African Water Facility
Facilité africaine de l'eau
Mobilising Resources for Water in Africa

REPUBLIC OF GHANA

REOPTIMISATION AND REOPERATION STUDY OF AKOSOMBO AND KPONG DAMS

PROJECT APPRAISAL REPORT

MAY 2010

African Water Facility | Facilité africaine de l'eau
African Development Bank | Banque africaine de développement
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LIST OF ACRONYMS AND ABBREVIATIONS:

AfDB:	African Development Bank
AIRD:	Associates for International Resources & Development
AWF:	African Water Facility
BMZ:	Federal Ministry for Economic Cooperation and Development, Germany
CSTF:	Community Stakeholder Task Force (Nene Pediator, coordinator)
ECOWAS:	Economic Community of West African States
EPA:	Environmental Protection Agency
GCLME:	Guinea Current Large Marine Ecosystem
GDP:	Gross Domestic Product
GEF:	Global Environment Facility
GLOWA:	GLOWA Volta Project, Center for Development Research, University of Bonn
GPRS:	Ghana Poverty Reduction Strategy
Harvard:	Harvard School of Public Health
IGCC:	Interim Guinea Current Commission
IUCN:	The World Conservation Union
IWMI:	International Water Management Institute
LOI:	Letter of Invitation
ME:	Ministry of Environment
MOU:	Memorandum of Understanding
MWRWH:	Ministry of Water Resources, Works & Housing
NCB:	National Competitive Bidding
NHI:	Natural Heritage Institute
PDF-B:	Project Preparation and Development Facility – Block B
PRSPs:	Poverty Reduction Strategy Papers
Purdue:	Purdue University Energy Center
SL:	Shortlist
TNC:	The Nature Conservancy
TU:	Tufts University
UG/CAW:	University of Ghana/ Center for African Wetlands
UG/VBRP:	University of Ghana/ Volta Basin Research Project
UNEP:	United National Environment Programme
US:	University of Stuttgart
VBA:	Volta Basin Authority
VBDF:	Volta Basin Development Foundation
VRA:	Volta River Authority
WAPP:	West African Power Pool
WRC:	Water Resources Commission
WRI/CSIR:	Water Research Institute/ Council for Scientific & Industrial Research

AFRICAN WATER FACILITY (AWF)
AFRICAN DEVELOPMENT BANK

PROJECT INFORMATION
Date: October, 2009

The information given hereunder is intended to provide some guidance to prospective suppliers, consultants and all persons interested in the procurement of goods and services for the projects. More detailed information and guidance should be obtained from the Recipient and Executing Agency.

1. **Country**	Republic of Ghana
2. **Name of Project**	Reoptimisation and Reoperation of Akosombo and Kpong Dams.
3. **Location:**	Akosombo and Kpong on the Volta River in Ghana.
4. **Recipient, Executing Agency: & Fiscal Agent**	Water Resources Commission P. O. Box CT 5630 Cantonment Accra. Ghana. Tel: + 233-21-763 651/ 765 860 Fax: + 233-21-763 649 E-mail: watrecom@ighmail.com Website: www.wrc-gh.org
5. **Project Description**:	The project is aimed at reoptimising and reoperating the Akosombo and Kpong dams to reintroduce to the extent possible downstream ecosystem functions and livelihoods and to buffer the effects of climate change while at the same time ensuring that previous benefits are retained. The project consists of the following two (2) components: (i) Re-operation and Re-optimization Study (ii) Project Management and Co-ordination.
6. **Key Technical Partners**	Volta River Authority (VRA), Ghana; Water Resources Commission (WRI) of CSIR, Ghana; Centre for African Wetlands (CAW), Ghana; Volta Basin Research Project (VBRP), Ghana; Natural Heritage Institute (NHI) & Purdue University Energy Centre, USA

7. **Total Cost**	**Euro 2.859 million (100%)**
Foreign	Euro 0.851 million (29.76%)
Local	Euro 2.008 million (70.24%)
8. **Financing Plan**	
AWF Grant	Euro 1.830 million (64.02%)
Other Sources of Financing:	
Ghana Government (In Kind)	Euro 0.908 million (31.78%)
Natural Heritage Institute (In Kind)	Euro 0.047 million (1.66%)
Ford Foundation	Euro 0.037 million (1.31%)
The Nature Conservancy	Euro 0.035 million (1.23%)
Total	**Euro 2.859 million (100%)**

9. Currency Equivalents
(October 2009)

1 UA = 1.129 Euro
1 Euro = 1.357 USD

10. **Estimated Starting Date of Work and Duration**	September 2010 for 36 months.

11 Timeframe **(Key milestones)**

Application	August 2008
Approval	July 2010
Effectiveness (Signatures)	October 2010 (maximum 90 days after approval)
First Disbursement	January 2011 (maximum 90 Days after Effectiveness)
Last disbursement	April 2013
Completion	October 2013 (36 Months after Effectiveness).

LOGICAL FRAMEWORK ANALYSIS

HIERARCHY OF OBJECTIVES	EXPECTED RESULTS	REACH BENEFICIARIES	PERFORMANCE INDICATORS	INDICATIVE TARGEST AND TIMEFRAME	RISKS AND MITIGATION MEASURES
GOAL:	**IMPACT:**		**Indicators:**	**Targets and Time Frame**	**Risks and Mitigation**
To contribute to economic growth and poverty reduction through reintroduction of downstream ecosystem functions and livelihoods by reoperating the Akosombo and Kpong dams.	o River plain connectivity established; o Aquatic ecosystems established; o Health improved; o Income of riparian communities improved; o Power reliability improved; o Flood risks reduced.	o Riparian communities downstream of Akosombo & Kpong (estimated 736,000 peoples of the lower Volta basin); o Residents of Togo & Benin; o Consumers of Power from Akosombo & Kpong Dams (54% of the 23.5 millions population of Ghana); o Riverine communities and ecosystems in Africa & rest of the world;	i) Incidence of malaria ii) Farmer incomes iii) Coverage of aquatic weeds Source: Steering Committee/WRC MOH, MOFA,	i) Target, decrease in malaria occurrences from 44% to 35% of all report cases Timeframe 5yrs after starting reoperation ii) Target, 100% increase in income of farmers & fishermen from GHc19.5 per annum in 2000 Timeframe 5yrs after starting reoperation iii) Target, 50% decrease in cover of aquatic weeds from 75% coverage in 2006 Timeframe 5yrs after starting reoperation	***Risk: The political will to implement the results of the reoperation study*** ***Mitigation measures: ensuring close involvement of the VRA in all aspects of the Study to enable them appreciate the real benefits of implementing the recommendations of the study*** ***Risks***: VRA may be financially and technically challenged to reoperate. ***Mitigation measures***: Capacity of staff will be improved. Since economic optimization is made a criterion, comparism will be made to show that the reoperation benefits will outweigh the increased cost of re operation. Government will be required to participate in investment to bring about the new benefits
PURPOSE/OBJECTIVES:	**OUTCOMES:**		**Indicators:**	**Targets and Time Frame:**	

HIERARCHY OF OBJECTIVES	EXPECTED RESULTS	REACH BENEFICIARIES	PERFORMANCE INDICATORS	INDICATIVE TARGEST AND TIMEFRAME	RISKS AND MITIGATION MEASURES
1. To produce technically and economically feasible reoperation plan which will retain existing benefits of Akosombo and Kpong operations while reintroducing lost livelihoods and ecosystems functions and generate knowledge for wide application.	A decision support tool developed which when operated will : o improve downstream ecosystems & human livelihoods; o Continue protection of downstream communities from larger flood events; o Increase total electric power outputs and reliability of water supply for hydropower generation; o Reduce incidence of water-borne disease vectors o Reduce coverage of aquatic weeds.	o Downstream communities o Consumers of electricity in Ghana, Togo, Benin and La Cote d'Ivoire o Institutions designing construction and operation of next generation of dam in Africa & rest of world. o Academic and research institutions	Report containing data collected, validated, analyzed and the hydro ecological, power generation and planning model ,economic model etc developed Source: Steering Committee/WRC	Target: Report of study submitted, reviewed and accepted Timeframe 1- 38monts from the start of the study	***Risk***. Delays likely to be caused during implementation due to the problems of managing many independent consultants. ***Mitigating measures*** Effective and efficient PMU and PM will be put in place

HIERARCHY OF OBJECTIVES	EXPECTED RESULTS	REACH BENEFICIARIES	PERFORMANCE INDICATORS	INDICATIVE TARGEST AND TIMEFRAME	RISKS AND MITIGATION MEASURES
ACTIVITIES	**OUTPUTS:**	**BENEFICIARIES**	**INDICATORS**	**TARGETS & TIME FRAME**	
Component I: Reoperation and reoptimisation study ***1) Define Restoration Flow Targets to reintroduce ecological functions comprising***:	Hydrographs for target flow patterns for wet, median and dry years, specified by magnitude, duration, frequency and timing.	Partners Downstream communities, including women VRA WRC	Report containing data collected and validated, analytical tools and methods used to arrive at the expected results Source: Steering Committee/WRC	Target: Report submitted, reviewed and accepted 7months from start of study Timeframe 0-6months	***Risks:*** Data required for simulation of water irrigation, & eco-hydraulic systems will not be complete accurate, or available. ***Mitigation measures***: Techniques for carrying out studies in poor data environment will be applied.
2) Construct & Evaluate Operational Scenarios to Achieve the Target Flows	**Operational Scenarios to achieve target flows constructed and evaluated**	WRC VRA VBA	Report showing data collected and validated, analytical tools and models used to arrive at results. Source: Semi-Annual Reports at WRC	Target: Report submitted, reviewed and accepted by end of 18 months from the start of the study. Time Frame: 6 - 18 months	
3) Construct a Model of the Power Generation &	Model of the Power Generation and Distribution System (Grid) to Evaluate Technical and	VRA Energy Commission	Report showing data collected and validated analytical tools and	Target: Report submitted,	

Distribution System (Grid) to Evaluate Technical & Economic Feasibility	Economic Feasibility constructed	VBA	models used to arrive at results. Source: Semi-Annual Reports at WRC	reviewed and accepted 24 months from the start of the study Timeframe 1-24 months	
4) Evaluate the Operationally Feasible Scenarios for Economic Feasibility	Operational Feasibility Scenarios for Economic Feasibility Evaluated	Partners Downstream communities including women Partners VRA VBA	Report showing data collected and validated, analytical tools and models used to arrive at results. Source: Semi-Annual Reports at WRC	Target: Report submitted, reviewed and accepted 28 months after start of the study. Timeframe 1-28 months	
5) Estimate the Effects of Reoperation of Akosombo & Kpong Dams on Public Health	Effects of Reoperation Akosombo and Kpong Dams on Public Health Estimated	Downstream communities including women Partners VRA VBA	Report of case study Source: Semi-Annual Reports at WRC	Target: Report submitted, reviewed and accepted 12 months after start of the study Timeframe 1-12	

HIERARCHY OF OBJECTIVES	EXPECTED RESULTS	REACH BENEFICIARIES	PERFORMANCE INDICATORS	INDICATIVE TARGEST AND TIMEFRAME *To be established in baseline and planning studies	RISKS AND MITIGATION MEASURES
ACTIVITIES:	**OUTPUTS:**	**BENEFICIARIES:**	**INDICATORS:**	**TARGETS & TIME FRAME**	**RISKS & MITIGATION**
6) Conduct Experimental Reoperation Demonstration and Monitoring	Experimental Reoperation Demonstration and Monitoring and governance institutional analysis carried out.	Downstream communities including women VRA VBA Partners	Report showing data collected and analysed to arrive at results. Source: Report of re-operation study at WRC	Target: Report submitted reviewed and accepted by end of 36 months from the start of the study Time Frame: 24 - 36 months	***Risk***: Additional generating capacity needed in the dry season during reoperation will not be available and the reoperation will fail. ***Mitigating measures:*** Plans for increasing generating capacity from hydro and thermal sources should be implemented in time
7) Implement Global Learning Program	i) Global workshops of component teams and outside experts to share results and disseminate learning organised	Partners Dam Designers & Operators in Africa and other parts of the world	Workshop reports Briefing reports Publication Documentary Source: Semi-Annual Reports at WRC	Target Report s submitted reviewed and accepted by end of 36month Timeframe 34-36 months	
ACTIVITIES:	**OUTPUTS:**	**BENEFICIARIES:**	**INDICATORS:**	**TARGETS & TIME FRAME**	**RISKS & MITIGATION**
Component II: Project Management Monitoring and Reporting	Effective and timely project management and coordination achieved	AWF, AfDB, WRC, VRA VBA	1) Necessary facilities delivered;	Source: Project progress reports, evaluation mission	

1) Establish PMU Operational facilities in place Efficient project management and reporting in place		Partners	II) & iii) Project reports submitted at agreed intervals Source: Project progress reports,	report	
2) Undertake Mid-Term Review	Midterm review response completed.	AWF, AfDB, WRC, VRA VBA Partners Downstream Communities International Stakeholders	Project reports submitted at agreed intervals Source: Project progress reports, evaluation mission reports	II) Target: Report submitted, reviewed and accepted by end of 20 month. Time frame: Month 19 -20	
3) Prepare Project Completion Report	Project completion report completed.	AWF, AfDB, WRC, VRA VBA Partners Downstream Communities International Stakeholders	Project reports submitted at agreed intervals Source: Steering Committee/WRC	Target: Report submitted, reviewed and accepted by end of 38 month. Time Frame: month 37-38	*Risks:* Inefficient management *Mitigation Measures:* Project to employ competent Project Manager.
Project Costs Total Cost: Euro 2.859 million AWF Grant: Euro 1.830 million GOG: Euro 0.908 million Others: Euro 0.120 million					

EXECUTIVE SUMMARY

Background and origin of the Project: The African Water Facility received a request on 6th August 2008 for funding from the Water Resources Commission of the Ministry of Water Resources Works and Housing, Ghana to finance a study on the *"Reoptimisation and Reoperation of Akosombo and Kpong Dams on the Volta River in Ghana to reintroduce downstream ecosystem functions and livelihoods and to buffer the effects of climate change"*.

Akosombo and Kpong dams were designed to generate an average of 6,100 GWh/year, which supplies 95% of Ghana's electricity consumption. As is typical of hydropower dams, Akosombo and Kpong have distorted the natural river flows by storing and releasing water in rhythm with the patterns of electricity demand in the service area rather than the seasonal patterns of rainfall and runoff in the catchment area. By eliminating the annual floods in the Lower Volta River floodplain and estuary, the dams have devastated the livelihoods of the downstream communities and the physical ecosystem processes on which they depend. As sediments accumulate in the channel, they are no longer replenishing the beaches in Ghana, Togo and Benin, resulting in massive beach erosion, loss of mangrove habitats and reductions in the productivity of the Guinea Current and its pelagic fishery.

Objective: The purpose of the project is to investigate the technical and economic feasibility of a technique for reoptimizing the operations of the Akosombo and Kpong hydropower dams to reintroduce (or at least improve or enhance) downstream livelihoods and ecosystems, while maintaining, and indeed enhancing, power generation output and reliability.

