



USAID
FROM THE AMERICAN PEOPLE



RURAL ENERGY PROGRAM

COOPERATIVE AGREEMENT NO. 114-A-00-05-00106-00

ENVIRONMENTAL MANAGEMENT PLAN FOR KABALI SMALL HYDROPOWER REHABILITATION PROJECT



ENVIRONMENTAL MANAGEMENT PLAN FOR KABALI SMALL HYDROPOWER REHABILITATION PROJECT

Prepared for: USAID / Caucasus
25 Atoneli Street
0105 Tbilisi, Georgia

Prepared by: Rural Energy Program 26 Dzmebi Kakabadzeebi Street, Tbilisi,
0105, Georgia
Tel: +995 32 50 63 43
Fax: +995 32 93 53 52

TABLE OF CONTENTS

1. Introduction.....	2
2. Kabali small hydropower project (kabali community).....	5
3. Environmental Review	10
4. Mitigation Plan	16
5. Monitoring Plan.....	22
Annex A. Environmental Screening of the Kbali Project Site.....	24
Annex B. Physical and Socio-Economic Environment.....	30
Annex C. Geological Evaluation of the Kabali SHP site	33

1. INTRODUCTION

The USAID-sponsored Rural Energy Program (formerly known as the Renewable Energy and Environment Development Program, or REED) in Georgia aims at developing in-country capacity to increase the utilization of small hydropower resources and realization of energy efficiency potential in rural Georgia.

The primary objectives of the Rural Energy Program include 1) increased supply of energy to rural areas (both grid connected and off-grid); 2) improved management of local energy production; 3) improved in-country capacity to develop and deploy renewable energy applications in rural communities; and 4) improved capacity to more efficiently utilize and protect the local energy resource base.

The Rural Energy Program envisions the implementation of a number of pilot projects in such areas as small, mini and micro hydropower installations, extensions of natural gas distribution networks, renewable energy systems (other than small, mini and micro hydro facilities), and natural resource management programs.

Rural Energy Program activities as funded by a federal government agency, USAID, are subject to applicable U.S. environmental laws, and regulations including USAID's environmental impact assessment procedures. These procedures intend to implement the requirements of the National Environmental Policy Act of 1970. Title 22 of the Code of Federal Regulations, Part 216 (so called 22 CFR 216), applies to all USAID programs, projects, activities and substantive amendments.

To comply with 22 CFR 216, the Rural Energy Program environmental team completed a Programmatic Environmental Assessment (PEA) for the Rural Energy Program in March of 2006. USAID approved the PEA for further implementation. The PEA scope contained (a) a definition of environmental screening criteria for a set of projects similar in size, range and magnitude of impacts, and (b) characterization of common mitigation measures for each project type to alleviate the recognized impacts. Projects that did not share common attributes (such as medium and large hydropower projects, projects located in national parks, or projects which raised substantial issues regarding wetlands or sensitive habitats that would require a separate Environmental Assessment) were not addressed in the PEA.

The PEA evaluated four types of projects considered for investment under the Rural Energy Program. These included the following project categories:

- Small-scale hydropower plants;
- Community natural gas (NG) distribution systems;
- Renewable energy/ energy efficiency projects; and
- Natural resource management projects.

Work completed by the PA Environmental Scoping Team set the stage for the PEA. Issues identified during preparation of the Rural Energy Program Scoping Statement (Appendix E) were examined by the multidisciplinary PEA Team through literature reviews, stakeholder interviews, multiple field evaluations and environmental screening analyses. Through a process of integrating issues identified through scoping with information collected in literature reviews, regulatory reviews, interviews, field and screening evaluations, the PEA Team identified environmental aspects that had to be addressed in the PEA.

The environmental aspects presented in the PEA included the following subjects:

- Geology and Soils
- Water Resources
- Biological Resources
- Socioeconomics (including Public Health)
- Cultural Resources.

The PEA also simplified environmental due diligence for the preparation of environmental management plans (including mitigation and monitoring plans) for a larger set of activities expected under the Rural Energy Program. Due to the completion of the Programmatic Environmental Assessment for the entire Rural Energy Program, it was unnecessary to define environmental significance ranking criteria for each individual environmental management plan. The unified significance criteria elaborated in the PEA were utilized for the environmental impact ranking presented in individual environmental management plans. An environmental management plan for each project is based on a specific environmental review conducted at each project site. The review process was designed to specify environmental impacts characteristic of each project site attributable to either construction or operational phases of project implementation. The mitigation options are aligned with the general mitigation recommendations specified in the PEA.

The Environmental Management Plans (EMP) consists of a set of mitigation, monitoring, and institutional measures to be taken into account during implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. The plans also include actions needed to implement these measures. EMPs identify feasible and cost-effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels. Specifically, the EMPs include the following:

- (a) Summaries of all anticipated significant adverse environmental impacts (including those involving indigenous people or involuntary resettlement);
- (b) Descriptions (with technical details) of each mitigation measure, including the type of impact to which it relates and the conditions under which it is required (e.g., continuously or in the event of contingencies), together with designs, equipment descriptions, and operating procedures, as appropriate;
- (c) Estimates of any potential environmental impacts of these measures; and
- (d) Linkages with any other mitigation plans (e.g., for involuntary resettlement, indigenous peoples, or cultural property) required for the project.

The monitoring section of the EMP provides the following information:

- (a) A specific description and technical details of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions; and
- (b) Monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures.

It was assumed that a legislative and regulatory framework is identical for all projects and was already discussed in the Programmatic Environmental Assessment for the Rural Energy Program. Obtaining accurate natural resource, ecological health and employment-related statistics in any part of Georgia is extremely difficult. Also, local hospitals and other institutions do not keep health records and are unwilling to discuss or acknowledge health problems. For these reasons, it was not been possible to analyze any data related to public health issues including environmental and occupational health statistics in the project communities.

2. KABALI SMALL HYDROPOWER PROJECT (KABALI COMMUNITY)

Kabali SHP had been examined and included in the PEA report prepared in March 2006. The specific project environmental impact categories and mitigation recommendations were identified during a second site visit completed by the Rural Energy Program environmental team in December 2006. The proposed mitigation measures are in line with the common recommendations outlined in the PEA.

The Kabali SHP is located on the left bank of the Kabali River, eight kilometers from the village of Baisubani in the Lagodekhi district of the Kakheti Region in Eastern Georgia.

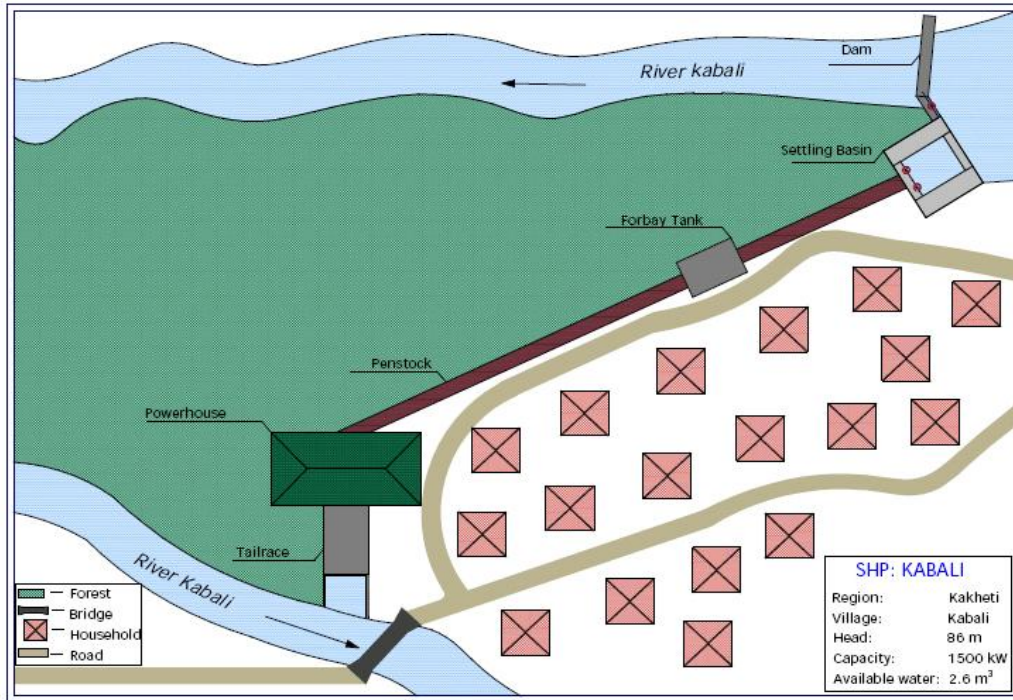
Figure 1. Location of Kabali SHP in East Georgia



The Kabali SHP was built in the early 1950s and began operation in 1953. From 1953 till 2001 the hydropower plant supplied 1,500 kW of electricity to the surrounding villages. The plant was closed in 2001. The current owner of the Kabali hydropower plant is Kablihesi 2006 Ltd, who bought all assets from Elektrokompania Ltd in 2006. In 2001, the owner of the project financed minor renovation works of the three turbine/generator units.

