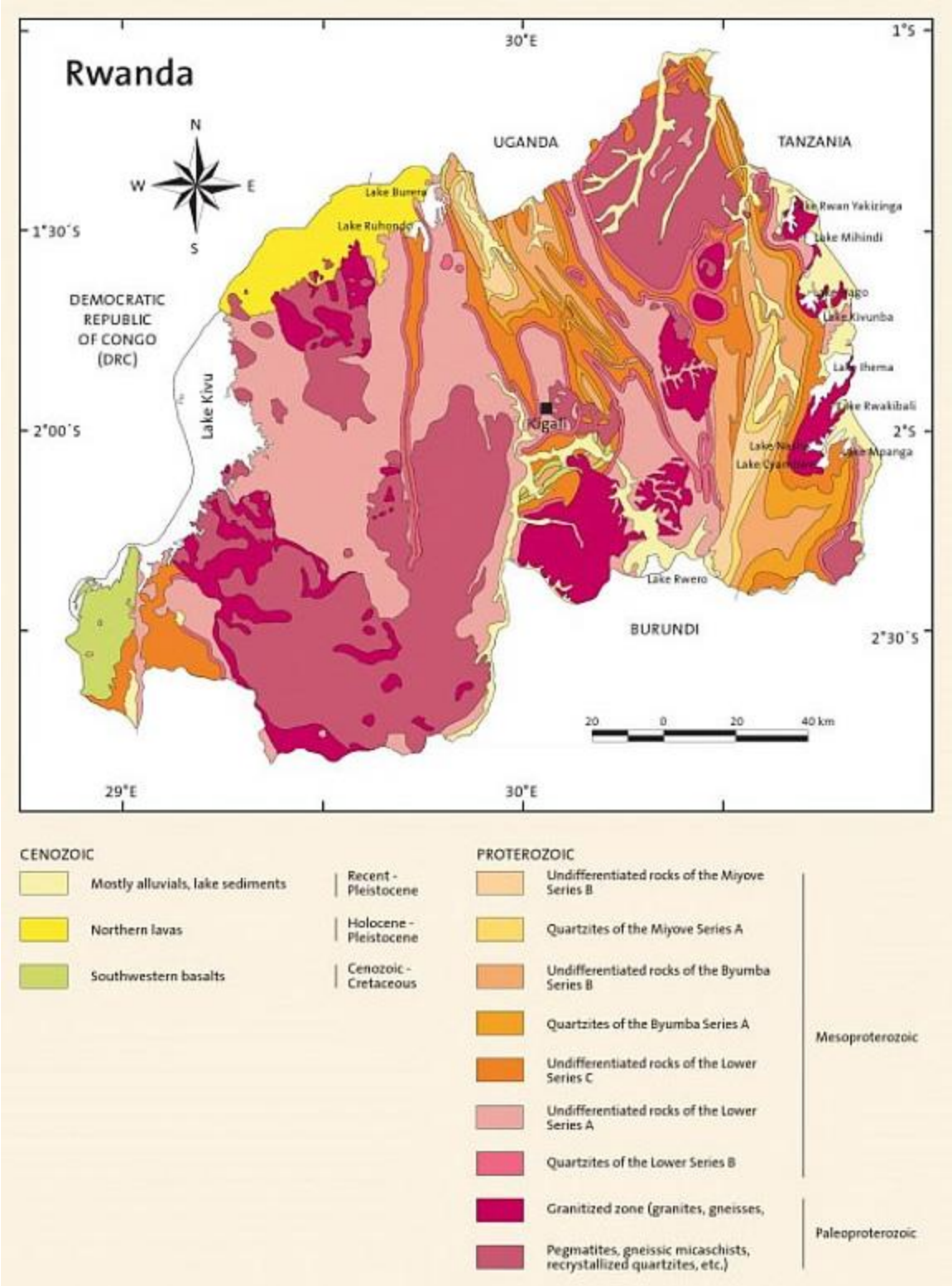

Fig. 16: Rwanda geology

The project area is prone to landslides and slope failures as was observed during the site reconnaissance. However, it appears that appropriate landslide remedial action was taken into

consideration during construction of each power plant component. This remedial action includes the use of protection for the slope cuts. Generally, all the remedial actions taken into consideration during previous design and construction are stable and they are in good condition.

3.3.2 Topography

Lake Burera stands at 1,860 above sea level. In general, due to its hilly topography, Rwanda shows high susceptibility to landslide, 42% of the country's area is classified as moderate to very high susceptibility (MIDIMAR, 2015). The water level in Lake Ruhondo is 1,759.2m. The Environmental Organic Law and the Land Law both prescribe buffer a distance of 10 meters for crops and 20 meters for housing respectively near waterbodies. Around some marshlands, buffer zones of 50 meters have been delineated and agro-forestry species have been planted. Visual inspection revealed that this regulation is observed along both Burera and Ruhondo lakes.

Fig. 17: Buffer zone on Ruhondo Lake

Available data, site visits and discussions with local inhabitants did not indicate severe slope failures at the periphery of Lakes Burera and Ruhondo since the impoundment of the Ntaruka dam. The national risk atlas of Rwanda also does not list Lake Burera zone among areas that are prone to high or very high landslide hazards.

Fig. 18: View of peripheries of Lake Burera and Ruhondo

3.3.3 Geotechnical Baseline

The entire area of the project site and surrounding area foundations consists of lateritic soils. Three major soil types were observed in the project area. The larger part is covered by reddish brown, fine to coarse grained lateritic soil. Other areas are covered by black fine sandy silt, organic soil and silt soil (**Fig. 19**).

Fig. 19: The soils in the Project Area

3.3.4 Earthquakes Records in Project Area

Rwanda is located in a seismic zone and so the entire population faces exposure to 'strong' or 'very strong' earthquakes. According to the national risk atlas of Rwanda, Burera District where Burera Lake is located is in the MMI scale (2% probability of exceedance in 50 years) of category V (**Fig. 20**). On Earthquake hazard zone scale, category V is defined as follows:

- PGA (g) correspondent: 0.039-0.092
- Shaking: Moderate
- Felt by nearly everyone: many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

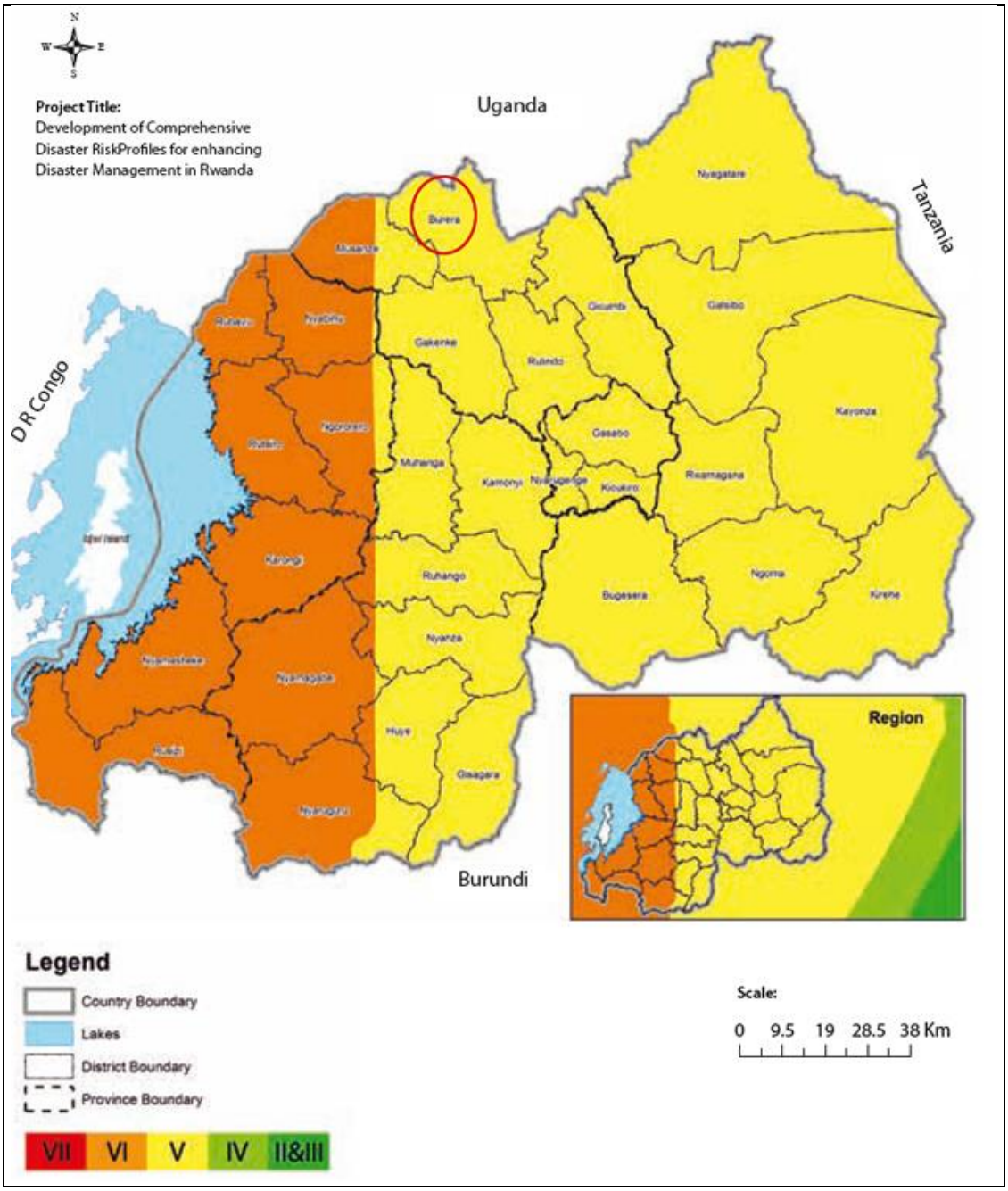

Fig. 20: Earthquake hazard zonation map at 10% probability of exceedance in 50 years
(Source: MIDMAR 2015)

3.4 Socio-economic Baseline Conditions of the Project Area

The project site is in Burera District, one of 5 districts that make up the Northern Province. It is in Nyagezi village.

3.4.1 Demography

Burera District, comprising of 17 sectors, had a population of 336,582 people (160,395 male and 176,187 female) according to the 2012 census. The average household size stood at 4.6 persons. The population of the District is predominantly rural (98.2%) versus 1.8% who live in urban areas.

In Kinoni Sector where Ntaruka HPP is located, the population was 17,523 people of which 8,400 were male and 9,123 were female, residing in approximately 3,790 households in the Sector. 48.9% of the Burera District residents aged 12 and above were married at the time of the census.

3.4.2 Land Ownership

Land categories in Rwanda include, state land, private state owned land local government land district, town and municipality land) and individual ownership. The power plant is strategically built on a 32 ha piece of land where the workers also stay and cultivate their food. This land is government owned. The people in the neighbouring village are about 300 metres away from the plant although they carry out their farming very close to the plant. All the rehabilitation activities will be within the confines of this land. Tree planting (eucalyptus) was also noticed in the area especially on the project land.

3.4.3 Settlement Patterns, Nature and Type of Buildings

The most common type of settlement in the project area in Burera District is clustered rural settlement (*Umudugudu*), catering to 69% of the private households. Dispersed/isolated housing caters for 21% of the private households (**Fig. 21**).

Dominant settlement type

Community house close to the intake

Staff houses on the project land

Fig. 21: Settlements in the project area

Along the road to the power plant, it was observed that settlements are linear and fairly populated. The houses were mostly semi-permanent. The area around the power plant is surrounded by staff houses for workers. Despite their old age, the staff houses are in fair condition.

Trading centres close to the hydropower plant include Munyanga, Kabaguma and Gahunga. The structures in Munyanga trading centres are very close to the road with almost no road reserve.

3.4.4 Economic Activities and Levels of Employment

Nyagezi village inhabitants and those of neighboring villages are mostly crop farmers. They grow cassava, beans, Irish potatoes and bananas and fruits. Farming is practiced for both home and commercial use. Given the hilly nature of the area, terracing type of gardening is practiced by almost all farmers. Crop cultivation was also noticed on the project land for staff members.

Other economic activities practised in the project area include: -

- Tree planting especially eucalyptus trees, used for firewood, sold for timber, and to curb soil erosion.
- Fishing (silver fish and Tilapia) is also practiced by the people in the area on Lake Ruhondo mainly through cooperatives.
- Bee keeping based on eucalyptus trees.
- Motorbike taxis (*bodas* or *motto*).
- Brick making, and
- Trade including trading centres and retail shops along the roads.

3.4.5 Employment Opportunities

In Burera district, the overall employment rate is 94% of the resident population aged 16 years and above. The unemployment rate is 0.2% and the economic inactivity rate is 5.9%. Burera district has the highest employment rate nationally. The national average employment rate is 84%, the un-employment rate is 0.9% and the economic inactivity rate is 15%. In Burera district, the unemployment rate is high in urban areas (2.7%) in comparison to that in rural areas (1.7%).

The hydropower plant provides employment to a total of 16 full time workers and 11 part time casual workers from the community. The permanent workers comprise of 6 Mechanical Engineers, 6 Electrical Engineers, 1 Driver, 1 Accountant, 1 Hydrological? Engineer and 1 Plant Manager (Senior Engineer). The permanent staff reside in the 22 permanent staff houses constructed on the project land.

3.4.6 Water and Sanitation

In Burera District, 76.1% of the households use improved sources of water. The main source of water used by households varies according to the area of residence. In urban areas, 96.7% of the households use improved sources of water while this percentage is 75.6% in rural areas. One of the challenges the power plant faces as informed by one of the engineers is that, the locals use water from the marshland that is about 50 kms away and sometimes this leads to water shortage which in turn limits water flow to the plant especially during dry season. This causes low water levels channelled to the plant resulting into limited power generation. The locals around the plant including its employees use the lake water of the lakes for domestic consumption as well as for production use.

At the sector level, the proportion of households using private pit latrines is high, and varies between 85% and 95%. At the project site, there are toilets available for the workers. However, these are dilapidated and in poor sanitary condition.

3.4.7 Vulnerable Groups

Groups that are considered particularly vulnerable by the Government of Rwanda are children under five years of age, elderly people aged 60 and over, and people with disabilities. The Government of Rwanda delivers a core set of social protection programmes through the Ministry of Local Government (MINALOC), supported by a number of complementary initiatives delivered by other ministries. Since this project will be a rehabilitation, the impact will mainly be indirect meaning that the effects of the project on the community will be minimal.

3.4.8 Energy

In Burera district the main sources of energy for lighting used by private households are kerosene lamps (34.4%), firewood (11.5%), electricity (6.4%) and candle (9.1%). However, there is a high percentage of the households (38.1%) that use unspecified source of energy for lighting. Ntaruka HPP is currently only able to produce a maximum of 9MW of electricity as compared to its potential of 11.25MW. The energy produced here is directly fed to the national grid. The substation is at Musanze town where distribution takes place. The rehabilitation will aid in meeting demand for electricity in the country.

3.4.9 Health Care

In Burera District there is one district hospital located in Butaro Sector. The district staff comprises of 12 General Medical doctors, 12 A0 Technicians, 65 A1 technicians, 64 A2 Technicians and 8 A3 Technicians. The major challenge faced by the hospital is insufficiency of ambulances that are used in the referral process (some of those ambulances are not regularly operational because of their state) and the geographic accessibility (mountainous area).

There is no medical facility at Ntaruka HPP.

3.4.10 Road Transport

The distance from Kigali to the power plant is about 107km. The main highway to Musanze is paved and in good condition but narrow. From Musanze to Gahunga business center, the road is asphalt in good condition. From Gahunga to the Ntaruka site, the road has a small section that is paved but mostly (around 12 km) is unpaved.

The road from the power plant to the intake is very narrow and has eucalyptus trees planted on both sides. It has proper water drainage channels. It was noted that the penstock crossed the road from the intake to the powerhouse.

Unpaved road at Munyanga centre to Ntaruka HPP

Road from the powerhouse to the intake

Fig. 22: Infrastructure to project site

3.4.11 Security

Currently, Rwanda is peaceful and secure. The crime levels are minimal due to the intensity of the security detail put in place. Likewise, at the project site, consultations with the plant staff indicated that security in the area and at the power plant was very good.

3.4.12 Natural Habitats and Biodiversity

In Rwanda, wetlands cover a surface area of about 254,847 ha, representing 10% of the national territory, of which 5.71% is lakes and rivers and 3.9% marshes. The lakes of the north include lakes Burera and Ruhondo and other small lakes like Lake Karago.

Rwandan rivers is include the Akagera, Nyabarongo, Akanyaru, Ruhwa, Rusizi, Mukungwa, Kagitumba and Muvumba. Marshes are found around the big rivers, with most of them are of low lying except for Kamiranzovu and Rugezi - the only major high altitude marshes.

All these ecosystems accommodate a diversified biodiversity that is rich in plant and animal species (more than 104 flower species are found there), except Lakes Kivu, Bulera and Ruhondo which have some limnologic problems (MINITERE, 2003). The aquatic flora and fauna in Lake Burera and Ruhondo are poor because of the physical-chemical situation which is quite unfavorable for their colonization, and also the isolation of the two lakes.

The concentration of the plankton is less significant in Lake Bulera than in Lake Ruhondo; there are 48 species distributed in 4 families (*Chlorophyceae*, *Cynaphyceae*, *Pyraphytes* and *Bacillariophyceae*). The vegetation of the banks is generally dominated by phragmites and *Typha capensis* which merge with *Pennisetum* hedges which are interrupted in some places by small islands of *Cyperus papyrus*. The submerged vegetation consists of the species *Potamogeton, Ceratophyllum Ottelia* and *Laorasipon*. The fish fauna is relatively poor, consisting of 10 fish species of fish, and 3 species introductions.

There are about 10 or so species of birds that are currently known around the two lakes.

3.4.13 Land Cover and Use in the project Area

The main land use in this project area is subsistence agriculture on the mountain slopes (**Fig. 23**). The most common crops grown are bananas, beans, eucalyptus trees and vegetables as shown in aerial view of the immediate upstream project area courtesy of google earth (below).

Communities living within the project area are mainly dependent on the rivers in the catchment area as their main source of water for domestic purposes, watering crops and animals.

Most of the runoff generated from the catchment is affected by irrigation and agricultural activities thus, since irrigation and agricultural land comprises more than two thirds of the entire catchment area. Irrigation activity composes about 3.63% of the land use and has a significant impact on the Ntaruka power plant production. As such, future planed irrigation development projects should be implemented in consultation with EUCL after assessment of their effect on Ntaruka power plant power production capacity.

Fig. 23: Land use activities upstream of Ntaruka HPP

In order to increase amount of inflow to Lake Burera, we recommend intensive soil and watershed conservation work on Burera catchment especially on open land, irrigation areas and agricultural land cover. This will improve ground water recharge and surface runoff. There is some tree planting in the project site (**Fig. 24**). Consultations with the technical team of the power plant indicated that the trees were mainly planted as a measure to reduce soil erosion on the slope between Ntaruka dam and the powerhouse.

Fig. 30: Tree planting (eucalyptus) on slope between dam and power house

4.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This Chapter highlights Rwanda legislation and the World Bank's Safeguards Policy requirements relating to the environmental and social issues relevant to the Ntaruka HPP project.

4.1 Relevant Rwandan Policy

4.1.1 National Environmental and climate change Policy (2019)

The National Environment and Climate Change Policy provides strategic direction and responses to the emerging issues and critical challenges in environmental management and climate change adaptation and mitigation.

The policy aims to conserve, preserve and restore ecosystems and maintain ecological and systems functioning, which are life supports, particularly the conservation of national biological diversity; and to create awareness among the public to understand and appreciate the relationship between environment and development. And further ensure the participation of individuals and the community in the activities for the improvement of environment with special attention to women and the youth.

Relevance: As one of its general principles, the policy requires that Environmental impacts be analysed during consideration of developmental projects such as the proposed rehabilitation of Ntaruka HPP. Rehabilitation and operation activities of Ntaruka Hydro Power Plant may harm wildlife (i.e. flora and fauna) biodiversity present at the site, and by undertaking this ESA, the potential impacts were considered.

4.1.2 The Occupational Safety and Health National Policy

The Occupational Safety and Health (OSH) National Policy provides for strategy objectives, scope of the OHS Policy, guiding principles, policy strategies, coordination and alignment of institutional roles and activity strategy, harmonisation of legislation and standard strategies, OSH inspection strategies, preventive measures, skills development and competent strategies, and integrated information system strategies.

Relevance: The rehabilitation and operation of the Ntaruka HPP take into account the national OSH policy provisions.

4.1.3 National Policy for Water Resources Management (2011)

The National Policy for Water Resources Management (2011) is the latest development in Government's consistent and continuous efforts to strengthen the water resources management sub-sector. It replaces the 2004 policy whose revision became indispensable due to its ill-alignment with the Water Law No. 62/2008, and the fact that, the GoR has been introducing reforms in the water sector that have significantly changed the context for water resources management and rendered the 2004 policy out of date.

Relevance: By consulting key stakeholders such as the Ministry of Environment (MoE) and Rwanda Natural Resources Authority (RNRA) during the ESA, the provisions in this policy were met.

4.1.4 The Rwanda Energy Policy (2015)

The national policy's goal is to meet the energy challenges and needs of the Rwandan population for economic and social development in an environmentally sound and sustainable manner. Since 1994, the energy sector as well as the overall economy has gone through structural modifications, where the role of the Government has changed, markets have been liberalised

and private sector initiatives encouraged. Hence, the energy policy document has to consider structural changes in the economy and political transformations at national and international levels. The mission of the energy sector is to create conditions for the provision of safe, reliable, efficient, cost effective and environmentally appropriate energy services to all sectors on a sustainable basis, thereby contributing to social economic development, and in the long-term framework, poverty reduction.

Relevance: Rehabilitation and effective operation of Ntaruka HPP, will contribute to the vision of this policy and mission of the energy sector.

4.1.5 National Water Supply Policy, 2016)

The overall objective of the policy is the improvement of the living conditions of the population through optimal use of water resources and access of all to water and sanitation services. By rehabilitating the hydropower plant, there is a likelihood that the ground and surface water sources could be interfered with, hence need for strict monitoring of the extent of effects of the project on these natural resources, especially since such springs are sources of wells downstream where locals fetch water.

Relevance: Any exploitation of waters in and around the project site shall follow strict regulations regarding water and sanitation policy.

4.1.6 Rwanda Wildlife Policy, 2013

The Rwanda Wildlife Policy aims to provide a framework for conserving, in perpetuity, country's wildlife, rich diversity of species, habitats and ecosystems for the well-being of the people of Rwanda and the global community. Policy Principles include, sustainability, systematic (or integrated) conservation Planning, management, Wildlife conservation, parks as Models, information exchange, application of adaptive management, Social justice and Equity, National security Issues, and the precautionary principle.

Relevance: The Rehabilitation and operation of Ntaruka HPP shall be undertaken in line with this policy in order to ensure minimal or no impact on wildlife.

4.1.7 Energy Sector Strategic Plan (ESSP) 2018/2018-2023/2024

Rwanda is embarking on a low-carbon development pathway as reflected in its National Strategy on Green Growth and Climate Resilience. Further, Rwanda hosted the update to the Montreal Protocol in 2016. Globally, energy is one of the most environmentally impactful sectors. The ESSP prioritises energy efficiency, including a reduction in emissions by 10%, an increase of 10% in electricity consumption efficiency and a reduction of transmission and distribution losses from 23% to 15%.

The ESSP prioritises renewables, aiming for at least 54.5% of the electricity to be renewable by 2024, far ahead of the international average and ahead of SE4ALL targets. Reducing reliance on traditional biomass energy is a priority of the ESSP's Biomass Energy Strategy, which aims at reducing the use of biomass and the negative environmental effects, including deforestation.

Relevance: The Rehabilitation and operation of Ntaruka HPP shall be undertaken in line with this policy in order to ensure minimal or no impact on environment.

4.2 Legal Framework

4.2.1 The Constitution of the Republic of Rwanda of 2003 revised in 2015

The Constitution of the Republic of Rwanda ensures the protection and sustainable management of the environment and encourages the rational use of natural resources. Article 22 requires that everyone has the right to live in a clean and healthy environment. Article 53 specifies that everyone has the duty to protect, safeguard and promote the environment. The state ensures the protection of the environment.