Outcome: The main outcomes of the project are (i) Improved downstream ecosystems and human livelihoods; (ii) Protection of the downstream communities from the larger flood events; (iii) Increased total electric power output from the dams; (iv) Increased reliability of water supply for hydropower generation; and (v) Reduced incidence of water borne disease vectors. In addition the results of the techniques and the lessons learnt documented and shared widely for application.

Institutional arrangements: The project will be executed by the Water Resources Commission with a Project Steering Committee providing strategic direction. A high level Scientific Advisory Committee will provide overall guidance and ensure scientific rigor. These two bodies will ensure that the project outputs and other results are efficiently achieved. The committees will be resourced by a full time Project Manager in a Project Management Unit to be set up by the Recipient.

Description: The scope of the project consists of two components, namely (i) *Reoperation and Reoptimisation Study and (ii) Project Management, Monitoring and Reporting*

Cost and financing: The overall duration of the project is 36 months duration. The total cost of the project is Euro 2,859,600 to be financed by the AWF, Government of Ghana, Ford Foundation (FF) and National Heritage Institute (NHI). The contribution from the AWF is Euro 1,830,810 and that from the GoG is Euro 908,630 with the remaining Euro 120,200 to be contributed by the FF and NHI.

Justification: The project falls within the African Water Facility's intervention areas of Water Governance and Water Resources Knowledge and Information building and dissemination. Further it meets the AWF policy that water resources should be developed and managed among other things to ensure ecosystem sustainability at national and transboundary levels**.**

Recommendations: Based upon a comprehensive assessment of the request for funding of the proposed project, and taking into consideration its relevance, effectiveness, efficiency and sustainability, and the recipient's credibility and capacity, it is recommended that the AWF approve funding for an amount not exceeding Euro 1,830,810 to implement the project as outlined in this report.

1. BACKGROUND

1.1. Origin of the Project

1.1.1 The African Water Facility received a request in August 2008 for funding from the Water Resources Commission of Ghana to finance a study on the *Reoptimisation of operations of Akosombo & Kpong Dams on the Volta River in Ghana to Reintroduce Downstream Livelihoods and Ecosystems and to Buffer the Effects of Climate Change.* Akosombo/Kpong dam reoperation project was developed and designed by the Ghanaian project partners in a workshop conducted in May 2007 at the Kofi Annan Center in Accra.

1.1.2 The project is one of a suite of regional investigations to demonstrate the technical and economic feasibility of re-optimizing the world's major irrigation, hydropower and flood management systems to enable their storage dams to be reoperated to reintroduce as much as possible the former productive floodplains, wetlands, deltas and estuaries in ways that maintain—and can often even enhance—the existing water supply, power generation and flood control benefits. The ultimate objective of this *Global Dam Reoptimization Program* is to reintroduce the human food production systems and livelihoods and the ecological functions that depend upon natural stream flows below the major dams of Africa and the rest of the world. This work will also take account of changes in rainfall and river runoff due to expected global climate change. The resulting toolbox of tools and techniques can be widely applied to the current inventory of major dams and to the next generation of dams to make them more environmentally compatible.

1.1.3 Thus, this project has the dual objective of improving the environmental performance of the major infrastructure on the Lower Volta River and also of contributing to a global process of shared learning. It will specifically examine techniques for optimizing major hydropower dams and the electrical grids into which they feed to approach a more natural flow pattern in the Lower Volta River.

1.1.4 The AWF reviewed the funding application and associated documents and considered that the proposal is eligible for support under the AWF Operational Procedures and included the proposal for appraisal under the 2009 AWF Operational Programme.

1.1.5 The AWF deployed a multi-disciplinary team to undertake a field appraisal and proceed with the preparation of Project Appraisal Report. The team carried out a field appraisal mission to Ghana from 29th September to 6th October, 2009 including field visits to Akosombo hydropower station and the Lower Volta estuary at Ada. The mission furthermore met and discussed with partners such as officials of the Volta River Authority, academic and research institutes, traditional authorities, community representatives and other stakeholders.

1.2. Problem Definition

1.2.1 Development of rivers for hydropower has conventionally come at a high cost in terms of riverine livelihoods and ecosystems.

1.2.2 The Akosombo dam, which was completed in 1965 formed Lake Volta, the largest man-made water storage reservoir in Africa and the world. Twenty-five kilometers downstream, the Kpong Dam operates as a run-of-the-river facility with minimal storage to re-turbine the Akosombo releases. Akosombo and Kpong dams were designed to generate an average of 6,100 GWh/year, which is 95% of Ghana's electricity consumption. In addition to power generation, Akosombo provides some degree of flood protection due to its very large storage capacity relative to inflow, and Kpong supplies a small amount of irrigation (only about 100 ha) for rice cultivation. Navigation and a robust lake fishery are important additional benefits of the reservoir.

1.2.3 Like storage reservoirs in general, the function of Akosombo is to store water during seasons and years of high inflow for power generation during seasons and years of lower inflow. In Ghana, the demand pattern causes Akosombo to be operated to generate a relatively constant output of power daily and seasonally. Thus, Akosombo alters the natural river flows by storing and releasing water in rhythm with the patterns of electricity demand in the service area rather than the seasonal patterns of rainfall and runoff in the catchment area. The effect on the downstream flow pattern is to reduce the peak flows and increase the base flows, effectively eliminating the dynamic interactions between the river and its floodplains, wetlands, deltas, estuaries, mangrove and beach environments. These are the great engines of riverine and marine biodiversity and the environmental services that they provide for the myriad of human livelihoods that are dependent upon a fully-functioning river system.

1.2.4 Thus, these hydropower dams have also devastated the livelihoods of the downstream communities and the physical ecosystem processes on which they depend. The results have been a drastic reduction in floodplain agriculture as natural flooding no longer leaves rich alluvial deposits that improve soil fertility in the overlying upland areas, and an explosion in the growth of exotic weeds that have choked off the once lucrative shell fishery, increased the snail vectors for the debilitating bilharzias, and fostered the formation of a permanent sandbar at the estuary.

1.2.5 The shellfish have been hit particularly hard. Before the dam, there was a robust clam fishery downstream from the dam. Clams that could only reproduce in brackish water moved up and down the river so they had a large habitat. Now that the front is fixed, they can only reproduce in a narrow strip. Due to the vegetation and water quality changes, clam picking, an occupation mainly dominated by women, has almost been eliminated. Many other commercially valuable species have severely declined or disappeared as well, including blue crab, shrimps, shad and herring.

1.2.6 The regulation of flows, the trapping of natural sediments in the reservoirs, and the formation of the sandbar have drastically changed the morphology of the river channel and the mangroves and beaches at the mouth of the river as well.

1.2.7 Before the dams, the shoreline erosion was estimated at 2-5 meters per year. Today, the beach is eroding at the rate of 10 meters per year. The coastal erosion also affects neighboring Togo and Benin, whose coasts are now being eaten away at a rate of 10-15 meters per year. This is because the dams trap the sediments that replenish the beaches.

1.2.8 The overall effect of the loss of agriculture, clam picking, and fishing activities has created intense poverty and led to a dramatic shift in income generating activities. Some 80,000 people are directly adversely affected by the change in livelihood.

1.3. Sectoral Priorities

1.3.1 The *Dam Reoperation* project described in this application addresses national poverty reduction and natural resources conservation priorities and Millennium Development Goals. While poverty fell from 52% in 1991-1992 to 28 % in 2005-2006[1], poverty reduction remains an important focus of the Ghanaian government. Citing lack of access to energy and food as the most critical dimensions of poverty, Ghana's second Growth and Poverty Reduction Strategy paper (GPRS II) identifies investment in water and agriculture infrastructure as the key to poverty reduction for both the urban poor and rural communities. Emphasis on advancing the agricultural sector is of primary importance because it is the greatest contributor to Ghana's GDP and the main livelihood activity for the poor,

[1] Ghana Living Standards survey 2005/6, cited in DFID Ghana Factsheet. http://www.dfid.gov.uk/pubs/files/ghana-factsheet.pdf

primarily women[2] Poverty is highest among food crop farmers, with 59.4% living below the national poverty line[3]. Thus, increased agricultural productivity will reduce poverty and increase access to food, and the *Dam Reoperation* project contributes by ensuring a more reliable supply of water for agriculture – including food crops, livestock, and fisheries.

1.3.2 Infrastructure development is also cited as one of Ghana's five priority areas for poverty reduction.[4] The World Bank Ghana country brief states that "energy problems could derail growth even though Ghana has achieved the highest electrification rate in Sub-Saharan Africa (54%), and is the anchor country for the West-African Power Pool (WAPP).[5] Ghana plans to add several large hydropower installations elsewhere in the basin will apply lessons from Akosombo dam to their site design and operation.

1.3.3 Improved management of Ghana's natural resources is another important national priority to ensure long-term sustainable development. In Ghana, "poor management of (natural) resources, with related health effects, is costing Ghana approximately 10% of GDP, with 3% due to forestry and wildlife depletion, and 4% due to water and air pollution", including depleted flows.[6] However, consistent with Ghana's GPRS II, the project will attempt to improve the management of water resources of the lower Volta River and thereby contribute to rejuvenate the declining fishery and clam industry; protect coastal mangroves by reintroducing sediment transport; recover native aquatic species; and reduce disease vectors associated with *schistosomiasis*, which overall will improve the livelihoods of communities who rely on these resources but which the dams hindered.

1.3.4 Furthermore, the project will support a number of similar environmental quality targets identified by the riparian states of the Volta River Basin in the preliminary Strategic Action Programme for the Volta River Basin GEF-PDF-B project, including (but not limited to): reintroducing natural surface water flow; arresting wetland loss; achieving adequate freshwater quantity; and achieving adequate groundwater quality and quantity.

1.3.5 The dam reoperation proposal also enjoys strong, vertically-integrated support in the water and power agencies in Ghana, including the Ministry of Water Resources, Works and Housing; Ministry of Energy; Environmental Protection Agency; Volta River Authority; and Water Resources Commission. The basin-wide, multi-national Volta Basin Authority is also a full partner and major beneficiary of the project. It will obtain a state of the art basin-wide water resource planning model from the project.

1.4 Beneficiaries and Stakeholders

1.4.1 The beneficiaries of this project will include:

- Riparian communities downstream of the dam (estimated 736,000 population) whose food production, livelihoods, and access to groundwater will be markedly improved, and whose flood risks will be reduced;

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[2] National Development Planning Commission. Ghana Growth and Poverty Reduction Strategy II (2006-2009). November 2005

[3] African Development Bank. *Ghana Country Strategy Paper: 2005-2009*. May 2005. http://www.afdb.org/portal/page?_pageid=473,969202&_dad=portal&_schema=PORTAL

[4] African Development Bank. *Ghana Country Strategy Paper: 2005-2009*. May 2005. http://www.afdb.org/portal/page?_pageid=473,969202&_dad=portal&_schema=PORTAL

[5] The World Bank. Ghana Country Brief. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/GHANAEXTN/0,,menuPK:351962~pagePK:141132~piPK:141107~theSitePK:351952,00.html

[6] The World Bank. Ghana Country Brief. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/GHANAEXTN/0,,menuPK:351962~pagePK:141132~piPK:141107~theSitePK:351952,00.html

- Residents of Togo and Benin who will benefit from the arrested erosion of their beaches and mangrove ecosystems;
- Consumers of power from Akosombo and Kpong dams (54% of the 23.5 millions population of Ghana) whose reliability will be improved by the hydropower and grid reoperations. These consumers are not just in Ghana, but also Nigeria, Togo, Benin, Cote d'Ivoire and Burkina Faso;
- Riverine communities and ecosystems all over Africa and the rest of the world who will benefit from the dam reoperation tools and techniques that will be illuminated and demonstrated in this project;
- Institutions designing the construction and operation of the next generation of dams in Africa and globally who will benefit from the lessons produced by this demonstration project.

1.4.2 The stakeholders in this project are also Partners who will be conducting the project. These are listed in Annex 4.

1.4.3 There are benefits that will promote social cohesion because the project will optimize rather than reallocate the benefits from these dams. It is the case that implementation of the reoperation concept will require the operations of existing thermal plants and possibly the construction of redundant thermal power capacity in the regional grid and that this will increase the capital costs of power generation. However, this will also greatly improve power reliability to all customers. The economic optimization analysis in the project workplan will identify the operational alternative that will provide the greatest benefit to the greatest number of power recipients.

1.5 Objectives of the Study

1.5.1 The long term objective or goal of the study is to contribute to economic growth and poverty reduction through improvement of downstream ecosystem functions and livelihoods by reoperating and reoptimising the Akosombo and Kpong dams**.**

1.5.2 The specific objectives or purpose of the study is to produce a technically and economically feasible reoperation plan which will retain existing benefits of Akosombo and Kpong operations while improving livelihoods and ecosystems functions. Thereafter to then demonstrate the efficacy of the resulting reoperations plan through experimental flow releases and to document and share the results of the techniques and the lessons learnt widely for application to the current inventory of major dams and to the next generation of dams to make them more environmentally compatible.

1.6 Justification of AWF intervention

1.6.1 The project's outcomes meet the African Water Facility's intervention areas of water governance and water resources knowledge and information building and dissemination. Further it meets the AWF policy that water resources should be developed and managed among other things to ensure ecosystem sustainability at national and transboundary levels. The AWF is supporting the Volta Basin Authority with the Volta HYCOS project which will provide information to the project and thereby create coherence and complementarities in AWF interventions in the Volta Basin. The project will examine the effect of climate change on the operations of the dams and propose adaptation measures on adverse impacts. This is in line with one of the operations focus of the AWF for 2010 as given by the Governing Council.

2. THE PROJECT

The project design is based on the results oriented management concept presented in the Logical Framework and the results from key activities elaborated below.

2.1 Impacts

2.1.1 The proposed reoperation study will bring river-floodplain connectivity, which reintroduce to the extent possible vigor to the aquatic ecosystems, and that, in turn, benefits the health, productivity and income of some of the poorest riparian communities particularly women who dominate the food production in the agricultural sector. The project will recommend reoperation plans that improve power reliability which will improve the quality of life of the population fed with power from the Akosombo-Kpong systems and reduce flood risks.

2.2. Outcomes

2.2.1 The optimization model will be developed and used to reoperate the dams to achieve the following outcomes:

- **Improved downstream ecosystems and human livelihoods.** This will include:-
  - Increased flood plain agricultural production as a result of controlled downstream flooding;
  - Increased human livelihoods namely due to employment in agriculture, fishing and related businesses;
  - Reduced coverage of exotic aquatic weeds;
  - Groundwater availability as a result of recharge due to annual flooding;
  - Resumed shell fishing due to re-establishment of the salinity regime;
- **Continued protection of the downstream communities from the larger flood events** that would jeopardize human settlements while accommodating seasonal inundation of farmlands. This is entailed by the reintroduction, to the extent possible, the natural flow patterns. In effect, the floodplain storage would augment the reservoir in attenuating flood pulses, allowing the reservoir to be maintained at higher storage levels year around.
- **Increased total electric power output** of the dams, while altering the generating schedule. This would be accomplished by maximizing the hydrologic head and thus increasing electricity output through simulation of the planning model.
- **Increased reliability of water supply for hydropower generation**. This would be accomplished by investigating the optimum reservoir levels that will keep the reservoirs full during the early years of an extended drought, thereby reducing the potential for power shortages in later years.
- **Reduced incidence of water borne disease vectors**. Re-operating Akosombo and Kpong will reduce the static water levels and therefore exotic weeds that are the breeding grounds of bilharzia and malaria, thus improving the health and productivity of millions downstream of those dams.