The layout of the area surrounding the facility is presented in Figure 2 below.

Figure 2. Layout of the Kabali Small Hydropower Plant



Headwork's



Penstock (in riverbed)



Turbine-Generators, Powerhouse

Planned project works are outlined in the Kabali Business Plan prepared by the Rural Energy Program engineering team in cooperation with the project owner.

The Rural Energy Program engineering team visited the site and summarized the status of the hydropower infrastructure as follows:

- The low height diversion weir is 5.4 meters high and 66 meters long. The weir is equipped with an emergency spillway and flow-regulating gate.
- A tyrol-type settling basin with the bottom based flashing facility is 3 meters high, 4 meters wide and 22 meters long. This structure has a second water inlet to allow the plant to continue to operate with limited capacity when repair works are needed for the diversion weir. The settling basin is equipped with the trash rack and flashing and flow regulating gates. The settling basin serves as a forebay tank as well.
- Water from the settling basin flows into the 2,300-meter long, and 1100-mm in diameter penstock, which conveys water to the horizontal setting hydro units in the powerhouse.
- Water is discharged back to the Kabali River through the 190-meter long tailrace.

The project design documents specify the following activities to be completed at the project site:

- Rehabilitation of the powerhouse (repairing of the roof, walls, and floor, installing of a glass wall in the control room) and cleaning and improving the powerhouse yard;
- Rehabilitation of the hydro-mechanical equipments;
- Rehabilitation of the weir;
- Rehabilitation of the tyrol-type water intake dam;
- Repair of the settling basin and spillway;
- Repair of the emergency spillway, flashing and flow regulating gates;
- Rehabilitation of the penstock (arrangement of a flood protection wall for penstock);
- Rehabilitation of the access road (from the SHP building to the headwork's (about 100 m distance);
- Rehabilitation of the tailrace;
- Cleaning the river bed in the upper and lower pools of the dam;
- Restoration of the switch yard;
- Extending a portable water pipeline to the SHP territory; and
- Electrical wiring.

Civil works associated with the rehabilitation of the low height diversion weir include the following activities:

- De-watering the intake pool using gabions or soil embankments. This action will allow drying of the section of the weir for the rehabilitation works;
- Removing debris from the de-watered section;
- Constructing wooden forms into which concrete will be poured and adding steel bars as required by the design;
- Removing and repairing the water intake and emergency spillway gates;
- Removing wooden forms after concrete is dry and set;
- On-site concrete mixing and forming;
- Reinstalling the water intake and emergency spillway gates;
- Collecting and disposing all debris, construction waste, scrap and remaining construction materials in designated disposal sites.

The water intake which represents a concrete pool with a number of emergency and flow regulating gates requires the following rehabilitation:

- Removing debris from the water intake pool;
- Constructing wooden forms for concrete and adding steel bars as required in the design;
- Removing all gates and sending them for repairs;
- Removing wooden forms after concrete is dry and set;
- Performing concrete testing;
- Installing the repaired water flow regulating gate;
- Performing testing of the water intake pool for leaks by filling it with water and closing the gate;
- In case of minor leaks, filling in the gaps with concrete;
- Disposing of all debris, scrap and left over construction materials in a designated disposal site; and
- Equipping the settling basin with safety handrails or netting fences.

The above-listed works shall be started and completed within the same timeframe, as the diversion weir works. This will assure that, in the event of flooding during the repair of the diversion weir, the rehabilitated system will be able to absorb some of the flood flow.

Kabali SHP penstock requires rehabilitation. The quality of the metal in the penstock will be inspected and weaker sections shall be replaced according to the instructions in the technical design. The penstock was damaged during recent flooding. In order to prevent future damage, it is planned to conduct the riverbed along the penstock and construct flood protection gabions of 600 m length. The penstock rehabilitation includes following activities:

- Removing the damaged section of the penstock using gas-welding equipment;
- Welding of the new sections using mobile electric welding machine;
- Reinforcing the supports of the penstock according the instruction in the design;
- After completion of the above-mentioned works, re-watering penstock and monitoring for a specific period of time (two days +/-) to identify and repair the leaks;
- Painting the penstock using water-based anticorrosion paint; and
- Disposing all debris, scrub and left over construction materials in an approved manner.

The tailrace at the Kabali SHP needs rehabilitation including the following activities:

- De-watering the joint section between the pipeline and canal gabions. This action will allow drying of the section for the rehabilitation works;
- Removing debris and sedimentation from the canal and tailrace;
- Constructing wooden forms for concrete and adding steel bars as required by the design;
- Removing wooden forms and waiting until concrete is dry and set;
- Testing concrete using special test equipment;
- Filling the tailrace and canal with water and testing for leaks;
- In case of minor leaks, filling in the gaps with concrete; and
- Disposing of all debris, scrap and left over construction materials at a designated disposal site and in an approved manner; and
- Equipping the tailrace with safety handrails or netting fences.

When all rehabilitation works are completed, the entire hydro system will be re-watered and monitored for a period of time specified in the design to identify and repair leaks.

Installation of electrical equipment: The Kabali SHP project envisages the restoration of the turbines and generator and rehabilitation of the power distribution and control panels. The following works are planned to be conducted:

- Removing of the turbines and sending their parts for repairs: casing, runner, shaft, bearings, flywheel, and governor. The draft tube and base plate may require repair in the powerhouse. The generator may be removed and sent for rewinding;
- Replacing the old wiring with the new one;
- Removing the old and non-functioning equipment and replacing it with modern, more efficient equipment;
- Repairing of the transformers, feeders, bus bars, transmission poles, and power lines;
- Securing the territory of the powerhouse with proper fencing and safety signs indicating types of potential hazards; and
- Posting high voltage signs to indicate a threat of electrocution in the powerhouse and on the powerhouse and switch yards.

Table 1. Electrical Equipment to be Installed at the Kabali SHP Project

Stationary Equipment
Generator
Regulator
Control DC board
Battery station with charging device
Unit control equipment

3. ENVIRONMENTAL REVIEW

The Rural Energy Program environmental team visited the site in December 2006 to assess the current environmental conditions and complete the screening analysis of potential environmental impacts. The following sections contain an analysis of the significance of the various potential environmental impacts associated with the project, and, where applicable, describe the mitigation measures (including monitoring) which are needed to address the identified impacts.

The results of the screening exercise at the Kabali SHP project site are presented in Annex 1.

Issues which were determined to be insignificant or irrelevant following the screening analysis (in compliance with the significance criteria outlined in the PEA) are shown in Table 2 below.

Table 2: Potential Environmental Impacts Excluded From Further Analysis

Construction Phase	
Issues	Reasons for Exclusion
Disruption to wildlife or sensitive ecological habitats	Rehabilitation of the existing scheme and no significant habitats in the vicinity
Disruption of local movement and access to roads	Most works will be away from village roads and relatively of small-scale
Operational Phase	
Disturbance or threat to important ecological habitats, including protected ecosystems (e.g. national parks)	Rehabilitation of the existing infrastructure and no significant habitats in the vicinity
Salt water intrusion	Not applicable
Impediment to movement of livestock and humans	Rehabilitation of the existing infrastructure, and no activities that hinder movement of livestock and human are planned
Threat to historic, cultural and aesthetic sites and features	Rehabilitation of the existing infrastructure, and no land acquisition
Disruption of fisheries	No fish of commercial importance present

Based on the conducted environmental review including environmental screening of the Kabali SHP project site, significant environmental impacts related to the assessed environmental aspects are identified and presented below.

It is necessary to note that the identified impacts have moderate to low probability for occurrence. Thus such impacts should be mitigated and prevented through following best management, construction and operational practices. The Mitigation Plan for the Kabali SHP outlines major mitigation activities associated with each impact.

Below there is a list of environmental impacts that were identified as moderate or significant for each environmental aspect proposed in the PEA. The impact list is accompanied with a set of measures recommended to mitigate the impacts.

1) Geology and Soil

Construction:

- ✚ Moderate to low impact from disturbance of topsoil and aggravation of erosion during the construction phase. Technical design, envisages earth excavation activities of approximately 250-300 m³ of soil for canal and forebay tank clean-up works. Minor quantities of the locally available river gravel will be

used in construction activities as an addition to cement, construction gravel and sand mixture.

Mitigation measures:

- ✚ Proper landscaping of slopes and replanting vegetation.

Construction:

- ✚ The Kabali SHP might have some geological impact during the construction of the low head weir.

Mitigation measures:

A geological study of the project has already carried out and results are attached in Annex C. Geological study address following issues:

- ✚ Evaluation the site suitability for construction of a small hydropower facility.
- ✚ Providing recommendations on types of construction materials to be used.
- ✚ Classification of the soil layer's strength to assess potential for geological hazards (e.g. landslide).
- ✚ Providing recommendations on adequate river bank protection in the catchment area to prevent erosion.

Operation:

- ✚ Moderate to low impact of soil contamination during the operation activities. This impact is related to improper handling of chemicals, lubricants and transformer oils during the operation.

Mitigation measures:

- ✚ Regular checking for oil leaks in the machinery.
- ✚ No machinery washing at the site.
- ✚ Subcontracting professional services for regular oil change in transformers.