Relevance: By undertaking this ESA Study, REG/EDCL is complying with provisions of the Constitution of the Republic of Rwanda.

4.2.2 Law on Environment, 2018

The Law N°48/2018 of 13/08/2018 on environment determines the modalities of protection, conservation and promotion of environment in Rwanda sets out the general legal framework for environmental protection and management. The Law gives a right to every natural or registered person in Rwanda to live in a healthy and clean environment.

The protection and management of environment is currently enforced in tandem with the Ministerial order 001/2019 of 15 April 2019 establishing the **list of works, activities and projects that have to undertake Environmental Impact Assessment**, defines Environmental and Social Audits, and also sets boundaries for development and settlement activities next to water bodies.

Relevance: Implementation of this law would protect sensitive areas and by undertaking this study, REG/ESA follows this law.

4.2.3 Law N° 70/2013 of 02/09/2013 Governing Biodiversity in Rwanda

This law provides for Biodiversity planning and monitoring; Ecosystems, endangered and invasive species; Bio-prospecting, access and benefit sharing; and Permits and administrative sanctions.

Relevance: Considering that the project may affect biodiversity especially in the adjacent lake Ruhondo and Lake Burera, project activities must be undertaken in line with the requirements of this law.

4.2.4 Law Governing Land in Rwanda, 2013

This law states that land is part of the public domain of all Rwandans; ancestors, present and future generations. With exceptions of the rights given to people, the state has supreme powers to manage all the national land, and this is done in public interest aimed at sustainable, economic development and social welfare, in accordance with procedures provided for by law. In that regard, it is the state that guarantees the right to own and use the land. The state also has rights to expropriation due to public interest, settlement and general land management through procedures provided by law and prior to appropriate compensation.

Relevance: During Rehabilitation of Ntaruka HPP, no property is expected to be affected. However, in case the need arises, the project affected persons will be compensated in line with provisions in this organic law particularly article 67.

4.2.5 Law relating to expropriation in the public interests, 2015

Article 9 stipulates that it is only the Government that shall order expropriation in the public interest and must be done with prior and fair compensation. The law also bars anybody from interfering of stopping expropriation "on pretext of self-centred interests". Accordingly, Article 3 provides for

any underground or surface activity carried out with in public interest on any land but with due and fair compensation to the land owner. Article 4 requires that any project, at any level, which intends to carry out acts of expropriation in the public interest, must budget and provide funding for valuation of the property of the person to be expropriated and for fair compensation.

It is important that the expropriation of properties and lands be based on the WB Environmental and Social Standard 5 (Land Acquisition, Restrictions on Land Use and Involuntary Resettlement), National and districts expropriation procedures. In case of mismatch between the national law and WB Environmental and Social Standard (ESS5), the WB ESS will prevail. All assets that will be damaged will be compensated in compliance with this law.

Relevance: Project activities will be undertaken in compliance with the requirements of this law.

4.2.6 The Water Law (Law N°62/2008 of 10/09/2008)

Water Law No.62/2008 of 10/09/2008 sets the regulation for the use, conservation, protection and management of water resources.

Relevance: Project activities will be undertaken in compliance with the requirements of this law.

4.2.7 Labour Law No. 66/2018 of 30/08/2018

The Labour Law No. 66/2018 of 30/08/2018 regulates all employment matters for employees in the private sector, contractual staff in public sector, interns, apprenticeships, and self-employed persons but only in regard to occupational health and safety (Art 2). As such, the labour law does not apply to other employees in public service unless otherwise stated by the general statutes regulating public sector employees.

Relevance: The entire of Chapter V (Articles 77 – 82) is dedicated to occupational health and safety in the work environment.

4.3 Administrative Framework

4.3.1 Rwanda Environment Management Authority (REMA)

To effectively manage environmental challenges such as wetland drainage, soil erosion, deforestation, water degradation, climate change and loss of biodiversity, the Government of Rwanda (GoR) established Rwanda Environmental Management Authority (REMA) by N° 16/2006 of 03/04/2006 Law determining the organisation, functioning and responsibilities of Rwanda Environment Management Authority

4.3.2 Ministry of Environment

The Ministry of Environment (MoE) is responsible for development of environmental policies and procedures (including impact assessments), protection of natural resources (water, land, flora, and fauna), environmental legislation, biodiversity, and other environmental aspects. MoE is one of the lead Agencies / Line Ministry as provided by the General Guidelines and Procedures for Environmental Impact Assessment.

4.3.3 Rwanda Development Board (RDB)

Rwanda Development Board (RDB) was created in September 2008, by combining 8 former government agencies: the Rwanda Investment and Export Promotion Agency (RIEPA); the Rwanda Office of Tourism and National Parks (ORTPN); the Privatization Secretariat; the Rwanda Commercial Registration Services Agency; the Rwanda Information and Technology Authority (RITA); the Centre for Support to Small and Medium Enterprises (CAPMER); the Human Resource and Institutional Capacity Development Agency (HIDA); and a part of the Rwanda Environment Management Authority (REMA) in charge of Environmental and Social Audit awareness and cleaner production.

4.3.4 Rwanda Bureau of Standards (RBS)

The mission of RBS is to provide standards for Consumer Protection and Trade promotion and for socio-economic growth in a safe and stable environment. RBS has prepared standards in many sectors such as food, buildings, water supply, effluent quality, etc. It shall be noticed that some standards are still under preparation because RBS is relatively a young institution. Therefore, the construction of buildings and the effluent discharge from new water facilities have to comply with the current RBS standards in order to avoid potential damages and accidents or environmental pollution of ecosystems.

4.3.5 Local Governments

Local Governments (including the City of Kigali and Gasabo District) under the General Guidelines and Procedure for EIA are tasked to perform the various functions such as hosting public and individual hearings, and public awareness.

4.3.6 Other Relevant Institutions

Institutions involved directly or indirectly in environmental management also include: -

a. Ministry of Emergency Management (MINEMA),
b. Ministry of Local Governance (MINALOC) through provinces and decentralised entities (districts, sectors),
c. Ministry of Agriculture and Animal Husbandry (MINAGRI),
d. Rwanda Environment Management Authority (REMA),
e. Rwanda Natural Resources Authority (RNRA),
f. Rwanda Utilities Regulatory Agency (RURA), and
g. Energy, Rwanda Energy Group (REG/EDCL).

4.4 World Bank Safeguard Policies

Projects supported by the Bank through Investment Project Financing are required to meet the following Environmental and Social Standards (ESS):

- ESS-1: Assessment and Management of Environmental and Social Risks and Impacts,
- ESS-2: Labour and Working Conditions,
- ESS-3: Resource Efficiency and Pollution Prevention and Management,
- ESS-4: Community Health and Safety,
- ESS-5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement,
- ESS-6: Biodiversity Conservation and Sustainable Management of Living Natural Resources,
- ESS-7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities,
- ESS-8: Cultural Heritage,
- ESS-9: Financial Intermediaries, and
- ESS-10: Stakeholder Engagement and Information Disclosure.

The environmental and social risk classification for the Ntaruka HPP is substantial; and the relevant ESSs applicable to the project include ESS1, ESS2, ESS3, ESS4, ESS5, ESS6, ESS8, ESS10.

As no initial ESIA had been conducted for Ntaruka HPP at implementation, this should be done with the planned rehabilitation. Only a preliminary Environmental and Social Impact Assessment for Ntaruka HPP Rehabilitation Project has been prepared as part of feasibility study.

4.5 GoR and World Bank EA Guidelines

The National Guidelines for Environmental Audit in Rwanda expounded in Ministerial Order N° 001/2018 of 25/04/2018 provides the Audit Process and protocols, which shall be followed in the Auditing of Ntaruka HPP.

World Bank Policy specific requirements relating to Audit are set out in Appendix 2 of the Bank's OP 4.01 which states that the bank requires environmental assessment of projects proposed for Bank financing.

Both recognise the need to determine the nature and extent of all environmental areas of concern at an existing facility (auditing) with a view to ensuring improvement in, or enhancement of the decision made with regard to the impacts identified earlier in the project formulation and design as well as implementation. Both are directed at ensuring that the project is environmentally sound and sustainable.

5.0 ENVIRONMENTAL AND SOCIAL ISSUES, RISKS AND IMPACTS

This section covers the environmental and social issues, risks and impacts of Ntaruka HPP, and compliance with WB/IFC Environmental and Social Safeguards Standards, as summarized in **Table 6 below**.

Table 6: Summary of Ntaruka HPP compliance with ESS Standards

WB/IFC ESS Standards	Ntaruka HPP ESS Compliance
ESS1	- No ESIA, nor any environmental and social management system, or elements of was prepared prior to the construction and operation of the plant. - There was no official current or recent correspondence between the environmental authority and Ntaruka dam management regarding the environmental and social performance of the dam, including any permits or authorizations.
ESS2	- There are no documented grievances expressed by Ntaruka dam workers, therefore it was not possible to know how these grievances were resolved; - No OHS rules and regulations that the dam follows only a one page sign board of security measures. - No evidence of work related accidents and incidents, and their severity, including Lost Time to Injury as no documentation was found on this issue.
ESS3	- Soil and water pollution is not expected from the rehabilitation exercise except for potential increased pollution loads in the water and soil from accidental spills or mishandling hazardous materials. - There is no concrete Waste Management Plan at the Plant. - No signs of pollution observed from lubricant as and waste oil. - Debris observed in compound, and designated waste collection points not clearly marked.
ESS4	- No significant impact of Ntaruka HPP operation on neighbouring communities and their livelihoods, upstream and downstream from the dam except few cases of crops damaged by works of construction of transmission lines from the Plant. - Dam safety issues are discussed in the following chapter and in Annex 6 of the Dam Safety Assessment Report.
ESS5	- No impact on legacy resettlement claims associated with the construction or operation of Ntaruka HPP
ESS6	- Except for positive impacts of electrification of neighbouring households and employment opportunities, there are no negative impacts caused by the construction of Ntaruka dam, or any residual impacts caused by its operation.
ESS7	Not applicable
ESS8	- No impact on cultural heritage with no important cultural sites in the neighbourhood of the plant.
ESS9	Not applicable
ESS10	- No documentation on the engagement of Ntaruka HPP Management with stakeholders and no evidence that there was any informal or formal engagement. - No grievance mechanism for affected individuals and communities was found during this study.

The environmental and social issues, risks and impacts of Ntaruka HPP are tackled in more detail, in the following sub-sections.

5.1 Assessment of Management of Environmental and Social Risks and Impacts (ESS-1)

The Ntaruka HPP was constructed before EIA became a requirement under Environmental Law in Rwanda in 2005. No ESIA was conducted initially thus. The company has a consolidated procedures manual covering policies related to the Classification of staff, Employment, Recruitment procedures, Performance management, Promotion and Transfer, Reward and remuneration management, Payroll Processing, Human Resources Development, Ethics and Staff Code of Conduct, Disciplinary Guidelines, Termination of Service, Grievance handling, Staff welfare, Leave, Travel policy, Career, Training and development, Equal Opportunity, Sexual or racial harassment, and Occupational Health and Safety.

5.2 Labour and Working Conditions (ESS-2)

Ntaruka HPP has a consolidated procedures manual covering policies including those on Occupational Health and Safety. Currently construction workers at Ntaruka HPP raise their concerns through supervisors. No evidence of discriminatory practice was found on site. Currently construction workers at Ntaruka HPP raise their concerns through supervisors. No evidence of discriminatory practice, child labour or forced labour was found during the site visit. The work site is free from harassment and abuse.

5.3 Resource Efficiency and Pollution Prevention and Management (ESS-3)

Pollution prevention and management issues, risks and impacts have been reviewed in respect of relevant National Environment and Climate Change Policies regarding pollution prevention, control and remediation and the WB **ESS3: Resource Efficiency and Pollution Prevention and Management.** The audit focused on assessment of environmental and social risks and impacts (actual and potential) of the project's solid wastes, hazardous materials management, and land contamination. Main pollution risks associated with Ntaruka HPP, re listed as follows: -

- Solid at Ntaruka HPP include wastes include broken dielectrics made of ceramic and glass, scrap material and residues of insulation materials. REG has a formal procedure for addressing housekeeping and equipment maintenance issues, and has entered in agreements with local municipal waste management companies. In general, the housekeeping in HPP is at acceptable level. All facilities and yard look clean and tidy except for debris (old, unused and demounted equipment, packaging materials, unused and broken materials, and insulator scrap material) whose management requires some improvement..
- Though dedicated areas for storage of the various waste materials have been set aside, with separate covered bins for collection of the different wastes, proper labelling needs to be improved.
- During the site visit, the audit team did not observe any signs of significant oil pollution. REG has no program regarding the monitoring of lubricants and turbine oil, and formal procedures for accounting for oil and oil losses are not established, and it is not possible to evaluate how much waste oil was is generated. Most of the oil purchased is turbine oil, with a very small amount catering for transformer oil.
- There were no signs of ground subsidence on the site and neighbourhood that were observed during visual inspection. Since the site has been used for power production for over 60 years and has had no legacy of industries, we conclude that its contamination hazard is low.
- Lake Burera which acts as a reservoir for Ntaruka HPP and Lake Ruhondo downstream, is sustained by inflow from a network of rivers flowing to Rugezi Marsh, serving as a link between land and water resources. The passage of the Environment Law in 2005, strengthened the legal authority of the GoR to control activities within the Rugezi Wetlands and along the shores of

Lakes Bulera and Ruhondo. Specifically, this law restricts agricultural and pastoral activities to 10 meters from the banks of streams and rivers, and 50 meters from the banks of lakes. In addition, GoR also declared the Rugezi Wetlands a protected area.

- No soil pollution was noted at the project site. Waste (hazardous materials, solid wastes and oil) are handed over to authorized contracted company for disposal in authorised dumpsites.
- Soil and water pollution is not expected from the planned rehabilitation, as it can be prevented. However, some increased pollution loads into water and soil may be caused by direct or indirect contamination due to accidental spills or mishandling of equipment or hazardous materials. All materials will be handled in line with instructions included in the Material Safety Data Sheets present at the construction site.

Recommendations

- REG should develop an improved Waste Management Plan, which provide a comprehensive description of all wastes generated, hazard class, procedures for collection, handling and labelling, storage and transportation of waste. The plan should also include waste prevention, reduction and reuse strategies, record keeping system for waste streams, waste disposal requirements, roles and responsibilities, and required trainings of personnel involved in waste management
- REG should prepare an Action Plan for Spill Prevention to cater to control and countermeasures for its facilities, and to ensure all workers are familiarized with the plan.
- REG should institute monthly inspections, and maintain inspection records in an Environmental Information Register.

5.4 Community Health and Safety (ESS-4)

Community Health Safety & Security management by REG has been reviewed in respect to national health and safety requirements, and the **WB ESS4: Community Health and Safety** provisions, in assessing health and safety issues related to project workers and community health and safety and the corresponding responsibility of REG to avoid or minimize such risks and impacts

The company has developed an Occupational, Health and Safety policy. An operating manual for plant maintenance procedure was found on site. First aid boxes for worker were provided at the project area and the fire extinguishers installed have an operating instructions on them. There are three 50 kg ABC dry powder extinguisher; thirteen 5 kg CO_2 extinguishers, and two 2 kg CO_2 extinguishers installed in total. All are serviced annually. The auditors recommends that the number are increased to 5, 20 and 10, 50 kg ABC dry powder, 5 kg CO2 and 2 kg CO2 extinguishers respectively.

Hazardous materials are kept in secure designated areas. The signage could be updated though for more visibility.

There are no health facilities built on site. There is a field vehicle available on site, for use by staff, and sometimes by community members for medical emergencies. Stretchers and medical kits are available procured at the site. The occupational accidents are recorded and reported timely. The accidents and incidents record is available on site. No occupational injuries, deaths, disability were recorded. Auditors did not find any report of incidences of any communicable diseases due to interaction of plant workers with the local community or migrant labour.

The project area is prone to landslides. However, appropriate landslide remedial action was taken into consideration during construction (use of protection for the slope cuts) of each power plant component. All the remedial action taken into consideration during previous design and construction were stable and in good condition.

Regarding Emergency preparedness, the company does not have an Emergency response plan (ERP). Based on regulations, ERPs must ideally be part of facilities related to energy production and transportation. The preparation of an ERP will be included into the Environmental and social Action Plan for the rehabilitation and operation of Ntaruka HPP.

Lake Burera reservoir also support local fishing. Currently, there are no warning signs provided at the reservoir on health and safety risks and prohibiting bathing. This issue was discussed with REG/technical department to ensure that they are incorporated and properly installed in the planned rehabilitation.

The power house and sub-station are located a distance away from the local population and are not likely to have impact on the inhabitants.

5.5 Land Acquisition, Restrictions on Land Use and Involuntary Resettlement (ESS-5)

Ntaruka HPP was built in 1959. Available data indicates no resettlement cases at the site in the 1950s. The land on which the plant stands has been owned by the GoR, and todays, it is owned by REG on behalf of GoR for power generation. From discussions held with REG, the auditors confirm no expropriation or displacement has taken place in the project's life.

The planned rehabilitation does not involve the construction of a new power station, but rather the rehabilitation of existing hydroelectric within the existing foot print, in order to improve the production and the distribution of electricity. REG does not require additional land thus, and respectively, no resettlement or displacement is envisaged.

5.6 Bio-Conservation & Sustainable Management of Living Natural Resources (ESS-6)

The World Bank Environmental and Social Standard 6 recognizes that protecting and conserving biodiversity and sustainably managing of living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support.

Ntaruka HPP facilities can still have potential impacts on aquatic ecosystems. Reservoir water is usually more stagnant than normal river water. As a result, the reservoir will have higher than normal amounts of sediments and nutrients, which can cultivate an excess of algae and other aquatic weeds. These weeds can crowd out other river animal and plant-life, and they must be controlled through manual harvesting or bio-control (fish that eat weeds).

Water is lost through evaporation in dammed reservoirs at a much higher rate than in flowing rivers. With damming there is also the expected sediment concentration, and acidification of the sub-soil.

The rehabilitation of Ntaruka hydropower plant is expected to have minimal impacts on the available fauna and flora. This will include loss of some vegetation from areas surrounding the penstock, dam, and surge tank when undertaking routing maintenance activities.

It is expected that the company will employ effective methods for minimisation of water quality degradation downstream during the dredging operations. And EIA shall discuss in detail the anticipated environmental impacts and propose adequate mitigation measures for reduction of significant impacts to acceptable level.

The Rugezi-Burera-Ruhondo watershed
The Rugezi-Burera-Ruhondo watershed is dominated by the Rugezi Wetlands, a Ramsar recognized Wetland of International Importance. The Rugezi wetlands are a peat bog of about 6,735 ha with a catchment area of 190.70 km^2. Water from the Rugezi Wetlands flows downstream first into Lake Burera supplying nearly half of its inflow and then into Lake Ruhondo before entering the Mukungwa River.

In the past this marshland has been reclaimed for agriculture production and progressively degraded due to overpressure by the increase of farmers. With 90% percent of the population surrounding the wetlands depending on agricultural activities for their livelihoods, this land fragmentation combined with over-cultivation has led to soil degradation, erosion by runoff, and a decline in crop and livestock productivity that further pushed farmers to seek new land for cultivation. By 2004, land degradation within the Rugezi-Bulera-Ruhondo watershed contributed to country's electricity crisis, with water levels in Lakes Burera and Ruhondo falling by up to 50%, and prompting GoR intervention, through development and implementation of policies and legislation to ensure adequate protection of the lake and hydropower plants. People were stopped from working in the wetland area, and agricultural activities have been banned within the wetland and buffer areas instituted round the wetlands and rivers. These measure have resulted in lake level increase of 4 m for Lake Burera, and power production which had decreased by 2007, started to increase from 2008 onwards and in 2010 the hydropower plants supported by Rugezi are operating nearly at its full capacity, reducing by half the use of diesel generators for electricity production.

By the time of visit, the auditors observed that Rugezi is now characterized by lush green vegetation and rich fauna. The restoration of the Rugezi reopened a corridor for migratory birds and fish, and favourable conditions for many plant and animal species. The Rugezi-Burera-Ruhondo watershed is one of the most important surface water bodies in Rwanda protected by law, and no further degradation on biological diversity including aquatic life is envisaged.

5.6.1 Ecological flow
The hydrological network of the project area is located in Nile basin and is composed of the Rugezi wetlands-Burera-Ruhondo complex.

Lake Burera situated on the southern slopes of Muhabura Volcano in Northern Rwanda at 1,862 m above sea level, is 12 km long and 8 km wide. It contains two small islands and is fed by 6 streams. The lake has a maximum depth of 173 m and an open water surface of approximately 3,500 ha. It drains from its southwestern extremity to Lake Ruhondo 1,764 m above sea level. The V shaped Lake Ruhondo is 9 km long, 3 km wide and 65 m deep, with and area of 2, 800 ha. In addition to the overflow from Lake Burera, it receives water from four other streams, of which

Gasura is the most important. There is a 500 ha swamp at the northern end of the lake i.e. at the apex of the 'V'. It drains to the southwest via the Mukungwa River, a tributary of the Nyabarongo.

Prior to the construction of Ntaruka HPP, lake Burera and Ruhondo were connected by Ntaruka stream. With the construction of the plant, the river was dammed and the waters channelled into the head race tunnel towards the surge tank before reaching the powerhouse via the penstock.

Human exploitation of water resources leads to increased annual and inter-annual fluctuations of water levels, at times far beyond natural amplitudes. One of the challenges the power plant faces as informed by one of the engineers is that, locals use water from the marshland located 50 km away and sometimes this leads to limited water flow to the plant especially during the dry season. This causes low water levels channelled to the plant resulting into limited power generation. The locals around the plant including its project staff, also use the water from the lake for domestic consumption.

5.7 Cultural Heritage (ESS-8)

No cultural heritage related issues have been identified at the project site.

5.8 Stakeholder Engagement and Information Disclosure (ESS-10)

Granted that Ntaruka HPP was installed in 1959, no documentation on the engagement of Ntaruka HPP Management with stakeholders at the development stage is available. No grievance resolution mechanism (company policy) for staff and communities was found during this study. There was no record of filed on grievances either. As mentioned earlier, the land on which Ntaruka HPP stands is owned by the REG on behalf of the GoR for power generation.

Regarding the planned rehabilitation, stakeholders were consulted as part of this ESA process, and will continue to be engaged in the lifetime of the plant. No issues on land acquisition and resettlement are foreseen, as this is rehabilitation works on the same Ntaruka HPP footprint. Issues covered in public consultation for this ESA are further discussed in the Annex 3: Stakeholder Participation and Consultation. The auditors recommend that a proper grievance resolution mechanism is developed during the project rehabilitation, to handle potential grievances from company staff and neighbouring communities.

5.9 Dam Safety Issues, Risks and Impacts

In looking at the dam safety issues, risks and impacts relating to the Ntaruka HPP, the task considered (but was not limited to) **ESS4 community health and safety including dam safety issues, risks and impacts; ESS6 biodiversity conservation and management of living natural resources**; **ESS3 pollution prevention and management**; **ESS5 land and natural resource tenure and use risks and impacts**; **ESS2 health and safety risks and impacts**; and **ESS8 cultural heritage**.

5.9.1 Risk category

In terms of the risk of dam failure and factors influencing the impact level, there are generally two broad classifications of dam failures, by type and by causes. Consequences of dam failure can be catastrophic, and can result in significant loss of life and / or property.

Dam failure classified by type includes: -

1. Loss of pool containment with water rushing downstream either through, around or over the dam,
2. An accidental event that could have led to failure but did not because of the intervention of the dam operators or good fortune, and
3. An incident which is any other unanticipated or adverse performance of the dam.

Dam failure classified by primary causes includes: -
1. Static failure caused by the structural failure of the dam itself,
2. Seismic failure caused by earthquake activity, and
3. Hydrological failure as a result of storm floods or even landslide-induced floods.