2.3. Outputs

The outputs comprise the following:

- A computer simulation of the physical processes and infrastructure operations in the entire Volta River system developed;
- A power system planning model constructed for the grid system at its current state of integration with Nigeria, Benin, Burkina Faso, Cote d'Ivoire, Niger, Nigeria and Togo (West Africa Power

Pool Zone A). The model also accounts for current hydro and thermal generation connected to that grid, including plants now under construction, as well as future additions to electrical supplies, which are also dynamic);

- An Economic model developed that estimates economic incentive structure to induce users and dam operators and stakeholders to implement reoperation;
- A feasibility report prepared on the legal, institutional and political implications of reoperating dams according to the natural flow patterns
- A report on the effects of reoperation of Akosombo and Kpong dams on Public Health prepared

If the model proves successful there will be the need for follow-on study to define downstream activities that shall be necessary

2.4 Activities

The scope of the project consists of two components:

*2.4.1 **Component I:** Reoperation and Reoptimisation Study*

This addresses the reoperation and optimization study which is to produce a technically and economically feasible reoperation plan which will retain existing benefits of Akosombo and Kpong operations; and demonstrate the efficacy of the resulting reoperation plan through experimental flow releases; and to document and share the results of the techniques and the lessons learnt widely for application to the current inventory of major dams and to the next generation of dams to make them more environmentally compatible.

The study will use various models by linking and sequencing them in the expected analytical work. The models will include hydrophysical and hydrobiological models, power generation and planning models, economic optimization and cost/benefit models. Some of these models are available like the Water Demand and Supply model with a Climate Change component for a part of the Volta River Basin available at the VBA. Also there is a Power Generation and Planning model used by the VRA. There is again the Long Term Power Planning model for WAPP developed by Purdue University for ECOWAS. Some of the existing models can be used as they are or can be adapted to suit the study. Still some new ones may be developed depending on the findings at the inception stage.

In the study it is proposed to create the necessary analytical tools, assemble the necessary data, and then use them to carry out the following activities:

Activity 1: Define Flow Targets to Reintroduce Ecological Functions & Livelihoods

Will consist of Orientation Workshop; Stakeholder consultations on objectives & future scenarios; Specification & quantification of the reintroduction of ecosystem functions and livelihood objectives; Environmental flow process & modeling; Event-based hydrological modeling of historical & present-day flow regimes and comparison of pre- to post-regulation ecological states for key components; Flow requirements for fisheries; Flow requirements for aquatic biodiversity; aquatic weeds; Agro-ecology (irrigation, farming systems); Fluvial geomorphology & floodplain hydrodynamic modeling including wetland connectivity & floodplain constraint analysis; Coastal system (morphology; sea level rise); Groundwater recharge & trends in use; Literature review and summary report on all parameters pertaining to environmental flow and livelihood requirements; Construction of target flow hydrograph(s); Design of adaptive management program to monitor results; Final workshop to review flow targets for all the activity partners.

Activity 2: Construct & Evaluate Operational Scenarios to Achieve the Target Flows

Will consist of construction of a Volta River Basin Wide simulation of physical processes; Construction of operations optimization model; Climate change model inputs; Formulation of operational scenarios, evaluation with the planning models, selection of optimal scenario.

Activity 3: Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility

Will Consist of modeling current power generation & distribution system; Hydrological model selection & sequencing; Construction of power generation & distribution models ; Estimate the carbon emissions that will be discharged into the atmosphere from the thermal plants that will be built; Selection of optimal grid operation scenarios.

Activity 4: Evaluate the Operationally Feasible Scenarios for Economic Feasibility

Will consist of economic feasibility analysis; Ecosystem valuation; Construction of cost-benefit model, determination of economically optimal scenario.

Activity 5: Estimate the effects of Reoperation of Akosombo and Kpong Dams on Public Health

Activity 6: Conduct Experimental Reoperation, Demonstration and Monitoring

Will consist of formulation of reoperation experiment; Conducting the experiment; Monitoring of reoperation experiment & reporting of results; Governance and institutional analysis.

Activity 7: Carry out Global Learning Program

The knowledge sharing and dissemination will take place through a process of structured workshops; high level briefings to the development assistance agencies, dam operators, national governments, non-governmental organizations and the academic community. The project will produce a major publication and video animation documenting the exploratory investigations and the project results. This will include a handbook on rapid assessment techniques to ascertain the best dams for successful reoperation, the analytic tools best employed to develop the reoperation plan, and a description of broadly replicable reoperation techniques.

2.4.2 Component II: Project Management Monitoring and Reporting

This will involve the establishment of the required project management arrangement that will ensure effective project implementation of the proposed study to reoperate and reoptimise the Akosombo and Kpong Dams to reintroduce to the extent possible downstream ecosystem functions and livelihoods.

Specifically it will consist of establishing a Project Management Unit for the day to day operation; the establishment of Project Steering Committee and a Scientific Advisory Committee to guide implementation of the project. Implementation is expected to take 36 months. The project management activities include the following:

- Administration of the Project
- Developing and implementing work plans
- Reporting periodically on progress of the project
- Organising Steering Committee meetings
- Carrying out financial management , accounting and auditing functions
- Procuring goods and services

- Monitoring project implementation

2.5 Risks

2.5.1 The greatest risk in this investigation will be that, the data needed to create a simulation of the water, irrigation, and eco-hydraulic systems will not be complete and accurate. The project partners will have to use techniques such as data transfer techniques for conducting this kind of analysis in data poor environments. Data transfer techniques are available in the literature of hydrological data analysis. An adaptive management element has been incorporated to permit the project to learn as it goes and adjust the reoperation plan accordingly.

2.5.2 There is a risk that not all of the reoperation scenarios will prove cost effective to implement. Rescheduling hydropower production will require construction of additional thermal generators to substitute for some part of the hydropower output during the dry seasons. These will be redundant during the wet season. So the capital (but not operating) costs of power generation and the system reliability will be increased. The economic analysis will be used to select the reoperation scenarios which are more cost effective to justify their implementation. The reoperation investigation will, in effect, present an alternative investment strategy that will allow the government to make an informed choice as between the costs of benefits of the current plans versus the reoperation alternative. The project has made economic optimization an explicit criterion for selection of the reoperation alternative that will be demonstrated.

2.5.3 There is a risk that the project implementation may face delays because of difficulties that may arise from managing the many independent consultants who will participate in the study. It is expected that the Steering Committee will appoint a strong and effective Project Manager with experience to ensure that deliverables are on time. In addition the project shall appoint The National Heritage Institute, one of the partners, to assist with coordination and making sure that deliverables are on time, in particular, deliverables of the foreign partners.

2.5.4 There is the risk that the extra generating capacity needed to meet the shortfall of power from Akosombo and Kpong during the dry season to meet current and future demand will not be available. In that case the proposed reoperation will fail. This can be avoided if present plans to increase generating capacity form hydropower sources (Bui, Juale, and Pwalugu) and thermal sources (Abandze, Tema) are brought on stream in a timely manner. Presently Bui is under construction and gas is expected from Nigeria to run thermal plant at Abandze at a cheaper cost. This will contribute to increasing reliability of power in the WAPP. The investment cost can be offset by revenue from additional power sales, reliability of power and the benefits from improved livelihoods and ecosystem functions downstream Akosombo and Kpong.

2.6 Cost and Financing Plan

2.6.1 The total cost of the project is Euro 2,859,600. A detailed matrix of the project cost by activities is presented in Annex 3. Overview summaries of project cost estimate by sources of funding and components and also by sources of funding and categories of expenditure are presented in Tables 2.1 and 2.2. Other cost summaries are presented in Annexes 3.1 to 3.3

Table 2.1: Estimated Project Cost by Components and Sources of Funding (Euros '000)

1. Reoperational and Reoptimisation Study		AWF Grant		Gov't	NHI	FF	TNC		Total		%
	Foreign Exch.	Local Cost									
COMPONENTS	(F.E)	(LC)	Total	L.C	F.E	F.E.	F.E.	L.C	L.C	Total	Total
	620.45	769.35	1,399.80	793.26	47.33	37.56	35.31	750.65	1,562.61	2,313.25	80.89
2. Project								110.47	446.87	546.35	19.11

Management and Coordination	100.47	330.53	431.00	115.34	-	-					
TOTAL PROJECT COSTS	**730.93**	**1,099.87**	**1,830.80**	**908.60**	**47.33**	**37.56**	**35.31**	**851.12**	**2,008.48**	**2,859.60**	**100.00**
% Total Costs	25.56	38.46	64.02	31.77	1.66	1.31	1.23	29.76	70.24	100.00	

Table 2.2: Estimated Costs by Sources of Funding and Categories of Expenditure (Euros '000)

		AWF Grant		**Gov't**	**NHI**	**FF**	**TNC**		**Total**		**%**
CATEGORY	**Foreign Exch. (F.E)**	**Local Cost (LC)**	**Total**	**L.C**	**F.E**	**F.E.**	**F.E.**	**F.E.**	**L.C.**	**Total**	**Total**
Goods	-	50.42	50.42	-	-	-	-	-	50.42	50.42	1.76
Services	581.65	641.20	1,222.85	793.26	-	-	35.31	616.96	1,434.46	2,051.42	71.74
Operating Costs	149.28	408.24	557.52	115.35	47.33	37.56	-	234.17	523.59	757.76	26.50
TOTAL PROJECT COSTS	**730.93**	**1,099.87**	**1,830.80**	**908.60**	**47.33**	**37.56**	**35.31**	**851.13**	**2,008.47**	**2,859.60**	**100.00**
% Total Costs	25.56	38.46	64.02	31.77	1.66	1.31	1.23	29.76	70.24	100.00	

3. PROJECT IMPLEMENTATION

3.1. Recipient and Capacity

3.1.1 The Water Resources Commission, an agency of the Ministry of Water Resources, Works and Housing of the Republic of Ghana will be the Recipient of the Grant. The Grant Agreement will be signed with the Water Resources Commission which will also be the Executing Agency.

3.1.2 The WRC was established by an Act of Parliament i.e. Act 522 of 1996 as the government agency charged with the regulation and management of the country's water resources and the coordination of policies in relation to them. The Commission is composed of the major stakeholders involved in the water sector including representatives of institutions relating to Hydrological Services, Water Supply, Irrigation Development, Hydro power generation, Water Research, Environmental Protection, Forestry, Minerals, Traditional Chiefs, NGO's, and Women interests. This structure of the Commission provides a forum for integration, cooperation and collaboration of the different interests in the water sector. These interests are manifest in the partnership created around the project.

3.1.3 The Commission has a Secretariat headed by an Executive Secretary who is supported by a team of full-time professional staff including the following: Water Resources Engineer; Water Resources Economist; Water Quality Specialist; Information Technology Specialist; Hydrogeologist (2); Ecologist (2); Legal Officer; Public Relations Officer; Accountant; and an Administrative Officer.

3.1.4 The Executive Secretary submits periodic administrative and management reports to the Commission about the general progress of its programmes. The day-to-day internal control of WRC management operations is based on a well established and functioning financial system, the Navision Financial System, which conforms to the Ghana Government Financial Administration Act 654 of 2003.

3.1.5 Procurement procedures are managed transparently within the WRC. The internal mechanism for procurement using government or donor funds has generally been under the authority of an Entity Tender Committee, which operates under the rules and regulations of Public Procurement Act 663 passed in 2003.

3.1.6 The Water Resources Commision therefore has the capacity and capability to execute the project. A brief on the Water Resources Commission is presented in Annex 5.

3.2. Implementation Arrangement and Capacity

3.2.1 The project is a partnership in the sense that all of the partners have had a role in the development and design of the project and all will have specific assigned responsibilities in the execution of the project work plan. Terms of reference will be developed to indicate the detailed work each partner will undertake under the project. These TOR will form part of the project start-up activities and will be approved by the AWF.

3.2.2 For the AWF funds, the Water Resources Commission (WRC) will serve as the fund applicant, executing agency, and the fiscal agency for the partnership. The Natural Heritage Institute will coordinate this component with other components of the *Global Dam Reoptimization Program* as the partner that has overall responsibility for the global learning program.

3.2.3 Functionally, the WRC's responsibility has included applying to the AWF and act as the Focal Point for project appraisal and execution. The WRC will disburse those funds according to the budget matrix that has been agreed among the partners. All funding for the various activities will be disbursed

pursuant to signing of MOUs with state institutions and contracts with all other organizations acting as service providers. There will be specific tasks, deliverables, timelines and reporting requirements assigned to each partner organisation. The profile, experience and previous relevant work are detailed in Annex 5.

3.2.4 Project Management and Coordination

i) The WRC will set up a Project Management Unit (PMU) which will be responsible for the day to day management of the project. The PMU will be headed by a Project Manager (PM) who shall report to the Executive Secretary of the WRC who in turn will report to the PSC

ii) A Project Steering Committee (PSC) which will be composed of representatives of the partners will be set up to guide the implementation of the project. The setting up of the Project Steering Committee (PSC) is a grant condition. The PSC will provide overall guidance and will be responsible for the overall directives and compliance to the Project Implementation Manual (PIM). The Steering Committee will meet half-yearly to examine quarterly progress reports, work plans / budgets, discuss implementation challenges and proffer solutions to the PMU. The level of achievement in relation to the project objectives and expected results shall be reported to, and be assessed by, the Steering Committee during its semi-annual meetings. These reports shall cover the technical, financial and administrative aspects.

iii) A Scientific Advisory Committee (SAC) composed of three leading international and two reputed national scientists knowledgeable in the field will advise the PSC. The SAC will meet yearly.

3.2.5 The Project Manager will be assisted by the Water Resources Engineer, the Basin Officer, the Legal Officer and Office Assistants of the WRC. The PM who shall be full time during the implementation of the project will be recruited on national competitive basis. The PM shall be a person with knowledge in procurement rules and procedures. He will be assisted by the Procurement Officer of the WRC in matters of procurement.

3.2.6 The Executive Secretary of the WRC who will work part time on the project will be responsible for ensuring that the articles of the Grant Agreement with AWF are executed. An organogram for the project management is presented in Annex 6.

3.3 Performance Plan

3.3.1 The essential project outputs and related deliverables and time milestones for their completion are summarized in Table 3.1 below, where M represents the time of the start of the study or the service contract. The project review team will be appointed by the PSC.

Table 3.1: Performance Plan

RESULT	CRITICAL MEASURABLE INDICATORS	TARGETS
Mobilisation, setting up of PMU Steering Committee, MOU, Opening of Special Account	Start of Service Contract	M
Report on Flow Targets to reintroduce ecosystem functions and livelihoods	Report Accepted by Project Review Team	M + 12
Report on the Construction and Evaluation of Operational Scenarios to achieve the Target Flows	Report Accepted by Project Review Team	M + 18
Report on the construction of Model of the Power Generation and Distribution System to Evaluate Technical and Economic Feasibility	Report Accepted by Project Review Team	M + 24
Report on the Evaluation of the Operationally Feasible Scenarios for Economic Feasibility	Report Accepted by Project Review Team	M + 28
Report on the Estimation of the Effect of Report on the reoperation of Akosombo and Kpong Dams on Public Health	Report Accepted by Project Review Team	M + 12
Report on Experimental reoperation Demonstration and Monitoring	Report Accepted by Project Review Team	M + 36
Report on the Global Learning Programme	Report on dissemination accepted by Project Review Team	M + 36
Final Completion Report	Report Accepted by Project Review Team	M + 39

3.4 Implementation Schedule

3.4.1 The project will be implemented over 36-month duration. The proposed schedule and milestone of activities for project implementation are presented in Table 3.2 below. The timing of the delivery of the outputs from the various study activities are elaborated in Table 3.2.The schedule is related to the Implementation Plan presented in Annex 8.