2) Water Resources

Construction:

- ✚ Increased Turbidity Downstream of the Headworks Construction. Construction activities require excavation, removal and movement of soil, gravel and rocks from the riverbed (i.e. creating embankments), and concrete mixing (i.e. large construction areas). The above activities will potentially generate high levels of suspended solids that will increase turbidity downstream of the weir.
- ✚ Increased Erosion of the Kabali River Stream. Construction activities at the headworks involve excavation, removal and movement of soil, gravel or rocks from the riverbed (e.g. create new embankments) and impoundments. A significant amount of concrete mixing is needed as well (i.g. large construction areas). These activities will potentially increase erosion of the river stream (in

case the excavated soil is piled inappropriately). This in turn may increase sedimentation of the waterway and generate changes to the floodplains.

Mitigation Measures:

- ✚ Avoid blocking stream flow during construction to eliminate the potential for flooding upstream to the weir and to increase the level of suspended solids coming from the floodplain.
- ✚ Avoid stockpiling soils on the river banks and the floodplains to minimize soil moving through run-off.
- ✚ Use concrete blocks instead of soil (where feasible) for temporary stream diversion to reduce soil movement and stream sedimentation.
- ✚ Restore landscaping and replant vegetation at the river bank and within the riparian ecosystem to its original form.
- ✚ Employ proper drainage techniques to prevent surface submersion.
- ✚ Avoid construction during wet seasons where possible; activities should be scheduled to reduce the duration of construction during the wet season.

Operation:

- ✚ Reduced conservational value of the Kabali River. During the operational phase water is diverted to the Kabali SHP. This will reduce the water flow between the diversion gates and the tailrace. The reduction of water flow in this segment of the river might cause changes in the flooding pattern as well as adverse impacts on the fish population, especially in the dry season. After rehabilitation of the Kabali SHP it is planned to expand electricity generation capacity by 500 kW, thus more water will be diverted to the SHP, which might aggravate the impact.
- ✚ Increased turbidity downstream of the weir: regular maintenance of the facility requires cleaning of weir from sediments once a year. Above activity will release soil and debris downstream and increase turbidity.

Mitigation measures:

- ✚ Use best management practices to preserve water quality during maintenance activities (e.g. provision of silt traps, stockpiling of soil and debris taken from the weir away from riverbanks, maintaining as much as possible of the riparian vegetation, etc).
- ✚ Proper scheduling of activities: planning maintenance activities during the dry season to minimize erosion and scheduling the placement of sediment capturing devices and key runoff control measures before major land disturbing activities to minimize sediment release.
- ✚ Use biodegradable compounds for pipe/tunnel cleaning, watershed treatment etc.

3) Biological Resources

Construction:

- ✚ Impact on Fish Spawning. If the construction activities are scheduled for the spring (May-June) and beginning of the fall season (September – October),

these works can disrupt fish spawning in the area, creating a negative effect on the fish population.

- ✚ Impact on the aquatic species. The construction phase involves temporary diversion of the stream from the weir. Blocking of the stream flow will dry the canal between the weir and the tailrace discharge point, which will cause significant impact on the aquatic species.

Mitigation measures:

- ✚ Maintain a minimal sustainable river flow (minimum ecological flow) to sustain the river hydrology pattern, water quality, existing fish population and wildlife (according to seasonal fluctuations in flow levels).
- ✚ Maintain minimum wet channel perimeters at all control structures with a constant flow in the river throughout the year.
- ✚ Avoid construction works during the fish spawning period.

Operation:

- ✚ Loss of Fish: The planned hydro-electrical system diverts a portion of the Kabali river flow from the weir to the turbine. Juvenile fish that passes through the turbine (entrainment) may be killed in the turbine. Both juvenile and potentially some adult fish might be affected by impingement against water intake structures and fish screens. The trout (*Salmo fario*) species listed in the Red Book of Georgia is present in the Kabali River. Therefore, the operation phase of the Kabali SHP project is anticipated to result in moderate and potentially significant impacts on juvenile fish.
- ✚ Impact on aqua fauna. A portion of the water flow will be diverted from the weir to the powerhouse, significantly reducing the river flow. Not maintaining a minimum river flow (especially in the dry season) would adversely affect the fish population.

Mitigation measures:

- ✚ Install fish screens at the intake to the canal where water is diverted from the river's natural course. The mesh in such screens is about 3 mm x 3 mm. It will prevent all larger fish and most small fish from entering the canal and the penstock. The screens require periodic cleaning from dirt and debris by the operator.
- ✚ Maintain a minimal sustainable river flow (minimum ecological flow) to sustain the river hydrology, water quality, existing fish population and wildlife (according to seasonal fluctuations in flow levels).
- ✚ Maintain minimum wet channel perimeters at all control structures with a constant flow in the river throughout the year.

4) Human Resources

Construction:

- ✚ Impact on the Kabali Community from Construction Activities (including the presence of temporary workers on the site). Local population can be disrupted during the construction phase from the increased transport traffic and the presence of temporary employees working at the site.

- ✚ Increased probability of work related injuries to workers and local population during the construction activities.
- ✚ Damage to workers/or inhabitants and to infrastructure due to the flooding. Flash floods occur during the summer and autumn periods in the Kabali River. Floods could pose a threat to workers as well as damage/or destroy the forms in which concrete would be poured, as well as gabions and soil embankments and other on-site equipment.

Mitigation measures:

- ✚ Establish and adhere to construction timetables to minimize disruption to normal activities at or in the vicinity of the construction area.
- ✚ Coordinate truck trafficking and other construction activities to minimize noise, traffic disruption and dust.
- ✚ Avoid construction during the wet season (where possible). If it is not feasible (because of the Kabali SHP project timeframe) activities should be scheduled to reduce the duration of construction during the wet season.

Operation:

- ✚ Increased probability of work related injuries and death for the plant personnel and the general public in case operation safety measures are not implemented.

Mitigation measures:

- ✚ Follow state safety regulations and guidelines, and implement best management practices. The REP Team has also prepared a list of safety equipment for mandatory installation at the SHPP. The list is presented in Table 3.

5) Waste materials

Construction:

- ✚ Pollution of Environment with Construction Waste. Construction related activities such as excavation, removal and movement of soil and concrete mixing; installation of electrical equipments etc. will generate certain amount of construction wastes.

Mitigation measures:

- ✚ Segregate waste that can be re-used; If re-using of wastes is not feasible, take waste materials to appropriate, designated local disposal areas;
- ✚ Minimize burning of waste materials;
- ✚ If waste will be buried on site, avoid siting burial pits up-gradient of the drinking water sources such as wells. Pits should be lined with impermeable materials.

Table 3. Personal Safety Equipment

SAFETY EQUIPMENT – MANDATORY

Hard Hats

Eye Protection - Goggles

Safety Shoes

Work Gloves

Respirators

First Aid Kit (for 50 people)

Oil Absorbing Pads 15X19in minimum weight 100 per case ABS 24,7 gallons quantity boxes

Orange Vests

Harness for Personnel (inspections/dam work)