The two primary causes for failure are (a) static failures caused by piping and seepage and (b) hydrological failures caused by overtopping or inadequate spillways. The probability of dam failure is estimated as 10^{-4} per dam year [Baecher et al.,1980; Brandesten et al., 1993]. However, the risk is not uniform throughout the life of a dam. In fact, the chance of failure is the highest at the very beginning, that is, the first time the reservoir is filled to capacity. The residual risk is more or less distributed uniformly over the remaining life of the dam. Once a dam fails, the damage is specific to each site. Studies of past dam failures indicate, that the level of damages has been found to depend on 1.) Population (and property) at risk, 2.) Warning time, and 3.) Type of terrain.

The natural reservoir of the Ntaruka HPP is Lake Burera on which was constructed a small weir-type dam of 5.5 m of height and a crest length of 28 meters. The dam has been in operation for more than 60 years, and there have been no safety issues historically recorded. The dam risk is categorized as low. In case of dam failure, water would flow into Lake Ruhondo through a natural channel (Ntaruka stream). Basically, only external cost of dam failure could be destruction of the existing unpaved road. Ntaruka stream drains into Lake Ruhondo some 150m to the SSE of Ntaruka HPP. Office and staff buildings are located 300m to 600m to the NNW of Ntaruka stream (**Fig. 23**).

Fig. 23: Ntaruka HPP facilities

No information regarding the warning time in case of dam failure was available documents at the project site. The terrain downstream of dam is steep mountain slopes. By applying SIMPACTS (Simplified Approach for Estimating Impacts of Electricity Generation Model), it shows that the inundated area is small, with no risk of loss of life for any dam failure except for low economic and/or environmental losses.

Applying the World Bank criteria, the dam risk category as assessed was assigned the low hazard potential classification as dam failure or disoperation will result in no probable loss of human life and low economic and/or environmental losses. In case such happen, the possible losses are principally limited to the plant infrastructure (dam) and the existing unpaved road.

At time of site visit, the auditor did not manage to conduct a full level inspection and dam safety assessments that have been conducted in the past due to lack of documentation / records. Only an operation and maintenance (O&M) plan was available. This plan included only subsystem/equipment to be maintained, activity, long-term maintenance schedule and risks associated on the maintenance. No Emergency Preparedness Plan, Construction Supervision and Quality Assurance Plan and Dam Instrumentation Plan were found on project site either.

Recommendations

The auditors recommend that the Plant owner: -

1. Develops and comply with a comprehensive O&M plan after project rehabilitation.
2. Develops an Emergency Preparedness Plan, to be followed in case of dam failure.
3. Develop and comply with a Rehabilitation Supervision and Quality Assurance Plan and a Dam Instrumentation plan. The latter will include instrumentation and monitoring of the dam body, also for monitoring the reservoir and the Rugezi-Burera-Ruhondo catchment area.

These plans will form the basis for development of dam safety programs, including properly recorded periodic safety inspections of the dam, and implementation of measures required in addressing safety issues after project rehabilitation.

Potential Inundation Maps in Case of Dam Break

Though Lakes Burera and Ruhondo are connected by the 600m long Ntaruka stream, the two lakes are separated by a dramatic drop in altitude of 100m (**Fig. 23**). The steep slopes mean that inundation would only occur in the area immediately adjacent to the Lake Ruhondo. Save for the Ntaruka HPP itself, the arear adjacent to the Lake is not inhabited.

(Up-stream view)

(Down-stream view)

Fig. 23: Potential inundation areas for The Ntaruka HPP

5.9.2 Evaluation of condition of all Ntaruka HPP's civil structures

The audit evaluated the state of civil structures, hydraulic structures, electromechanical components, and the performance history of Ntaruka HPP, plant as well as geo-technical and geological issues. This is a weir type dam with a height 5.5m of height and a crest length of 28 m. The gates are installed 2m below the original riverbed outlet.

a. River bank training works

Minor defects were observed on both side (i.e. left and right). On the right bank, it was observed that there was vertical movement on the foundation of the river training stone pitching for slope

protection. Slope stone pitching foundation had numerous cracks. On the left bank, it was observed that there was vertical movement on the foundation of the river training stone pitching for slope protection. Slope stone pitching foundation showed some appreciable damage and cracks too.

b. Intake dam

Generally, the body and foundation of the Ntaruka intake dam is in good structural condition and can be used for many more years to come with minor maintenance work, as noted below.

The foundation and body of the intake dam was checked against concrete cracks, leakage, concrete reinforcement cover and concrete carbonation/weathering. There were no signs of leakage through the dam foundation and body.

The concrete cover on the body of the dam is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in the concrete. The entire surface weathering of the concrete cover on the dam was limited to 30-50mm, which is good. The current weathering depth is insignificant when compared with the current available concrete cover of 60-70mm, which sufficient to protect reinforcement from corrosion and provide fire resistance to the reinforcement bars embedded in the concrete,

The entire body of the dam was found to be free of surface and subsurface discontinuities except the walkway on top of the dam which has minor surface discontinuities. Significant concrete damage was not observed on the dam foundation and body except for minor plastering fractures on top of the spillway crest at right hand bank. Erosion on the concrete face of the dam body and spillway was not observed.

The auditors did not observe any signs of vertical movement or settlement of the dam foundation and body. However, the dam is missing equipment for recording vertical and horizontal settlement. The downstream face of the dam was found to be covered in fungus and algae.

The steel and concrete structures of the intake control floor area was found to have minor surface discontinuities and foliation, which were limited to surface plastering. The intake control floor concrete cover was found to be sufficient to protect the slab reinforcement from corrosion and to provide fire resistance to reinforcement bars embedded in the concrete. No signs of vertical movement or settlement of the intake control floor were observed.

Regarding the status of the Hydraulic Structures, the steel and concrete components of the intake gate were tested. For the upstream revision gates, not feasible to reduce the velocity of 2.3m/s at full load by new gates, some corrosion was observed and it was also observed that there were some loose seals and, generally, the operational gate is inadequate

For the Main intake gate, the sliding gate cannot be operated, the main intake gate is under dimensioned and poorly designed so it is not feasible to reduce the velocity of 3.0m/s at full load, the main intake gate is also corroded and many of its seals are broken resulting in severe leaking.

For intake Auxiliary Equipment, the gantry crane for the handling system, hoist handling and head valve control cylinder is not functional for both intake gates and trash racks. The water level indicator at Lake Burera that displays level values of the piezoelectric probe is not functional and the ladder for access is missing.

c. Surge tank

The surge tank wall was found to be free of major surface and subsurface discontinuities which cause leakage, The concrete cover on surge tank wall ranges from 55mm to 63mm, and is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in concrete. In most countries, a concrete cover of 50mm is recommended for protection against seawater and/or aggressive chemical environment for completely or partially submerged components in sea water and/or components in saturated salt air; aggressive industrial atmospheres and/or water and earth.

Most of the surge tank access ladders are completely covered with rust and a few are broken. The top grill beams are in good shape, but some of the mesh wires are damaged. Some fungi and algae were observed on the walls of the surge tank.

d. Penstock

The entire length of the penstock was checked for surface and subsurface discontinuities, lining weathering, leakage, ponding of water and erosion. The entire length of the tunnel lining is free of discontinuities and leakage. Weathering on the concrete lining ranges between 20mm to 50mm. This depth of weathering is insignificant when compared with the design thickness of 150mm for the outer upper tunnel lining. The entire length of the tunnel is not subjected to any ponding of water and excessive erosion and few fungi and algae were observed on the walls of the tunnel.

The internal and external corrosion on the steel structure at all points tested is below 1mm, leaving an effective plate thickness of at least 14.42mm. Given that no more than 9.875% of the plate has been lost to corrosion over the last 60 years, the conclusion is that, the penstock is still in good condition and can serve for another 30 years.

All the penstock anchor blocks and supports for the foundations were found to be free from vertical and horizontal movement, except a minor horizontal movement on one support block foundation. Only a few of the anchor and support blocks were not clean, all anchor and support blocks were free of major surface discontinuities, and concrete damage and erosion, except for a minor crack on one support block.

The concrete cover on all anchor and support blocks was found to be above 55mm, which is adequate to protect the reinforcement and anchor bolt from corrosion and to provide fire resistance to bars and anchor bolts embedded in concrete. The weathering of the concrete cover on all anchor and support blocks was limited to 5mm. As such, the remaining concrete cover was found to be sufficient to protect reinforcement and anchor bolts from corrosion and provide fire resistance to reinforcement bars embedded in the concrete.

The entire length of penstock is free of any surface and subsurface discontinuities. The existing thickness of the penstock is the same as specified in original drawings, Vibration amplitude of the penstock is insignificant, the entire length of the penstock is free of water leakage, and the entire length of the penstock is free from erosion and cavitation damage. There were no signs of misalignment and sagging along the length of the penstock.

The penstock pipe exhibited some damage at the road crossing, with visible external corrosion. Additionally, some expansion box fasteners were corroded. All sections of the penstock were found to be free from distortions/flat spots, all weld points and sections were in good condition.

Most of the bearings/rollers were clean, the interior of the penstock was found to be free of peeling and blisters, except some spot corrosion both internal and outside, there was some corrosion of the paint along the length of the penstock given that it is moderately old. The entire length of the penstock was free of ponding of water. Air valve/vent connections were also free of debris, the penstock drainage pipe and valve in the powerhouse was severely corroded. Leakage was detected in the emergency valve.

e. Power house

Some of the window glazing was damaged and some of the air vent windows are also damaged. A few fragments of slope retaining stone pitching are missing. Some trees and grass were observed on slope rating structure wall. Almost the entire slope stability retaining structure work and powerhouse walls were free of excessive cracks. The foundation works for the retaining structure and power house were free from concrete damage and erosion. The weathering of the concrete cover on the slope retaining structure and power house was limited to 5mm and 2mm respectively. The remaining concrete cover is sufficient to protect reinforcement and anchor bolts from corrosion and fire.

f. Tailrace

The tailrace system of the Ntaruka hydropower scheme consists one reinforced concrete open channel that joins Lake Ruhondo. The results of the non-destructive tests and visual inspection of the tailrace canal indicated that there were signs of vertical movement and cracks on both sides of the bank stone pitching works of the tailrace canal and on the foundation. The tailrace water level raiser/seal structure has decayed and some of the stone pitching fragments have been washed-out and there was some grass and trees growing out of the stone pitching.

For more details regarding Status of the Electromechanical Components and other accessories, the detailed evaluation results are given in **Annex 6 - Dam Safety Report**.

5.9.3 Internal and external threats

External threats to Ntaruka HPP include: -

1. **Prolonged periods of rainfall and flooding:** The risk of flooding is low due to the steep slopes of the catchment.
2. **Landslides into reservoirs, which cause surges that result in overtopping:** The risk of landslide into reservoir is low as the catchment of the lake Burera is well protected by terraces and tree plantations.
3. **High winds, which can cause significant wave action and result in substantial erosion:** This risk is very low as the project is not located in a windy area.
4. **Earthquakes, which typically cause longitudinal cracks:** This risk is low as the project is in dormant volcanic region.

Internal threats to Ntaruka HPP include: -

1. **Age and lack of maintenance:** Due to the age of the dam(60 years), minor plaster fractures have been on top of the spillway crest close to right hand bank of the lake outlet, and the downstream face of the dam was covered by fungus and algae.
2. **Compromising the dam**: Lack of proper dam safety plan for monitoring and maintenance can exacerbate the negative effects of aging, thereby creating unsafe conditions.
3. **Regular maintenance is the proper corrective measure.** The proposed rehabilitation project will also be the sustainable solution for those internal issues.

5.10 Environmental and Social Issues, Risks and Impacts of Associated Facilities

The potential environmental and social risks and impacts of Associated Facilities include the upgrading of transmission lines and the rehabilitation of the substation.

5.10.1 Upgrading of the transmission line

This activity will potentially result in some loss of biodiversity due to disturbance of the natural habitats and damages to crops from equipment and workers. The activity will also potentially result in soil loosening.

Working with cranes and other lifting equipment also present potential injury from broken wires, lifting tackle and swinging objects during tower election. There are also potential risks of accidents during lifting equipment to position, erection of towers, stringing and wiring as well as connection.

Stringing of lines can cause major traffic blockage where roads are crossed and/or create impacts on occupational health and safety.

5.10.2 Rehabilitation of substation

This activity will potentially result in minor biodiversity loss from site preparation. There will also be some increase in dust emissions from transport of materials on the unpaved road; and also, some minor increase in air pollution noise levels.

Rehabilitation activities will give rise to a potential solid waste increase from stockpiled metal waste, concrete, earth and stones from demolished infrastructures.

Rehabilitation activities will also potentially result in some soil degradation, due to accumulation of earth excavated materials, and a slight risk of localized soil erosion and run off during rainy period.

6.0 RECOMMENDATIONS AND ACTION PLAN

6.1 Summary of potential positive impacts of the proposed rehabilitation

a. Potential Socio-Economic Benefits

The impacts of the project on socio-economic development of the people in the area include additional electricity to the national grid that lowers the energy deficit, energy to support economic activities and the related creation of jobs and provision of services.

b. Employment

Some employment opportunities as casual labours would be sourced from the surrounding communities.

c. Human capacity building and technology transfer

The current plant workforce should be involved in the rehabilitation activities as much as possible. A training program should be drawn by the Plant Manager and engineers to facilitate the knowledge and technological transfer from the skilled personnel to the plant personnel.

6.2 Summary of potential negative impacts of the proposed rehabilitation

The rehabilitation project will mainly focus on upgrading of equipment to bring generation capacity back to installed capacity of 11.25 MW from the current 9MW based on the weir type dam on Lak Burera with a height of 5 meters and a crest length of 28 meters. Energy production clearly hinges on water availability in the reservoir (Lake Burera), which in turn depends on the health of its catchment.

6.2.1 Environmental and Social Risks and Impacts (ESS-1)

Ntaruka HPP was constructed in 1959, well before EIAs became a requirement for projects in Rwanda in 2005. There was no official current or recent correspondence between the environmental authority and Ntaruka dam management regarding the environmental and social performance of the dam, including any permits or authorizations. No matter how small the risk of dam failure and its effects are, it's always good practice to plan for any eventualities.

The rehabilitation project presents an opportunity to mainstream compliance at the plant, starting with an ESIA for the activity, and the development of Dam Safety Plans (Construction Supervision & Quality Assurance Plan, Instrumentation Plan, and an Emergency Preparedness Plan), to cater for overall catchment monitoring, the rehabilitation activities, and site safety.

6.2.2 Labour and working conditions and Community Health (ESS-2 & ESS-4)

For the proposed rehabilitation activities, and referring to Ministerial Order N°01 of 17/05/2012 determining modalities of establishing and functioning of occupational health, ESS-2: Labour and working conditions, ESS-4: Community Health and Safety, and WBG EHS Guidelines, it is anticipated that traffic will increase especially during the transportation of heavy equipment to the site. Equipment weighing a minimum of 60 tonnes is expected to be transported to the project site.

Current residential staff quarters are also in need of rehabilitation. Some of the roofs have rust and leak, and parts of the ceilings are damaged, so are some of their doors. The sanitation facilities at the staff quarters are also old, and not in good working condition, needs electrical repairs, and also repairs for cracked floors, and paint jobs.

The main effects of increased traffic volumes concern the additional safety risks that all road users would be exposed to whilst competing for road space such as increased risk of accidents and injuries. Potential injuries and accidents are also expected during the installation of new equipment and structures during the rehabilitation process.

6.2.3 Resource Efficiency and Pollution Prevention and Management (ESS-3)

Potential waste related impacts were analysed taking into account Ministerial Order N°01 of 17/05/2012 determining modalities of establishing and functioning of occupational health and safety, National Environmental law, 2018, ESS-3: Resource Efficiency and Pollution Prevention and Management, and WBG EHS Guidelines.

Wastes will generated during the rehabilitation and operation phase of the plant. Solid wastes will include paint containers, dead plant material, waste cement, old parts that will be replaced with new ones, such as the old grill wire mesh covering the surge tank, old ladders, etc.

Pollution from used oil (turbine, generator and transformer oil) can also potentially result in soil contamination. This if not appropriately disposed of will result in soils, surface and ground water contamination, and subsequently affect the health of aquatic and terrestrial biodiversity particularly in the adjacent lakes, and humans.

There will be potential minor impact on water quality during the rehabilitation phase, anticipated to arise from inputs of suspended matter to the Ruhondo Lake as a result of rehabilitation activities and erosion of the banks of the lake channels by the higher velocity flows during diversion.

Transportation of materials will potentially result in generation of dust along the unpaved access routes, of concern particularly during the dry season.

6.2.4 Land Acquisition, Use, Resettlement and Cultural Heritage (ESS-5 and ESS-8)

In reference to ESS-5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement and ESS-8: Cultural Heritage, the power plant is strategically built on a 32 ha government owned plot that was handed over to REG for purposes of power generation. There are cultural heritage and resettlement issues related to the rehabilitation activities thus, as the said activities will take place on the same footprint.

6.2.5 Biodiversity Conservation and Sustainable Management (ESS-6)

Analysis referred to the Law N°48/2018 of 13/08/2018 on Environment, and ESS-6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. The findings of the audit indicate that there will be very minimal potential negative effect on biodiversity. There will be some clearing and excavation activities to rehabilitate the penstock foundation.

6.2.6 Stakeholder Engagement and Information Disclosure (ESS-10)

Referring to ESS-10: Stakeholder Engagement and Information Disclosure, the audit found no evidence (documentation) of any formal or informal engagement of Ntaruka HPP management with stakeholders, with no record of past grievances.

The rehabilitation project presents an opportunity to mainstream compliance at the plant, starting with an ESIA for the activity, and the development and / or update their Grievance Redress Plan

(from the consolidated company manual) to cater for and site safety including staff and neighbouring communities' welfare.

6.2 Remedial Action Plan

Negative impacts from the rehabilitation of Ntaruka hydropower plant will affect the surrounding physical, biological and socio-economic environment during all the phases of the project including design and planning, construction, operation and decommission phases. For each negative impact, examples of mitigation measures are proposed (**Table 7**).

Table 7: Proposed Mitigation measures to address audit findings

Environmental and social issue	Corrective measures	Compliance with National regulations	Compliance with WB Environmental and Social Standards	Timeline	Indicator	Responsible bodies	Budget in USD
Inadequate or missing Dam Safety Plans (No Construction Supervision & Quality Assurance Plan, Instrumentation Plan, Emergency Preparedness Plan, Grievance Redress Plan)	• Development construction / rehabilitation Supervision and Quality Assurance Plan • Development of instrumentation plan • Development of dam safety program • Implementation of measures required addressing safety issues • Implementation of Grievance Redress mechanism	The Law N°48/2018 of 13/08/2018 on environment Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees (Ministerial Order N°01 of 17/05/2012)	ESS1 Assessment and Management of Environmental and Social Risks and Impacts sets ESS4: Community Health and Safety	During rehabilitation and operation of power plant	Dam safety plan Construction plan Emergency Preparedness Plan O&M plan Instrumentation plan Grievance Redress Plan	REG	8,000
	• Employ dam engineers			During rehabilitation and operation t	No. dam engineers		@12,000pa
	• Development of Emergency Preparedness Plan			Before rehabilitation			2,000
Fire risk issue	• Development of fire response plan • Installation automatic fire detection features • Additional fire fighting equipment (extinguishers)	The Law N°48/2018 of 13/08/2018 on environment	ESS1 Assessment and Management of Environmental and Social Risks and Impacts sets	During rehabilitation and operation phases	Fire response plan Installed automatic fire detection Installed extinguishers	REG	15,000
Water quality pollution (waste water & waste oil - turbine, generator and transformer)	• Development and implementation of Waste Management Plan • Safe disposal of waste water • Safe disposal of waste oil	National Policy for Water Resources Management, 2011 The Law N°48/2018 of 13/08/2018 on environment	ESS3 Resource Efficiency and Pollution Prevention and Management	During rehabilitation and operation phases	Water quality records Waste management plan	REG, Contractor	15,000
Solid waste pollution	• Development and implementation of solid waste management plan	The Law N°48/2018 of 13/08/2018 on environment	ESS3 Resource Efficiency and Pollution Prevention and Management	During operation and rehabilitation phases.	Waste management plan	REG, Contractor	5,000
Hydrological regimes of lakes	• Development of Instrumentation Plan (catchment monitoring) • Continuous water level monitoring • Replacement of existing water level system able to	National Policy for Water Resources Management, 2011	ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	During operation and during construction / rehabilitation activities	Water level control which is functional	REG	27,600

Environmental and social issue	Corrective measures	Compliance with National regulations	Compliance with WB Environmental and Social Standards	Timeline	Indicator	Responsible bodies	Budget in USD
	communicate with powerhouse.						
Impacts on biodiversity (flora & fauna) from pollution	• Minimization of water quality degradation downstream during rehabilitation / operation phases.	• Ministerial Order establishing the list of protected animal and plant species (Ministerial Order No 007/2008 of 15/08/2008) • Law N° 70/2013 of 02/09/2013 Governing Biodiversity in Rwanda	ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	During rehabilitation and operation phases	Hectares of vegetation cleared and died aquatic animals	REG, Contractor	1,500
Sediment management	• Development of Instrumentation Plan (catchment monitoring) • Sediments control measures	National Policy for Water Resources Management, 2011	ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	During power plant rehabilitation and operation	Water turbidity	REG, Contractor	3,000
Health and safety issues	• Development of Instrumentation Plan • Development of Emergency Preparedness Plan • OSH Training • Proper maintenance of all equipment	Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees (Ministerial Order N°01 of 17/05/2012)	Community Health and Safety	During rehabilitation and operation phases.	Health and safety plan Training manual	REG, Contractor	10,000
	• Do repairs on old staff housing units • Do repairs on old sanitation facilities an staff housing quarters	ESS2: Labour and working conditions ESS4: Community Health			Repairs done		5,000
Noise pollution	• Provide relevant PPE • Follow Rwanda Law on Noise pollution & OSH good practice	The Law N°48/2018 of 13/08/2018 on environment	ESS3 Resource Efficiency and Pollution Prevention and Management	During construction	Complaints from employees	Contractor	10,000
Air quality pollution form vehicle emission	• Control vehicle speeds to project site • Sprinkle water on unpaved road	The Law N°48/2018 of 13/08/2018 on environment	ESS3 Resource Efficiency and Pollution Prevention and Management	During rehabilitation and operation activities	Dust on leaves of trees. Frequency of airborne debases in the area	REG, Contractor	1,500

6.3 Recommendations

The Environmental and Social Audit of Ntaruka HPP revealed that there will be no major negative impacts associated with the implement of the rehabilitation project. Overall, Ntaruka HPP's environmental and social compliance level has both positive aspect, and some that can be improved with the implementation of the rehabilitation project. A summary of the conclusions by way of key achievements and for improvement, covering Environmental Management, Dam Safety, and Labour, Health and Safety issues are presented below.

6.3.1 Environmental management

The plant has been operational since 1959. Referring to the Law on Environment in Rwanda, it should be noted that all facilities have been constructed and operational prior to 2005 were exempt from EIA process.

It is recommended to embrace the opportunity presented by the proposed rehabilitation project, to conduct a full Environmental and Social Impact Assessment (ESIA) including ESMP prior to implementation of the rehabilitation works.

6.3.2 Dam safety

The dam risk is categorized as low risk considering its dimensions, location and operation record. Its failure or disoperation will result little of no damage to property and/or human life. However, there were no dam safety plans found on site.

The auditors recommend that the plant owner: -

1. Complies with warning time for evacuating population in case of dam failure,
2. Develops and complies with the following dam safety documents i.e. an Emergency Preparedness Plan, Rehabilitation Supervision and Quality Assurance Plan, and an Instrumentation Plan for the dam body, reservoir and the catchment area.
3. Develops and complies with a comprehensive O&M plan after project rehabilitation,
4. Develops a Dam Safety Programs which include periodic safety inspections of the dam after project rehabilitation and implementation of measures required addressing safety issues.
5. Invest (employ) civil / dam engineers.

Potential pollution risks associated with the company operations, such as reservoir management, management of oils and lubricants for turbine, transformers and support infrastructure, solid waste management are will be addressed by implementing provided mitigation measures.

The planned Ntaruka HPP rehabilitation activities will not affect the Rugezi-Burera-Ruhondo watershed complex. Instead, the activities present an opportunity to implement instrumentation for monitoring of both dam and catchment health, vital in maintaining a health hydrological regime.