Table 3.2: Implementation Schedule

ITEM No.	ACTIVITY	ACTION BY	START DATE	COMPLETION DATE
	A ADMINISTRATION			
A.1	Protocol Grant Approval	AfDB	Nov. 2009	Dec. 2009
A.2	General Procurement Notice	AWF/WRC	Jan. 2010	Feb. 2010
A.3	Protocol Grant Agreement Signed	AWF/WRC	Feb. 2010	March 2010
A.4	Special Account Opened.	WRC	April 2010	June 2010
A.5	Signed MOU between WRC & Lead Partners	WRC/Lead Partners	March 2010	June 2010
A.6	Setting up of Project Steering Committee	WRC	March 2010	June 2010
A.7	Grant Effectiveness and First Disbursement	WRC/AWF	April 2010	June 2010
A.8	Mid-Term Review	AWF/WRC/ Consultant	October 2011	February 2012
A.9	Project Completion Report	AWF/WRC	April 2013	June 2013
	B PROJECT MANAGEMENT & COORDINATION			
B.1	Engagement of Project Manager	WRC	Sept 2010	June 2013
B.2	Project Management Team Nominated	WRC	April. 2010	April 2013
B.3	Project Launching	WRC/AWF	Sept 2010	October 2010
B.4	Project Completion Activities	WRC	January 2013	April 2013
	C SERVICES (STUDIES)			
C.1	Draft TORs, LOI and Shortlist Submitted and Approved	WRC	April 2010	October 2012
C.2	Advertisement and Submission of Proposals	WRC	May 2010	November 2012
C.3	Evaluation Reports	WRC	July 2010	December 2013
C.4	Contract Awarded	WRC	Aug. 2010	January 2013
C.5	Implementation – Studies	WRC	Sept. 2010	April 2013
C.6	Global Learning Programme	All Partners & Others	January 2013	April 2013
	D GOODS			
D.1	Draft Bidding Document	WRC	April 2010	May 2010
D.2	Specific Procurement Notice	WRC	June 2010	June 2010
D.3	Bid Period	WRC	June 2010	July 2010
D.4	Bid Evaluation Report and Approval	WRC/AWF	August 2010	Sept. 2010
D.6	Contract Awarded	WRC	Oct. 2010	November. 2010
D.7	Goods Supplied	WRC	November 2010	December 2010
	E PROJECT AUDIT			
E.1	Annual Audit – AWF	AWF	June 2011, June 2012, July 2013	July 2011, July 2012, August 2013

3.5 Procurement and Execution

3.5.1 All procurement of goods and acquisition of consulting services financed by the AWF shall essentially be governed by the AfDB's Rules *of Procedure for Procurement of Goods and Works*, or *Rules of Procedure for the Use of Consultants*, using the relevant Bank Standard Bidding Documents. The modes of procurement of goods and services under the Facility shall essentially be governed by the existing AfDB Rules of Procurement as modified by the current *AWF Operational Procedures (December 2007 edition).*

3.5.2 The responsibility for procurement of goods and acquisition of services rests solely with WRC. The modalities and conditions will be embedded in the grant agreement with AWF. It is WRC's obligation to ensure that the AWF funds are used in a cost efficient manner and only for eligible project expenditures. The project will involve three (3) categories of expenditure-the procurement of goods and services including operating costs.

Goods

3.5.3 Contracts for goods are valued in aggregate at Euro 50, 420. Procurement of a vehicle for project supervision and monitoring, valued at Euro 33,800 will be carried out under shopping procedures. One such contract will be awarded. The vehicle can be procured on the local market, as there are enough qualified local suppliers to ensure competition. Contracts for goods consisting of office equipment, furniture, laptops and computer accessories, and other goods valued in aggregate at Euro 16,620 will be awarded through Shopping procedures. Three (3) such contracts (valued at Euro 15,120) will be awarded- one for the contract for office equipment (valued at Euro 7,760), one contract for office furniture (valued at Euro 1,510), and one contract for laptops and computer accessories (valued at Euro 5,860). Euro 1,500 is allocated for other goods to be procured as needed. Shopping is an appropriate procurement method as the goods are readily available off-the-shelf items and standard commodities in quantities of small value, which could be procured locally.

Services

3.5.4 Services are valued in aggregate at Euro 2,118,830 out of which Euro 1,313,020 will be sourced from the Grant. The selection procedures are through *Quality and Cost-Based Selection* (QCBS) and Single Source Selection (SSS).

3.5.5 The consultancy services to specifically carry out technical studies and investigations (Component I) under the project are unique, because it involves a global initiative and the consultants are also technical implementing partners. All the implementing partners have had roles in the development and design of the project and all will have specific assigned responsibilities in the performance of the project. The technical implementing partners, both within Ghana and external, consist of individual experts, government –owned universities or research centers. The partners have relevant unique and exceptional experience and their participation is critical to the project implementation. See Annex 5 for a summary of the background of the key technical partners. The method of procurement for their engagement will be by direct negotiations, using Single Source Selection (SSS) as it presents clear advantages over competition. Sixteen (16) and three (3) service contracts are under Components I and II respectively. Three of the service contracts will be procured through short listing. Twelve (12) out of the sixteen (16) service contracts under Component I are under Euro 50,000.

3.5.6 Contracts for Mid-term Review and Project Completion Report are valued at Euro 31,550 and Euro 24, 040 respectively. Regional Short Listing using QCBS will be used to engage consultants.

3.5.7 The Project Management Unit's (PMU) full time Project Manager (PM), under WRC, will be engaged as an Individual Consultant, for 36 months, through national short listing. The PM shall be the only PMU staff whose remuneration is drawn from the Grant. One such contract will be awarded for the engagement of a PM at a value of Euro 67,610.

3.5.8 The PMU shall have part time project staff (nominated from WRC staff), as WRC's/the Government of Ghana's (GOG) in-kind contribution to the project. The CVs of all the nominated PMU staff shall be reviewed by AWF before project start up.

3.5.9 Auditor: The AWF will recruit and retain an auditor for a term of one-year renewable for not more than three years. The auditor will perform ex post evaluation or a review of supporting documents and audit the project. The costs of such audit shall be charged to AWF and are not involved in the Grant.

Operating Costs

3.5.10 Procurements for the operations of the project amounts to a total of Euro 990,040 out of which Euro 366,650 will be sourced from the Grant. These are in respect of general operating costs for project management activities, operation and maintenance of equipments and a vehicle, procurement related activities for the engagement of consultants for the studies, and the Global Learning Program. Shopping and Direct Purchasing shall be the modes of procurement.

Procurement Arrangement

3.5.11 The procurement arrangement is summarized in Table 3.3 below.

Table 3.3 : Procurement Arrangements (Euro 000)

Procurement Category	NCB	Shortlist	Other *	Total
1. CONSULTING SERVICES & TRAINING				
Studies				
1.1 Defining Flow Targets to Reintroduce Ecological Functions & Livelihoods to the extent possible			347.52	347.52
1.2 Constructing & Evaluating Operational Scenarios to Achieve the Target Flows			349.73	349.73
1.3 Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility			138.97	138.97
1.4 Evaluate the Operationally Feasible Scenarios for Economic Feasibility			76.63	76.63
1.5 Estimating the effects of Reoperation of Akosombo and Kpong Dams on Public Health			45.08	45.08
1.6 Experimental Reoperation Demonstration and Monitoring			231.80	231.80
Consultancy for Mid-Term Review		31.55		31.55
Consultancy for Project Completion Report		24.04		24.04
PMU Project Manager	67.61			67.61
Sub-Total – Services		1312.93		2118.75
2. GOODS				
2.1 Vehicle			33.80	33.80
2.2 Office Equipment & Furniture (photocopier, fax machine, scanner, Printer, filling cabinets)			9.26	9.26
2.3 Laptops and Computer Accessories			5.86	5.86
2.4 Other Goods			1.50	1.50
3. OPERATING COSTS (Miscellaneous)				
3.1 Operating Costs Studies Procurement Activities			100.63	100.63
3.2 Training Capacity Building – Global Learning			130.60	130.60
3.3 Workshops and General Operating Costs			235.89	235.89
Sub-Total – Operating Costs				651.89
TOTAL PROJECT COST – OTHER FUNDING				**1830.03**
TOTAL PROJECT COST				**2821.06**

NCB : National Competitive Bidding

*Other includes Shopping and Direct Negotiations Figures in brackets are amounts financed by AWF.

Executing Agency

3.5.14 The Water Resources Commission will be responsible for the procurement of goods and services. The resources, capacity, expertise and experience of WRC are adequate to carry out the procurement. The WRC procurement staff will be trained on the Bank's new procurement rules and procedures.

Review Procedures

3.5.15 **Post-review**: Post procurement review procedures allow WRC to proceed with procurement of goods and services without having to obtain approval from AWF for some contracts. Given the numerous small value contracts, all contracts not exceeding Euro 50, 000 will be subject to Post - review procedures. Procurement carried out under these procedures will be reviewed for compliance during supervision missions or special audits. Ex-Post Technical Verification and Ex-Post Financial Controls systems will be used in these instances to allow WRC to procure goods and consulting services in accordance with the thresholds indicated in Section 3.5.2 without obtaining prior "no-objection". Procurement documents including Specific Procurement Notices (if any), tender/bid documents or request for proposals, bid evaluation reports/award recommendation and reports on the evaluation of consultants' proposals as well as signed contracts will be kept by WRC for periodic review by the AWF supervision missions or the external auditor. The AWF shall carry out post procurement review to confirm compliance.

3.5.16 **Prior-review**: All contracts exceeding Euro50,000 will be subject to procurement prior review procedures. The following documents will be submitted for AWF's review and approval before promulgation i) the Specific Procurement Notice (if any); ii) draft bidding documents, Terms of Reference (TOR) and Letter of Invitation (LOI) to consultants; iii) Evaluation reports and award recommendations; iv) draft contracts in the event of modification of those included in the bidding documents.

Procurement Plan

3.5.17 WRC is responsible for preparing, during the project Appraisal and submitting to the AWF before Grant Approval, a Procurement Plan acceptable to the AWF and setting forth (a) the particular contracts for goods, and consulting services for at least the initial eighteen (18) months of the life of the project; (b) the proposed methods of procurement; and (c) the related AWF review procedures (prior or post review). Details of the Procurement Plan which has been prepared by WRC and agreed with AWF are provided in Annex 7. WRC shall update the Procurement Plan annually or as needed throughout the duration of the project. Any revisions proposed to the Procurement Plan shall be furnished to the AWF for its prior approval. WRC shall implement the Procurement Plan in the manner in which it has been approved by the AWF. The Procurement Plan shall be prepared using the Bank's excel-based format. The updated annual procurement plan will form part of the annual work plan and budget report.

3.6 Disbursement Arrangements

The funds of the Grant, for AWF's exclusive share of eligible expenses, will be channeled through the WRC. The latter will open a Special Account denominated in foreign currency in a bank acceptable to the AfDB. The operation of the account will be the sole responsibility of the WRC. The Bank would replenish the Special Account from time to time upon justification of utilization of previous tranches in accordance to Bank procedures. Project funds will be disbursed according to the expenditure schedule, and cost tables as shown in Annex 3. Disbursements of proceeds of the grant are made only at WRC's

request. Supporting evidence that the funds are used in accordance with the Grant Agreement shall be submitted with WRC's withdrawal applications. There will be three tranches of disbursements within the project period.

3. 6.2 A expenditure schedule based on the activity implementation schedule is presented in Tables 3.4 and 3.5 below.

Table 3.4: Expenditure Schedule by Categories of Expenditure (Euros '000)

COMPONENTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	Total	% Total Cost
Goods	50.42	-	-	-	50.42	1.76
Services	287.56	655.50	810.16	298.20	2.051.42	71.74
Operating Costs	146.42	176.17	200.40	234.77	757.76	26.50
TOTAL PROJECT COSTS	484.40	831.67	1,010.56	532.97	2,859.60	100.00
% Total Costs	16.94	29.08	35.34	18.64	100.00	

Table 3.5: Expenditure Schedule by Sources of Funding (Euros 000)

COMPONENTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	Total	% Total Cost
AWF Grant	399.59	670.55	495.17	258.43	1,830.80	64.02
Government of Ghana (in kind)	68.28	117.47	498.86	223.99	908.60	31.77
Ford Foundation (FF)	-	-	-	37.56	37.56	1.31
Natural Heritage Institute (NHI) - in kind	9.47	18.93	9.47	9.47	47.33	1.66
The Nature Conservancy (TNC) - in kind	7.06	24.71	7.06	3.53	35.31	1.23
Total Costs	484.40	831.67	1,010.56	532.97	2,859.60	100.00
% Total Costs	16.94	29.08	35.34	18.64	100.00	

3.7 Accounting and Audit Arrangements

3.7.1 The AWF will recruit and retain an external auditor to perform ex post evaluation or supporting documents review and audit the project. All detailed documents related to the utilization of AWF funds will be held by WRC for subsequent verification and confirmation by the external auditors. The AWF will require that a statement of expenditure and supporting documents review be performed and certified by the independent auditor at predetermined intervals to ensure that funds have been utilized in line with the grant agreement. The costs of such audit shall be borne by the AWF and not the Grant.

3.7.2 Segregation of duties shall be maximised between authorising, accounting and bank signatory functions.

3.8 Monitoring, Evaluation and Reporting Arrangement

3.8.1 The WRC's PMU, under the management of the Project Director and the Project Manager, will be responsible for the overall monitoring and supervision of project activities. The PMU will be responsible for preparing project reports. A Project Completion Report (PCR) on the activities and the financial situation shall be produced by the PMU after completion of the project, using the Bank's format. A participatory approach to monitoring and evaluation of the project in collaboration with the stakeholders is encouraged.

3.8.2 The objectives, actions, and expected results of project activities, as summarized in the attached Logical Framework Analysis (LFA) matrix adopted by WRC. A list of specific indicators of achievement and means of verification in the LFA will serve as a basis for results -based performance monitoring during implementation and after completion.

3.8.3 The Project Implementation Manual (PIM) to be prepared by the PMU, prescribes the modalities for implementation, roles and responsibilities of stakeholders, Steering and Scientific Advisory Committees, communication lines etc. The procedures in the PIM shall comply with the Bank rules and procedures for procurement, disbursement, financial, accounting and auditing. The PIM shall be approved by AWF as part of project start-up activities.

3.8.4 During project implementation the AWF and Bank staff will visit the project area for the purpose of exchanging views, reviewing documents and assisting WRC to resolve implementation problems. These supervision missions however do not relieve WRC of their primary responsibility for supervision of the project. The Ghana Field Office of the Bank will support in resolving problems arising during implementation and in supervision missions.