4. MITIGATION PLAN

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
Repair of the intake pool and rehabilitation of the dam and the head-works	Injury to contractors workers and other persons during works	Moderate – Possible	Safe working procedures to be followed by contractor	Contractor, Kabali Community Organization	Verify applicability of written safe working procedures. <i>Ad hoc</i> inspection of works	REP Program, Kakheti Regional Environmental Office/ SHE Officers; REP Program	Negligible – Unlikely
	Injury to contractors workers and others from unsafe storage of waste	Moderate – Possible	All waste material to be stored in a secure, designated area prior to removal to a designated waste landfill site	Contractor, Kabali Community Organization	<i>Ad hoc</i> inspections	REP Program, Kakheti regional Environmental Office / SHE Officers; REP Program	Negligible – Unlikely
	Soil contamination from spilled chemicals, liquid concrete, other liquid materials	Moderate – Possible	Best management practices are implemented by construction contractors	Kabali Community Organization, Contractor	<i>Ad hoc</i> inspection of the construction site	REP Program	Negligible – Unlikely
	Water and soil pollution (visual and other) caused by improper disposal of waste materials	Moderate – Possible	Waste to be disposed of at a designated waste landfill site	Kabali Community Organization, Contractor	<i>Ad hoc</i> inspections	REP Program, Kakheti Regional Environmental Office; REP Program	Negligible – Unlikely
	Disturbance to residential areas caused by noise generated during installation	Moderate – Probable	Installation to be scheduled during normal weekday working hours only.	Kabali Community Organization, Contractor	<i>Ad hoc</i> inspections	REP Program, Kakheti Regional Environmental / SHE Officers; REP Program	Moderate – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Increased downstream turbidity in the river	Moderate -- Probable	Avoiding blocking stream flow during construction, Using concrete forms rather than soil as temporary stream diversions, Avoiding stockpiling soils in river banks and the floodplain; Replacing topsoil along the river bank and restoring the riparian ecosystem and land contours to their original condition,	REP Program, Contractor	<i>Ad hoc</i> inspections	REP Program, Kakheti Regional Environmental Office	Moderate – Possible
	Increased erosion of river/stream	Moderate -- possible	Avoiding blocking stream flows; Using concrete blocks rather than soil as temporary stream diversions; Avoiding stockpiling of soil; Scheduling maintenance activities during dry season; Using erosion control measures such as bales to prevent run—offs; Minimizing the use of heavy machinery	Kabali Community Organization, REP Program, Contractor	<i>Ad hoc</i> inspections to the site	REP Program, Kakheti Regional Environmental Office	Low – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Increased flooding	Moderate -- possible	Work schedules during dry seasons;	REP Program, Contractor	<i>Ad hoc</i> inspections, scheduled inspection	REP Program, Kakheti Regional Amelioration of the Ministry of Agriculture	Moderate – Possible
	Damage to fish stock including disruption of fish spawning	Moderate -- possible	Arrangement of fish by-passes for migrating fish; installation of net fish screens to prevent entrance to the supply canal and penstock; maintain a minimal ecological flow in the river.	REP Program, Contractor	REP Program, then periodic inspections by operator	REP Program, Kakheti Regional Environmental Office	Moderate – Possible
Repair of the penstock	Pollution (visual and other) caused by improper disposal of waste materials	Moderate – Possible	Disposal of waste at a designated waste landfill site	REP Program, Contractor	<i>Ad hoc</i> inspections	Kakheti Regional Environmental Officer, REP Program	Negligible – Unlikely
	Injury to contractors workers from construction equipment	Moderate - Probable	Workers must follow safety guidelines and if necessary wear protective gear	REP Program, Contractor	<i>Ad Hoc</i> inspections	Kakheti Regional Environmental Office/ SHE Officers, REP Program	Negligible – Unlikely
Modern. of powerhouse including replacement of auxiliary equipment	Injury to contractors workers and other persons during works	Moderate – Possible	Safe working procedures to be followed by contractor	Contractor	Verify applicability of written safe working procedures. <i>Ad hoc</i> inspection of works	REP Program, Kakheti Regional Environmental Inspectorate, SHE Officers	Negligible – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Injury to contractors workers and others from unsafe storage of waste	Moderate - Possible	All waste material to be stored in a secure, designated area prior to removal to a designated waste landfill site	Contractor	<i>Ad hoc</i> inspections	Kakheti Regional Environmental Inspectorate/ SHE Officers	Negligible - Unlikely
	Pollution (visual and other) caused by improper disposal of waste materials	Moderate - Possible	Waste to be disposed of at a designated waste landfill site	Kabali Community Organization, Contractor	<i>Ad hoc</i> inspections	Kakheti Regional Environmental Inspectorate	Negligible – Unlikely
	Disturbance to occupiers and nearby residential areas caused by noise generated during installation of electrical equipment	Moderate - Probable	Installation to be scheduled during normal weekday working hours only.	Kabali Community Organization ,Contractor	<i>Ad hoc</i> inspections	REP Program Kakheti regional Environmental Inspectorate SHE Officers	Moderate – Possible
			Equipment is to be installed only within suitable buildings/ powerhouse (not outside)	REP Program, Contractor	Inspection at commencement of works	Kakheti Regional Environmental Inspectorate, SHE Officers	Negligible – Unlikely
Operation of the Kabali SHP facility	Oil pollution of soil and water during SHPP operation	Moderate – Likely	Daily checks of machinery for leaking oil	Facility Operator	<i>Ad hoc</i> inspection	Kakheti Regional Environmental Inspectorate	Minor – Possible
			No washing of machinery at the site, no oil change at the site	Operator	<i>Ad hoc</i> inspection	Kakheti Regional Environmental Inspectorate	Minor – Possible

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Disruption of fish spawning and increased juvenile fish mortality	Moderate – Possible	Reduce plant load to maintain minimal ecological flow in the river, during the spawning season; Installation of net fish screen to prevent entrance to the penstock	Operator	Periodic inspection	REP program, Kakheti Regional Environmental Inspectorate	Negligible – Unlikely
Restoration of the switch yard and electrical lines	Damage to eco-systems, or habitats as a result of installation of new poles	Moderate – Possible	Selection of new line routes (if any) to avoid sensitive habitats	Design Consultant and contractor	Regular inspection of construction sites and operation zones	Kakheti Regional environmental Inspectorate	Negligible – Unlikely
	Loss of topsoil leading to increased soil erosion	Moderate – Probable	Separation of topsoil and subsoil during pole installation, repair or replacement and replacement of topsoil after the poles are installed	Contractor	Regular inspection of trenching works and other operation zones	Kakheti Regional environmental Inspectorate	Minor – Possible
	Oil pollution of soil and water at construction site	Moderate – Likely	Daily checks of machinery for leaking oil	Contractor	<i>Ad hoc</i> inspection	Kakheti Regional environmental Inspectorate	Minor – Possible
			No washing of machinery at construction site	Contractor	<i>Ad hoc</i> inspection	Kakheti Regional environmental Inspectorate	Minor – Likely
	Noise pollution in village	Moderate – Definite	Works performed strictly during normal weekday working hours	Contractor	<i>Ad hoc</i> inspection	Kakheti Regional environmental Inspectorate	Major – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Visual impact (lines are installed above ground)	Major - Definite	Route alignment to minimize areas of above ground piping	Design consultant	<i>Ad hoc</i> inspection	Regional Environmental Officer	Negligible – Unlikely
	Reduced amenity values of the area	Moderate – Possible	Landscaping and replanting of construction area after the completion of line installation works	Contractor	Regular inspection of completed sections of the pipeline	Oblast / Rayon Environmental Officer	Negligible – Unlikely
Connection of electrical lines to homes / apartments	Damage to Poisoning or explosion due to gas leaks	Major - Possible	Only fully trained personnel to carry out installations according to industry best practice guidance and standards	Utility Company / Contractor	Regular inspections by regulatory authority	Inspector from regulatory authority	Major – Unlikely
		Major - Possible	Safety information to be given to householders	Utility Company / Contractor	Regular inspections	Inspector from regulatory authority	Major – Unlikely
			Trained professional to inspect, clean, and adjust equipment every year	Utility Company / Contractor	Follow up inspections	Inspector from regulatory authority	

5. MONITORING PLAN

The Monitoring Plan presents a number of criteria against which monitoring indicators are set.

Monitoring Categories

Criteria	Descriptor	Evidence
<p>Regulatory Compliance:</p> <p>The facility complies with the requirements of national environment, health and safety laws and regulations.</p>	<p>The facility, or proposed facility, has all the necessary permissions and permits required under Georgian national laws and regulations.</p>	<ul style="list-style-type: none"> The project owners have obtained all required construction and operation permits and licenses including an environmental permit. The REP Program in cooperation with the project owner prepared the Programmatic Environmental Assessment and developed an environmental management plan per requirement of the project sponsors (USAID, EBRD).
<p>Water Flow:</p> <p>The facility maintains a minimum ecological flow in the river that is adequate for the existing fish population, wildlife and water quality taking into account seasonal fluctuations in flow levels.</p>	<ul style="list-style-type: none"> Maintain minimum wetted channel perimeters, at all control structures, with a constant flow in the river throughout the year. Facility operation schedules are based on the minimum ecological flow required to sustain the existing environment. 	<ul style="list-style-type: none"> The project owner has obtained a water use permit Ecological-sanitary flow of the Kabali River has been determined (which is equal to $Q_{san}=0.30m^3/sec$) Periodic measuring of the water flow rate to assure that the minimal ecological flow is maintained.
<p>Water Quality:</p> <p>The facilities operations do not contribute to the deterioration of water quality either upstream or downstream of the facility.</p>	<p>The facility has minimal impact on water quality at the head-works, canal, tailrace and diversion dam.</p>	<p>Best management practices on hydropower construction are followed. The facility will not contribute to the deterioration of water quality after the completion of the construction activities.</p>
<p>Fish Passage and Protection:</p> <p>The facility had minimal impact on local fish populations, provides effective fish passage for local and migrating fish species and also protects fish from entrainment.</p>	<ul style="list-style-type: none"> There should be minimal loss of fish or fish habitat. Facility preserves fish population. Facility construction and operation do not limit fish movement, migration and spawning. Flows at the intake and downstream of the tailrace are adequate to support aquatic and riparian species in the facility area. 	<ul style="list-style-type: none"> Information has been gathered on both the local and migratory fish populations; The project design includes fish screens; The project design includes adequate mitigation measures to ensure that fish protection criteria are met.
<p>Watershed Protection:</p> <p>The facility does not negatively impact environmental conditions in the watershed.</p>	<ul style="list-style-type: none"> The facility does not affect the integrity of the existing ecosystem either upstream or downstream of the facility. Facility components and infrastructure (e.g. access roads, power lines, and generation facilities) have minimal impact on the riparian environment. 	<ul style="list-style-type: none"> An assessment of impacts associated with additional components has been made. An assessment of upstream and downstream impacts has been made. Adequate mitigation measures have been provided to ensure the eligibility criteria are met.