The minor potential negative impacts, mostly related to transportation of equipment and materials, are expected to be localised and short-term. These can be mitigated by putting up signage, spraying water on dirt roads, , etc.

6.3.3 Labour and working conditions

The company has a consolidated procedures manual covering policies related the Classification of staff, Employment policy, Recruitment procedures, Performance management, Promotion and Transfer, Reward and Remuneration Management, Payroll Processing, Human Resources

Development, Ethics and Staff Code of Conduct, Disciplinary Guidelines, Termination of Service; Grievance handling; Staff welfare; Leave, Travel policy, Career, Training & Development, Equal Opportunity and Sexual or Racial Harassment, Grievance Redress, and Occupational, Health and Safety policy.

Currently construction workers at Ntaruka HPP raise their concerns through supervisors. No evidence of discriminatory practice, child labour or forced labour was found during the site visit. Work site is free from harassment and abuse.

The staff residential camp established near power house has sufficient accommodation for the workers and provides living space with room heaters and warm water for bathing, filtered water facility, and medical insurance including first aid services. However, the current residential staff quarters and related sanitation facilities are also in need of rehabilitation. For some of the houses, roofing sheets have rust and leak, and parts of the ceilings are damaged. Some also have damaged doors in need of repairs. Sanitation facilities are old and not in good condition, and also needs electrical repairs, repairs for cracked floors, and paint jobs

6.3.4 Areas for Improvement

Communication

- Plant staff, supervisors, and managers need to be oriented on newly developed HR policies such as Child Labour, Forced labour, Retrenchment Policy, and Freedom of Association. The policies should be shared in an employee handbook, given out for personal reference.
- There is need for documentation (records) of oral grievances and action taken against the complaints.
- Additionally, first-aid boxes and fire extinguishers should be provided in the staff residential camp.

Occupational health and safety;

- Enhance signage to show proper PPE usage, hazardous areas, location of first aid boxes, and location of fire extinguishers.
- Conduct risk assessment as a basis for a comprehensive Emergency Response Plan to be developed by the company.
- Implement OSH training including regular fire and emergency evacuation drills.
- Provide acoustic enclosure for the noisy diesel generator installed in the staff residential camp.

Working / living conditions for staff

- Do repairs on the staff houses including replacement of roofing sheets, ceiling repairs, and also door repairs.
- Upgrade the old sanitation facilities, including necessary electrical repairs, cracks on floors and application of fresh coats of paint.

External social performance

REG should take advantage of the rehabilitation project to enhance social performance of its activities by: -

- Commissioning an ESIA that ideally includes all stakeholders including community members
- Development of Emergence Preparedness and Response Plan.
- Development (update) of their Grievance Redress Mechanism, to handle staff and community grievances, including grievance record keeping

7.3 Conclusion

The Ntaruka NPP dam safety risks are summarised in **Table 7** below.

Table 7: Summary of Ntaruka HPP Dam Safety Risk

PARAMETER	THEME / COMPONENT	RISK ASSESSMENT
A. EXTERNAL THREATS	1. Prolonged rainfall and flooding	• Low risk attributed to steep slopes of the catchment
	2. Landslides	• Low risk of landslide into reservoir is low as the catchment of the lake Burera is well protected by terraces and tree plantations
	3. High winds	• Low Risk. Project not located in windy area
	4. Earthquakes	• Low risk. Project located in volcanic region which is no longer active • In a MM! earthquake zone V i.e. moderate effects with some shaking, felt by nearly everyone
B. INTERNAL THREATS	5. Age / Lack of maintenance	• Dam over 60 years old • Minor plaster fracture have been developed on top of the spillway crest • downstream face of the dam was covered by fungus and algae
	6. Compromise (Lack of proper safety plan)	• Unsafe conditions • Lack of proper dam safety plan for monitoring and maintenance • Exacerbates the negative effects of aging
	7. Regular maintenance	• Regular maintenance is the proper corrective measure • Proposed rehabilitation will be a sustainable solution for internal issues.
C. CIVIL STRUCTURES	8. River Bank Training	• Minor defects on both sides, slope pitching foundation has cracks • Good structural condition, Can be used for many more years with minor maintenance
	9. Intake dam foundation and body	• No signs of leakage
	10. Intake dam concrete cover	• Weathering limited to 3-5 mm, available concrete cover 60 -70 mm
	11. Intake dam body	• Free of surface and sub-surface discontinuities • Minor plastering fractures on spill way crest
	12. Dam in general	• Missing equipment vertical and horizontal settlement
	13. Penstock	• Free of discontinuities and leakage • Weathering on concrete lining 3-5mm compared to design thickness of 150mm
		• Steel structure internal and external corrosion of points tested below 1mm.aginst a plate depth of 14.42 mm (no more than 9.875% of the plate has been lost to corrosion over the last 60 years) penstock is still in good condition and can serve for another 30 years.
		• All anchor blocks and supports for foundations free from vertical / horizontal movement except for minor movement on one support. All were free from concrete damage and erosion

PARAMETER	THEME / COMPONENT	RISK ASSESSMENT
		• Weathering of the concrete cover on all anchor and support blocks was limited to 5mm against a concrete cover on all anchor and support blocks found to be above 55mm • Sufficient to protect reinforcement and anchor bolts from corrosion and provide fire resistance to reinforcement bars embedded in the concrete
		• Penstock pipe exhibited some damage at the road crossing there was visible external corrosion • Some expansion box fasteners were corroded
		• Some corrosion of the paint along the length of the penstock given that it is moderately old • Penstock drainage pipe and valve in the powerhouse was severely corroded resulting in a laborious operation and Leakage was detected in the emergency valve
	14. Surge tank	• Free of from surface and sub-surface discontinuities • Concrete cover weathering of 3-4mm against a concrete cover range of 55 to 63mm • Most of the surge tank access ladders are completely covered with rust and few are broken
	15. Powerhouse	• some of the window glazing was damaged • some of the air vent windows are also damaged. • A few fragments of slope retaining stone pitching are missing • weathering of the concrete cover on the slope retaining structure was 5mm • weathering of the power house was limited to 2mm • Almost the entire slope stability retaining structure work and powerhouse walls were free of excessive cracks • sufficient to protect reinforcement and anchor bolts from corrosion and fire
	16. Tail trace	• Signs of vertical movement and cracks on both sides of the bank stone pitching works of the tailrace canal and on the foundation • Tailrace water level raiser/seal structure has decayed • Some of the stone pitching fragments had been washed-out
	17. Hydraulic structures – upstream revision gates	• Upstream revision gates, cannot reduce the velocity of 2.3m/s at full load • Corrosion and some loose seals observed operational gate is inadequate
	18. Hydraulic structures – main intake gate	• Sliding gate cannot be operated • Main intake gate is under dimensioned and is poorly designed • Reduce the velocity of 3.0m/s at full load • Corroded and with broken seals
	19. Intake auxiliary equipment – gantry crane	• Gantry crane for the handling system, hoist handling and head valve control cylinder is not functional for both intake gates and trash racks. • Water level indicator / piezoelectric probe at Lake Burera is not functional

PARAMETER	THEME / COMPONENT	RISK ASSESSMENT
D. ASSOCIATED FACILITIES	20. Upgrading of transmission line	• Loss of biodiversity, habitat modification • Damage to crops from excavation • Injury, accidents in tower erection, stringing and wiring, crane operations • Excavation – loosens soil • Excavation in swampy areas – water pumped out - erosion • Risk of tower failure and societal hazards
	21. Rehabilitation of substation	• Biodiversity loss from site preparation • Dust emissions on unpaved road to site • Air pollution (minor SO2, NOx, and CO2 from vehicles and machinery) • Noise pollution • Soil degradation, erosion, compaction • Water pollution • Solid waste • Injuries, accidents

Conclusion

Despite its age (60 years) Ntaruka HPP's civil structures are still in good condition, and can be used for many more years with minor repairs and maintenance. The proposed rehabilitation would be the ideal way to go as it will handle some of the current risk aspects, starting with Environmental compliance (full ESIA), to doing the needed repairs, and culminating in the creation of a proper Safety Plan implemented through a clear Operations and Maintenance (O&M) Plan.

ANNEXES

ANNEXES

Annex 1: References

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28. Twin lakes Burera and Ruhondo. https://www.explorerwandatours.com/attractions/twin-lakes-burera-ruhondo.html retrieved on 05th June 2020
29. WB,2018. Environmental and Social Framework;

Annex 2: Rwanda Hydropower Plants Production Record

No	Plant Name	Installed Capacity (MW)	COD	Status	Type of Technology
1	Ntaruka	11.25	1959	Existing	Hydro
2	Mukungwa 1	12.00	1982	Existing	Hydro
3	Nyabarongo I	28.00	2014	Existing	Hydro
4	Gisenyi	1.70	1957	Existing	Hydro
5	Gihira	1.80	1984	Existing	Hydro
6	Murunda	0.1	2010	Existing	Hydro
7	Rukarara 1	9.0	2010	Existing	Hydro
8	Agatobwe	0.2	2011	Existing	Hydro
9	Janja	0.2	2011	Existing	Hydro
10	Rugezi	2.6	2011	Existing	Hydro
11	Keya	2.2	2011	Existing	Hydro
12	Rushaki	0.04	2010	Existing	Hydro
13	Nkora	0.68	2009	Existing	Hydro
14	Mutobo	0.2	2011	Existing	Hydro
15	Mukungwa 2	3.6	2011	Existing	Hydro
16	Nyabahanga	0.2	2017	Existing	Hydro
17	Cyimbili	0.3	2012	Existing	Hydro
18	Mazimeru	0.5	2012	Existing	Hydro
19	Nyamyotsi II	0.1	2013	Existing	Hydro
20	Nyirabuhombohombo	0.5	2012	Existing	Hydro
21	Nyamyitsi I	0.1	2012	Existing	Hydro
22	Nshili1	0.4	2013	Existing	Hydro
23	Gashashi	0.28	2013	Existing	Hydro
24	Musarara	0.4	2013	Existing	Hydro
25	Rukarara 2	2.2	2013	Existing	Hydro
26	Giciye 1	4	2013	Existing	Hydro
27	Giciye 2	4	2016	Existing	Hydro
28	Gaseke	0.50	1984	Existing	Hydro
29	Rwaza-Muko	2.60	2018	Existing	Hydro
30	Ruzizi 2	12.00	2019	Existing	Hydro
31	Mushishito	2.00	2019	Existing	Hydro
32	Rubagabaga	0.45	2019	Existing	Hydro
	S-total	**104.10**			**Hydro**
31	Jabana 1	7.8	2004	Existing	Diesel
32	Jabana 2	20	2009	Existing	HFO-Diesel
33	So Energy	30	2017	Existing	Diesel
	S-total	**57.8**			**Diesel**

No	Plant Name	Installed Capacity (MW)	COD	Status	Type of Technology
34	Gishoma	15	2016	Existing	Peat
	S-total	**15**			**Diesel**
35	Biomass (Rice Husk)	0.07	2016	Existing	Biomass
	S-total	**0.07**			**Biomass**
36	KP1	3.6	2008	Existing	Methane
37	Kivuwatt Phase I	26.4	2016	Existing	Methane
	S-total	**30**			**Methane**
38	Jali	0.25	2007	Existing	Solar
39	GigaWatt /Rwamagana	8.50	2013	Existing	Solar
40	Nyamata Solar	0.03	2009	Existing	Solar
41	Nasho Solar PP	3.30	2017	Existing	Solar
42	Ndera	0.15	2014	Existing	Solar
	S-total	**12.23**			**Solar**
43	Ruzizi 1	3.50	1957	Existing	Imports
44	UETCL	2.00		Existing	Imports
	S-total	**5.50**			**Imports**
	Grand Total	**224.7**			

Annex 3: Stakeholder Participation and Consultation

1. Stakeholder Consultations

A number of stakeholder consultation meetings were held during the month of May 2020. The meetings were held in Kigali City and Burera District within villages affected by the project. Issues and response reports were generated for each of the meetings and have been incorporated in this environmental and social Audit report.

The public/stakeholder meetings were conducted to ensure that stakeholder engagement was undertaken in an inclusive manner and provided important input to the ESA process. The objective of engagement is to ensure that sources of existing information and expertise are identified, legislative requirements are met and that stakeholder concerns and expectations are addressed.

Public/stakeholder meetings form an integral part of the ESA process. Various types of meetings were held with respect to the proposed project. These included stakeholder meetings with authorities and other community members, focus group meetings with the youth and women and one-on-one meetings.

The most common issues raised by the public include:

- Economic issues (employment, economic benefits, etc.);
- Ecological issues (impacts on terrestrial ecology);
- Health, safety and security arising from the operation of the project;
- Social issues (conflicts over job opportunities, disruption of infrastructure and services, local community access to electricity, construction/maintenance/power line extension works that make damage to people's fields and crops, etc.).
- Grievance mechanism for project-affected parties (PAPs) and communities.

In order to ensure that the interests of the community, the Project Affected Persons (PAPs) and the public at various levels, are addressed and incorporated into the rehabilitation design of the project, a consultative-participatory approach was adopted to shed more light on the project components, implementation activities, and to explain the likely impacts from the project. As part of this ESA Study, a comprehensive public/stakeholder consultation process was carried out at national and district levels with the various government ministries and departments, regulatory lead agencies and members of the various communities. The consultations were in form of one-on-one meetings, workshops and *barazas*.

The Auditor undertook a comprehensive stakeholder mapping exercise using a power/interest matrix and classified the stakeholders based on their level of interest and the power. A list of the potential stakeholders was drawn for both the national and district level.

The consultations that were held at national level in Kigali City were with the various government lead agencies such as MININFRA, MINEMA, RWAFA, REMA/RDB, RBS, RURA, REG/EUCL, Ntaruka HPP. At the district level meetings were held with the various district authorities and local community.

A number of public/stakeholder consultation meetings were held from 29 May to 1 June 2020. At each meeting, the presentation introduced the project to those in attendance, enabled I&APs the opportunity to discuss their perceptions about the potential environmental and social impacts

and I&APs were provided with an opportunity to discuss/highlight/raise any concerns or issues that they have with regards to the project with the ESA team.

2. Summary of Comments and Responses

The key stakeholder views captured during the stakeholder consultations are summarised below.

Summary of Comments and Responses

Subject	Issues	Responses / Comments
1. About the project	Whether they know about the project and if they will benefit from the project/or if they have been benefiting from the existing facility	Most of local community stakeholders consulted were not aware of the planned rehabilitation project. For the Plant Manager, this project would enable the plant to increase the capacity at its normal capacity and also the plant is quite old and with the rehabilitation, spare parts shall be available on the market, which is not the case now.
2. Employment and income generating activities	Number of employment opportunities during the rehabilitation and operation stage and what will be done to ensure those ones.	There will be some employment opportunities during the rehabilitation phase and during the operational phase. The available opportunities will include labourers, security guards, cleaners, welders and electric engineers among others
3. Public Hazards posed by the Plant rehabilitation and operation	Whether there will some measures to minimize these impacts	Yes there are some safety measures that were set up and include communication/raising awareness materials, technical options like fencing of the facilities, EHS Notice Boards within the facility
4. Community Water Supply	Whether the community water supply will be affected both in quantity	The Ntaruka HPP used water from reservoir of lake Burera and the evacuation of this water downstream allows to replenish the other lakes and rivers such as lake Ruhondo, rivers of Mukungwa and Nyabarongo which then allow to operate other power plants (Cascade Mode). Therefore no impact on water quantity as it is fully reused.
5. Community Electrification	Whether the community will be supplied with electricity	With the rehabilitation of the Plant. The local community stakeholders consulted hope to benefit from this project such as to have access to reliable and affordable electricity (which till now is not accessible by a number of them who just live in the neighborhood of the Plant). Reason given by Plant Manager is that supplying electricity to local community living within the plant neighborhood is too difficult/or not feasible (too expensive) as is a dispersed habitat. The government and local authorities are taking all measures to group the local community into villages (Imidugudu)
6. Resettlement and Land Acquisition	What will be done to compensate those who any be resettled/Whether there are those who will lose their land as a result of the project	There would be no physical resettlement or land acquisition of people as it is an existing plant and no dwellings exist within the proposed footprint on the project.
7. Impact on wildlife	How the project will impact on wildlife	There won't be any significant potential impact on wildlife with the rehabilitation of the plant. Only the disruption to the movement of some birds through the forest. The rehabilitation works will cause noise, will disturbed them. Mitigation measures relating to the timing of construction have been recommended. It is also recommended that the least possible length of excavation for the pipeline be left open at any one time.

Subject	Issues	Responses / Comments
8. Impacts on the trees and forest cover	will be/or have been any loss of trees and forest cover as a result of the project	Some clearance of trees may be required during the rehabilitation but will not affect the surrounding vegetation as most of rehabilitation works will be done at power plant level. Some mitigation measures were proposed to ensure that the minimum clearance of trees will be required.
9. Stakeholders Engagement Progress	How the stakeholders were identified	A stakeholder mapping exercise was undertaken to identify all relevant stakeholders based on power and interest (power/interest matrix). All relevant stakeholders have been identified and consulted as part of this ESA process. Consultation will be on going through the lifetime of the project.
10. Noise and vibration impacts	What will be/have been done to address the issue of noise during the operation phase	The noise generated during operation of the turbine is expected to be insignificant. The power station will be located at the bottom of the valley, approximately 300-500 meters from the closest residences. The distance and topographical position will diminish the noise. Furthermore, the turbine will be and housed inside a closed structure.
11. Air Pollution Impacts	What will be done to address the issue of air pollution	During the construction phase there will be minimal air pollution arising from dust generated by the moving vehicles, excavation process and transport of construction materials. The proponent will ensure the contractors adhere to the Rwanda Environmental Management Authority (REMA) regulations and IFC guidelines on air emission and ambient air quality. There will be negligible air pollution during the operational phase as the Plant uses exclusively water.
12. Impacts on the aquatic environmentt	How the project will affect the aquatic environment	An assessment regarding the water use and the impact on aquatic ecology in the lake has been carried. Project design will be based on a suitable environmental flow that takes into consideration prevailing socio-environmental water uses and demand. The diversity of aquatic organisms in the lake Burera and Lake Ruhondo is very low. There is a waterfall of approximately 200m upstream of the position of the proposed powerhouse. This waterfall acts as an impenetrable barrier to the upstream migration of fish in the two lakes. Thus, the project will not result in a hitherto non-existent impact as far as fish migration is concerned.
13. Impacts on Agriculture	How the project will affect agriculture	No agricultural land for the rehabilitation of Ntaruka HPP will be affected as all land is Ntaruka HPP property.
14. Archaeological and cultural heritage resources	What will be done to ensure the project does not tamper with any archaeological and cultural heritage resources	Archaeological assessment has indicated that there are no archaeological and cultural heritage sites within the project footprint.
15. Upgrading of the Access Road	Whether the access road to the pipeline will be upgraded	No need for the existing unpaved road within the forest to be upgraded and will not be widened or tarred.
16. Safety during the construction/rehabilitation stage	How the occupational hazards will be addressed during the construction stage	Proponent will ensure adherence to OSHA 2007 and IFC Performance Standard 2 relating to labour and working conditions. Workers will receive training on safety requirements and will be required to use appropriate personal protective equipment appropriate to the type of hazard they will encounter in their work. The local community will also be sensitised about hazards related to the construction project, including the spread of sexually transmitted diseases and traffic safety hazards.

Subject	Issues	Responses / Comments
17. Commencement and duration of the project	Duration and commencement of the project.	The project is expected to commence once all the regulatory approvals have been obtained e.g. REMA and WB/IFC ESA approval. Construction is expected to take two years from the time of commencement
18. Health and Safety	Measures that will be put in place to ensure the health and safety of the construction workers	The contractor will ensure all employees are provided with and use the appropriate Personal Protective Equipment (PPE) and are well trained on Health and Safety.

3. List of key respondents during Stakeholder / Public Consultations

Name	Institution	Function	Contact
Government Level			
1. Peace Kaliisa	MININFRA		
2. Remy Norbert Duhuze	REMA/RDB	Director of Regulation and pollution control	
3. Marshal Banamwana	MoE	Biodiversity conservation specialist	
4. Marie Chantal Uwamahoro	RSB	Environmentalist	
5. Karara jean de Dieu	RDB	Environmentalist	
6. **Project Level**			
7. Clementine Umugwaneza	REG	Director of strategic planning	
8. Claver Gakwavu	REG/EUCL	Director of planning	
9. Jean Providence Twajyamahoro	Ntaruka HPP	Manager of power plants/EUCL	
10. Tom Rwahama	REG/EUCL	Director	
11. Fabien Nshimiyimana	REG/EUCL	Environmentalist	
12. Jackson Ruhigula	REG/EDCL	Head procurement	
13. Modeste Dusengimana	Ntaruka HPP	Ntaruka HPP Manager	
14. Fidele Nshimiyimana	Electrical	Engineer/Ntaruka HPP	
15. Local Community and Private Sector Community			
16. Uwiragiye Claudine	Burera, Kinoni	Trader	0780822363
17. Uwimana Sarma	Burera, Kinoni	Trader	0781135444
18. Mudahemuka Beatrice	Burera, Kinoni	Trader	0784207338
19. Uwizeye Beatrice	Burera, Kinoni	Trader	0784910967
20. Simpatwa Fidele	Burera, Kinoni	Farmer	0786711128
21. Bayanga Ernest	Burera, Kinoni	Farmer	-
22. Bapfakwita Capitoline	Burera, Kinoni	Farmer	078855438
23. Burindi Ezechiel	Burera, Kinoni	Carpenter	0784317984
24. Nzabonimpa Moise	Burera, Kinoni	Builder	-
25. Ntamutorano Jerome	Burera, Kinoni	Farmer	0781303036
26. Uwizeyimana M. Jeanne	Burera, Kinoni	Farmer	0783373312
27. Musabyimana Beatrice	Burera, Kinoni	Farmer	0783335988
28. Nyamvure Esperance	Burera, Kinoni	Farmer	0788549962

4. Photos of Public Consultations

Consultations with Ntaruka HPP Manager at Burera Dam and Intake site

Community consultations at Kinoni Market Place

Ntaruka HPP Manager discussion

Consultations with the local community

Annex 4: Data Capture Instruments (Templates)

1. Guiding questionnaire: <u>Environmental Field Baseline Checklist</u>

-Catchment protection (terraces, ant erosive, agroforestry, shrubs…..), Yes there is important forest that has been planted and fencing benches
-Land use around the lake Burera (settlement, agriculture, forestry….), Yes presence of settlements, agriculture, forestry
-Observation of soil structure around the reservoir (fragile or not) for its resistance to soil erosion, Yes fragile and resistance to soil erosion due to lots of vegetation/forest and agriculture plantations,
-Type of vegetation around the reservoir, Cfr above
-Type of slope around the lake, Steep slope (mountainous and valley/flat at the power house
-Visual observation of the quality of water of Lake Burera (turbidity), No turbidity (no visual sediments) as no impact of soil erosion due to the presence of agroforestry and forestry upstream of the lake, very clear water
-Protection type of lakeside: lots of vegetation/forestry and agroforestry
-Observation of status of intake, check if there is an impact, no visual impact
-Observation of underground canal and penstock, couldn't check it as the power was running but documents received from Plant Manager can have more details on the status of dam, intake and penstock
-Operation plan of the plant (from plant manager), already sent
-Technic used for water quality monitoring (from plant manager), No such data at the plant
-Technic used for air quality monitoring (from plant manager), No such data at the plant as no significant emissions into the air the plant used exclusively water and no air emissions from the turbines and other machines
-Solid waste management plan (from plant manager), only oils used to run turbines and these are well disposed and recycled
-Hazardous waste management plan (from plant manager), no such data available at the plant but the plant doesn't generate any significant hazardous wastes
-Waste water management plan (from plant manager), no such data at the plant but the plant doesn't generate any significant wastewater as the water used to produce electricity is recovered at the offtake/outlet and drain into the lake of Ruhondo
-Noise pollution management plan (from plant manager), yes but for workers they have PPE to minimize the impact
-Complain of surrounding population about any pollution from the plant, Not at all, only complaints can arise from the powerline extension construction works that can damage their fields and crops

2. Questionnaire for Key respondents

Name of the respondent:
Contacts: Village Cell
Sector
District

Telephone number:

The government of Rwanda with the support of the World Bank is planning to rehabilitate Ntaruka hydropower plant to expand access to high quality, reliable and affordable electricity. Do you think you shall benefit from this facility? Yes □ No □

Explain your answer……

To minimize public hazards posed by the project implementation and operation, there are some measures including communication materials, fencing of the facilities that were set up.