3.8.5 Project Monitoring and Evaluation (M & E) tools include the Grant Agreement, procurement plan, the Project Appraisal Report, the PIM, quarterly and annual progress reports, mid-term review, project and assignment completion reports. M & E events include project launching activities, workshops, meetings, field visits by the stakeholders, AWF supervision missions and project completion activities. A mid-term review of project activities will be conducted in 2012. This is necessary due to the length of the project and the need to allow possible revision of the original objectives of such as complex project as well as draw interim lessons halfway through the project. At the end of each individual assignment completion reports will be prepared by the consultants, using formats acceptable to the AWF.

3.8.6 The WRC is required to prepare evaluation reports on the consultants' performance, after the completion of each assignment. These will form the basis of the PCR at the end of the project. The evaluation reports will be kept by the WRC for record purposes.

4. PROJECT BENEFITS

4.1 Effectiveness and Efficiency

The study has been designed to establish the technical and economic feasibility to reintroduce lost ecosystem functions and livelihoods to the extent possible in the Akosombo and Kpong hydropower system. The toolkit of methodologies and models to be developed will be shared with others globally. The sequencing of the activities for the study has been so structured to ensure that the project will be effectively implemented and the expected outcomes attained. In addition AWF project and financial management procedures and guidelines to be used in implementing the project by the Steering Committee and the Project Management Unit will ensure that this is efficiently done.

4.2 Sustainability

4.2.1 As stated in the background there are over 1700 large dams currently under construction in various parts of the world. In Africa alone there are some 70 large dams proposed to be built. The results of the study will therefore be of interest to a number policy makers, dam designers and dam operators all over the developing, in particular dams in locations with similar hydrographic conditions. It is this interest in the new way of thinking about how to design and operate dams to add environmental benefits to operational benefits that will ensure the sustainability of the outcomes of this project.

4.2.2 The Akosombo and Kpong projects have had considerable economic benefits in the provision of electricity, fisheries, navigation and others. It has also had some adverse social and environmental impacts as stated in the background and problem definition. In addition to the present benefits, the reoperation will lead to a reintroduction of ecosystem functions, increased food production, better health, education and improved incomes which will accrue to all irrespective of gender, tribal affiliation, location, age, religion, or any other demographic category that will ensure the sustainability of the project outcome.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 The project is in line with the country's developmental objective of achieving increased food production and poverty alleviation while safeguarding the ecosystem (both aquatic and terrestrial). It is also in compliance with the objectives and priority areas of the mandate of the African Water Facility.

5.1.2 The VRA and the communities have a strong sense of ownership and commitment. The VRA has shown its understanding of the project by articulating the plans it is making to bring additional generation on line to back up Akosombo and Kpong in the dry season to meet growing demand. The authority has a strong Environmental Department which is active in providing services to mitigate some of the environmental impacts of the current operation. The communities are committed to see the project implemented as they see in it an opportunity to have their livelihoods and health improved.

5.1.3 The universities and research institutes as partners have collected a vast amount of data on the Volta basin and are committed to make them available to solve not an academic problem but a practical one to reduce poverty.

5.1.4 The study will take into account the effects of planned projects such as the Accra Plains Irrigation Scheme, Water Supply Project for Lome and the Bui Dam currently under construction.

5.1.5 The capacity of the Recipient, the VRA and partners to execute the project is assessed to be satisfactory.

5.1.6 The project will mitigate the effects of climate change and enhance security of access to water supply, food production (crop and fisheries) river navigation, hydropower, mitigate the impact of floods. The eligibility of the Recipient and the project is found to be in accordance with the strategies of the AWF. The anticipated relevance, effectiveness, efficiency and sustainability of the project are found acceptable.

5.2 Recommendations

5.2.1 From a critical assessment of the relevance, effectiveness, efficiency and sustainability of the project and credibility of the recipient it is recommended that the AWF approves grant funding not exceeding Euro 1,830,810 for the project as described in this appraisal report.

Conditions

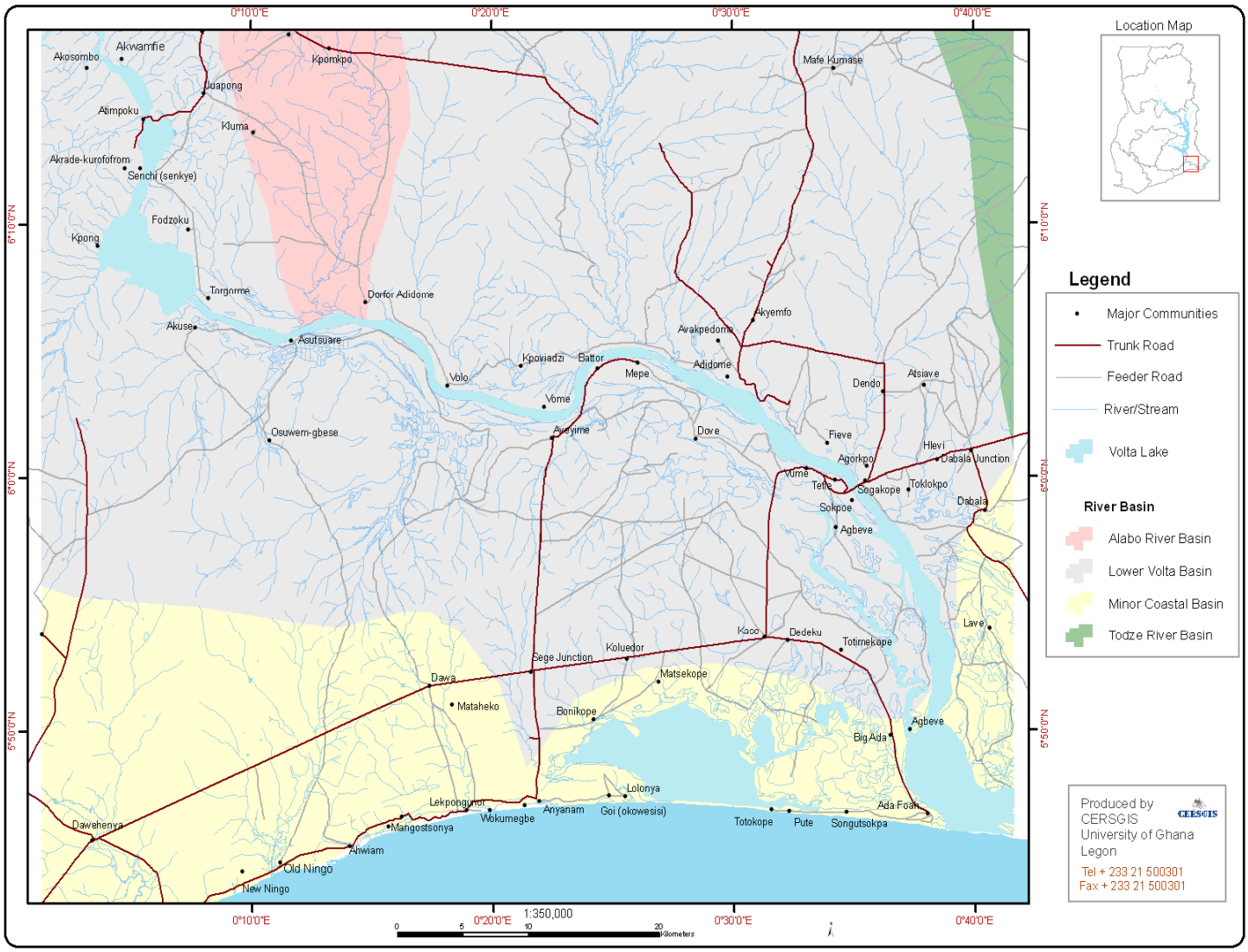
5.2.3 The project will come into force when the Grant Agreement is signed between the AfDB and the Recipient.

5.2.4 The conditions precedent to first Disbursement are i) the engagement of a Project Manager acceptable to the AWF; ii) evidence that a Project Management Unit has been established; iii) Opening of a Special Account in Euros to receive the funds of the Grant and iv) evidence that a Project Steering Committee has been established.

ANNEXES

Annex 1: Map of Country/Location & Project Area

Annex 2: Map of Project Area



Annex 3: Detailed Cost Estimates and Cost tables

COMPONENT I-REOPERATION & REOPTIMISATION STUDIES	Lead Institutions/Implementing Partner	Unit	Qty. Local (L)	Qty. Foreign (F)	Euro 000 Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	Source of Funding- Euro 000 AWF	FF	GoG (in Kind)	Others* (in Kind)
Consultancy Services & Tasks		**Activity 1-Defining Flow Targets to Reintroduce Ecological Functions & Livelihoods**											
1.1 Services- Downstream Community Consultations	**CAW/VBRP**												
1.1.1 Downstream Community Consultations		man mon	8.2	-	4.92	6.97	40.32	-	40.32	40.32	-	-	-
1. 2 Services- Specification and quantification of objectives	**CAW**												
1.2.1. Specification and quantification of objectives		man mon	1.8	0.8	4.92	6.97	8.65	5.57	14.22	13.52	-	-	0.70
1.3 Services- Environmental flow process & modeling; Agro-ecology	**NHI**								(51.80)	(38.26)			
1.3.1 Environmental flow process & modeling:	NHI	man mon	1.9	3.9	4.92	6.97	9.01	27.17	36.18	22.64	-	-	13.54
1.3.2 Agro-ecology (irrigation, farming systems)	WRI	man mon	3.2	-	4.92	6.97	15.62	-	15.62	15.62	-	-	-
1.4 Services: Basin hydrological modeling	**NHI**												
1.4.1 Basin hydrological modeling		man mon	4.5	4.5	4.92	6.97	22.13	31.36	53.48	50.76	-	-	2.72
1.5 Services : Flow requirements for aquatic biodiversity; Groundwater recharge & trends in use; Construct Target Flow Hydrograph (s)	**WRI**								(47.09)	(40.83)			
1.5.1 Groundwater recharge & trends in use	WRI	man mon	3.3	-	4.92	6.97	15.98	-	15.98	15.98	-	-	-
1.5.2 Construct Target Flow Hydrograph (s)	NHI	man mon	1.4	0.5	4.92	6.97	6.88	3.48	10.37	6.84	-	-	3.53
1.5.3 Flow requirements for aquatic biodiversity	WHI	man mon	2.8	1.0	4.92	6.97	13.78	6.97	20.74	18.01	-	-	2.73
1.6 Services : fisheries; Coastal system study	**CAW**								(47.75)	(41.38)			

Consultancy Services & Tasks													
1.6.1 Flow requirements for fisheries	WRI & CAW	man mon	5.4	0.4	4.92	6.97	26.55	3.12	29.67	28.30	-	-	1.37
1.6.2 Coastal system study	NHI	man mon	2.6	0.8	4.92	6.97	12.78	5.29	18.08	18.08	-	-	-
1.7 Services : Fluvial geomorphology & floodplain hydrodynamic modeling	**NHI**												
1.7.1 Fluvial geomorphology & floodplain hydrodynamic modeling		man mon	3.3	4.0	4.92	6.97	16.23	27.74	43.97	41.24	-	-	2.73
1.8 Services: Design of adaptive management program	**VBRP**												
1.8.1 Design of adaptive management program		man mon	2.2	0.8	4.92	6.97	10.82	5.57	16.39	13.66	-	-	2.73
1.9 Services: Literature review - environ. & livelihood flow	**CAW**	man mon	2.2	-	4.92	6.97	10.82	-	10.82	10.82	-	-	-
1.10 Services: Final target flow	**CAW**	man mon	2.7	1.3	4.92	6.97	13.28	9.06	22.33	20.28	-	-	2.05
Sub- Total (Activity 1-16 No. Service Contracts)							**222.85**	**125.33**	**348.17**	**316.08**	**-**	**-**	**32.10**
		Activity 2-Constructing & Evaluating Operational Scenarios to Achieve the Target Flows											
2.1 Services: Construct Volta Basin simulation	**VRA**	man mon	12.6	13.9	4.92	6.97	61.95	96.82	158.78	131.31	-	27.47	-
2.2 Services: Construct operations optimization model; Climate change model inputs; & Formulate optimal scenarios	**VRA**								(275.27)	(186.64)			
2.2.1 Construct operations optimization model	NHI	man mon	20.4	16.7	4.92	6.97	100.30	116.10	216.40	144.78	-	71.62	-
2.2.2 Climate change model inputs	WRI	man mon	3.0	-	4.92	6.97	14.75	-	14.75	14.75	-	-	-
2.2.3 Formulation of optimal scenarios	VRA	man mon	4.4	3.2	4.92	6.97	21.83	22.29	44.12	27.11	-	17.01	-
Sub Total (Activity 2-2 No. Service Contracts)							**198.83**	**235.21**	**434.05**	**317.95**	**-**	**116.10**	**-**

COMPONENT I-REOPERATION & REOPTIMISATION STUDIES	Lead Institutions/Implementing Partners	Unit	Qty. Local (L)	Qty. Foreign (F)	Euro 000 Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	Source of Funding- Euro 000 AWF	FF	GoG (in Kind)	Others* (in Kind)
Consultancy Services & Tasks		**Activity 3 -Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility**											
3.1 Services: Construct a Model of the power generation & distribution; Hydrological model selection & sequencing; Selection of optimal operation scenarios	**VRA**												
3.1.1 Construct a Model of power generation & distribution	VRA & Purdue	man mon	3.5	2.9	4.92	6.97	17.21	20.34	37.55	27.32	-	10.23	-
3.1.2 Hydrological model selection & sequencing	VRA & Purdue	man mon	6.9	6.4	4.92	6.97	33.93	44.58	78.51	61.46	-	17.05	-
3.1.3 Selection of optimal operation scenarios	VRA & Purdue	man mon	3.5	3.9	4.92	6.97	17.15	27.27	44.42	37.56	-	6.86	-
Sub Total (Activity 3-1 No. Service Contract)							**68.29**	**92.19**	**160.48**	**126.34**	**-**	**34.13**	**-**
		Activity 4-How to Evaluate the Operationally Feasible Scenarios for Economic Feasibility											
4.1 Consultancy services: Economic feasibility analysis; Ecosystem valuation; Construct cost-benefit model	**VRA**												
4.1.1 Economic feasibility analysis	VRA	man mon	6.9	-	4.92	6.97	33.93	-	33.93	33.93	-	-	-
4.1.2 Ecosystem valuation	VRA & IWMI	man mon	3.8	-	4.92	6.97	18.58	-	18.58	18.58	-	-	-
4.1.3 Construct cost-benefit model	VRA & IWMI	man mon	3.5	-	4.92	6.97	17.15	-	17.15	17.15	-	-	-
Sub Total (Activity 4-1 No. Service Contract)							**69.66**	**-**	**69.66**	**69.66**	**-**	**-**	**-**