<p>Threatened & Endangered Species Protection:</p> <p>The facility does not negatively impact any threatened or endangered species nor any areas designated for their protection.</p>	<ul style="list-style-type: none"> • The facility is not constructed on a protected or sensitive river. • The facility does not threaten or harm the habitat or migratory routes of endangered species. • The facility has no significant impact on the existing wildlife habitat and populations. 	<ul style="list-style-type: none"> • Sensitive or protected areas on or around the river have been identified. • Endangered or threatened species present in the area of, or downstream from, the facility have been identified. • The REP environmental team has assessed the potential impact of the facility on any such area or species. • The project design provides for adequate mitigation measures to ensure that the criteria are met.
<p>Recreation:</p> <p>The facility does not stop or limit recreational uses of the river.</p>	<p>Access to the water remains unchanged with the facility and accommodates recreational activities on the river.</p>	<p>Identification of any current recreational uses of the river around the site and confirmation that these uses will not be affected by the development of the facility.</p>
<p>Cultural Issues:</p> <p>The facility does not inappropriately impact cultural property</p>	<p>Cultural property includes sites having archaeological (prehistoric), paleontological, historical, religious and unique natural values. Cultural property includes remains left by the previous human inhabitants and unique natural features such as canyons and waterfalls.</p>	<p>No cultural sites or property in the vicinity of the facility has been identified.</p>
<p>Community Issues:</p> <p>The facility does not reduce local community use of either the river or the surrounding lands.</p>	<p>The facility does not prevent or limit the local community from access to the river as a communal leisure amenity, and the irrigation facility</p>	<ul style="list-style-type: none"> • Local community uses of the river have been identified. • The locally affected community has been notified and consulted prior to the development of the facility. • Adequate mitigation measures have been agreed to ensure that eligibility criteria are met.

ANNEX A. ENVIRONMENTAL SCREENING OF THE KBALI PROJECT SITE

1) General Information

Project Name	Kabali SHP
Type of project	Rehabilitation
Location (district / region)	Region - Kakheti
Ownership	Private (Giorgi Bibiluri)
Surrounding Present Land Use	[<input checked="" type="checkbox"/>] Agriculture [<input type="checkbox"/>] Residential [<input type="checkbox"/>] Tourism [<input type="checkbox"/>] Industrial [<input checked="" type="checkbox"/>] Forest Land [<input type="checkbox"/>] Institutional [<input type="checkbox"/>] Commercial [<input type="checkbox"/>] Open Spaces [<input type="checkbox"/>] Others, pls. Specify : State lands
Installed Capacity (kW)	1500
Project Cost (USD)	\$350, 000

2) General Construction Activities

Is there and impact because / to	Construction	Operation and Maintenance
Construction / rehabilitation of structures and buildings?	Y	N
Construction / rehabilitation of access roads?	N	N
Construction / rehabilitation of transmission lines?	N	N
Temporary sites used for construction works or housing of construction workers?	Y	N
Significant risk associated with waste transport?	N	N
Inadequate waste disposal facilities?	Y	N
Include grading, trenching, or excavation > 1.0 hectares	N	N
Conducted near geologic hazards (faults, landslides, liquefaction, un-engineered fill, etc)?	N	N
Require offsite overburden / waste disposal or borrow pits >1.0 ton?	N	N
Cause loss of high quality farmlands > 10 hectares	N	N
Require the use of dangerous / hazardous substances (e.g. oil, lubricants, chemicals; pls. Specify)?	Y	Y
Require an oil / lubricants collection and disposal system?	Y	Y
Increase vehicle trips > 20% or cause substantial congestion?	Y	N
Cause or contribute to safety hazards?	Y	Y
Inadequate access or emergency access for anticipated volume of people or traffic?	N	N
Produce solid wastes during construction or operation or decommissioning?	Y	N
Involve actions that will cause physical changes in the locality (topography, land use, changes in water bodies, etc)?	Y	Y

3) Geology and Soils

Is there and impact because / to	Construction	Operation and Maintenance
Earthquakes, subsidence, landslides or erosion?	N	N
Movement of soil?	Y	N
Rates of erosion or siltation by wind or water?	N	N
Management of excess soil or spoil material (from mining)?	N	N
Physical degradation of the local environment?	N	N

4) Water Resources

Is there and impact because / to	Construction	Operation and Maintenance
Risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal waters or the sea?	Y	N
Run-off as a result of the hardening of surfaces, or loss of the sponge effect of vegetation?	N	N
Flooding or extreme or adverse climatic conditions?	Y	Y
Ability to absorb run-off?	N	Y
Changes to flood plains?	N	N
Quantity of surface water, groundwater or public water supplies?	N	N
Threats to hydrological functioning through existing or altered water extraction?	N	N
Withdrawals from or discharges to surface or ground water?	N	N
Threats through existing or altered impoundment construction?	N	N
Conservational or recreational value of rivers, streams, lakes, wetlands, dams or islands?	N	N
Threats through existing or altered pollution?	N	N
Threats through existing or altered turbidity?	N	Y
Threats through existing or altered agricultural run-off?	N	N
Threats through existing or altered chemical processes or nutrient balances?	N	N
Threats through existing or altered changes in sediment flows and siltation rates?	N	N
Changes through existing or altered canalization?	N	Y
River, stream or lake onsite or within 30 meters of construction?	Y	Y
Excavation or place of fill, removing gravel from a river, stream or lake?	Y	Y
Onsite storage of liquid fuels or hazardous materials in bulk quantities?	N	N
Decreased water flow that may change the flooding regime, resulting in the destruction of wetlands?	N	N
Decrease in downstream water flow that may affect downstream users (human, fisheries, and wildlife)?	N	Y

5) **Biological Resources**

Is there and impact because / to	Construction	Operation and Maintenance
Important, high quality or scarce resources that could be affected by the project?	N	Y
Located in a Protected Area or Wildlife Corridor?	N	N
Inundate or remove wetland habitats?	N	N
Survival of rare or endangered plant species?	N	N
Diversity of plant communities?	N	N
Vegetation communities of conservation or scientific importance?	N	N
Natural replenishment of existing species?	N	Y
Firewood collection?	N	N
Overexploitation of biological resources?	N	N
Survival of rare or endangered animals?	N	Y
Diversity of animal communities?	N	N
Natural migration of species?	N	Y
Introduction of alien species?	N	N
Loss of native species or genetic diversity?	N	N
Vegetation removal or construction in wetlands or riparian areas > 1.0 hectare?	N	N
Use of pesticides / rodenticides, insecticides, or herbicides > 1.0 hectare?	N	N
Construction in or adjacent to a designated wildlife refuge?	N	N
Decreased water flow that may change the flooding regime, resulting in the destruction of wetlands?	N	N
Decrease in downstream water flow that may affect downstream users (human, fisheries, and wildlife)?	N	Y
Re-entry pipe cause increased scouring of stream bank where water is returned to the stream?	N	N
Flora and / or fauna of ecological or commercial significance to be found?	N	N

6) Socioeconomic Issues

Is there and impact because / to	Construction	Operation and Maintenance
Existing settlements in the vicinity of the proposed project?	Y	Y
Existing land uses on or around the project that could be affected by the project?	N	N
Areas on or around the location of the project that are already subject to pollution or environmental damage?	N	N
Permanent or temporary change in land use, land cover or topography including increases in intensity of land use?	N	N
Social infrastructures located in or near the project area (e.g., schools, health canterers / clinics, places of worship, others?)	N	N
Be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslide etc)?	N	Y
Social acceptability of the project (community, government, non-governmental organizations)?	Y	Y
Visual and odor effects of waste sites?	N	N
Risk to the community and the local environment should the facility break down?	N	Y
Potential conflict with adjacent land uses?	N	N
Non-compliance with existing codes, plans, permits or design factors?	N	N
Construction in national park or designated recreational area?	N	N
Relocation of >10 individuals for +6 months?	N	N
Interrupt necessary utility or municipal service > 10 individuals for + 6 months?	N	N
Loss or inefficient use of mineral or non-renewable resources?	N	N
Noise levels > 5 decibels for + 3 months?	N	N
Adverse visual impact when compared to the surrounding natural landscape?	N	N
Affect future land uses on or around the location?	N	N
Are there any areas on or around the location that are densely populated or built-up, which could be affected by the project?	N	N
Highly visible to many people?	N	N
Lead to pressure for consequential project that could have significant impact on the environment (erg more housing, new roads, new supporting industries or utilities, etc)?	N	Y
Cumulative effects due to proximity to other existing or planned projects with similar effects?	N	N
Social changes, for example, in demography, traditional lifestyles, and employment?	Y	Y

7) Cultural Issues

Is there and impact because / to	Construction	Operation and Maintenance
Prehistoric, historic, or paleontological resources within 30 meters of construction?	N	N
Unique cultural or ethnic values at the site?	N	N