Are you aware of such safety measures set in place during the construction phase? Yes □ No □
Explain you answer……
How did you feel about it……..

Are you aware of any environmental hazards that might have occurred? Yes □ No □

Explain you answer……

Is there additional measures you would recommend in the future? Yes □ No □

Explain you answer……

Can you name any public hazards (air pollution, water leakage…) that may have happened since the project started operating? Yes □ No □

Explain you answer……

Do you have any relative or do you know anyone who get a job from the project during the construction or operation of the project? Yes □ No □

Explain you answer……

What is your general perception of the project: positive □ negative □

Explain you answer……

3. Checklist of the environmental and social audit

A. INSTITUTIONAL & ADMINISTRATIVE

County:	
Sub-Project title:	
Scope of project and activity:	
Institutional arrangements (Name and contacts)	Project recipient
	Project Management (Name and contacts)
Implementation arrangements (Name and contacts)	Environmental and Safeguards supervision
	Contractor / Supervisor
	Construction Supervision

Site Description

Name of site:	
Describe site location:	Attachment 1: Site Map [ ]Y [ ] N
Who owns the land?	
Describe the geographical, physical, biological, geological, hydro-graphical and socio-economic context	

Legal framework

Identify legal framework and permits applicable to the project	

Public Consultation

Identify when / where the public consultation process took place	

Institutional Capacity Building

Will there be any capacity building?	[ ] N or [ ]Y if Yes, provide capacity building program

B. ENVIRONMENTAL /SOCIAL AUDIT SCREENING

Will the site activity include/involve any of the following potential issues and/or impact	**Activity and potential issues and/or impacts**	**Status**
	1. Building rehabilitation • Site specific vehicular traffic • Increase in dust and noise from demolition and/or construction • Construction waste	[ ] Yes [ ] No
	2. New construction • Excavation impacts and soil erosion • Increase sediment loads in receiving waters • Site specific vehicular traffic • Increase in dust and noise from demolition and/or construction • Construction waste	[ ] Yes [ ] No
	3. Acquisition of land • Encroachment on private property • Relocation of project affected persons • Involuntary resettlement • Impacts on livelihood incomes	[ ] Yes [ ] No
	4. Hazardous or toxic materials • Removal and disposal of toxic and/or hazardous demolition and / or construction waste • Storage of machine oils and lubricants	[ ] Yes [ ] No
	5. **Impacts on forests and/or protected areas** • Encroachment on designated forests, buffer and /or protected areas • Disturbance of locally protected animal habitat	[ ] Yes [ ] No

C. PHYSICAL ASPECTS

S/No	Parameters	Project Activity	Predicted Impact	Actual Impact	Mitigation Measure	Effectiveness	Indicator	Sources of data	Accuracy (%)
1	Air quality								
2	Water quality								
3	Noise level								
4	Slope stability								
5	Hydrology								
6	Land use pattern								

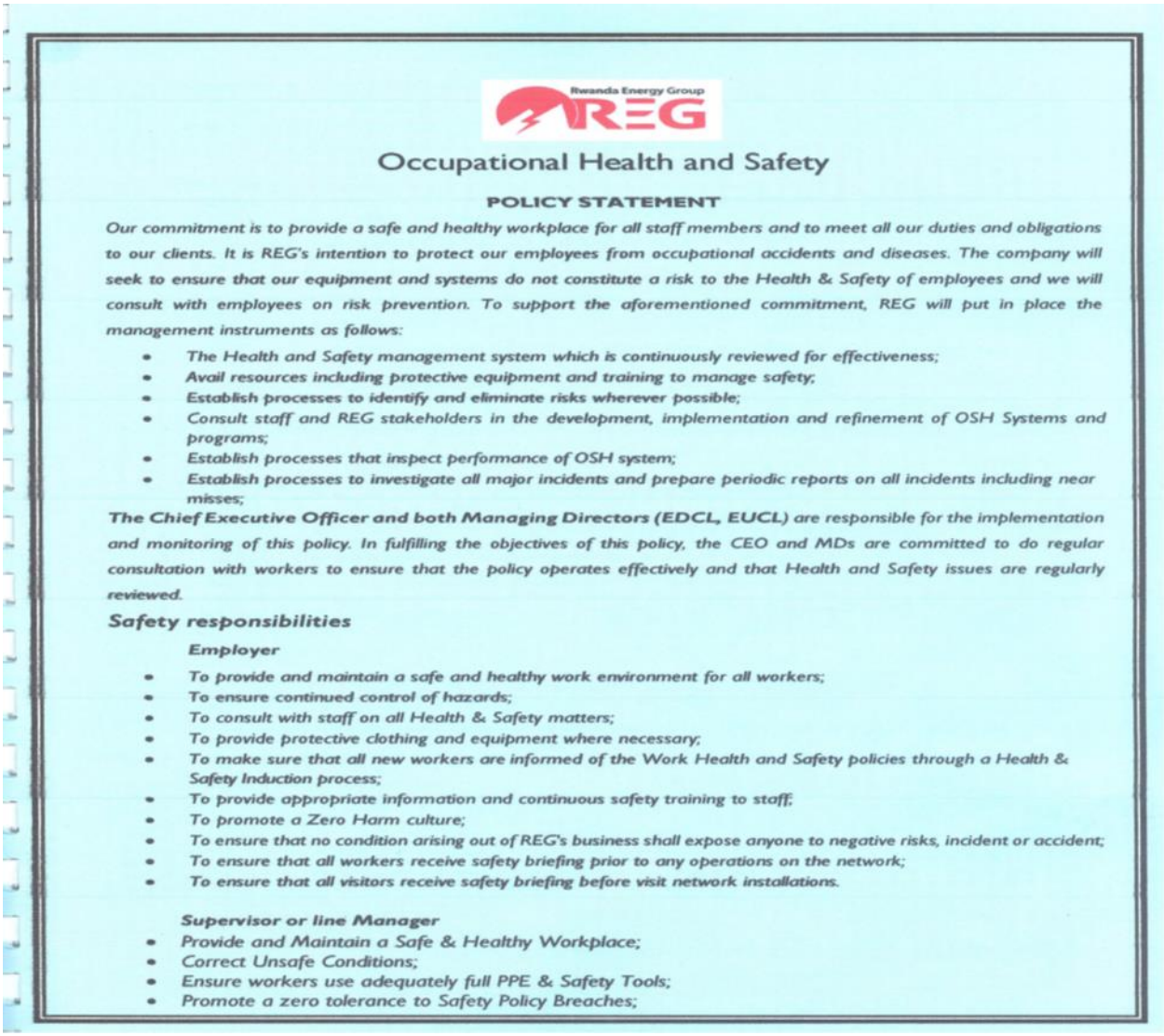
D. BIOLOGICAL ASPECTS

S/No	Parameters	Project Activity	Predicted Impact	Actual Impact	Mitigation Measure	Effectiveness	Indicator	Sources of data	Accuracy (%)
1	Forests								
2	Flora								
3	Fauna								
4	Non-timber forest								
5	products (NTFPs)								
6	Fishes								
7	Rare and Endangered								

E. SOCIO-ECONOMIC ASPECTS

S/No	Parameters	Project Activity	Predicted Impact	Actual Impact	Mitigation Measure	Effectiveness	Indicator	Sources of data	Accuracy/ Precision
1	Employment								
2	Education								
3	Agriculture								
4	Immigration and								
	Migration								
5	Health and sanitation								
6	Aesthetic value								
7	Gender issues								
8	Religious and cultural resources								

Annex 5: OHS Policy



Rwanda Energy Group REG

Occupational Health and Safety

POLICY STATEMENT

Our commitment is to provide a safe and healthy workplace for all staff members and to meet all our duties and obligations to our clients. It is REG's intention to protect our employees from occupational accidents and diseases. The company will seek to ensure that our equipment and systems do not constitute a risk to the Health & Safety of employees and we will consult with employees on risk prevention. To support the aforementioned commitment, REG will put in place the management instruments as follows:

- *The Health and Safety management system which is continuously reviewed for effectiveness;*
- *Avail resources including protective equipment and training to manage safety;*
- *Establish processes to identify and eliminate risks wherever possible;*
- *Consult staff and REG stakeholders in the development, implementation and refinement of OSH Systems and programs;*
- *Establish processes that inspect performance of OSH system;*
- *Establish processes to investigate all major incidents and prepare periodic reports on all incidents including near misses;*

The Chief Executive Officer and both Managing Directors (EDCL, EUCL) *are responsible for the implementation and monitoring of this policy. In fulfilling the objectives of this policy, the CEO and MDs are committed to do regular consultation with workers to ensure that the policy operates effectively and that Health and Safety issues are regularly reviewed.*

Safety responsibilities

Employer

- *To provide and maintain a safe and healthy work environment for all workers;*
- *To ensure continued control of hazards;*
- *To consult with staff on all Health & Safety matters;*
- *To provide protective clothing and equipment where necessary;*
- *To make sure that all new workers are informed of the Work Health and Safety policies through a Health & Safety Induction process;*
- *To provide appropriate information and continuous safety training to staff;*
- *To promote a Zero Harm culture;*
- *To ensure that no condition arising out of REG's business shall expose anyone to negative risks, incident or accident;*
- *To ensure that all workers receive safety briefing prior to any operations on the network;*
- *To ensure that all visitors receive safety briefing before visit network installations.*

Supervisor or line Manager

- *Provide and Maintain a Safe & Healthy Workplace;*
- *Correct Unsafe Conditions;*
- *Ensure workers use adequately full PPE & Safety Tools;*
- *Promote a zero tolerance to Safety Policy Breaches;*

- Ensure Safety Briefs for all people visiting installations;
- Provide Tool Box Talk Every day before departure to worksites;
- Enforce Safe Work Practices, safety policies and rules;
- Prevent Unsafe or Unhealthful Workplace Conditions or Hazards.

Employee

- Adhere to and comply with this policy, all REG Safety documentation and Rwanda Safety laws and guidelines;
- Execute all operations in a safe and attentive manner;
- Respect REG's health and safety operating procedures;
- Refrain from execution of operations and any work in hazardous conditions;
- Are required to utilise PPE and Safety Tools during execution of work on the network;
- Report any potential hazard to management;
- Be knowledgeable of the nearest emergency exits and firefighting and location of first aid equipment;
- Are required to Participate in and apply knowledge acquired during Safety Training (e.g.: 1st Aid, Authorisation, etc.);
- Refrain from any form of horseplay or prank likely to lead to injury;

Team Leader

- Assess safety conditions prior to commencement of work;
- Instruct the team on proper use of safety equipment and emergency procedures;
- Check and monitor security and sanitation conditions before and during the work;
- Authorize the team-members to commence the work;
- Supervision during execution, and conclusion of works in accordance with established safety procedures and instructions;
- Report any incident compromising safety or security.

Contractor

REG shall, as far as practicable, ensure that contractor and its workers:

- Carryout their work in safe premises using proper and safe plant and equipment;
- Employ systems of work that are safe and in which there has been adequate instruction, training and supervision;
- Contractors engaged to do work for REG also have obligations to ensure safe work practices and shall comply with REG OSH policy.

Approved by:

Jean Claude KALISA
The Managing Director

Félix GAKUBA
The Managing Director

Ron Weiss
The Chief Executive Officer

Annex 6: Dam Safety Assessment Report

DAM SAFETY RISK ASSESSMENT REPORT

1.0 INTRODUCTION

Society demands an increase in the safety and reliability levels of essential infrastructures, like large dams. It is globally recognized that there is always a probability associated with dam failure, even if it might be very low, and there exists a possibility for adverse consequences to occur. Consequently, there is an associated risk that should be estimated, managed and minimized. Available dam information is re-viewed during the identification of failure modes process and it is used as input data in the quantitative risk model. Risk is the combination of three concepts: **what can happen**, **how likely it is to happen** and **what are the consequences in the case that it happens** (Kaplan 1997). This combination of probability of events and consequences is the key to defining risk across different fields and industries.

In Risk Assessment applied to dam safety, what can happen refers to dam failure, how likely it is to happen is related to failure probability of the dam and the consequences are the effects resulting from the dam failure, including economic consequences and loss of life. Numerically, risk is estimated combining the likelihood of occurrence of loads (e.g., flood, earthquake, etc.), the likelihood of dam failure due to these loads, and the failure consequences. The only way to respond positively to these expectations is to integrate the dam's design, construction and operation in a framework of risk management that ensures effective mitigations of natural and anthropic threats. Consequently, global strategies of risk management have gained great importance during the last years.

Studies have showed that in concrete dams, foundation problems are the most common cause of failure, with internal erosion, insufficient shear strength and overtopping (20%) accounting for about 20%, 26% and 20% of the failure rates respectively. In masonry dams, the most common cause is overtopping (43%) followed by internal erosion in the foundation (29%). A great number of failures have occurred in very young dams (0-10 years), especially during the first year, due to foundation or dam problems that were not detected during the design or the construction (DRIP, 2019).

1.2 Dam Description

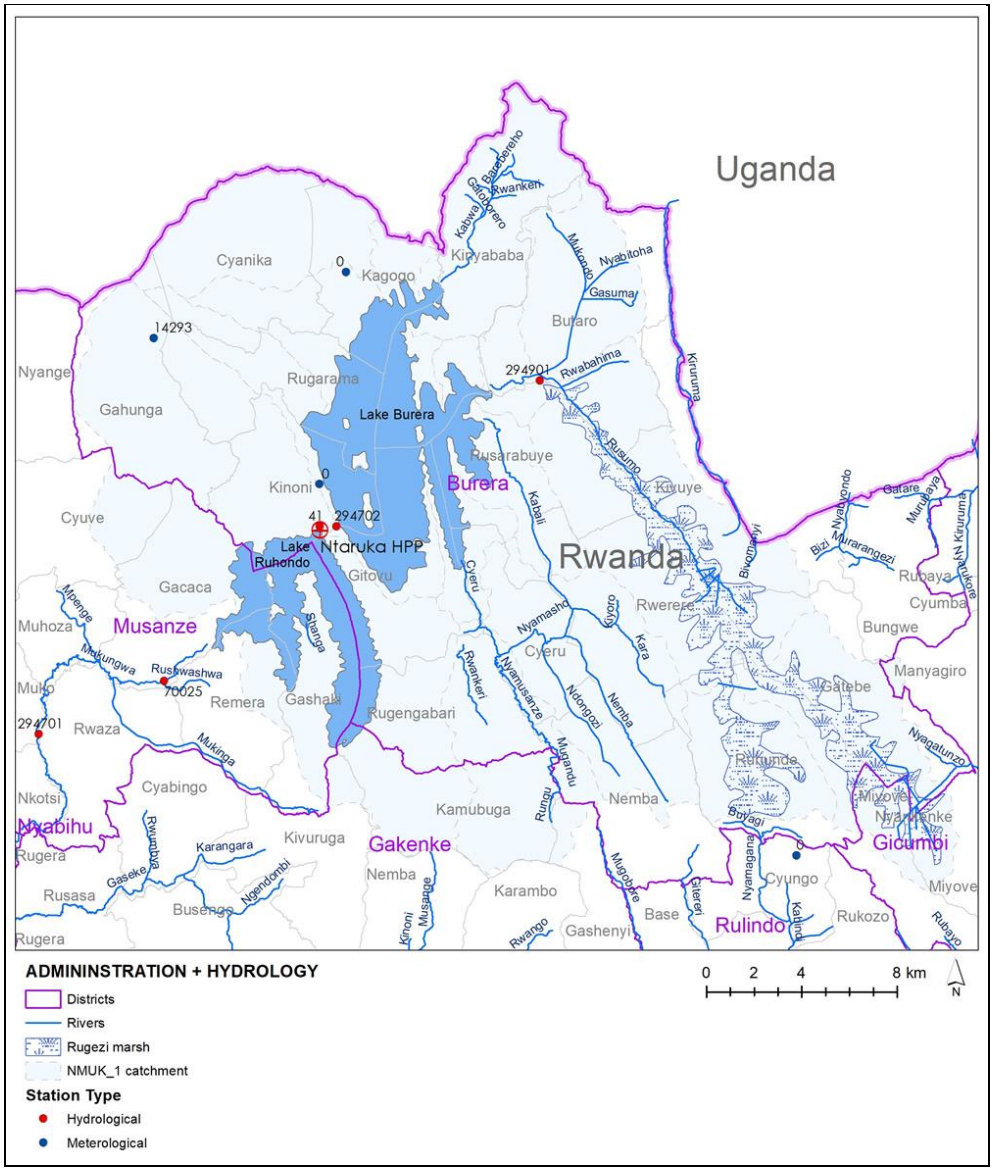
This section covers a brief description of the Ntaruka Dam-reservoir system.

1.2.1 Location Map

Ntaruka HPP is located in Northern Province of Rwanda, in Burera District between Burera and Ruhondo Lakes (Map 1). This is a compilation of [8]Rwanda Level 3 catchment data, Africover data[9], [10]RCMRD data, and [11]GADM data.

[8] Rwanda Level 3 Catchments. https://www.arcgis.com/home/item.html?id=d98ec9cde35b4e13838fd01c2d30de43
[9] Multipurpose Landcover Database for Rwanda – AFRICOVER. http://www.fao.org/geonetwork/srv/en/metadata.show?id=38100&currTab=simple
[10] Rwanda Rivers. RCMRD Geoportal. http://geoportal.rcmrd.org/layers/servir%3Arwanda_rivers
[11] Global administrative Areas (GADM). https://gadm.org/data.html

Ntaruka HPP location and Lake Burera catchment



The River Ntaruka originates from Burera Lake, at an altitude of about 1,860 m above the mean sea level. The river was diverted by construction of a weir across it and a headrace channel though the mountain to convey water to a power house the through intake gates, surge chamber and penstock.

Burera Lake has approximately 47 km^2 and has a catchment area of 580 km^2. There are four alternating seasons. Long rainy (March-April-May) and short rainy (September-October-November) seasons alternate with long dry (June-July-August) and short dry seasons (December-

January-February). Available data indicates that the dam is allowed to work between 1864m and 1859.7m which gives a live storage capacity of 202.1million m3 of water. Dam safety assessment must cover two distinct issues: (1) the likelihood of the dam failing; and (2) what would happen if the dam failed.

In addition to E&S risks, the draft ESA identifies engineering issues that rehabilitation must address for Ntaruka HPP to be financially and technically feasible.

1.2.2 Storage capacity

Even though the reservoir has a live storage capacity of 202.1million m3 of water, the table below indicate that the since 1997 the available water in the Dam has been always far lesser than the maximum storage. This is because that the average inflow water from the catchment is small compared to the water that the plant may require to run continuously at full capacity.

The plant operator informed the auditor that the plant operated as peaking plant to meet daily and seasonal demand peaks.

Date	water level	Annual produced energy	Available heigt of water for power production	Height of the weir	Lake surface area (km2)	Volume of water available for power production (Mm3)	Additional volume of water resulting from erection of dam
1/1/1996	1864.18	13.96	4.48	2.23	47	210.56	105.75
1/1/1997	1864.2	36.3	4.5	2.23	47	211.5	106.69
1/1/1998	1863.5	45.63	3.8	2.23	47	178.6	73.79
1/1/1999	1863.29	39.06	3.59	2.23	47	168.73	63.92
1/1/2000	1861.9	32.2	2.2	2.23	47	103.4	-1.41
1/1/2001	1860.57	24.2	0.87	2.23	47	40.89	-63.92
1/1/2002	1861.46	28.9	1.76	2.23	47	82.72	-22.09
1/1/2003	1861.14	36.17	1.44	2.23	47	67.68	-37.13
1/1/2004	1860.25	20.22	0.55	2.23	47	25.85	-78.96
1/1/2005	1859.84	15.35	0.14	2.23	47	6.58	-98.23
1/1/2006	1859.85	5.68	0.15	2.23	47	7.05	-97.76
1/1/2007	1861.13	1.16	1.43	2.23	47	67.21	-37.6
1/1/2008	1863.6	15.09	3.9	2.23	47	183.3	78.49
1/1/2009	1863.4	29.42	3.7	2.23	47	173.9	69.09
1/1/2010	1863.2	40.209	3.5	2.23	47	164.5	59.69
1/1/2011	1862.36	30.84	2.66	2.23	47	125.02	20.21
1/1/2012	1863	45.9	3.3	2.23	47	155.1	50.29
1/1/2013	1861.65	23.3	1.95	2.23	47	91.65	-13.16
1/1/2014	1862.75	40.1	3.05	2.23	47	143.35	38.54
1/1/2015	1861.87	36.4	2.17	2.23	47	101.99	-2.82
1/1/2016	1860.67	3.662	0.97	2.23	47	45.59	-59.22
1/1/2017	1862.09	36.342	2.39	2.23	47	112.33	7.52
1/1/2018	1860.97	26.332	1.27	2.23	47	59.69	-45.12
1/1/2019	1861.17	11.024	1.47	2.23	47	69.09	-35.72
1/1/2020	1862.14	15.8	2.44	2.23	47	114.68	9.87

1.2.3 Dam Design / Description of outlet works and spillways

A. Type and overall dimensions of intake structures

The dam is a weir structure, made of concrete structure constructed across the original river bed. It has a height of 2.3m meters above the foundation grade and has a crest length of 25.7 meters. The gates are installed at 2m below the original river outlet bed.

Ntaruka dam

After construction of the dam in 1957 the water level changed as indicated as follows:

- Minimum level: 1,859.7m
- Maximum level of water in the lake: 1,864m with possibility to reach 1,865m (special situation which may occur when there are heavy rains in the catchment area.
- The dam is equipped with features to allow for normal flow from the upper Lake Burera to downstream Lake Ruhondo through the original river bed in case the power plant stops operating for a long time due to any reason i.e. maintenance or rehabilitation activities, breakdown, etc.

Ntaruka HPP was designed with a strong weir to withstand both pressure in the reservoir and spillway water to flow over it. Spillway crest level is located at the elevation of 1864m. The audit tests indicated that the dam is strong enough to withstand water weight and spill way water in case of overflow.

Opening in the weir (left) and weir bypass facility (right)

In 2016 following long shut down of the power plant due to damage caused during liberation war, the dam was equipped with facilities to allow for flow of water from the upper lake (Burera) to downstream lake (Ruhondo) through the original river bed. This would serve the same purpose in one of the following scenarios:

- The intake is blocked (intake screen/trash rack is obstructed by debris)
- The headrace tunnel or penstock fails
- The manifold that bypasses the turbines fails
- Rehabilitation activities
- Repair activities that may take long time etc.

B. Main characteristic of intake structures and structure integrity

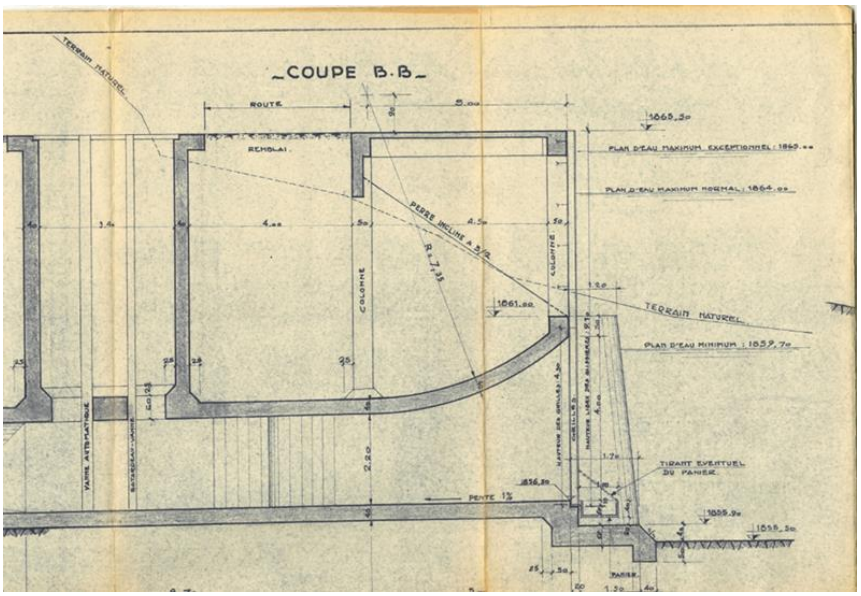
Intake and headrace channel

The water is conveyed to the turbine through an intake arrangement that controls water flow into the headrace channel and then to the penstock. The intake is made of concrete, and has a trash rack with a height of 4.5m that prevents debris from entering the conduit, and two intake gates one after another whose are dimension are 2.2x2.5m. The gate baterdeau / cofferdam is manoeuvred manually using a mobile gantry crane which is maintained at the intake while the automatic gate can be operated automatically / electrically from the power house or locally through a control cubicle near the gate.