COMPONENT I- REOPERATION & REOPTIMISATION STUDIES	Lead Institutions/Implementing Partners	Euro 000								Source of Funding- Euro 000			
		Unit	Qty. Local (L)	Qty. Foreign (F)	Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	AWF	FF	GoG (in Kind)	Others* (in Kind)
Consultancy Services & Tasks		**Activity 5-Estimating the Effects of Re-operation of Akosombo & Kpong Dams on Public Health**											
5.1 Services: Estimate effects on public health	**VBRP**	man mon	6.9	1.0	4.92	6.97	33.93	6.97	40.89	40.89	-	-	-
Sub Total (Activity 5-1 No. Service Contract)							**33.93**	**6.97**	**40.89**	**40.89**	**-**	**-**	**-**
6.1 Services to Formulate Re-operation Experiment; Conduct Experiment; Monitor Re-operation Experiment & Governance & institutional analysis	**VRA**	**Activity 6-Experimental Re-operation Demonstration and Monitoring**											
6.1.1 Formulation of re-operation experiment	VRA	man mon	4.9	4.4	4.92	6.97	23.99	30.98	54.97	49.36	-	5.61	-
6.1.2 Conduct the experiment	VRA	man mon	111.7	-	4.92	6.97	549.33	-	549.33	32.96	-	516.37	-
6.1.3 Monitoring re-operation experiment	VRA & WRI	man mon	22.2	3.9	4.92	6.97	109.16	27.26	136.41	107.97	-	28.44	-
6.1.4 Governance & institutional analysis	VRA & VBRP	man mon	3.3	0.6	4.92	6.97	16.25	4.18	20.43	20.43	-	-	-
Sub Total (Activity 6-1 No. Service Contract)							**698.73**	**62.42**	**761.15**	**210.73**	**-**	**550.42**	**-**

TOTAL BASE COSTS (COMPONENT I -16 No. Service Contracts)											**1,081.64**			
COMPONENT I- REOPERATION & REOPTIMISATION STUDIES	**Lead Institutions/Implementing Partners**	**Unit**	**Qty. Local (L)**	**Qty Foreign (F)**	**Unit Cost (L)**	**Unit Cost (F)**	**Base Cost (L)**	**Base Cost (F)**	**Total**	**AWF**	**FF**	**GoG (in Kind)**	**Others * (in Kind)**
					Euro 000					**Source of Funding- Euro 000**			
7 .1 Operating Costs of Studies		**Activity 7-Operating Costs (Component I)**											
7.1.1 Global learning Project	**VRA/WRC/NHI**	Lump Sum	1	1	27.52	89.60	27.52	89.60	117.12	47.80	34.15	20.49	14.68
7.1.2 Publications and dissemination of results	**VRA/WRC/NHI**	Lump Sum	1	1	54.22	45.82	54.22	45.82	100.05	71.71	-	-	28.34
7.1.3 Operating Costs - Procurement Activities: documentation, meetings,	**WRC**	Lump Sum	1	1	46.52	24.87	46.52	24.87	71.39	71.39	-	-	-
Sub Total ((Activity 7 - Operating Costs)							**128.27**	**160.29**	**288.56**	**190.90**	**34.15**	**20.49**	**43.02**
TOTAL BASE COSTS (COMPONENT I -16 No. Service Contracts & Operating Costs)							**1,420.55**	**682.41**	**2,102.96**	**1,272.54**	**34.15**	**721.14**	**75.12**
COMPONENT II -PROJECT MANAGEMENT & COORDINATION													
COMPONENT II -PROJECT MANAGEMENT & COORDINATION					**Euro 000**					**Source of Funding- Euro 000**			

		Unit	Qty. Local (L)	QtyForeign (F)	Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	AWF	FF	GoG (in Kind)	Others* (in Kind)
1 Services													
1.1 Project Manager (full time)		Per mon	36	-	1.71	-	61.46	-	61.46	61.46	-	-	-
1.2 Mid - Term Review		man mon	0.3	0.7	11.95	35.85	3.59	25.10	28.68	28.68	-	-	-
1.3 Project Completion Report		man mon	0.6	0.4	13.66	34.15	8.20	13.66	21.85	21.85	-	-	-
Sub Total (Services)							**73.24**	**38.76**	**112.00**	**112.00**	-	-	-
2 Goods													
2.1 Vehicle (4x4) for monitoring and evaluation		Unit	1	-	30.73	-	30.73	-	30.73	30.73	-	-	-
2.2 Computer(s) Lap Tops		Unit	3	-	1.37	-	4.10	-	4.10	4.10	-	-	-
2.3 Computer accessories -UPS, etc.		Unit	3	-	0.41	-	1.23	-	1.23	1.23	-	-	-
2.4 Photocopier		Unit	1	-	5.46	-	5.46	-	5.46	5.46	-	-	-
2.5 Fax machine		Unit	1	-	0.41	-	0.41	-	0.41	0.41	-	-	-
2.6 Printer		Unit	1	-	0.68	-	0.68	-	0.68	0.68	-	-	-

COMPONENT II -PROJECT MANAGEMENT & COORDINATION		Unit	Qty. Local (L)	Qty. Foreign (F)	Euro 000 Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	Source of Funding- Euro 000 AWF	FF	GoG (in Kind)	Others* (in Kind)
2.8 Scanner		Unit	1	-	0.50	-	0.50	-	0.50	0.50			
2.9 Other goods		Unit	1	-	1.36	-	1.36	-	1.36	1.36	-	-	-
Sub Total (Goods)							**45.84**	**0**	**45.84**	**45.84**	-	-	-
3 Operating Costs													
3.1 Project Director (Executive Secretary (WRC)		Per month	18	-	1.02	-	18.44	-	18.44	-	-	18.44	
3.2 Water Resources Engineer		Per month	18	-	0.75	-	11.27	-	11.27	-	-	11.27	-
3.3 Accountant		Per month	18	-	0.65	-	9.73	-	9.73	-	-	9.73	-
3.4 Procurement Officer		Per month	18	-	0.61	-	9.22	-	9.22	-	-	9.22	-
3.5 Basin Officer		Per month	18	-	0.75	-	11.27	-	11.27	-	-	11.27	-
3.6 Water Resources Lawyer		Per month	18	-	0.75	-	13.27	-	11.27	-	-	11.27	-

COMPONENT II -PROJECT MANAGEMENT & COORDINATION		Unit	Qty. Local (L)	Qty. Foreign (F)	Euro 000 Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	Source of Funding- Euro 000 AWF	FF	GoG (in Kind)	Others * (in Kind)
3 Operating Costs													
3.7 Secretary		Per month	18	-	0.34	-	5.12	-	5.12	-	-	5.12	-
3.8 Accounts Clerk		Per month	18	-	0.34	-	5.12	-	5.12	-	-	5.12	-
3.9 Driver		Per month	16	-	0.31	-	4.30	-	4.30	-	-	4.30	-
3.10 PSC and other Committee (meetings)		each	10	4	5.80	8.88	58.05	35.51	93.56	93.56	-	-	-
3.10 Per Diem		Days	250	-	0.10	-	25.61	-	25.61	25.61	-	-	-
3.11 O & M for Vehicle		per month	27	-	1.02	-	27.66	-	27.66	27.66	-	-	-
3.12 O & M for equipment		per month	30	-	0.27	-	8.20	-	8.20	8.20	-	-	-
3.13 Consumables - office supplies		per month	30	-	0.48	-	14.34	-	14.34	14.34	-	-	-
3.14 Other services - communications, utilities, etc.		per month	30	-	0.48	-	14.34	-	14.34	14.34	-	-	-
3.15 Office facility - WRC		per month	36	-	0.34	-	12.29	-	12.29	-	-	12.29	-
3.16 General operating costs		Lump sum	1	1	40.03	17.07	40.03	17.07	57.11	50.28	-	6.83	-
Sub Total (Operating Costs)							**286.26**	**52.58**	**338.84**	**233.98**	-	104.86	-

COMPONENT II -PROJECT MANAGEMENT & COORDINATION		Euro 000								Source of Funding- Euro 000			
		Unit	Qty. Local (L)	Qty. Foreign (F)	Unit Cost (L)	Unit Cost (F)	Base Cost (L)	Base Cost (F)	Total	AWF	FF	GoG (in Kind)	Others* (in Kind)
TOTAL BASE COSTS COMPONENT II (Project Mgmt. & Coordination)							**405.34**	**91.34**	**496.68**	**391.82**	**0.00**	**104.86**	0.00
TOTAL BASE COSTS COMPONENTS I & II							**1,825.89**	**773.75**	**2,599.64**	**1,664.36**			
Physical Contingency (3%)							54.78	23.21	77.99	49.93			
Price Escalation (7%)							127.81	54.16	181.97	116.51			
Sub Total Contingencies							**182.59**	**77.37**	**259.96**	**166.44**			
TOTAL COST							**2,008.48**	**851.12**	**2,859.60**	**1,830.80**			

* Include NHI, TNC

Annex 3.1: Estimated Project Cost by Sources of Funding and Components (Euros '000)

COMPONENTS				Total Cost Euro ('000)			%
				F.E.	L.C.	Total	Total
1. Reoperational and Reoptimisation Study				682.41	1,420.55	2,102.96	80.89
11. Project Management and Coordination				91.34	405.34	496.68	19.11
Total Base Costs				773.75	1,825.89	2,599.64	100.00
Physical Contigency (3%)				23.21	54.78	77.99	
Price Escalation (7%)				54.16	127.81	181.97	
TOTAL PROJECT COSTS				851.12	2,008.48	2,859.60	

Annex 3.2: Estimated Project Cost by Category of Expenditure

CATEGORY OF EXPENDITURE	Euro (thousand)			Euro (thousand)			
	Foreign Exch. (F.E)	Local Cost (LC)	Total	F.E.	L.C.	Total	Total
Goods	-	-	-	-	45.84	45.84	1.76
Services	-	1,528.97	1,528.97	560.87	1,304.07	1,864.93	71.74
Operating Costs	-	222.32	222.32	212.88	475.98	688.86	26.50
Total Base Costs	-	1,751.29	1,751.29	773.75	1,825.89	2,599.64	100.00
Physical Contigency (3%)	-	52.54	52.54	23.21	54.78	77.99	
Price Escalation (7%)	-	122.59	122.59	54.16	127.81	181.97	
TOTAL PROJECT COSTS	-	1,926.42	1,926.42	851.12	2,008.48	2,859.60	

Annex 3.3: Estimated Costs by Source of Funding (Euros '000)

SOURCES	Foreign Exch. (F.E)	Local Cost (LC)	Total	% Total
AWF Grant	730.93	1,099.87	1,830.80	64.02
Government of Ghana (in kind)	-	908.60	908.60	31.77
Ford Foundation (FF)	37.56	-	37.56	1.31
Natural Heritage Institute (NHI) - in kind	47.33	-	47.33	1.66
The Nature Conservancy (TNC) - in kind	35.31	-	35.31	1.23
Total Costs	51.12	2,008.48	2,859.60	100.00
% Total Costs	29.76	70.24	100.00	

Annex 4: List of Partners and Co financiers for the Project, Names and Addresses

Co-financiers include:-

- **The Ford Foundation** – 320 East 43rd Street, New York, New York 10017 USA
- **The Natural Heritage Institute –** 100 Pine Street, Suite 1550, San Francisco, California 94111, USA

The names and addresses of the partners for this project are:-

- **The Ministry of Water Resources, Works and Housing** - P.O Box M43, Accra, Ghana
- **Ministry of Energy** - P. O. Box T40, Stadium Post Office, Accra, Ghana
- **Ghana Environmental Protection Agency** - PO Box M326, Accra, Ghana
- **Volta River Authority** - 28 February Road, P.O. Box MB 77, Accra, Ghana
- **Water Resources Commission** - P.O. Box CT 5630, Cantonment, Accra, Ghana
- **Water Research Institute of the Center for Scientific & Industrial Research**- P.O. Box M32, Accra, Ghana
- **University of Ghana, Volta Basin Research Institute** - P.O. Box LG 209, Legon, Accra, Ghana
- **Center for African Wetlands at the University of Ghana** – P.O. Box LG 209, Legon, Accra, Ghana
- **Volta Basin Authority -** 11 BP 1437 Ouagadougou 11, Ouagadougou, Burkina Faso
- **Volta Basin Development Foundation -** Richard Twum [rtwumus@yahoo.com]
- **Chiefs and Political Leaders of the Local Communities** – Nene Tsatsu Pediator IV, Coordinator: P.O. BOX AN 12962, Accra North, Ghana or c/o Volta Basin Development Foundation
- **Interim Guinea Current Commission** - 1 Akosombo Street, Airport Residential, Accra, Ghana
- **Purdue University Energy Center** - 500 Central Dr., Potter 270, West Lafayette, IN 47907-2022
- **Associates for International Resources and Development** - 185 Alewife Brook Parkway,
- Cambridge, MA 02138
- **GLOWA Volta Project** - Center for Development Research (ZEF), University of Bonn, Walter-Flex-Str. 3, D-53113, Bonn, Germany
- **University of Stuttgart: Modeling- Policy Interface (NMPI) Network** – Institute fuer Landscaftsplanung und Oekologie, Universitaet Stuttgart Keplerstr.11, 70174 Stuttgart, Deutschland
- **International Water Management Institute** - PMB CT 112, Cantonments, Accra, Ghana
- **World Conservation Union (IUCN) -** Rue Mauverney 28 Gland 1196 Switzerland
- **The Nature Conservancy -** 4245 North Fairfax Drive, Suite 100, Arlington, VA 22203-1606
- **The Natural Heritage Institute (Executing Agency & Global Coordinator) -** 100 Pine St., Suite 1550, San Francisco CA 94111 U.S.A.

Annex 5: Brief on Implementing Partners -Justification for Sole Sourcing

5.1 VOLTA RIVER AUTHORITY (VRA)

5.1.1 Introduction

The Volta River Authority (VRA) is an electric power utility with the primary business of generating electricity Ghana, and distributing electricity in the Northern parts of Ghana. VRA also supplies power to the neighboring countries Togo, Benin and Burkina Faso. VRA also exchanges power with La Cote D'Ivoire and also wheels power from Cote D'Ivoire to Togo and Benin. Currently, VRA has constructed two hydroelectric dams on the Volta River, the Akosombo and Kpong dams. VRA also owns a 330 MW combined cycle thermal plant at Aboadze, near Takoradi. VRA, in joint partnership with CMS Energy of Michigan, also owns another 220 MW thermal plant at Aboadze known as TICO. The construction of the dams resulted in the formation of the Volta reservoir and the Kpong Headpond which are used primarily used for hydro-energy production. Other significant uses are navigation, fisheries, water supply (commercial and domestic), tourism and irrigation. VRA is also responsible for the development of the Volta basin in Ghana by providing facilities to promote socio-economic development of the Volta basin.

5.1.2 The Volta Hydroelectric Dams

The VRA owns and operates two hydroelectric generating stations at Akosombo and Kpong. The Akosombo Hydroelectric plant, which was commissioned in 1965, had an installed capacity of 912 MW but after a retrofit, is now 1020 MW. The Kpong project is about 25 km downstream from Akosombo and was commissioned in 1982. The Kpong dam has an installed capacity of 160 MW bringing the total hydro capacity to 1180 MW.