8) Public Health issues

Will the project affect...	Construction	Operation and Maintenance
human or community health or welfare?	Y	Y
The quality or toxicity of air, water, foodstuffs and other products consumed by humans?	N	N
Morbidity or mortality of individuals, communities or populations by exposure to pollution?	Y	Y
Occurrence or distribution of disease vectors including insects?	N	Y
Vulnerability of individuals, communities or populations to disease?	N	Y
Individuals' sense of personal security?	Y	N
Community cohesion and identity?	N	N
Cultural identity and associations?	N	N
Minority rights?	N	N
Housing conditions?	N	N
Employment and quality of employment?	Y	Y
Economic conditions?	Y	Y
Social institutions?	Y	Y
Cause accidents that could affect human health or the environment?	Y	Y
- From explosions, spillages, fires etc?	Y	Y
- From storage, handling, use or production of hazardous or toxic substances?	Y	Y
Be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslip, etc)?	N	N
Vulnerable groups of people who could be affected by the project (e.g. hospital patients, the elderly)?	Y	Y

9) Air Quality

Is there and impact because / to	Construction	Operation and Maintenance
Onsite air pollutant emissions?	Y	N
Violation of applicable air pollutant emissions or ambient concentration standards?	N	N
Vehicle traffic during construction or operation?	Y	N
Demolition or blasting for construction?	N	N
Odor during construction or operation?	N	N
Alteration of microclimate?	N	N
Release pollutants or any hazardous, toxic or noxious substances to air?	Y	N
- Emissions from combustion of fossil fuels from stationary or mobile sources?	Y	N
- Emissions from materials handling including storage or transport?	N	N
- Emissions from construction activities including plant and equipment?	Y	N
- Dust or odors from handling of materials including construction materials, sewage and waste?	Y	N
- Emissions from burning of waste in open air (e.g. slash material, construction debris)?	N	N

10) Noise and Vibration

Is there and impact because / to	Construction	Operation and Maintenance
Noise and vibration or release of light, heat energy or electromagnetic radiation?	Y	Y
- From operation of equipment (e.g. engines, ventilation plant, crushers)?	Y	Y
- From construction or demolition?	Y	N
- From blasting or piling?	N	N
- From construction or operational traffic?	Y	N
- From sources of electromagnetic radiation?	N	N

ANNEX B. PHYSICAL AND SOCIO-ECONOMIC ENVIRONMENT

1. Physical Environment

The Kabali River represents a left tributary of the Alazani River, which belongs to the Caspian Sea Basin. The Caspian Sea Basin is located in the eastern part of the country and influences the region's drier climate. The main rivers of the Caspian Sea Basin include the Kura River with its tributaries, Terek, Alazani and Iori Rivers.

Geology

The Kabali SHP is positioned in the Kakheti region in the Eastern Georgia. The Northern part of the district lies on the southern slopes of the Kakheti Caucasus Mountains. The Alazani River is situated further to the South of the Kakheti Caucasus Mountains (Atlas of Georgia, 1964).

The Alazani Plain consists of alluvial sediments of different origin and nature that accumulated on the surface of a young continental geo-syncline. At the end of the middle Pliocene period the sub-mountainous relief of the Caucasus Ridge consisted primarily of low mountains and hills in the area where the Alazani Plain is located today. This relief experienced tectonic subsidence in the upper Pliocene; a process that continues today. Due to this subsidence, the mountainous-hilly relief has been eroded; its base subsided and was covered by a thick layer of sediments.

Geo Hazards

The territory is considered an active seismic zone. The seismic rating of the region is "nine" (9) on the MKS scale (Map of Seismic Hazard Assessment of Georgia, 2006). Sudden floods (flash floods) may occur, during heavy rains especially in summer / autumn or intense snow and ice melting on the Kabali River (Department of Monitoring and Prognosis, 2005).

Soils

Various soil types are found in different parts of the Kakheti region due to differences in physical, geographical, and climate conditions. On the left bank of the Alazani River sandy, alluvial and non-calcareous soils are most common. On the lowest strip of the first upper terrace near the Alazani River flood plain primarily meadow, alluvial, and carbonate soils swampy in some locations are present. Forest-meadow, alluvial and non-calcareous soils predominate also in the vast areas of the left bank. Toward the mountain strip these soils gradually change into forest brown soils (Map of Soil Types of Georgia, 1999).

Climate

The climatic factors of the Kabali River Basin are determined by the distance from the Black Sea and its orographical conditions. The annual average temperature is 12.6⁰ Celsius. The absolute maximum air temperature is 38⁰ while the absolute minimum point is - 23⁰. The total annual precipitation averages 1076 millimeters with an average wind speed of 11 meters per second (Lagodekhi Meteorological Station).

Hydrology

The source of the Kabali River is located on the Southern slope of the Caucasian Range at the height of 2720. The length of the Kabali River is 48 km, the total drop is 2500 m, the catchments basin area is 291 km², and the average depth is 850 m.

The Kabali River water regime is characterized with floods in spring, flash floods in autumn and summer, unsuitable low water levels in summer and stable low water periods in winter. The average annual discharge rates of the Kabali River are given in Table 1 below (Department of Hydrometeorology of Georgia).

Table 1: The Average Annual Discharge of the River Kabali m³/sec

Section	Fkm ²	Hav	Hmm	Qm ³ /sec Av	Cv	Cs	Provision p %					
							25	50	75	80	90	95
Design	73.9	1625	1360	3.18	0.28	0.56	3.72	3.09	2.54	2.42	2.11	1.88

Vegetation

The village of Kabali is about 20 kilometers from the Lagodekhi Reserve (Map of Protected Areas, WWF, 2005). A large, almost pristine forest area is found in the Lagodekhi district, along with small and isolated patches of degraded flood plain forests. The following plant species are found in the flood plain forest: oak (*Quercus pedunculiflora*), elm (*Ulmus foliacea*), poplar (*Populus canescens* and *Populus nigra*), willow (*Salix excelsa*), and others.

In the upper part of the district near the village of Kabali, the following plant species are present: oak (*Quercus pedunculiflora*), hornbeam (*Carpinus caucasica*), ash (*Fraxinus excelsior*), lime (*Tilia caucasica*), and maple (*Acer campestre*). The sub-forest area is formed by the following species: privet (*Ligustrum vulgare*), medlar (*Mespilus germanica*), dogwood (*Comus mas*), hazel (*Corylus avellana*), etc.

Ground flora is species-poor and consists of several grass species including tor grass (*Brachypodium sylvaticum*), fescue (*Festuca gigantean*), and orchard grass (*Dactylis glomerata*) with a mixture of some widespread taxa such as creeping cinquefoil (*Potentilla reptans*), goldenrod (*Solidago virgaurea*), and others.

The following species found in the vicinity of the village are listed in Georgia's Red Book: ivy (*Hedera pastuchowii*), oak (*Quercus pedunculiflora*) and wild vine grape (*Vitis sylvestris*). The endemic herb species of Georgian woundwort (*Gallantus lagodechianus*) (CITES list) is found in the vicinities of the village of Kabali.

Mammals

The following species were reported in the area: wild cat (*Felis silvestris*), pine marten (*Martes Martes*), fox (*Vulpes vulpes*), jackal (*Canis aureus*), bear (*Ursus arctos*, Red Book of Georgia, National Category-Endangered), badger (*Meles meles*), forest dormouse (*Dryomys nitedula*), mouse (*Apodemus ponticus*, *Apodemus fulvipectus*, *Apodemus uralensis*), and others.

The following species found in the area are included in the IUCN list of rare and endangered species: greater horseshoes (*Rhinolophus ferrumequinum*), little horseshoe (*Rhinolophus hipposideros*), lesser noctule (*Nyctalus leisleri*), Caucasian squirrel (*Sciurus anomalus*), otter (*Lutra lutra*), and lynx (*Lynx lynx*, Red Book of Georgia National category-Critically endangered).

Avifauna

From spring to autumn, the area surrounding the Lagodekhi district and specifically the Alazani Flood Plain, serves as a corridor for migratory birds, providing resting grounds and feeding grounds for these migratory groups. However, the presence of the migratory species was not confirmed near the village of Kabali (Map of Alazani Flood Plain Birds, 2005). Syrian woodpecker (*Dendrocopos syriacus*) is found in the vicinity of the village and is listed in the Red Book of Georgia. Its nesting period is in April (Jordania R, Boeme B, 1999).

Reptiles

According to the available literature, the following were reported species within the Lagodekhi district: snake (*Elaphe quatuorlineata sauromates*), European glass lizard (*Ophisaurus apodus*), slow worm (*Anguis fragilis*), lizard (*Lacerta strigata*), etc. The following amphibians inhabit the area: frog (*Rana ridibunda* and *Hyla arborea*) and toad (*Bufo viridis*) (Alazani Flood Plain Forest Management Plan, 2005).

Fish

The following fish species were reported in the Kabali River: trout (*Salmo fario*, Red Book of Georgia, Statute-Vulnerable) and silver bream (*Blicca bjoerkna transcaucasica*) (Elanidze, 1988). Spawning periods for major fish species found in the river are noted in Table 2 below.