The lowest base of trash rack is situated at 1,856.5m level. The slope of the water channel from trash rack to the headrace channel through headrace gates is 1%.

The wing walls are made of gabions with cement joints. However, during the site visit it was observed that the wings of all the structure was partially washed-out on both side of the lake slope protection and showed vertical movement and cracks.

Diagram below shows the arrangement of the trash rack, intake gates and different level of water in the lake.



Trash rack and intake gates arrangement

Headrace Tunnel

Water directed from Lake Burera through the intake and conveyed through a tunnel up to the surge tank. Ntaruka HPP comprises of one headrace tunnel, a concrete-lined 463m long and 2.25m diameter tunnel buried in the hill.

The entire length of the penstock was checked for surface and subsurface discontinuities, lining weathering, leakage, ponding of water and erosion.

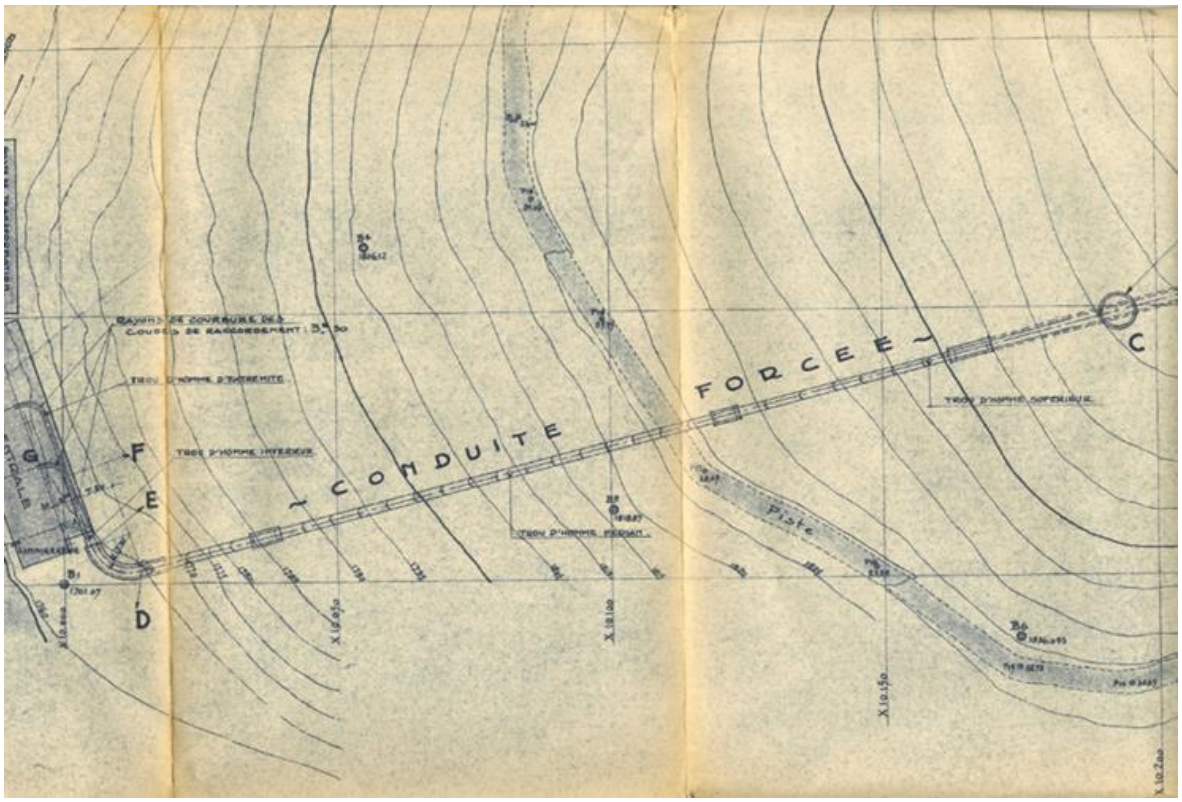
The head loss in the headrace tunnel is 0.7m, equivalent to a Manning Coefficient of 0.017. This shows that the head loss in the concrete lined headrace tunnel is within the acceptable limit and is almost the same head loss expected in most power plants.

Surge Tank

Ntaruka HPP has a surge tank at the end of the headrace tunnel for regulating the water flow during load reduction and / or load increase on the hydro generator (water flow transients in penstock) and thus reducing the pressure on the penstock. Ntarukra hydropower plant's surge tank is 17m high and 6m in diameter.

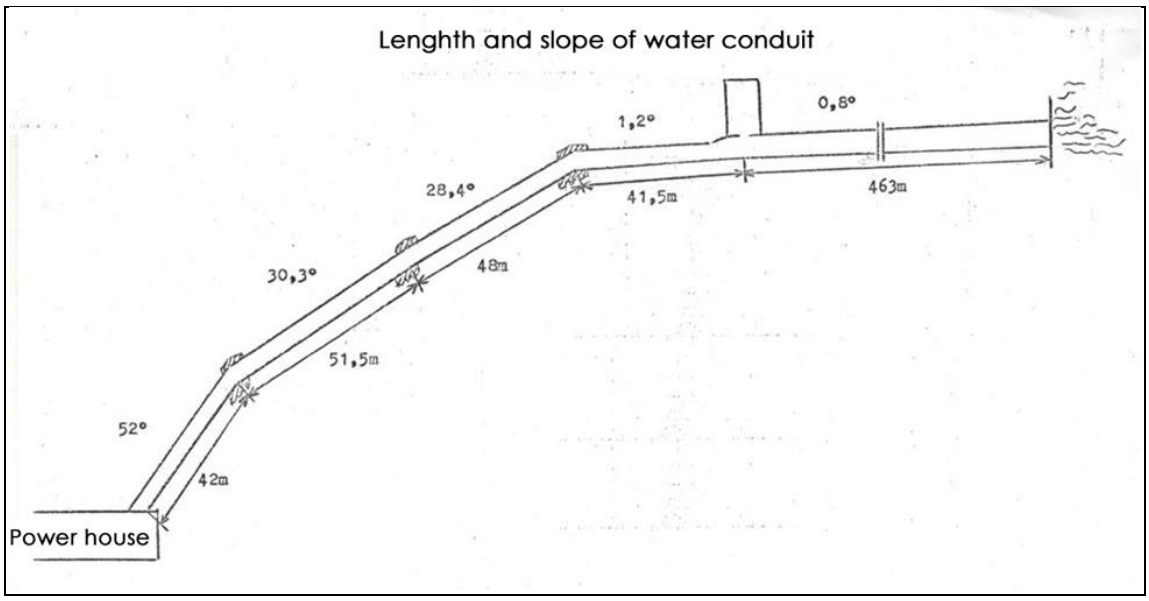
Penstock Steel Structure

Ntaruka hydropower plant has a 120m long steel penstock which, during the time of commissioning, had an internal diameter of 1800mm and a steel plate thickness of 16mm. It is supported by anchor blocks at different points (**Figure 5**).



Penstock arrangement from construction design of 1957 (No updated map available at the plant)

The penstock has variable slopes at different points of its length (***Figure 10***).



Slope of the penstock

Tailrace System

The tailrace system for Ntaruka hydropower scheme consists of one reinforced concrete open channel that joins Lake Ruhondo.

The non-destructive tests and visual inspection of the tailrace canal carried out revealed that the tailrace has signs of vertical movement and cracks on both sides of the bank stone pitching works of the tailrace canal, and on the foundation. The tailrace water level raiser/seal structure has decayed, some of the stone pitching fragments had been washed-out, and there was some grass and trees growing out of the stone pitching.

C. Assessment of Structural Integrity

Dam body

The foundation and body of the intake dam was checked against concrete cracks, leakage, concrete reinforcement cover and concrete carbonation/weathering. Furthermore, the alkalinity test result at the intake dam was related to the compressive strength of fresh concrete.

The finding on intake dam are summarized as below:

- There were no signs of leakage through the dam foundation and body. During this field assessment against leakage, the water level in reservoir/lake was at 1852.6m amsl, which is at 1.5m from the crest of the spillway. This shows that when the plant is operating at normal/full reservoir level, the dam is not susceptible to leakage.
- The entire body of the dam had a concrete cover of more than 60mm. It is important to note that for most countries, the standard concrete cover against seawater and/or aggressive chemical environment for components completely or partially submerged in sea water and/or components in saturated salt air with aggressive industrial atmospheres and/or water and earth faces is 50mm. As such, the concrete cover on the body of the dam is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in the concrete.

- The entire surface weathering of the concrete cover on the dam was limited to 3 -5mm, which is good. The current weathering depth is insignificant when compared with the current available concrete cover of 60-70mm, which is sufficient to protect reinforcement from corrosion and provide fire resistance to the reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on the body of the dam was found to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).
- The entire body of the dam was found to be free of surface and subsurface discontinuities except the walkway on top of the dam which has minor surface discontinuities.
- Significant concrete damage was not observed on the dam foundation and body except for minor plastering fractures on top of the spillway crest at right hand bank.
- Erosion on the concrete face of the dam body and spillway was not observed.
- No observations of any signs of vertical movement or settlement of the dam foundation and body. However, the dam is missing equipment for recording vertical and horizontal settlement.
- The downstream face of the dam was found to be covered in fungus and algae.
- Generally, the body and foundation of the Ntaruka intake dam is in good structural condition and can be used for many more years to come with minor maintenance work.

Dam abutment/groin

Minor defects were observed on the river bank training works at both side (i.e. left and right).
Vertical movement on the foundation of the river training stone pitching for slope protection, Slope stones pitching foundation have numerous cracks and few stones pitching fragments are seen as washed-out to the lake bottom.
With these defects water would infiltrate in lake banks and accelerate side erosion which in turn weakness the strength of headrace, weir and intake structure. It is therefore important to rehabilitate the structure before big damages occur.

Leakage

Visual inspection downstream the dam did not reveal any sign of seepage/leakage through the dam. This also conformed the results of other tests that concreate structure of Ntaruka Dam are still strong enough to operate several years with only minor maintenance works.

Intake

Each of the steel and concrete components of the intake were checked using the checks on steel and concrete. The findings on the concrete structures of the intake are summarized below:

- The intake control floor area was found to have minor surface discontinuities and foliation which were limited to surface plastering.
- The intake control floor concrete cover was found to be in the range of 55mm to 65mm and is sufficient to protect the slab reinforcement from corrosion and to provide fire resistance to reinforcement bars embedded in the concrete.
- Weathering on the concrete cover of the gate control slab was limited to 5mm. This depth of weathering is insignificant when compared with the current available worst condition concrete cover of 55mm, which is sufficient to protect reinforcement from corrosion and provide fire resistance to reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on the intake control floor was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).
- No observation of any signs of vertical movement or settlement of the intake control floor.

From the historical records, measurements and inspection carried out at site and in consideration that the Dam has been into operation for about 60 years the risk of failure is very low.

Headrace and penstock

The water directed from Lake Burera through the intake is conveyed through a tunnel up to the surge tank. Ntaruka power plant comprises of one headrace tunnel which is concrete lined 463m long and 2.25m in diameter inside the hill.

During assessment water was blocked by closing main intake gates to allow visiting the headrace canal. The lowest base of trash rack is situated at 1856.5. The slope of the water channel from trash rack to the headrace channel through headrace gates is 1%.

Ntaruka hydropower plant has a 183m long steel penstock which, during the time of commissioning it had an internal diameter of 1800mm and a steel plate thickness of 16mm. It is supported by supporting anchor blocks at different points.

The entire length of the penstock was checked for surface and subsurface discontinuities, lining weathering, leakage, ponding of water and erosion.

The assessment against the above mentioned parameters are summarized as below:

The head loss in the headrace tunnel is 0.7m it is equivalent to a Manning Coefficient of 0.017. This shows that the head loss in the concrete lined headrace tunnel is within the acceptable limit and is almost the same head loss that is expected in most power plants.

Ntaruka hydropower plant's penstock is an exposed above ground surface type penstock & supported on piers. Both the steel and concrete foundation supports were tested using a PROCEQ Profometer 3 reinforcement bar detector and locator and a cover meter. The Consultant also performed a test for alkalinity. The findings of these tests are summarized as below:

- All foundations were free from erosion.
- All the penstock anchor blocks and supports for the foundations were found to be free from vertical and horizontal movement, except a minor horizontal movement on one support block foundation.
- Only a few of the anchor and support blocks were not clean.
- All anchor and support blocks were free of major surface discontinuities, except minor crack on one support block.
- All foundation of anchor and support blocks were free of concrete damage and erosion.
- The concrete cover on all anchor and support blocks was found to be above 55mm, which is adequate to protect the reinforcement and anchor bolt from corrosion and to provide fire resistance to bars and anchor bolts embedded in concrete,
- The weathering of the concrete cover on all anchor and support blocks was limited to 5mm. As such, the remaining concrete cover was found to be sufficient to protect reinforcement and anchor bolts from corrosion and provide fire resistance to reinforcement bars embedded in the concrete.
- The compressive strength of the concrete on all anchor and support blocks was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).

Surge tank

The Ntaruka hydropower plant has a surge tank at end of the headrace tunnel for regulating the water flow during load reduction and sudden increase in the load on the hydro generator (water

flow transients in penstock) and thus reducing the pressure on the penstock. This surge tank is 17m high and 6m in diameter. The detailed assessment of surge tank is summarized as below:

- The surge tank wall was found to be free of major surface and subsurface discontinuities which cause leakage,
- The entire surface of the surge tank foundation and wall was found not to have major damage and/or erosion,
- The concrete cover on surge tank wall ranges from 55mm to 63mm, and is sufficient to protect the reinforcement from corrosion and to provide fire resistance to the reinforcement bars embedded in concrete. In most countries, a concrete cover of 50mm is recommended for protection against seawater and/or aggressive chemical environment for completely or partially submerged components in sea water and/or components in saturated salt air; aggressive industrial atmospheres and/or water and earth.
- The concrete cover weathering ranges between 3mm and 4mm. As such, the current available concrete cover is sufficient to protect reinforcement from corrosion and provide fire resistance to the reinforcement bars embedded in concrete without any further improvement work.
- The compressive strength of the concrete on walls of the surge tank was deduced to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).
- There were no signs of vertical movement or settlement of the surge tank's foundation. This shows that the foundation of the surge tank set on firm ground.
- Most of the surge tank access ladders are completely covered with rust and few are broken.
- The top grill beams are in good status, but some of the mesh wires were damaged.
- Few fungi and algae were found on the walls of the surge tank.

Powerhouse

Ntaruka power plant powerhouse is a surface power house constructed from reinforced concrete and structural steel, and located on a lean bank. The powerhouse accommodates a loading/service bay, overhead gantry crane, three units of Francis turbines, a control block and offices. The current status of the powerhouse civil structures is summarized below:

- Some of the window glazing was damaged and some of the air vent windows are also damaged
- A few fragments of slope retaining stone pitching are missing,
- Some trees and grass were observed on slope rating structure wall,
- Almost the entire slope stability retaining structure work and powerhouse walls were free of excessive cracks,
- All anchor and support blocks were free of major surface discontinuities, save for a minor crack on one of the support blocks,
- The foundation works for the retaining structure and power house were free from concrete damage and erosion,
- The weathering of the concrete cover on the slope retaining structure and power house was limited to 5mm and 2mm respectively. The remaining concrete cover is sufficient to protect reinforcement and anchor bolts from corrosion and fire,
- The compressive strength of the concrete on slope retaining work and power house was estimated to be the same as the fresh concrete. The pH of all alkalinity tests was greater than 13 for most of the tests conducted on the dam surface. (pH of fresh concert is typically greater than 12.5).

The tailrace system of the Ntaruka hydropower scheme consists one reinforced concrete open channel that joins Lake Ruhondo. The results of the non-destructive tests and visual inspection of the tailrace canal are summarized below:

- There were signs of vertical movement and cracks on both sides of the bank stone pitching works of the tailrace canal and on the foundation,
- The tailrace water level raiser/seal structure was decayed,
- Some of the stone pitching fragments had been washed-out and there was some grass and trees growing out of the stone pitching.

D. Electromechanical equipment and Operational OHS Aspects

Non-ionizing Radiation

Working in proximity to electric power generators, equipment, and connecting high-voltage transmission lines can expose HPP workers to elevated levels of electric and magnetic fields (EMF). Exposure to intense, direct amounts of non-ionizing radiation may result in damage to tissue due to heat. Occupational EMF exposure at Ntaruka HPP should be prevented or minimized by preparing and implementing an EMF safety program that includes -

- Identification of potential exposure levels in the at Ntaruka HPP, and establishment of safe zones at the plant,
- Training of workers in the identification of occupational EMF levels and hazards,
- Provide personal exposure monitoring equipment relevant staff,
- Put up warning signage, and
- Implementation of and action plans to address potential exposure levels including work rotation to limit exposure.

Noise

Generally, external noise pollution from Hydroelectric Power Plants is not a hazard to community noise levels. However, because of the amount of machinery, such as turbines, air compressors and rotors associated to each generating unit, noise production is high inside the power plants. These components are typically located in enclosed building structures for protection against the elements, thus significantly attenuating environmental noise. However, to minimize noise at the Ntaruka HPP, the following measures are recommended: -

- Identification of high noise areas, and marking with proper signage,
- Provide sound-insulated control rooms, and
- Require that workers high noise areas (typically areas with noise levels greater than 85 dBA), always use relevant PPE.

Confined Spaces

Specific areas for confined space entry may include turbines and turbine wells, as well as certain parts of generator rooms (during maintenance activities). Recommended confined space entry procedures at Ntaruka HPP include the following: -

- Access hatches should accommodate 90% of the worker population with adjustments for tools and protective clothing,
- Safety precautions should include Self Contained Breathing Apparatus (SCBA), life lines, and safety watch workers stationed outside the confined space, with rescue and first aid equipment readily available, and

- Develop and implement Standard Operating Procedures (SOPs) to ensure all PPE and safety measures are in place before work by solitary workers.

Electrical Hazards

Energized equipment and power lines can pose electrical hazards for workers at hydropower power plants. Recommended measures to prevent, minimize, and control electrical hazards at Ntaruka HPP will include: -

- Marking all energized electrical devices and lines with warning signs,
- Establishing "No Approach" zones around or under high voltage power lines,
- Appropriate labeling of service rooms housing high voltage equipment, and
- Establishing "No Approach" zones around or under high voltage power lines.

3.0 IDENTIFICATION OF FAILURE MODES

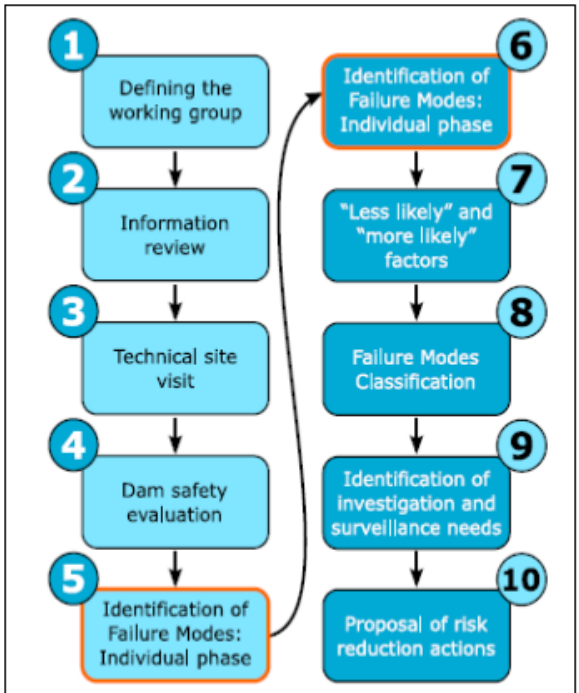
Introduction

A **failure mode** is a specific sequence of events that can lead to a dam failure. This sequence of events must be linked to a loading scenario and will have a logic sequence: starting with an initiating event, one or more events of progressive failure and will end with dam failure or mission disruption of the dam reservoir system.

In general, any failure mode with the potential to produce adverse social or economic consequences could be analyzed. The identification is not limited to the dam structure and it may include any feature or component of the dam-reservoir system. To structure a risk calculation and analysis, failure modes were linked with several **loading scenarios**, according to the loading event that triggers the failure mode. The three loading scenarios analysed are:

- **Normal scenario:** What can happen in an ordinary day and normal operation?
- **Hydrologic scenario:** What can happen when a flood occurs?
- **Seismic scenario:** What can happen when an earthquake occurs?

The process for Identification of Failure Modes in *Ntaruka* Dam was made following the recommendations provided by the *Guidelines for Assessing and Managing Risks Associated with Dams* during different working sessions as shown in the following figure:



Recorded thus

Step	Date
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Identification of Failure Modes steps and dates.

This process was made by a collaborative effort of engineers and environmental specialist, including a comprehensive review of available information, a technical visit to the dam and a group discussion about the current state of the dam.

Failure modes were identified in two phases: individual (where each participant made a first identification) and group phase (where all the failure modes identified by the participants were put in common). Finally, identified failure modes were analysed in detail and classified, and proposals for potential actions for uncertainty and risk reduction were made. This process is explained in detail in the following sections.

Working session on Failure Mode Identification for Ntaruka Dam, 29th May 2020

Identification of Failure Modes was made by a multidisciplinary group that included engineers and technicians in charge of the daily operation of the dam to regional/national experts in some of the topics addressed. The working group for Ntaruka Dam included more than 3 engineers, including staff members from REG and partners of the Green Growth Solutions Ltd. There has never been any project conducted previously for improving dam safety management. Names of participant in the field visit included the following:

Name	Title (s)	Entity
Vincent Mpaka	Electrical Engineer	Green Growth Solutions Ltd
Bigagaza Jean	Social Environmental specialist	Green Growth Solutions Ltd
Francoise Iragena	Safety &Health officer	Green Growth Solutions Ltd
Twajamahoro Jean Providence	Chief Engineer Power Plant Performance	REG
Dusengimana Modeste	Senior Engineer Power Plant	Ntaruka HPP
	Civil engineer	
Fabien Nshimiyimana	Environmentalist	EUCL
Fidele Nshimiyimana	Engineer	Ntaruka HPP

Dr. Elias BIZURU	Ecologist/Botanist	Green Growth Solutions Ltd
Dr. Rose MUNYENGANGO LØVGREN	Socio-economist	Green Growth Solutions Ltd

During this session, a more reduced group of 10 participants, including expert engineers on dam risk analysis and the Ntaruka Dam reservoir system operator conducted the dam safety evaluation.

This failure mode identification session for Ntaruka Dam was facilitated by Jean Bigagaza who has proven experience in coordinating these types of sessions.

Information review

The information available about Ntaruka Dam was reviewed during the period from May 29th to 4June 2020 to support the Failure Mode Identification session conducted at Ntaruka on 29 and 30th May 2020. This review was further completed with additional information obtained in the period 2017 by New Plan. The main documents reviewed before and during the failure mode identification session and during the Risk Assessment process include:

Document title	Author	Date

After the detailed review of information on the Ntaruka Dam, the main conclusions about the available information are summarized below:

- In general, there exist up-to-date information on conducted recent actions to improve dam safety of the Ntaruka Dam.
- A new hydrologic study was recently done to evaluate design flood.
- There is no information on soil conditions at the dam-foundation contact. Therefore, there is high uncertainty on the resistant characteristics at the dam foundation that should be better characterized for analysing potential failure modes related mainly to sliding failure mechanisms. Consequently, a geotechnical study at Ntaruka Dam is required to reduce uncertainty and gain better knowledge on foundation materials.