5.1.3 The Volta Basin in Ghana

The Volta System in Ghana comprises of the Volta Lake and its main tributaries, the Main Reservoir, the Kpong Headpond and the Lower Volta. The main tributaries of the Volta Lake are the Black Volta, White Volta, Afram, Daka and Oti rivers. The area of the Volta Basin in Ghana is about 106, 300 square kilometers ($km^{2)}$. The Volta reservoir has a surface area of about 8,500 km^2, an average depth of about 18.8 meters (m) and a shoreline of about 5,500 km. The deepest portions of the lake are about 90 m. The total volume of water in the reservoir at full supply level of about 84.73 m is approximately 150 billion m^3. The seasonal rise and fall is about 2.0-6.0 m and the areas covered by seasonal fluctuations are about 100,000 hectares (ha). The Kpong Headpond, i.e. the area between the Akosombo dam and the Kpong Dam, has a surface area of 12 km^2 with a total volume of about 190 km^3. The average headpond elevation is about 14.7 m. The Lower Volta area, i.e. the area between the Kpong Dam at Akuse and the estuary at Ada, is about 68,600 km^2.

5.1.4 VRA's Initiatives

Socio-Economic initiatives

i) <u>Residual Resettlement Program</u>

Socio-economic enhancement of project affected persons is one of the very important keys to the success of any project. VRA has taken the initiative to undertake activities to compliment original resettlement program associated with the construction of the dams on the Volta Basin. The construction of the Akosombo dam caused a total approximate area of 8,500 square kilometers to be flooded. Subsequently, a population of about 80,000 people who were living in this flooded area had to be resettled in 52 new resettlement townships. Compensation was paid for properties destroyed by the

floods. The affected people were involved in the selection of their new resettlement sites. Some of the factors, which determined the selection of these sites, included the availability of farmlands and access to water. A provision of a maximum of £3.5 million (M), out of the total project cost of £70.0 M, was made to cater for compensation and resettlement. However, by end of 1964, a total of £10.0 M had been spent on compensation and resettlement, as compared with the actual works cost of £65M. To help in the socio-economic enhancement of the resettled communities, VRA solely finances a Resettlement Trust Fund, set up in July 1996, into which the cedi equivalent of US $500,000 is paid annually for the benefit of the 52-resettlement townships built under the Akosombo program. Since the Trust Fund began operation, various socio-economic and infrastructure program such as rehabilitation of school buildings, water supply, construction of clinics, solar electrification etc. have been financed.

ii) Public Health

Public health problems, especially water-borne diseases, have increased as a result of the formation of the lake. Two major health hazards that prevailed in the Volta basin were onchocerciasis (river blindness) and schistosomiasis (bilharzia).VRA has embarked on a schistosomiasis control program in the Kpong Headpond and the Lower Volta Basin. The program involves the administration of drugs, control of weeds and the snail vector, health education and the provision of sanitary facilities.

iii) Fishery

In 1995, an estimated 52,000 metric tonnes of fish was produced from the Volta Reservoir alone out of an estimated total national consumption of about 375,000 metric tonnes [3]. The fisheries of the Volta river system, therefore, play a vital role in the socio-economy of the nation, especially, the rural community. VRA has established the Volta Lake Transport Company Limited (VLTC) on behalf of the Government of Ghana, as a subsidiary to operate river transportation for passengers, bulk haulage, and haulage of petroleum products on the Volta Lake. Due to the general north/south orientation, the formation of the Volta Reservoir has served as a waterway for both large and small vessels. Goods can now be transported cheaply on the lake. The navigable length on the Volta Lake is 415 km (Akosombo to Buipe).

Some threats to navigation on the Volta Lake are inadequate landing ramps, rocky outcrops, tree stumps, outdated bathymetric and topographic information and the destruction of navigation aids by storms. To arrest these threats, VRA, in 1973, introduced a Legislative Instrument, LI 862 (Lake Traffic Regulations), which seeks to regulate and control the types and mode of transportation on the lake. These regulations cover licensing, policing and safety measures on the lake. A Lake Traffic Control Unit has been established within the Environment & Sustainable Development Department of VRA to enforce LI 862, in collaboration with the Ministry of Roads & Transport.VRA undertakes tree stumps clearing to ensure safe passage for large vessels. VRA in 2001 undertook a project known as the "Volta Lake Debre Shoals Dredging and Maintenance Project" to remove rocks and sediments from the bed of the lake from parts of the lake to ensure safe passage by large vessels. With the passing of the Ghana Maritime Authority Act, 2002 (Act 630), the Ghana Maritime Authority is expected to be responsible for regulating activities on shipping in the inland waterways including the safety of navigation in inland waters.

iv) Commercial Irrigation

The Volta reservoir has brought about possibilities of commercial irrigation. To demonstrate its viability, VRA established the Kpong Farms limited as a subsidiary company to promote leadership in agricultural systems, irrigation practices and food processing technologies. The project utilizes water from the Kpong Headpond by a gravity-irrigated scheme covering an area of approximately 100 hectares.

v) Lower Volta Environmental Impact Studies

Now that VRA has more or less contained the problems upstream, attention has now been focused on the settlements downstream, whose ecology has experienced some changes due to the construction of the dams. The ecological changes that have occurred include the growth of aquatic plants (surface & submerged), the incidence of the snail vector of bilharzias resulting in the prevalence of the disease, reduction in, the once lucrative clam and oyster-like shellfish, and formation of a sandbar at the estuary.The VRA commissioned the Volta Basin Research Project (VBRP) of the University of Ghana in April 1996, to undertake environmental impact assessment of the construction of the dams in the Lower Volta basin at a cost of about $740,000.00. The study, known as the Lower Volta Environmental Impact Studies (LVEIS), was completed in September 2000. The study identified activities in the area of agriculture, fishing, potable water, compost production, sanitation & health, establishment of potential industries as well as the provision of social infrastructure.

vi)Environmental Enhancement Initiatives

Deforestation & Land Degradation

After the formation of the Volta reservoir, many fisher-folks migrated and settled in uncontrolled human settlements that sprung up around it. Agricultural activities, felling of trees and other land uses in the forest belt by the fisher-folks have resulted in erosion, siltation and sedimentation in the lake and deforestation of large areas around the lake. As at December 2001, over 180 hectares of forest trees had been grown and several hectares of the basin lands at the Yeji area have been projected for regeneration; and over 1,000 improved mud stoves as well as chorkor smokers had been introduced to the riparian communities to reduce fuel wood use. Also, as at March 2002, over 1700 hectares of degraded lands in the Akosombo area had been successfully reforested and about 5,200 hectares of natural vegetation had also been protected against bush fires. In an effort to generate the settlers' interest in the protection of the forest and also t Sandbars at the Volta estuary. Before the impoundment of the river, the force of the annual floods that occurs during the rainy season clears out any sand bar formed at the Volta estuary. With the cessation of annual floods, due to the construction of the dams, the sand bar gradually started to grow. Within a period of 20 years, the sand bar had partially blocked the estuary and the saline water from the sea could no more penetrate the channel of the river during high tides. With the absence of salt water into the river channel, fresh waterweeds started growing at the estuary. These weeds formed a habitat for the schistome snail and this resulted in the occurrence of bilharzias also at the estuary. In 1990, VRA acquired a dredger (See Figure 2) to clear a channel through the sand bar to restore salinity in the river channel. This has allowed free flow of saline water into the channel upstream and as a result the incidence of bilharzia has been controlled in the area. The dredging has also decreased the flow resistance of the river and therefore limits the flooding danger in case of spillage from the dams. It has also lowered the water level at the estuary.

5.1.5 Conclusion

In conclusion, the construction of the Volta hydroelectric dams, which is considered to be one of the largest water resources developments in the tropics, can be said to be of great success in terms of power generation. Water available from the reservoir resulting from the construction of the dams is primarily used for hydro-energy production, other significant uses being transportation, fishery, domestic purposes, tourism and irrigation. As a result of these significant uses, maintaining the integrity of the lake is critical to sustainable hydroelectric power production. The VRA has adopted the strategy of carrying out studies on both positive and negative changes in all development projects. The results of these studies are then used to help design measures to regenerate the natural environment and assist to eliminate poverty and also to improve on the economic efficiency of affected people so that no one is worse off as a result of VRA's intervention. The VRA carries out technical operations, socio-economic and environmental initiatives to ensure continuous, safe, efficient and competitively priced electricity for

sustainable power production from the Volta hydroelectric dams. In this respect, the VRA undertakes dam safety operations. The VRA is also undertaking a retrofitting project on the Akosombo Hydroelectric power plant with the objective of increasing the installed capacity from 912 to 1020 MW. VRA is also engaged in activities to promote socio-economic status of the communities affected by the Volta hydroelectric dam projects. This includes developing some potentials of the lake with the objective of attracting private investment, which would bring socio-economic development especially to the riparian communities and to the country as a whole. The VRA is also engaged in the development of the natural environment of the Volta reservoir basin, in conjunction with other public agencies. In line with the modern concept of environmental and involuntary resettlement program associated with such projects, VRA is currently developing an "Environmental Management Plan (EMP) and Emergency Preparedness Plan (EPP) for the Volta Dams and Reservoirs". VRA is moving abreast with the present best practice where, apart from technical considerations, socio-economic and environmental considerations have become paramount in developmental projects.

ROLE ON AKOSOMBO AND KPONG DAM PROJECT

5.1.6 Background of VRA Team Leader

Name: **Charles Kofi Obuobi Addo**

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Mr. C.K.O. Addo, currently Ag. Manager, Generation Planning in the Engineering Services Department of the Volta River Authority (VRA), has worked for the past 30 years with the VRA as an Assistant Civil Engineer, Civil Engineer, Senior Civil Engineer and Principal Engineer. During this period, he acquired his M. Eng. Computational Hydraulics degree from McMaster University, Hamilton, Canada. He also had several attachment programs with Electricité De France (EDF), Acres International of Canada, Coyne ET Bellier of France etc in the area of hydrology, optimum management of interconnected hydropower systems, inflow forecasting, reservoir modeling, power and energy simulation, generation planning and supply planning. With that experience he spent two years with the Lesotho Highlands Development Authority (LHDA) as an Operations Planning Specialist on a World Bank funded project to strengthen the Operations Planning Department of the LHDA. He represents the VRA on matters relating to the water resources of the Volta Basin especially with respect to other organisations like the Ghana Meteorological Agency (GMA), the Hydrological Services Department (HSD), the Water Resources Commission (WRC), SONNABEL of Burkina Faso and the Volta Basin Authority (VBA). He has considerable experience with programming methods and languages and is very conversant with modeling in general and hydropower simulation in particular. Charles brings these experiences to the project with regards to the main tasks of constructing and evaluating operational scenarios to achieve the target flows; constructing model of the power generation and distribution system to evaluate technical feasibility; and will lead the VRA team the experimental reoperation demonstration and monitoring.

5.1.7 Project Tasks

VRA together with experts from Purdue University will play a lead role in Activity 3 -Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility. VRA will be the lead partner for Activity 4 -How to Evaluate the Operationally Feasible Scenarios for Economic Feasibility and Activity 6 -Experimental Re-operation Demonstration and Monitoring, in addition to being part of teams for various tasks. VRA will play a key role in the Global Learning Programme.

5.2 WATER RESEARCH INSTITUTE (WRI) OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR), GHANA

5.2.1 Introduction

The Water Research Institute (WRI) is one of the 13 research institutes of the Council for Scientific and Industrial Research (CSIR). It is a public institution and it was established in 1996 from the merger of the former Institute of Aquatic Biology (IAB) and the Water Resources Research Institute (WRRI) of the CSIR. The IAB and WRRI were established in the 1960s. The mandate of the CSIR Water Research Institute is to conduct research into water and related resources. In pursuance of this mandate, WRI generates and provides scientific information, strategies and services toward the rational development, utilization and management of the water resources of Ghana. This is to support the socio-economic advancement of the country, especially in the health, agriculture, industry, energy, transportation, education and tourism sectors. The long-term objectives of the Institute are to:

i. generate, develop and transfer appropriate technologies, information, and services for sustainable development, utilization and management of water resources for socio-economic development of the country,
ii. generate, process and disseminate information on the amount of potable water that can be abstracted from groundwater resources as well as the reliability and sustainability of its recharge,
iii. generate, process and disseminate water and waste water quality information to end-users,
iv. enhance public health status through sound environmental management and water pollution control strategies and,
v. increase local fish production through participatory research and technology transfer in aquaculture, and sustainable management strategies in inland and coastal waters of Ghana.

5.2.2 Divisions

The objectives of the Institute are achieved through the activities of the following Technical and Supporting Divisions.

Technical Divisions:

i. Surface Water
ii. Groundwater
iii. Environmental Chemistry
iv. Environmental Biology and Health
v. Fisheries & Aquaculture

Supporting Divisions:

vi. Commercialization and Information
vii. Administration (including Transport)
viii. Finance

5.2.3 Staff & Laboratories

The CSIR WRI boasts of highly trained and experienced research scientists in hydrology, water resources engineering, irrigation engineering, soil & water engineering, hydrogeology, remote sensing & GIS, chemistry, chemical engineering, (micro)biology, fisheries and aquaculture, sociology and economics. The Institute also has two (2) reference water quality laboratories for physico-chemical and microbiological analysis of water (potable, industrial effluent & sewage). CSIR WRI has an outstation at Akosombo, which is dedicated to fisheries and aquaculture research and development.

5.2.4 Branches

CSIR WRI is headquartered in Accra, with branches in Tamale (Northern Region) and Akosombo (Eastern Region).

5.2.5 Clientele

The Institute has a large clientele and the beneficiaries include:

- Ministries, Departments and Agencies in the Water, Agriculture, Environment, Tourism and Health Sectors
- Manufacturing and Mining Industries
- Research and Development Institutions and University Departments
- Food Crop, Poultry and Fish Farmers
- Metropolitan, Municipal, District Assemblies and Communities
- International Development Partners/ Donor Agencies (DANIDA, FAO, DFID, AFD)
- Borehole Drilling Companies
- Regulatory Commissions
- Non-Governmental and Private Sector Organizations
- Riparian Communities
- Private Individuals.

ROLE ON AKOSOMBO AND KPONG DAM PROJECT

5.2.6 Background of Water Research Institute (WRI) of CSIR Team Leaders and Task Assignments

Key Scientists

i) <u>Yaw Opoku-Ankomah (Director)</u>

Dr. Yaw Opoku-Ankomah is a Director and a Principal Research Scientist of CSIR Water Research Institute. He has carried out studies of major rivers in Ghana in assessing available water resources of the country. The studies determined the annual and inter-annual flow characteristics of the rivers which are essential for the planning and development of the water resources of the country. Dr. Opoku-Ankomah led a team of experts in carrying out a pioneering study of impacts of climate change on water resources of Ghana through the use of products of General Circulation Models (GCMs), Hydrological and Water management models. The GCMs were used in the development of climate scenarios. The impacts of Climate Change were evaluated in the following sectors: Surface and Groundwater resources, Hydropower Generation, Water Supply for domestic and industrial use, Irrigation and Socio-economic development of the country. He has supported the development of rural water supply schemes through consultancy services offered in evaluation of spring sources and low flows of streams for the DANIDA-supported activities under Volta Region Rural Water Supply and Sanitation Programme. An important study he also undertook was a GEF-supported preliminary Transboundary Diagnostic analysis of the Volta River Basin for the development of a Strategic Action Programme for addressing transboundary concerns in the basin and its downstream coastal area. Other study undertaken was a hydro-political assessment of water governance in the Volta basin. The objective was to investigate the possibility of incorporating viable indigenous approaches to current water governance in the basin.