Table 2. Kabali River Fish Spawning Periods

Fish	Spawning Period
Silver Bream	May-June
Trout	September-October

2. Socio-Economic Environment

Population and Settlements

The community (sakrebulo) of Kabali consists of the following villages: Kabali, Karajala, Uzuntala, and Ganjala. At present, 3,289 households and 10,797 persons are registered in the community. The population rate is 12% higher than it was in 1989. Almost 100% of the community's population is Azeri Muslims. The community also has six Russians, two Georgians, two Lezgins, and one Armenian (Jemal Almazov, Kabali sakrebulo chairman).

Land Use

The total community area equals to 2,373 hectares. The community land is either privately owned (47%) or leased. 1,633 hectares are arable lands, and 153 hectares are pastures. The community has 4,293 cattle heads of which 14,972 are sheep, goats and horses, and 17,110 are poultry (Jemal Almazov, Kabali sakrebulo chairman).

Income and Employment

Two percent (2%) of the population are wage employees, working for budgetary organizations, and 47% are self-employed involved in selling agricultural products. The average monthly household cash-income is \$25 (Jemal Almazov, Kabali sakrebulo chairman).

Social Infrastructure

In the community there are one kindergarten and five schools.

The Kakheti Distribution Company supplies grid electricity to the local community. Electricity is fairly reliable both in summer and winter periods. As alternative energy sources the local population uses kerosene, candle and diesel fueled power generators. There is no centralized gas supply in the community (Jemal Almazov, Kabali sakrebulo chairman).

There is also no central water supply system in the community, and households must depend on local wells for water supply (Jemal Almazov, Kabali sakrebulo chairman).

The duration of the local roads is 80 kilometers, of which seven kilometers are paved with asphalt. However, the surface of the paved segments is damaged, and the remaining 73 kilometers of the local roads are unpaved (Jemal Almazov, Kabali sakrebulo chairman).

Attitude towards rehabilitation of the hydropower plant

After the rehabilitation the Kabali SHP will supply electricity to seven villages and nearby small enterprises. Employment is the most important benefit to be received from the operation of the Kabali small hydro power plant.

ANNEX C. GEOLOGICAL EVALUATION OF THE KABALI SHP SITE

1. Foreword

In compliance with a Terms of Reference provided by the Rural Energy Program, the engineering team undertook to conduct visual inspection of the construction site of the hydroelectric power plant on the river Kabali and revise the results of geotechnical investigation of the same construction site carried out by the Georgian Office of the Association of Energy Engineers in 2002.

The group of independent engineers has conducted geotechnical investigation of the Kabali SHP rehabilitation area and the revetment on the Kabali River. Particle-size analysis of water samples from the rehabilitation area and the riverbed was carried out on the spot.

2. Geological and Hydrological Features

The study area is constituted by Kimeridgian and Titonic layers of the upper Jurassic covered by late Quaternary sediments.

Petrographically, the Malm layers are represented by clay shale of Mestia-Tianeti zone, breccia, argillite, gravelite, and sandstone turbidites with flysch inclusions.

The Quaternary structures are composed of delluvial, proluvial and alluvial sediments. The study area is formed by boulders with loamy sand matrix of alluvial genesis, broken stone and cobbles.

The Kabali River originates from the junction of mountain springs on the southern slopes of the Caucasus Range at the height of 2720 m. It flows into the Alazani River from the left side 3 km northward of the Eriskari Village.

The Kabali's length is 48 km; total gradient – 2500 m; average slope – 52.1%; catchment area – 391 km². The mountainous part of the catchment is constituted by sandstone, limestone and clay shale. The soil is represented by forest brown soil type. The area between the 2000th and 2200th meters is covered with alpine meadows and about 65% of the catchment area is covered with forests.

Presence of fresh water in alluvial soil is characteristic of hydro geological conditions of the area. Groundwater occurrence depth in the investigated area ranges between 0.5 and 1.5 m.

The Kabali River regime is characterized by floods in spring, unstable low level of water in summer, stable low level of water in winter and high level of water in autumn. During summer and autumn floods caused by rainfalls, water sometimes rises higher than during spring floods. For instance, on August 18th, 1955, flood caused by a heavy rainfall damaged the Kabali HPP pressure pipeline and agricultural lands.

Construction of the Kabali SHP low-head weir will cause the changes in the flow regime in the downstream of the weir, and will have impact on the Kabali river geomorphology.

The river is studied insufficiently in hydrological sense; therefore its average annual discharge was defined using a method given in "Water Balance of Georgia" monograph. Average annual discharges of the Kabali River have been calculated using the distribution curve parameters and the coordinates of three-parameter distribution as given in table 1.

Table 1. Average Annual Discharges of the Kabali River

Section	H ave.	Fkm ²	Hm	Qm/sec ave.	Cv	Cs	Provision p%					
							25	50	75	80	90	95
Design value	1625	73.9	1360	3.18	0.28	0.56	3.72	3.09	2.54	2.42	2.11	1.88

3. Geotechnical Characteristic of the Rehabilitation Area

The study area includes the Kabali river floodplain and the adjacent 1st terrace.

Two geotechnical elements (GE) have been identified in the study area:

GE-1: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; fine sand matrix – 30-35%.

GE-2: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; dust sand matrix - 30-35%.

The SHP area surface is composed of well-rounded alluvial cobbles and gravel material. GE-1 occurs down to 1.3m in the test pit #2, while GE-2 is bedded beneath it to the prospected depth of 3.0m.

Two shallow test pits (0.5m) have been made to define particle-size distribution of soil (GE-1) in the floodplain. The results of particle-size analysis (field and laboratory) of the soil from the test pits as well as the particle-size distribution diagram are given in the tables 7, 8, 9 .

Table 2 shows composition of different grain sizes in the soil (example: D10 is a diameter up to which all grains sizes constitute 10% of soil).

Table 2. Composition of Grain Sizes

	D ₅	D ₁₀	D ₁₆	D ₃₅	D ₅₀	D ₆₀	D ₆₅	D ₈₄	D ₉₀	U(D ₆₀ /D ₁₀)
GE-1	0.032	0.064	0.150	2.36	6.09	16.72	27.70	114.60	195.38	261

Estimated value of modulus of deformation under load (P=0.1-0.2 MPa) makes up: 45 MPa for GE-1 and 43 MPa for GE-2.

Strength parameters (angle of internal friction and cohesion): 44⁰ and 0.011 MPa for GE-1 and 42⁰ and 0.016 MPa for GE-2.

GE-1 estimated soil resistance R₀ makes up 6.0 0.1 MPa (Rules and Regulations - СНиП 2.02.01.83, Table 9).

GE-2 estimated soil resistance makes 5.0 0.1 MPa.

Based on their seismic characteristics the soils in the study area fall under the second category (СНиП II-7-81, Part 2, Article 7); the area belongs to 8-point seismic zone.

Results of laboratory examination of water samples are given in Tables 3, 4, 5. According to them, the water contains hydrogen carbonate, sulphate, and calcium. The water is colorless, odorless and tasteless; its total hardness is 2.84 mg/ equivalent.

The water belongs to non-aggressive type (Tables 3, 4 and 5)

Table 3. Groundwater Chemical Testing – Laboratory Data

#	River	Unit	Content per 1 liter							PH
			Anions				Cations			
			Dry residual	HCO ₃ ⁻	CL ⁻	SO ₄ ⁻	Ca ⁺⁺	Mg ⁺⁺	Na ⁺ +K ⁺	
1	Kabali	mg-l	48.4	36.6	4.254	10	8.8	3.7	3.4	6.9
		mg-equiv.		0.60	0.12	0.21	0.44	0.30	0.18	
		% mg-equiv.		64.64	12.93	22.43	47.32	32.79	19.89	

Table 4. Groundwater Aggressiveness to Structures

No.	River	Sampling depth, m	Aggressiveness:	Groundwater aggressivity to structures					
				In soils Kf>0.1m/24h			In soils Kf<0.1m/24h		
				Concrete grade per permeability					
				W4	W6	W8	W4	W6	W8
1	Kabali	0.00	Bicarbonate hardness mg_eq/l	No	No	No	No	No	No
			Hydrogen ion	No	No	No	No	No	No
			Aggressive carbon dioxide content, mg/l	-	-	No	-	-	No
			Magnesia salt content, mg/l	No	No	No	No	No	No
			Ammonia salt content, mg/l	-	-	-	-	-	-
			High alkalinity content, mg/l	No	No	No	No	No	No
			Sulfates for concrete						
			Portland cement (FOCT10178-76)	No	No	No	No	No	No
			Portland blast-furnace (slag) cement	No	No	No	No	No	No
			Sulfate-resistant cement	No	No	No	No	No	No

Table 5. Water Aggressiveness on Metal

No.	River	Sampling depth, m	Water aggressiveness impact on reinforced concrete metal parts		Soil aggressiveness to hydrocarbon steel, below groundwater level with infiltration rate >0.1m/24h
			If in water	If periodically subject to water	
1	Kabali	0.00	No	feebly	Feebly

4. Geotechnical Characteristic of Revetment Construction Site

A lengthwise test pit allowed examining litho logic section along the Kabali bank. Two identical geotechnical elements were found in the headwork area and in the revetment construction site.

GE-1: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; fine sand matrix – 30-35%.

GE-2: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; dust sand matrix - 30-35%.