Dam safety evaluation

The Dam safety evaluation was based on a number of criteria. Special attention was paid to the main problems identified during the review of information of Ntaruka Dam, including aspects such as the general state of dam body and equipment, seepage, leakage, settlements and maintenance of outlet works, among others. In broad terms, risk assessment criteria included the following aspects as detailed in the previous sections:

- Flood design
- Simulated earthquake (maximum credible event)
- Properties of construction process and properties of construction materials
- Design philosophy
- Foundation conditions
- Height of dam and volume of materials contained
- Quality control during construction

- Management capacity of the client and operator
- Provisions for financial responsibility and closure
- Population at risk downstream of the dam
- Economic value of assets at risk in case of dam failure

Instrumentation:

- Proposed rehabilitation works encompassed the revision of the instrumentation related to hydro meteorological in the power house.
- The water level in the Dam is manual recorded using a simple scale mounted on the intake structure
- No instrumentation were found in the Ntaruka Dam embankments for measurement of weir movement
- The instrumentation for measuring and monitoring flow and pressure in the penstock are defective and these parameters are not controlled.
- It was not possible to find references of instrumentation for seismic activity monitoring.

The Dam Safety Assessment Report concluded that, currently, no proper set of monitoring instruments are available in the dam.

The rehabilitation works specified the installation of piezometers and deformation surveillance. The project would support the installation of proper instrumentation equipment and implementation of instrumentation plans

Current O&M Procedures

- Currently, no proper O&M plans are under implementation in Ntaruka dam, only water level is recorded and monitored on daily basis.
- There was no copy of the National Dam Safety Policy found at the dam for reference and implementation.
- There was no copy of report to prove that the owners implemented regular dam safety inspection, with appropriate frequency.
- The auditor did not find copy of specific Dam safety inspection procedures at the power plant
- Dam Safety Reporting: The consultant received copy of the last Engineering assessment made in 2017 that confirmed the integrity of the Dam civil structure. Engineering assessment compared integrity of the structure to that of new concrete though it was constructed in 1959.

O&M Plans:

- Currently, no proper Dam O&M plans are under implementation.
- The preparation of O&M Plans was not included in the Rehabilitation scope. This should be taken in consideration during tender publication. The O&M Plans, to be contained in the rehabilitation works, should have a detailed scope, covering key features such as management structure, operating procedures, maintenance program, and inspection procedures in a content consistent with World Bank requirements.

Emergency Preparedness Plans

Currently there are no Emergency Preparedness Plans available. The Rehabilitation Works should address emergency aspects (emergency situations and emergency procedures), and cover the scope of an EPP, as defined in the international Dam Safety Policy.

Look at the topography and the settlement downstream Ntaruka Dam revealed to the auditor that there is a very low risk associated to the Dam failure. However, a comprehensive EPPs (covering dam break inundation maps and tables, roles and responsibilities of key relevant entities, EPP response process, emergency identification, evaluation, and classification procedures, emergency response matrix, EPP maintenance and training) should be included in the scope of the Project.

4.0 CONCLUSIONS

Ntaruka Dam is still robust enough to serve for several years; only minor repair works on the embankment and weir top are required. Intake gates should be refurbished to solve the issue of leakage through seals to allow for full closure of gates and safe inspection of headrace channel. Risk of abrupt rupture due to overflow and earthquake is very low. There is no habitation between Dam and power house, in case the dam may fail the risk of death is very low. Risk of rupture (piping and erosive breaches) is very low (no seepage detected, but there a clear warning sign should prevent higher vehicles to pass in road under the penstock. Risk of failure in associated structures moderate due to deteriorated pipes in the power house; this risqué would be reduced to very low by rehabilitation works and installation of new pipes.

Instrumentation for measurement of pressure and flow in the penstock are not functional and should be restored to ensure close monitoring. Appropriate equipment should be installed for monitoring of water level and earthquake recorder should be installed near the DAM.

Currently there is no Emergency action plan, inspection reports and/or safety assessments identified. These should be established and systematic inspection of the dam carried out. EDCL should put in place clear operation and maintenance plan to be implemented by Dam operator. There was not proof that the power plant O&M team includes a trained Dam engineer, therefore owner should include in the rehabilitation scope, the training of a good number of dam engineers.

Annex 7: TORs

TERMS OF REFERENCE
CONSULTANCY SERVICES FOR ENVIRONMENTAL AND SOCIAL AUDIT OF NTARUKA HYDROPOWER PLANT REHABILITATION

(Version of February 7, 2020)

Project Background

1. The Government of Rwanda, through Rwanda Energy Group (REG[12]), under the oversight of the Ministry of Infrastructure (MININFRA) is preparing a project titled "Rwanda - Energy Access and Quality Improvement Project (EAQIP) with a World Bank support. The objective of the Project is to improve access to energy and efficiency of energy service delivery to households, businesses and public institutions in Rwanda. As part of its key activities, the Project will undertake rehabilitation of an old small domestic hydropower plant (HPP) called Ntaruka, to contribute to the security of renewable energy generation.

2. Ntaruka HPP was built on the Mukungwa River (arises from the Burera Lake), one of the tributaries of the Nyabarongo River, and has been in operation since 1959. The Ntaruka dam is an intake weir with a height of 5 meters and a crest length of 28 meters[13]. The natural reservoir ((Burera Lake) has a total area of about 47 km^2. The Plant was rehabilitated in 1986/7, specifically in which *the electrical installation in the powerhouse was replaced* and *one of the three turbines was repaired*. The Plant has an installed capacity of 11.25 MW, but is currently only capable of generating 9 MW. Based on its age and current performance, it has been found necessary to ***rehabilitate mainly the power plant*** by upgrading to modern equipment in order to bring the generation capacity back to the installed capacity levels. This fact plays a significant role in the design, which has to be developed relating to the original layout and to provide the expected functionality. For this purpose, the rehabilitation of Ntaruka HPP is being initiated and will be implemented by Energy Development Corporation Limited (EDCL), one of the two independent subsidiaries of REG.

3. Therefore, EDCL seeks the services of a consultant to carry out the environmental and social audit of the Ntaruka HPP being considered for rehabilitation. In addition to EDCL, REG is a key government counterpart for this assignment. These two institutions (REG and EDCL) are also responsible for coordinating with other government institutions, including MININFRA and the Ministry of Finance and Economic Planning.

Objectives

4. The main objectives of the audit are to identify the nature and extent of all environmental and social areas of concern at the existing Ntaruka HPP along with the dam/intake weir, and assess their current status as per the requirement of the GoR's safeguards laws and regulations and the World Bank environmental and social standards; and to identify and justify appropriate

[12] REG is a Government owned holding company comprising two independent subsidiaries, the Energy Utility Corporation Limited (EUCL) and the Energy Development Corporation Limited (EDCL).
[13] EUCL, March 2018. Data Collection, Preliminary Design and Establishment of Technical Specifications for Rehabilitation Works of Ntaruka Hydropower Plant, Kigali, Rwanda.

measures and actions to mitigate the areas of concern and estimate the costs of the measures and actions for the rehabilitation of the HPP.

Scope of the work and tasks

5. The consultant will carry out the audit of the Ntaruka HPP, including its equipment, facilities and operations with a focus on (a) inspection and evaluation of the safety status of the dam, its appurtenances, and its performance history; (b) reviewing and evaluation of the owner's operation and maintenance procedures, (c) presenting findings and recommendations for any remedial work or safety related measures necessary to rehabilitate the Plant along with the intake weir/dam and related infrastructure to an acceptable standards of safety. It also considers the overall environmental and social risks and impacts of the project, its environs and Associate Facilities[14]. To this end, the main tasks include, but not limited to, the following.

Task 1. Project description

6. The task shall address the following issues concisely.

1) Detailed description of the existing project activities in its different stages, including the area of influence, project location patterns and geographical data, environmental, social, and temporal context and any Associated Facilities;
2) Description of all equipments associated with the projects activities
3) Identify the existence of any plans already developed to address specific environmental and social risks and impacts if any (e.g., land acquisition or resettlement plan, cultural and historical heritage plan, biodiversity plan); and
4) Include maps of sufficient details, showing the site of the existing project or activities and the proposed site for the proposed project.

Task 2. Relevant Institutional, legislative and regulatory frameworks

7. This task addresses relevant institutional, legislative and regulatory frameworks applicable to the project being considered for the rehabilitation.

1) Review the GoR's institutional and legal arrangements for the project;
2) Review applicable regional and GoR's environmental and social laws and regulations as well as procedures and guidelines for identifying, assessing, mitigating and monitoring potential risks and impacts of dams related projects; and relate the relevance to the project;
3) Review the World Bank Environmental and Social Framework (ESF) and Environmental and Social Standards (ESSs) applicable to the project; and
4) Review the World Bank Group Environmental, Health, and Safety Guidelines (EHSGs)[15] with a focus on environmental risks and impacts identified in the WBG EHSGs and relate the relevance to the project.

Task 3. Environmental and social issues, risks and impacts of Ntaruka HPP

8. The audit will consider the key environmental and social issues, risks and impacts relating to the existing project or activities. This will cover the risks and impacts as per the requirements of the GoR's laws and regulations, the World Bank environmental and social standards (ESSs1-10), and the WBG ESHS Guidelines as relevant to the existing Ntaruka HPP project or activities. Therefore, this specific task considers, but not limited to, the following.

[14] For facilities or activities to be Associated Facilities, they must meet all three criteria: a) directly and significantly related to the project; (b) carried out, or planned to be carried out, contemporaneously with the project; and (c) necessary for the project to be viable and would not have been constructed, expanded or conducted if the project did not exist.

[15] http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/~our+approach/risk+management/ehsguidelines

I. *Dam safety issues, risks and impacts*

1) Inspect and evaluate the safety status of the dam (see info, given on height, crest length and natural reservoir capacity on page 1 of this ToR), its appurtenances, and its performance history as follows. In assessing the safety status of the dam, consider the following:
   - *Size or retention capacity*.
     - Assess whether Ntaruka dam could cause safety risks, such as an unusually large flood-handling requirement, located in a zone of high seismicity, and/or have potential for significant downstream impacts. In relation with these, evaluate whether dam safety plans (*a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan*) are required for the proposed project. Also, evaluate periodic safety inspections of the dam after completion, and implementation of measures required to address safety deficiencies.
     - If Ntaruka dam does not fall into the above stated category, evaluate the dam safety provisions and plans, considering that dam safety measures designed by qualified engineers (in accordance with the GoR and the WB requirements) were adequate, and adopted and being implemented accordingly.
   - *Civil structures, hydraulic structures and electromechanical components and other appurtenances*. Also evaluate the condition/state of these structures, components and other appurtenances, along with the performance history of the plant and possible environmental related risks
   - *Internal and external threats (if any)*. Internal threats are errors and omissions in the dam and water conveyance structures´ design, operation and maintenance; and external threats are beyond the dam owner control, and are originated outside the dam and reservoir system boundaries.
2) Review and evaluate the owner's operation and maintenance procedures.
3) Review and assess any safety issues and cases recorded that may be associated to the dam operation.
4) Assess the full level inspection and dam safety assessments that have been conducted and documented, including dam safety reports based on the category of the Ntaruka dam (see above).
5) Provide findings and recommendations for any remedial work or safety-related measures necessary to rehabilitate/upgrade the existing dam to an acceptable standard of safety.

II. *Biodiversity conservation and management of living resource*

9. Assess environmental and social risks and impacts (actual and potential) of the project on (a) protection, conservation, maintenance and restoration of natural habitats and biodiversity; and (b) those related to ecosystem services and the use of living natural resources, such as fisheries, wetlands and forests. The assessment should cover all project phases including design, construction and decommissioning phases. The description of the impacts has to be cleared time lined either being direct or indirect

III. *Pollution prevention and management issues, risks and impacts*

10. Assess environmental and social risks and impacts (actual and potential) of the project on solid wastes and hazardous materials management, and contaminated land as follows.

1) Wastes and hazardous materials management
   - Assess and evaluate solid waste management of the Plant and related pollutions and impacts
   - Assess and evaluate wastewater management of the Plant and related pollutions and impacts
   - Assess and evaluate hazardous materials/chemicals and waste management of the Plant and related pollutions and impacts
   - Asses and evaluate hazardous substance management, including storages, at the site and related pollutions and impacts

2) Contaminated Land
   - Assess and evaluate any land contamination due to anthropogenic releases of hazardous materials, wastes, or oil. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal. Land is considered contaminated when it contains hazardous materials or oil concentrations above background or naturally occurring levels.
   - Asses and evaluate if contaminated land has been identified and corrective measures taken to avoid further releases and associated adverse impacts.
   - Assess and evaluated the impacts of land use upstream and in the vicinities of the dam and the surroundings of HPP.

IV. *Risks and impacts associated with land and natural resource tenure and use.*

11. Assess the existing project impacts on local land use patterns and tenurial arrangements, land access and availability, food security and land values, and any corresponding risks related to conflict or contestation over land and natural resources.

V. *Health and safety issues, risks and impacts.*

12. Assess health and safety issues related to communities and projects workers as follows.
1) Project workers. Assess and evaluate On-site occupational health and safety practices, related to facility design and operation, communication and training, hazards and monitoring, based on, among other, documentation of occupational accidents, diseases and incidents, including fatalities, related to project workers; available remedies for adverse impacts such as occupational injuries, deaths, disability and disease; and emergency prevention and preparedness and response arrangements to emergency situations, among others; and
2) Community health and safety. Conduct a site environmental and health risk assessment to determine impacts and risks posed to the surrounding communities.

VI. *Cultural heritage.*

13. Assess cultural heritage issues, impacts and impacts of the project on cultural heritage.

VII. Grievance redress system.

14. Assess whether there are grievances as well as a functional grievance redress system to strengthening up transparency and institutional responsibility processes, and to foster greater public accountability.

Task 4. Environmental and social issues, impacts and risks of Associated Facilities

15. Identify and assess, to the extent appropriate, the potential environmental and social risks and impacts of Associated Facilities.

Task 5. Environmental and Social Analysis.

16. The audit will also assess (i) the potential impacts of the proposed rehabilitation project taking into account the findings of the audit with regard to the existing project or activities; and (ii) the ability of the proposed rehabilitation project to meet the safeguards requirements of the GoR laws and regulations, and the World Bank environmental and social standards.

Task 6. Proposed Environmental and Social Measures

17. Based on the findings of the audit, set out the suggested measures to address such findings. The suggested measures will include, but not limited to, the following.

a) specific actions required to meet the safeguards requirements of the GoR laws and regulations, and the World Bank environmental and social standards;
b) corrective measures and actions to mitigate potentially significant environmental and social risks and impacts associated with the existing project;
c) measures to avoid or mitigate any potential adverse environmental and social risks and impacts associated with the proposed project/rehabilitation of the HPP; and
d) Audit plan comprising key environmental and social issues/concerns and corrective actions/measures along with budget, timeline and responsible bodies.
e) Description of the methods and frequencies that will be used in monitoring and evaluation of the state of HPP in terms of environmental and Social protection,
f) Provide detailed mitigation measures including an estimation cost of the implementation cost of the proposed measure.

Task 7. Stakeholder consultations and participations

18. Please note the following to carryout meaningful stakeholder consultation.

1) In coordination and consultation with the client, identify and consult with relevant stakeholders, including local communities and vulnerable peoples/groups based on the environmental and social audit objectives of this consultancy assignment;
2) Undertake meaningful consultation with all relevant stakeholders in a culturally appropriate and inclusive manner with an objective to identify their values and views/concerns in relation to environment and social risks and impacts of the project;
3) Review and discuss with the client the findings of consultation meetings; and
4) Document stakeholder consultations and comments received; and ensure that they reflect an accurate and true reflection of discussions; and summarize and include the main issues raised during consultation meetings in the report.

Methodology

19. The methodology for the environmental and social audit will follow desk reviewing of all relevant documentation related to the tasks mentioned above; assess environmental and social issues, risks and impacts associated with the existing project or activities; assess the potential environment and social impacts of the proposed rehabilitation project; and propose

environmental and social actions and measures. It will also include site observation of biophysical and social environment in the project setting; and consultative meetings with relevant institutions, key informant interviews (including HPP staff), and focus group discussions with concerned stakeholders to gather relevant data and information. It will comprise consultation workshop to seek additional information and reconfirm the assessment as well.

Expected deliverables and timelines

20. The individual consultant will deliver the following outputs.

a) *Inception Report*. The consultant shall prepare and submit an inception report which briefly describes the detailed work plan, the methodology and approach of the environmental and social audit process, contents of the audit, and key information required for achieving the objectives of the assignment. The consultant shall submit two soft/electronic and two hard copies of the inception report to the client not later than four days after the commencement of the consultancy.

b) *Draft Environmental and Social Audit*. The consultant shall prepare and submit draft audit not later than 17 days after the commencement of the consultancy.

c) *Final Environment and Social Audit*. The consultant shall submit the final audit (after incorporating inputs and comments received from relevant stakeholders, including the client, the World Bank, and participants of a consultative workshop) not later than 30 days after the commencement of the consultancy.

The submitted reports are subject to assessments and comments by different stakeholders that shall be invited in a one day workshop before their final approval

Specific inputs to be presented by the client

- Access to government data sources, official experts, and key background documents.
- Participation in joint planning of meetings and events/ workshop.

Special terms and conditions

21. *Location*: The work will be conducted in Rwanda with substantial engagement with relevant GoR's institutions, officials and experts with travels to the project site for collection of data and information and consultation of revenant communities and district offices. Data analysis and internal quality reviews could be conducted elsewhere.

22. *Coordination and reporting arrangements:* The consult will report to the client (EDCL and EUCL) for the above tasks. The consultant will ensure close coordination with the GoR's counterparts, and other relevant stakeholders, including the World Bank, to attain the objectives of the assignment.

23. *Duration:* The overall assignment is for a period from contract signing (March 2, 2020) through April 6, 2019.

24. *How to apply*: Please submit a detailed CV and cover letter to EDCL…The Cover Letter should explain clearly why the Applicant is most suitable for the work. Only short-listed candidates will be contacted for an interview.

Consultant selection criteria: required qualification

a. A post-graduate or equivalent qualification in engineering or relevant discipline;
b. At least 15 years of professional experience in the development, implementation, rehabilitation and monitoring of hydropower dam projects, with proven track record of project optimization with due consideration to environmental and social issues;
c. Expertise covering all aspects of civil engineering, including field investigations, design of dam and water conveyance structures, etc.;
d. Recognized competences and practical experience in dam and hydropower plant assessment and monitoring;
e. Demonstrated knowledge and experience in with WB safeguards policies, including dam safety;
f. Demonstrated experience and skills in facilitating stakeholder consultations;
g. Relevant regional (East Africa, Rwanda) experience will be an added advantage; and
h. Fluency in English-strong oral and written communication skills.

Indicative outline of environmental and social audit

1. *Executive Summary*
2. *Introduction*
3. *Objective and scope*
4. *Methodology*
5. *Project Description.*
6. *Institutional, legislative and regulatory frameworks*
7. *Environmental and Social Issues Associated with the Existing Project or Activities, and the Associated facilities.*
8. *Stakeholder consultation and participation*
9. *Environmental and Social Analysis.*
10. *Proposed Environmental and Social Measures*
11. *Conclusions and recommendations*

Annexes: Questionnaire, list of consulted people and communities, minutes of meetings, etc.

Annex 8: Auditor Details

1. Consulting Company

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

Environmental Assessment and Management including:

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

Geographical Information Systems (GIS) including remote sensing images (Land sat TM, SPOT and Radar) i.e. rectification, interpretation, classification among others

Experience in Baseline Survey including Biomass Energy and Rural Stoves Survey, Rapid Social Survey Analysis for Hydropower projects, Baseline Survey for Rural Development Projects, Resettlement Action Plan (RAP)

Communities Involvement and Civil Society Participation in projects related to Water Development Projects, Agriculture Production

Environment and Conflict including Ecological Sources of Conflicts in Sub-Saharan Africa

Water and Sanitation including Solid Waste Management(Valorisation, Collection and Recycling of Domestic Wastes), develop a regulatory framework for water supply and sanitation services in Rwanda including developing strategic planning and implementation of technical and economic regulations in Water and Sanitation. Design and Installation of wastewater treatment systems

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

2. Environmental and Social Audit Team Leader

Mr. Jean BIGAGAZA

Tel: +250738306659

Email: jbigagaza@gmail.com

3. List of the specialists who prepared audit and their Key Qualifications

Name	Key Qualifications
Jean BIGAGAZA ESIA Expert and Team Leader	Mr. Bigagaza holds a Master's degree in Environmental Engineering from East China University of Science and Technology (China - Shanghai) and a postgraduate specialization in Geomatics from University of Geneva (Switzerland). Mr. Bigagaza has attended training courses in Environmental Impact Assessment and specifically training in World Bank Environmental and Social Safeguards he is familiar with the operational policies and procedures including preparation of ESIAs, ESMFs, RPFs, RAPs and Strategic Environmental Assessment (SEA). For the last 15 years, Mr. BIGAGAZA has conducted several Environmental and Social Impact Assessment studies (ESIA) for projects related to Energy (Hydropower, Gas Extraction, Solar, transmission lines, waste to power, etc.), Housing, Construction, Rural Development (Agriculture and Livestock, Feeder Roads, Valley dams, Biogas, Mining projects, Marshlands Development, etc..), Solid Waste Management, Geothermal Exploration Environmental studies, Water Supply and Sanitation, Humanitarian Response, Coffee Roasting, Mining, etc.
Dr. Rose MUNYENGANGO LØVGREN Socio-economist	**PhD, University of Copenhagen, 02/2015 – 05/2019** **The PhD was written in the field of African Studies and completed in** cooperation with Centre for Advanced Migration Studies at Section for Ethnology. Master of Arts in African Studies, University of Copenhagen, 09/2011 – 09/2014 Master of Arts in Philosophy, University of Copenhagen, 09/2011 – 09/2014 Bachelor in Philosophy, University of Copenhagen, 09/2007 – 01/2011 Elective studies in qualitative research methodology Rose Munyengango L**øvgren** is a driven researcher and policy analyst with 8+ years' experience working in universities and practice oriented research. She is specialized in gender equality and state-society relations, and particularly knowledgeable about Rwanda. Rose Munyengango Løvgren has extensive experience in surveys and field research in Rwanda both as an auditor in the energy sector and as an individual researcher.

Dr. Elias BIZURU Ecologist/Botanist	Dr Bizuru hold a PhD in Sciences (Life Sciences) of Free University of Brussels,Belgium and Msc in life sciences from Free university of Brussels, and bachelor degree in biology sciences from University of Burundi, Dr Bizuru has more than 20 years' proven working experience in ecology or biological sciences matters, and particular experience and knowledge of wetland ecology.
Vincent de Paul KABALISA Hydrologist/Water Resource Management Specialist	Msc in Water Resources Survey, ITC, Enschede, Netherlands, May 1995, Bsc in Physical Geography, National University of Rwanda, Ruhengeri, 1988 Major: Water resources management, Groundwater, Rainwater harvesting, Physical Geography, GIS, Remote Sensing Graduated with high honors 20 years upwards and progressive experience in the field of Water management and development both at technical and policy level in various sectors including Integrated Water Resources Management, Domestic Water supply, Water for irrigation, Wash, Food security, More than 15 years at senior leadership in Water sector at national and Basin Wide in Africa with high skills in financial management, procurement and budgetary control (> $7M/year), overall management of staff (40+ people) and equipment.
Vincent Mpaka Electromechanical Engineer/Dam Specialist	Bachelor's degree, Electronics and Telecommunication Engineering. Diploma in Electrical Engineering. **Eng. MPAKA** is conversant with the region and has worked with 18 years' hands-on experience in Generation, Transmission and Distribution system planning and development, project management, operations and maintenance in Rwanda and EAPP (Eastern Africa Power Pool) member states for Power System installations operating at voltage levels, 220kV, 110kV, 70kV, 66kV, 30kV, 15kV, 10kV and 0.4kV respectively. He is experienced in Generation, Transmission and Distribution installation design, financing, procurement, construction, testing and commissioning in the Eastern African Power Pool region. Proficient in condition based maintenance, faults diagnostic techniques on power transformers, circuit breakers and other power system equipment and apparatus with an experience in energy efficient and demand-side management practices. Eng. MPAKA Worked with Rwanda Energy Group a Utility body for 18 years, From 1 June 1999 to 28 February 2017. Last Position held at REG/EUCL: Director of Electricity Operations at Energy Utility Corporation Limited (EUCL) managing the Operations

	and Maintenance, Planning and Development of the Generation, Transmission and Distribution value chain.

Annex 9: Ntaruka HPP Maintenance Activities Plan 2020-2021

Introduction

The Operation and Maintenance activities aim at reducing failure rate by ensuring smooth running of the power utility. This can be achieved by adopting a timely preventive maintenance schedule regarding all vital areas of the power plant. Generation management should be well-advised to follow the well-known dictum: "Prevention is better than cure".

Ntaruka HPP Maintenance Activities Plan 2020-2021

S/No	Subsystem	Equipment / component	Activity	Frequency	Duration	Requirement	Previous schedule	NEXT SCHUDULE At 2020	Risk associated on the maintenance
1	Intake and head race	Trash rack	Unclogging	Daily	-	-			Non-operating of turbine unavailability of water flow
			Bottom bucket emptying and cleaning	2 years	4 hours	Power plant shut down Mechanical tool box, boat, soap and rags	01/03/2020	12/03/2022	
			Painting	5 years	24 hours	Power plant shut down Enamel paint , thinner and brushes	01/03/2020	12/03/2024	
		Embankment	Weed cleaning	Monthly	8 hours	-			
			Bank cracks repair	5 years	3 days	Civil work specialist and tooling support, rags and soap			
		Intake gates	Leakage check	Annually	6 hours	Power plant shut down Mechanical tool box , rags and linkage of the gates	01/03/2020	12/03/2022	
			Paint inspection	Annually	6 hours	Power plant shut down Mechanical tool box , soap and rags	01/03/2020	12/03/2022	
		Automatic intake valve	Leakage check	Annually	6 hours	Power plant shut down Mechanical tool box and rags	01/03/2020	12/03/2022	
			Control check	Annually	6 hours	Power plant shut down Mechanical tool box and rags	01/03/2020	12/03/2022	
		Hoist and gantry	Load hook check	Monthly	1 hour	Mechanical tool box ,rags and soap	01/03/2020	12/03/2022	
			Chain maintenance	Monthly	1 hour	Grease , grease pump and rags	01/03/2020	12/03/2022	
			Motor test	Monthly	1 hour	Multimeter , screwdrivers and rags	01/03/2020	12/03/2022	
			Pendant control test	Monthly	1 hour	Multimeter , screwdrivers, rags	01/03/2020	12/03/2022	
		Tunnel	Internal inspection & debris removing	Annually	6 hours	Power plant shut down Mechanical tool box, bucket , rope, ladder, rags and hang up linkage of the gates	01/03/2020	12/03/2022	Leakage and risk of hill erosion and collapse of the tunnel
		Surge chamber	External check	Annually	1 hour	Ladder, rope, rags and soap	24/05/2020	13/03/2022	
			Internal check	Annually	1 hour	Power plant shut down	24/05/2020	13/03/2022	

						Ladder , rope, plier, torch and rags			Risk collapse of the tunnel by water hammer
			Steel ladder paint	Annually	1 hour	Power plant shut down Enamel paint and brushes	24/05/2020	13/03/2022	
			Top grill & beams check	Annually	1 hour	Ladder and rope ,rags and soap	24/05/2020	13/03/2022	
		Protection	Over speed parameter check	Weekly	20 min	Mechanical tool box and multimeter, rags			Trip of the units or failure of machine coupling on the grid Failure to signal operator about the turbine operation. Failure aggregates coupling from the control panel
			Level sensor check and cleaning	5 years	1 hours	Ladder , rope , multimeter, screwdrivers and rags			
		Unplanned maintenance	Breakdown & repair maintenance	Daily	-	Availability of spares will reduce maintenance time , rags and soap	-		
2	Penstock	External	Anchor block inspection	Monthly	2 hours	Ladder and rope , rags and soap			-
			Extension boxes leakage and tightening check	Semester	5 hours	Ladder , rope and mechanical tool box, soap and rags			Non-operating of turbine unavailability of water flow
			Paint inspection	Annually	1 month	Ladder and rope, rags and soap	24/05/2020	13/03/2022	
			Trees pruning	Annually	4 hours	Machetes and axes	24/05/2020	13/03/2022	
			MIV and drainage valve leakage check	Monthly	1 hour	Mechanical tool box and rags			
		Internal	Paint inspection	Annually	11 hours	Mechanical tool box , pieces of timbers , torch and rope	24/05/2020	13/03/2022	
			Collector debris removing	Annually	3 hours	Power plant shut down Mechanical tool box , bucket , rope, ladder, rags and pull lift	24/05/2020	13/03/2022	
			Manholes collectors leakage check	Annually	1 hour	Power plant shut down Mechanical tool box , bucket , rope, ladder, rags and pull lift	24/05/2020	13/03/2022	
		Protection	Flow sensor check	Annually	30 min	Power plant shut down Mechanical tool box, multimeter and rags	24/05/2020	13/03/2022	Trip of the units or failure of machine coupling on the grid Failure to signal operator about the

									turbine operation. Failure aggregates coupling from the control panel
			Pressure sensor check	Annually	30 min	Power plant shut down Mechanical tool box, multimeter and rags , signal conversion sensor 4- 20 mA to 0 -16 bars	24/05/2020	13/03/2022	Trip of the units or failure of machine coupling on the grid Failure to signal operator about the turbine operation. Failure aggregates coupling from the control panel
		Unplanned maintenance	Breakdown & repair maintenance	Daily	-	Availability of spares will reduce maintenance time	-		
3	Turbines	Main inlet valves	Leakage check	Daily	-	-			
			Bearings greasing	Monthly	3 hours	Mechanical tool box , grease , pump grease and rags			Non-operating of servo-drives, unavailability of time turbines for a very long
			Control check and filters cleaning	Monthly	3 hours	Each unit shut down Tool box , metallic brush , painting brush and rags			Non-operating of servo-drives, unavailability of time turbines for a very long
			MIV cleaning	Daily	-	-	-		Non-operating of servo-drives, unavailability of time turbines for a very long
			Check and refilling oil for MIV for unit 2	Monthly	1 hour	Unit 2 shut down Mechanical tool box, bucket , manual pump and one drum of oil Hydran 46			Non-operating of servo-drives, unavailability of time turbines for a very long
		Spiral casings	Leakage check	Daily	30 min	-			
			Internal paint inspection	Annually	1 hour	Each unit shut down Tool box , metallic brush and rags	24/05/2020	13/03/2022	

			External paint inspection	Daily	-	-	-		-
		Wicket gates	Governor oil level, viscosity, pumping system, strainers, filters cleaning	¼ year	6 hours	Each unit shut down and 2 hours/unit , 6 drums of oil Hydran 68, mechanical tool box , viscometer , air compressor, vacuum cleaner, metallic brush and rags			Increasing them Unavailability of the turbine for a long time the clearance in bushing blades, which would lead to replacing Increasing them -
			Cooling device cleaning	Monthly	6 hours	Each unit shut down, mechanical tool box , air compressor and rags			
			Speed governor parameter check	Weekly	30 min	Screwdrivers , multimeter and rags			
			Governor control check	Annually	3 hours	Mechanical tool box and multimeter, soap and rags	24/10/2020	23/10/2021	
			Shear pins check and greasing	Monthly	3 hours	Pump grease , grease and rags			
			Linkage greasing	Monthly	45 min	Pump grease , grease and rags			
		Guide vanes	External leakage check	Daily	10 min	-	-		
			Twinsets greasing	Monthly	1 hour	Pump grease , grease and rags and a drum of grease MARSON EPL 2			
			Internal leakage check	5 years	11 hours	Power plant shut down Mechanical tool box , bucket , rope, ladder, rags , pieces of timbers torch	24/10/2020	23/10/2021	
			Clearance measurement and adjustment	5 years	11 hours	Power plant shut down Mechanical tool box , gages , bucket, rope, ladder, rags , pieces of timbers and torch	24/10/2020	23/10/2021	
		Runner	Unclogging	5 years	11 hours	Power plant shut down Mechanical tool box , levers , bucket, rope, ladder, rags , pieces of timbers and torch	24/10/2020	23/10/2021	The impossibility to maintain control on the adjustment of the rotor. The unavailability of the turbine for a very long period of time
			Cavitation erosion check	5 years	11 hours	Power plant shut down Mechanical tool box , rope, ladder, rags , pieces of timbers and torch	24/10/2020	23/10/2021	
			Clearance check	5 years	11 hours	Power plant shut down Mechanical tool box , gages , rope, ladder, rags , pieces of timbers and torch	24/10/2020	23/10/2021	

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		Bearings	Oil level	Daily	-	-	-		-
			Viscosity check	Annually	3 hours	Viscometer, soap and rags	24/10/2020	23/10/2021	The impossibility of turbine functioning The burning of the rubber backings The unavailability for a long period of time which represents financial losses
			Pumping system check, strainers and filters cleaning.	Monthly	3 hours	Each unit shut down and 2 hours/unit , 3 drums of oil Hydran 68, mechanical tool box , viscometer , air compressor, vacuum cleaner , metallic brush and rags			
			Cooling devices cleaning	Annually	11 hours	Each unit shut down, mechanical tool box , air compressor and rags	24/10/2020	23/10/2021	
			Tightening check	Annually	30 min	Mechanical tool box, rags and soap	24/10/2020	23/10/2021	
			Temperature sensors inspection or check	Daily	-	-	-		
			Vibration check	2 years	12 hours	Mechanical tool box and a laser Doppler vibrometer, soap and rags			
		Low pressure tank	Cleaning of 4m^3 tank	Annually	5 hours	Power plant shut down , mechanical tool box , air compressor , brooms, buckets , soap and rags	24/10/2020	23/10/2021	The impossibility of turbine functioning The burning of the rubber backings The unavailability for a long period of time which represents financial losses
		Shaft	Unbalancing and alignment check	2 years	24 hours	Power plant shut down , mechanical tool box , 2 comparators , sensor (Palpeur), thinner and rags	24/10/2020	23/10/2021	Non-operating of servo-drives, unavailability of time turbines for a very long
			Sliding check	2 years	24 hours	Power plant shut down , mechanical tool box , 2 comparators , sensor (Palpeur) , thinner and rags			Non-operating of servo-drives, unavailability of time turbines for a very long
			Temperature sensors inspection or check	Annually	9 hours	Each unit shut down, mechanical tool box, yardstick temperature sensor, stove and saucepan ,soap and rags	24/10/2020	23/10/2021	Non-operating of servo-drives, unavailability of

									time turbines for a very long
		Shaft glands	Leakage check and tightening	Daily	-	-	-		-
			Greasing	Monthly	1 hours	Mechanical tool box , grease , pump grease , grease MARSON EPL 2 and rags			Impossibility of Plant operation
		Breaks	Control check and filters cleaning	¼ year	3 hours	Mechanical tool box , metallic brush			Non-operating of the power plant
			Pad and fly wheel check and cleaning	Annually	6 hours	Mechanical tool box , 5 liters of petrol , 5 liters of thinner , sand papers, hand grinding stone, rags	24/10/2020	23/10/2021	
		Protection	Over speed parameter check	Semester	1 hour	Each unit shut down , Mipreg parameter checkup ,soap and rags			Impossibility of plant operation Non-operating of the power plant
			Directional power relay check	Semester	1 hour	Each unit shut down , protection specialist and tooling support ,soap and rags	-		
			Reverse power relays check	Semester	1 hour	Each unit shut down , protection specialist and tooling support ,soap and rags	-		
			Pressure sensors check	Semester	1 hour	Each unit shut down , mechanical tool box , signal conversion sensor 0 -16 bars to 4- 20 mA, rag and soap	-		
			Temperature sensors check	Semester	3 hours	Each unit shut down ,mechanical tool box, yardstick temperature sensor , stove and saucepan	-		
			Temperature and pressure sensors calibration or replacement	2 years	3 days	Each unit shut down , mechanical tool box , signal conversion sensor 0 -16 bars to 4- 20 mA, yardstick temperature sensor , stove and saucepan or specialist and tooling support, rags and soap	24/10/2020	23/10/2021	
		Unplanned maintenance	Breakdown & repair maintenance	Daily	-	Availability of spares such : - MIPREG cards (CAL 523, INT 522, MIC 521) - Bearing pads will reduce maintenance time	-		-

4	Alternator	Stator	Dust cleaning	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner, air compressor and rags	25/10/2020	24/10/2021	Non-operating of generator unavailability of alternator for a very long time
			Earth fault check	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor , megohmmeter and rags	14/03/2020		
			Dielectric check	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor , megohmmeter and rags	14/03/2020		
		Rotor	Dust cleaning	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor and rags	25/10/2020	24/10/2021	Non-operating of generator unavailability of alternator for a very long time
			Earthing check	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor , megohmmeter and rags	14/03/2020		Trip of the units or failure of machine coupling on the grid Failure to signal operator about the turbine operation. Failure aggregates coupling from the control panel
			Dielectric check	Annually	6 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor , megohmmeter and rags	15/4/2020		
		Low pressure tank	Cleaning of 25m^3 tank	¼ year	5 hours	Power plant shut down , mechanical tool box , air compressor , brooms, buckets , soap and rags	15/4/2020		
			Filters and cooling device cleaning.	2 years	12 hours	Each unit shut down, mechanical tool box , air compressor, vacuum cleaner, rubber ball, copper cane and rags	25/10/2020	24/10/2021	
		Sleep rings & brushes	Adjust brush holder or replacement of worn brushes	Weekly	3 hours	Each unit shot down , electrical tool box , file, metallic brush , vacuum cleaner ,air compressor and rags			The impossibility of turbine functioning The burning of the ring The

			Rings and brushes cleaning	Weekly	3 hours	Each unit shot down , electrical tool box , file, metallic brush , vacuum cleaner ,air compressor and rags			unavailability for a long period of time which represents financial losses
		Control panels	Cleaning	Daily	-	-	-		-
			AVR, control relays, field contactor, mini jumps switches check , connection tightening and public light check	Semester	6 hours	Each unit shot down , electrical tool box , vacuum cleaner ,air compressor and rags			Impossibility of Plant operation Non-operating of the power plant
			Lamps check and replacement	Daily	-	-	-		-
		DC batteries	Check acid , distilled water level and refilling	Weekly	1 hour	Acid hydrometer tester , 100 liters of distilled water/ year	-		Failure of control and protection of the units
			Connections tightening check	¼ year	5 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor and rags			
			Rectifier-chargers maintenance	Monthly	2 hours	Each unit shut down, electrical and mechanical tool boxes , vacuum cleaner air compressor and rags			
		Protection	Temperature, smoke sensors and PT100 check	Annually	1 hour	Each unit shut down ,mechanical tool box, yardstick temperature sensor , stove and saucepan	25/10/2020	24/10/2021	The accuracy of the sensors and PT100 prevents the untimely and delay of equipment alarm and trip.
			Water flow sensors check and filters cleaning	Monthly	3 hours	Each unit shut down, mechanical tool box , air compressor, metallic brush , painting brush , petrol and rags	12/01/2020	17/04/2021	
			Cooling device cleaning	2 years	11 hours	Each unit shut down, mechanical tool box , air compressor, vacuum cleaner rubber ball , copper cane and rags			
			Directional power relay check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist ,tooling support , soap and rags	25/10/2020	24/10/2021	Trip of the units or failure of machine coupling on the grid

			Differential relay check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist , tooling support and rags	25/10/2020	24/10/2021	Failure to signal operator about the generator
			Overcurrent relay check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist ,tooling support ,soap and rags	25/10/2020	24/10/2021	
			Overload relay check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist , tooling support and rags	25/10/2020	24/10/2021	
			Alternator negative sequence protective relays check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist ,tooling support , rags and soap	25/10/2020	24/10/2021	
			Stator earthing relays check	Annually	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support ,rags and soap	25/10/2020	24/10/2021	
			Rotor earthing relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support ,rags	05/07/2020	17/04/2021	
			Max/min of voltage relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support , rags and soap	05/07/2020	17/04/2021	
			Max /min of frequency relays	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support and rags	05/07/2020	17/04/2021	
			Reverse power relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support , rags and soap	05/07/2020	17/04/2021	
			Loss of excitation relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support and rags	05/07/2020	17/04/2021	

			Cables earthing relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist and tooling support , rags and soap	05/07/2020	17/04/2021	
			PT100 check	2 years	9 hours	Each unit shut down ,mechanical tool box, yardstick temperature sensor , stove and saucepan	05/07/2020	17/04/2021	
			Automatic extinguishers check	Semester	3 hours	Specialized workshop	05/07/2020	17/04/2021	
			Protection relays parameter and calibration	2 years	3 days	Each unit shut down, electrical tool box , protection specialist and tooling support, rags and soap	05/07/2020	17/04/2021	
		PLC	Dust cleaning and physical status of cards check	Monthly	3 hours	Vacuum cleaner , broom and rags			
			Power supply check	Monthly	3 hours	Multimeter , screwdrivers and rags			
			Control relays and mini jumps check	Semester	6 hours	Multimeter, screwdrivers and rags			
			Program display I/O check	Annually	9 hours	Each unit shut down, Télémécanique TSX T407 tool or MS-DOS computer ,soap and rags	08/11/2020	07/11/2021	08/11/19
			Compatibility of the program with sequences check	2 years	9 hours	Each unit shut down, Télémécanique TSX T407 programmer or MS-DOS computer and rags	08/11/2020	07/11/2022	08/11/18
		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares such: - AVR UNITROL M cards (UN 0503, 0800, 0802, 0804, 0809, 0810, 0820, 0825, 901), - PLC TSX 47-20 cards (Supply, Processor , I/O and memory) - Rectifier - chargers 110V & 48V cards (CCCT 3 phase 48V , CCCT 3 phase 110V) will reduce maintenance time	-		-
6		Motors	Cleaning	Weekly	1 hour	Broom and rags	-		-

	Overhead crane		Connection tightening check	Semester	1 hour	Each unit shot down , electrical tool box , vacuum cleaner , air compressor and rags	22/01/2020	22/07/2020	Risk of accident and delay of maintenance timing
		Gears	Oil level check or refiling	Semester	1 hour	Gear oil 5 liters , rags	22/01/2020	22/07/2020	
			Greasing	Semester	1 hour	Mechanical tool box , grease , pump grease , grease MARSON EPL 2 and rags	22/01/2020	22/07/2020	
		Panel	Cleaning	Weekly	1 hour	Broom and rags			
			Connection tightening and contactors check	Semester	2 hours	Each unit shot down , electrical tool box , vacuum cleaner ,air compressor and rags	22/01/2020	22/07/2020	
		Breaks	Break shoes check and cleaning	Annually	1 hour	Mechanical tool box , 1 liters of petrol , 1 liters of thinner , sand papers, hand grinding stone, rags	22/01/2020	21/01/2021	
			Electromagnet and counterweigh check	Annually	1 hour	Mechanical tool box , 1 liters of petrol , 1 liters of thinner , sand papers, hand grinding stone, rags	22/01/2020	21/01/2021	
		Bus bars	Dirtiness cleaning	Weekly	2 hours	Thinner and rags			
		Rail ways	Debris removing and dust cleaning	Weekly	2 hours	Broom , petrol and rags	-		
		Load hook and cables	Cleaning and lubricating	¼ year	1 hour	Thinner, rags and grease			
		Protection	Stop and trip switches check	Annually	1 hour	Tool box , multimeter and rags	22/01/2020	21/01/2021	
		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares will reduce maintenance time	-		-
7	Substation	Transformers	Body cleaning	Monthly	6 hours	Brooms and rags			When raining earth and overcurrent faults are frequent which can be from dust or fungi on switchgears equipment. Remind that every trip of outside circuit breakers of
			Cables connection check	Annually	5 hours	Each feeder shut down , tool box and rags	09/02/2020		
			Bus bars tightening check	Annually	5 hours	Each feeder shut down , tool box and rags	09/02/2020		
		Isolators	Status check	Daily	-	-	-		

			Opening and closing control test	2 years	3 hours	Each feeder shut down , Tool box , multimeter ,soap and rags			transformers trips associated inside 6.6KV CB , affecting the units and generation factor
			Greasing with Vaseline	2 years	3 hours	Each feeder shut down , Tool box Vaseline and rags			
		Insulators	Status check	Daily	-	-			
			Dust cleaning	2 years	9 hours	Each feeder shut down, rags , soap and buckets			
		Protection	Oil temperature check	Daily	-	-			
			Coil temperature check	Daily	-	-			
			Buchholz relays check	¼ year	1 hour	Each unit shut down , electrical tool box , protection specialist ,tooling support , soap and rags			
			Differential relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist ,tooling support ,soap and rags			
			Over current relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist , tooling support , soap and rags			
			Overload relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist , tooling support ,soap and rags			
			Cables earthing relays check	Semester	1 hour	Each unit shut down , electrical tool box , protection specialist , tooling support and rags			
			Temperature sensors parameter and calibration or replacement	2 years	3 days	Each unit shut down , mechanical tool box , yardstick temperature sensor , stove and saucepan or specialist and tooling support			
			Protection relays parameter and calibration	2 years	3 days	Each feeder shut down, electrical tool box , protection specialist ,tooling support and rags			

		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares will reduce maintenance time	-		-
8	Standby generator	Engine	Cleaning	Daily	-	Broom and rags	-		Impossible of heavy maintenance
			Fuel refilling	Weekly	30 min	200 liters of diesel / year	-		
			Oil check and refiling	Weekly	20 min	16 liters of oil SAE 40 diesel/year	-		
			Test	Weekly	10 min	-	-		
			Replacement of battery	Annually	20 min	One Battery 12 V 150Ah/ year	-		
			Oil filter replacement	2 years	1 hour	One oil filter within 2 years	Nov 2020	Nov 2022	
			Fuel filter replacement	2 years	1 hour	One gasoil filter within 2 years	Nov 2020	Nov 2022	
			Air filter cleaning	weekly	30 min	Air compressor and rags	-		
		Alternator	Control check	Weekly	10 min	-	-		
			Output check	Weekly	10 min	Voltmeter ,ammeter and rags	-		
		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares such: Cards 9 MULTIMODE CONTROL PCB P086 , AMF UPGRADE PCB P096 , OVERSPEED MODULE P112 and rectifiers will reduce maintenance time			-
9	Power house	Units	Cleaning	Daily	-	Brooms, rags , petrol ,thinner and brushes	-		-
		Roof	Leakage check	Semester	-	-			
			Weed cleaning in rain seasons	Semester	-	-			
			Sheet tightening check	3 years	5 hours	Mechanical tool box ,ladder and rags			
		Walls	Spiders , mostiquos and dust cleaning	Daily	-	Brooms and rags	-		
			Doors and windows maintenance	¼ year	3 hours	Tool box and spare parts depending on the issue	-		
		Basement	Cleaning	Daily	-	-	-		

			Drainage check	Daily	-	-	-		
		Tailrace	Weed cleaning	Monthly	2 hours	-	-		Collapse of the tailrace
			Seal cracks	Annually	5 hours	Civil work specialist and tooling support and rags	March 2020		
		Safety	Water extinguishers check	Semester	3 hours	Mechanical tooling and rags			Fire accident of the staff and components
			Powder extinguishers check	Semester	-	-			
			CO_2 extinguishers check	Semester	-	-			
		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares will reduce maintenance time	-		
10	Workshop	House	Cleaning	Daily	-	Brooms, rags , soaps	-		
			Doors and windows maintenance	Annually	3 hours	Tool box and spare parts depending on the issue	Jan 2020		Delays of component repairs and risk of accident of the staff and components
		Machine tools	Maintenance and test	Weekly	3 hours	Mechanical tool box and rags	-		
			Greasing and lubricating	Weekly	2 hours	Mechanical tool box , grease , pump grease, grease MARSON EPL 2, soluble oil Gensol and rags	-		
		Safety	CO_2 Extinguisher check	Semester	-	-			
		Unplanned maintenance	Breakdown & repair maintenances	Daily	-	Availability of spares for the lathe & milling machine tools will reduce maintenance time	-		

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