The SHP area surface consists of well-rounded alluvial cobbles and gravel material.

The identity of soils and groundwater in both areas conditioned identical physical and mechanical characteristics. Design parameters for both GEs are given in Table 6.

Table 6. Design Parameters of Geotechnical Elements

GE #	Soil category by ease of excavation (СНМП-IV-5-85)	Soil category by seismicity (СНМП-II-7-81)	Temporary slope for water- saturated soil		Density • , gr/cm ³	Modulus of deformation E, MPa	Angle of internal friction φ^0	Cohesion C, MPa	Estimated soil resistance R_0 , MPa
			Down to 3.0m	Down to 5.0 m					
1	6B-III	II	1:0.5	1:1	2.00	45	44	0.011	6
2	6B-III	II	1:0.5	1:1	1.95	43	42	0.016	5

5. Conclusions and Recommendations

1. Two geotechnical elements (GE) have been identified in both study areas by means of geotechnical investigation and laboratory analysis:

GE-1: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; fine sand matrix – 30-35%.

GE-2: cobbles – 35-40%; gravels – 20-25%; boulders – 10%; dust sand matrix - 30-35%.

The study shows that the floodplain is suitable for construction of the headwork for reception of required volumes of water and the hypsometric curve in the area from the headwork to the power-plant enables free flow of water.

2. No hazardous geological processes able to hinder operation of the facility have been registered on the study area.

3. Water of the river Kabali and the groundwater belongs to non-aggressive and not dangerous for any type of concrete.

4. It is necessary to conduct adequate bank protection in catchment area to protect the headwork and the line structure from future erosion. For this reason, we recommend following actions: a) maintenance of riparian vegetation; b) extract coarse materials from the riverbed and c) use sediment trapping devices.

5. To reduce changes in the river geomorphology due to the construction of the low head weir, it is recommended to maintain minimum ecological river flow. According to the calculations done by the hydrometeorological department, ecological-sanitary flow of average 10% long-term water discharge (norm) in the Kabali River is equal to $Q_{san}=0.30 \text{ m}^3/\text{sec}$;

7. Geological engineer's presence during the Kabali SHP construction is preferable to make timely corrections in case of need.

Table 7. Particle Size Distribution (Sieving) – Sample 1

SOIL DESCRIPTION:			Sample no.	1
Cobbles – 35-40%; gravels – 20-25%; boulders – 10%; sand matrix – 30-35%.			Depth, m	0.50
TEST METHOD:		BS 1377 : Part 2 : 1990 : 9.3	Date	09,03,2007
Initial dry mass	m_1	93560.0 g		
BS test sieve	Mass retained g		Percentage retained	Cumulative percentage passing
	actual	corrected, m		
400 mm	-	-	-	100.00
200 mm	7404.4	7404.4	8.65	91.35
120 mm	3971.8	3971.8	4.64	86.71
100 mm	5230.2	5230.2	6.11	80.60
75 mm	3620.9	3620.9	4.23	76.37
63 mm	2970.3	2970.3	3.47	72.90
50 mm	1241.2	1241.2	1.45	71.45
37.5 mm	3518.2	3518.2	4.11	67.34
28 mm	2850.5	2850.5	3.33	64.01
20 mm	3638.0	3638.0	4.25	59.76
Passing 20 mm	m_2	51154.6		
total	(check with m_1)	85600.0		
riffled	m_3	2000.0		
riffled and washed	m_4			
correction factor	$\frac{m_2}{m_3}$	25.58		
14 mm		78.7	2013.1	57.11
10 mm		100.4	2567.6	53.73
6.3 mm		128.0	3274.1	49.42
Passing 6.3 mm	m_5	1692.9		
total	(check with m_4)	2000.0		
riffled	m_6	200.0		

Correction factor	$\left(\frac{m_2 \times m_5}{m_3 \times m_6}\right)$	216.50			
5 mm		17.1	3706.2	4.23	45.19
3.35 mm		27.8	6019.2	6.87	38.32
2 mm		32.2	6965.5	7.95	30.37
1.18 mm		5.3	1147.8	1.31	29.06
600 μm		18.5	4012.8	4.58	24.48
425 μm		11.5	2488.3	2.84	21.64
300 μm		6.3	1366.8	1.56	20.08
250 μm		14.0	3040.3	3.47	16.61
150 μm		5.4	1174.1	1.34	15.27
63 μm		26.2	5668.8	6.47	8.80
Passing 63 mm	m_F or m_E	35.6	7710.2	8.80 %	
Total	(check with m_6)	200.0	43299.8	100.00 %	

Table 8. Particle Size Distribution (Sieving) – Sample 2

SOIL DESCRIPTION:			Sample no.	2
Cobbles – 35-40%; gravels – 20-25%; boulders – 10%; sand matrix – 30-35%.			Depth, m	0.50
TEST METHOD:		BS 1377 : Part 2 : 1990 : 9.3	Date	09,03,2007
Initial dry mass	m_1	93560.0 g		
BS test sieve	Mass retained g		Percentage retained	Cumulative percentage passing
	actual	corrected, m		
400 mm	-	-	-	100.00
200 mm	6933.0	6933.0	8.65	91.35
120 mm	3719.0	3719.0	4.64	86.71
100 mm	4897.2	4897.2	6.11	80.60
75 mm	3390.3	3390.3	4.23	76.37
63 mm	2781.2	2781.2	3.47	72.90
50 mm	1162.2	1162.2	1.45	71.45
37.5 mm	3294.2	3294.2	4.11	67.34
28 mm	2669.0	2669.0	3.33	64.01
20 mm	3406.4	3406.4	4.25	59.76
Passing 20 mm	m_2	47897.6		
total	(check with m_1)	80150.0		
riffled	m_3	2000.0		
riffled and washed	m_4			
Correction factor	$\frac{m_2}{m_3}$	23.95		
14 mm		78.7	1884.9	2.65
10 mm		100.4	2404.1	3.38
6.3 mm		128.0	3065.6	4.31
Passing 6.3 mm	m_5	1692.9		
total	(check with m_4)	2000.0		
riffled	m_6	200.0		

Correction factor	$\left(\frac{m_2 \times m_5}{m_3 \times m_6} \right)$	202.71			
5 mm		17.1	3470.2	4.23	45.19
3.35 mm		27.8	5636.0	6.87	38.32
2 mm		32.2	6522.0	7.95	30.37
1.18 mm		5.3	1074.7	1.31	29.06
600 μm		18.5	3757.3	4.58	24.48
425 μm		11.5	2329.9	2.84	21.64
300 μm		6.3	1279.8	1.56	20.08
250 μm		14.0	2846.7	3.47	16.61
150 μm		5.4	1099.3	1.34	15.27
63 μm		26.2	5307.8	6.47	8.80
Passing 63 μm	m_F or m_E	35.6	7219.3	8.80 %	
Total	(check with m_6)	200.0	40543.0	100.00 %	

Table 10. Particle Size Distribution (Sieving) – Sample 3

SOIL DESCRIPTION:			Sample no.	3
Cobbles – 35-40%; gravels – 20-25%; boulders – 10%; sand matrix – 30-35%.			Depth, m	0.50
TEST METHOD:		BS 1377 : Part 2 : 1990 : 9.3	Date	09,03,2007
Initial dry mass	m_1	93560.0 g		
BS test sieve	Mass retained g		Percentage retained	Cumulative percentage passing
	actual	corrected, m		
400 mm	-	-	-	100.00
200 mm	7283.3	7283.3	8.65	91.35
120 mm	3906.9	3906.9	4.64	86.71
100 mm	5144.6	5144.6	6.11	80.60
75 mm	3561.7	3561.7	4.23	76.37
63 mm	2921.7	2921.7	3.47	72.90
50 mm	1220.9	1220.9	1.45	71.45
37.5 mm	3460.6	3460.6	4.11	67.34
28 mm	2803.9	2803.9	3.33	64.01
20 mm	3578.5	3578.5	4.25	59.76
Passing 20 mm	m_2	50317.9		
total	(check with m_1)	84200.0		
riffled	m_3	2000.0		
riffled and washed	m_4			
Correction factor	$\frac{m_2}{m_3}$	25.16		
14 mm		78.7	1980.1	57.11
10 mm		100.4	2525.6	53.73
6.3 mm		128.0	3220.5	49.42
Passing 6.3 mm	m_5	1692.9		
total	(check with m_4)	2000.0		
riffled	m_6	200.0		

Correction factor	$\left(\frac{m_2 \times m_3}{m_3 \times m_6} \right)$	212.96		
5 mm		17.1	3645.5	4.23
3.35 mm		27.8	5920.8	6.87
2 mm		32.2	6851.5	7.95
1.18 mm		5.3	1129.0	1.31
600 mm		18.5	3947.2	4.58
425 mm		11.5	2447.6	2.84
300 mm		6.3	1344.5	1.56
250 mm		14.0	2990.6	3.47
150 mm		5.4	1154.9	1.34
63 mm		26.2	5576.0	6.47
Passing 63 mm	m_F or m_E	35.6	7584.1	8.80 %
Total	(check with m_6)	200.0	42591.6	100.00 %