He will bring his experience to lead the task of climate change model inputs under Activity 2.

ii) <u>Stephen Dapaah-Siakwan (Deputy Director/Head, Groundwater Division)</u>

Dr. Stephen Dapaah-Siakwan is the Head of the Groundwater Division of the CSIR Water Research Institute. He holds a Ph.D. in Groundwater and

Environmental Isotopes Hydrology from the University of Tsukuba, Japan; M.Sc. degree in Groundwater Hydrology (FUB, Brussels, Belgium) and B.Sc. degree in Physics (KNUST, Ghana). He has played very important roles in the planning, and execution of several water-related projects in Ghana. As a Senior Principal Scientist, he had worked and still continues to work as a steering committee member on several water projects in Ghana. Dr. Dapaah-Siakwan has undertaken several groundwater assignments for both private, government agencies including CWSA, the Water Resources Commission (WRC) of Ghana as well as non-profit organizations. With more than 30 years of working experience, he has worked as Hydrogeologist across all the geological formations in Ghana. Due to his long service in the water sector, Dr. Dapaah-Siakwan has gained a lot of experience in the areas of research and in-depth knowledge in groundwater resources assessment in several river basins in Ghana, geophysical exploration, drilling supervision, borehole construction, borehole geophysics as well as groundwater monitoring in Ghana. He is actively involved in the groundwater monitoring network programmes in the Ghana including groundwater monitoring project in the three Northern Regions of Ghana. At present, Dr. Dapaah-Siakwan is the project coordinator for the DANIDA-sponsored White Volta River Basin groundwater project.

Dapaah's experience will be put into the task of modelling groundwater recharge and trends in use in the project area under Activity I.

iii) Kankam-Yeboah (Head, Surface Water Division)

Dr. Kwabena Kankam-Yeboah is a Senior Research Scientist and Head of the Surface Water Division at the Water Research Institute (Council for Scientific & Industrial Research), Ghana. He holds a Ph.D. in Water Resources Engineering from Okayama University, Japan (2005); M. Sc. (Irrigation Engineering) Degree (1993) from the Universiteite Katholieke Leuven, Belgium; M.Sc. (Tropical Agriculture) degree (1989) from the Université Catholique de Louvain, Belgium; and a B.Sc. (Agriculture) Hons. Degree (1984) from the University of Cape Coast. Dr. Kankam-Yeboah's areas of research and development include water resources systems; surface and groundwater hydrology; Agrometeorology, remote sensing and GIS applications in hydrology; integrated water resources and environmental management; and agricultural/irrigation water management. Since joining the CSIR Water Research Institute in 1986, he has worked extensively on hydrology and water resources projects and is a member of several professional associations and societies.

His background and experience will be for the task on studies on agro-ecology (irrigation, farming systems) under Activity 1.

iv) J.K. Ofori (Head, Fisheries & Aquaculture Division)

Dr. Joseph K. Ofori is a Senior Research Scientist *at* the CSIR-Water Research Institute, Ghana for the past 28 years. He is currently the Head of Division- Fisheries & Aquaculture; having served as the Officer-In-Charge of the WRI's Aquaculture Research and Development Center at Akosombo for the past 15 years. Dr. Ofori obtained his Ph D. in Biological Sciences- Aquaculture from the Kwame Nkrumah University of Science and Technology - Kumasi, Ghana and has attended various certificated courses in his area of professional discipline as well as in management development. He is involved in research work in fisheries and aquaculture including fish feed formulation and evaluation for tilapia, pond management, tilapia production in cages, on-farm residues and their effects on pond productivity, water quality and tilapia growth studies, integrated agriculture-aquaculture systems and predator-prey interactions in Tilapia/Lates culture in ponds, fisheries development in dugouts in Northern Ghana Cage culture studies in the Volta Lake, and writing of feasibility and business plans for aquaculture related projects. Dr. Ofori serves on a number of important committees and review teams including Aquaculture Implementation Committee (AIC) of the Ministry of Food & Agriculture (Fisheries), World Bank-Government of Ghana review teams of sponsored Aquaculture and Fisheries projects, Research and Linkage Committees (RELC) of National Agriculture Research Project (NARP), and Coordinator of the Freshwater Fisheries Programme of the Agriculture Sub-Sector Improvement Programme (AgSSIP). He currently serves on the board of the Fisheries Commission of Ghana and has to his credit over 20

publications journal articles and technical reports. Some of the responsibilities and working area include (a) fish stock assessment of the Volta Lake (1980-1981) Seasonal fish distribution and composition of major rivers subjected to Simulium larvicide treatment in the Onchocerchiasis Control Programme (OCP) area of Northern Ghana (1981-1985); (b) studies on reservoir fisheries of the Kpong and Weija impoundments (1985-1987); Documentation and Evaluation of the Nile tilapia *Oreochromis niloticus* in Ghana (1988-1990); (c) Aquaculture Development Project, Ghana (1990-1994); (d) Coordinator-Inland fisheries Research for CSIR- WRI AgSSIP (2000-2004), Coordinated collaborative research with other research institutions both local and international on fish culture systems including Integrated Agriculture Aquaculture (IAA), Polyculture, fish feed formulation, evaluation and development for aquaculture production; (e) Project Leader: WRI-Aquafarm Project; Research-Farmer collaboration on developing technologies for improved pond fish production (2004-2005); (f) Project Investigator, Challenge Programme (CP34): Working with fish farmers and fishers on development of pen and cage culture in the Volta Lake and lower Volta River (2005-2009); (g) Project Investigator- CP 6:- Fish enhancement in dugouts in the Upper East and Northern Regions of Ghana. Working with members of selected communities to improve fish production in community dugouts in the savanna eco-zone of Ghana (2004-2009); (h) Project Leader:- Commercial production of tilapia fingerlings for commercial cage farmers in the Volta Lake. Targeted to produce over 2 million fingerlings for West Africa Fisheries Limited and other farms on the Volta Lake (2008-2009); (i) Project Leader-Technical: Extending micro financing support and technical knowledge for potential fish farmers in the Asuogyaman District, Ghana for the development of small cage farms (2009-2011), and (j) Lecturer Part-time: Teaching Aquaculture at the Department of Oceanography and Fisheries, University of Ghana –Legon from 2005 to present. Dr. Ofori has also provided extensive consultancies and extension services in aquaculture and fisheries.

Dr. Ofori's key role will be the task of developing flow requirements for fisheries under Activity I.

v) <u>Barnabas Amisigo (Senior Research Scientist)</u>

Barnabas Amisigo is a Hydrologist and Water Resources Engineer with experience in water resources management and hydro climatic modeling. He has been a member of a team of research scientists on the integrated Water Resources Development and management research projects at the CSIR-Water Research Institute (CSIR-WRI), Accra, Ghana, since joining that Institute in 1991. He is also currently a Senior Researcher (hydrology and Climate Change Modeling) in the Sustainable Water Use under Changing Land Use, Rainfall Reliability and Water Demands in the Volta Basin of West Africa – the GLOWA-Volta Project (GVP) - a scientific research project financed by the Ministry of Science and Education (BMBF) of the Federal Republic of Germany and led by the Centre for Development Research (ZEF) of the University of Bonn.

He will bring his experience to the task of climate change model inputs

5.2.7 Project Tasks

WRI will play the lead role in Activity 1 tasks (Agro-ecology; Flow Requirements for Fisheries; and Groundwater Recharge and Trends in Use) with NHI experts. Activity 2 task include 'Climate Change Model Inputs'.

5.3 THE CENTRE FOR AFRICAN WETLANDS (CAW)

5.3.1 Introduction

The Centre for African Wetlands (CAW) was established in 2000 as a sub-regional initiative with funding from the Royal Netherlands government. It is hosted by the University of Ghana and covers 12 West African countries (Benin, Burkina Faso, Cameroon, Cape Verde, Cote d'Ivoire, Ghana, Guinea Bissau,

Liberia, Mali, Mauritania, Nigeria, and Senegal). The ultimate goal of CAW is to contribute to the preservation of the global, sub-regional, national and local values of West African wetlands for:

- the benefit of society as a whole,
- improving the quality of life for people living within and around wetlands,
- maintaining wetland biodiversity and enhancing the general ecological integrity of wetlands.

5.3.2 The Mandate of CAW

The mandate of CAW is to promote sustainable wetland management through research (ecological, socio-economic and policy), capacity building, information dissemination, networking, advocacy and policy support. Currently CAW focuses its programme on six main areas, namely:

- Training and capacity development (wetland research and management planning; water resources management, water and sanitation issues)
- Wetland Inventory and Classification (mapping; hydrology and biodiversity);
- Long term wetland assessment and monitoring (focusing on ecological character, indicators and wetland values);
- Climate Change (impacts, adaptation & mitigation);
- Pollution/Degradation (biological & chemical pollutants, invasive and exotic plant species; watersheds degradation; wetlands and health);
- Conservation and utilization (local livelihoods; ecotourism; traditional knowledge systems; wetland laws and policy);

5.3.3 Centre for African Regional Node

CAW serves as the African Regional Node for Wetlands and Coastal Zone Management for the START (System for Analysis, Research and Training for global change), and has partnerships with a number of institutions in Europe, including the Netherlands Institute for Sea Research and the University of Groningen.

ROLE ON AKOSOMBO AND KPONG DAM PROJECT

5.3.4 Background of CAW Team Leader

Professor Christopher Gordon (Ph.D) is an Environmental Scientist with many years of experience as a limnologist and aquatic resource management advisor, with special interest in biodiversity of coastal, wetlands, freshwater systems and the functioning of such systems. As an Associate Professor with the Volta Basin Research Project, Dean of International Programmes and the Interim Director of the Centre for African Wetlands (CAW) of the University of Ghana, he has been involved in many policy decisions and provided policy guidance on aquatic resources and their management as well as general wetland and general biodiversity conservation issues to government and non-governmental organisations.

He has a number of publications (30 scientific publications, 25 conference papers and posters, and 16 reports and mimeographed materials) in the areas of aquatic resource use and management, freshwater/wetland conservation, tropical and general biodiversity, and eco-toxicology. Most of his studies have focused on the Volta basin and in particular, he has examined the effects that the Volta Dams have had on downstream environment and communities and how mangroves can be sustainably managed by local communities. He is, therefore, well placed and would bring this exemplary experience to the project that seeks to undertake studies on re-operation and re-optimising of the Volta dams. He would be the key person from CAW to take on the tasks on the consultations with downstream communities (with VBRP) and on objectives and future scenarios, and specification and quantification of reintroduction of ecological functions and livelihood objectives.

Chris also has a problem solving approach to issues involving consensus of stakeholders, strong administrative skills, and has experience in the review, evaluation and editing of documents. The task of reviewing literature and summary report on all parameters pertaining to environmental and livelihood flow requirements would be assigned to him.

5.3.4 Project Tasks

CAW will be responsible for the following tasks:

i) Downstream Community Consultation with VBRP;
ii) Specification and Quantification of Objectives;
iii) Flow Requirement for Fisheries (in collaboration with WRI);
iv) Literature review – environmental and livelihood flow requirements;
v) Coordinating Final Target Flow Workshop for Activity 1 tasks.

CAW will also be part of other teams working on various tasks.

5.4 VOLTA BASIN RESEARCH PROJECT (VBRP)

5.4.1 Introduction

The University of Ghana set up the Volta Basin Research Project (VBRP) in 1963 as a multi-disciplinary unit, with the mandate to carry out a range of research activities on fisheries, agriculture, hydrobiology, public health, socio-economic, aquatic plants, water quality, limnology, among others. The initial task of VBRP was to collect information that might no longer be available after the completion of the Akosombo dam and the consequent formation of the Volta Lake. Currently, VBRP's research activities have been extended to cover ecological changes resulting from the damming and the human responses to the post-dam conditions. These research efforts are aimed at providing the relevant information for effective management of the basin and sustainable utilization of resources within the basin. The multidisciplinary nature of the project has ensured the provision of a holistic view of the various problems facing the river basin.

5.4.2 Research Programmes

VBRP has generated substantial scientific information on the Volta Basin and contributed significantly towards its socio-economic development by finding solutions and making appropriate recommendations to the problems associated with the damming. Since its establishment, Volta Basin Research Project has carried out numerous ecological and socio-economic studies in the Volta Basin, notable of which are:

- Archeological explorations in the Volta Basin.
- Hydrobiology and fisheries of the Volta Lake and development of aquaculture in the Lower Volta Basin
- Distribution of aquatic plants in the Volta River channel and major creeks.
- Ecological and socio-economic problems associated with the Volta dams, particularly in the lower basin.
- Agricultural land-use dynamics and soils in the draw down area of the Volta Lake and the Lower Volta Basin.
- Exploitation and utilization of local resources including mangroves and reeds.
- Sources and quality of water for the inhabitants in the Lower Volta Basin and public health, particularly bilharzias.
- Schistosomiasis and its relation with HIV/AIDS in the Basin.

- Promotion of Clam and Crab Culture in the Lower Volta Basin.

ROLE ON AKOSOMBO AND KPONG DAM PROJECT

5.4.3 Background of VBRP Team Leader (Yet to be submitted)

5.4.4 Project Tasks

VBRP will be responsible for 'Downstream Community Consultations' under Activity 1 with CAW, and Activity 5 task on 'Estimate the Effects on Public Health'. VBRP will be part of teams working on various other tasks. VBRP has a long record of interaction and working in the communities within the Volta Basin.

1. Assignment Name: Lower Volta Environmental Impact Studies	**Name of Client:** Volta River Authority (VRA)
Narrative description of Project: This research involved an environmental appraisal of the Lower Volta Basin as a means of generation the requisite data for planning the sustainable utilisation and effective management of the environment and aquatic resources of the Lower Volta Basin. **Status:** Completed	
2. Assignment Name: Environmental Impact Studies on the Lower Volta Basin: Bilharzia Survey in the Ada Area.	**Name of Client:** Volta River Authority (VRA)
Narrative description of Project: Measurement of the water quality parameters, distribution of aquatic weeds, distribution of intermediate snail hosts, and investigation of the prevalence of bilharzias *(Schistosoma haematobiumand S. mansoni)* among school children of the communities living close to the river bank. **Status:** Completed	
3. Assignment Name: Water Quality Schistosomiasis, HIV/AIDS in the Afram Basin	**Name of Client:** Ministry of Water Resources Works and Housing.
Narrative description of Project: The research involved determination of water quality, an appraisal of the status of urinary schistosomiasis and establishment of data on prevalence of genital schistosomiasis through clinical assessment. **Status:** Completed	
4. Assignment Name: Homestead Crab Culture	**Name of Client:** Ministry of Food and Agriculture (MOFA)
Narrative description of Project: The research examined the status of lagoon-crab industry in the Volta Delta. It also designed ways of raising crabs in captivity for livelihood support. **Status:** Completed	
5. Assignment Name: Development of the Volta Clam, *Galatea Paradoxa* in the Volta Estuary	**Name of Client:** Ministry of Food and Agriculture
Narrative description of Project: The research examined the harvesting and catch pattern of the clam *Galatea paradoxa* for provision of scientific information to assist in culturing for socio-economic support. **Status:** Completed	
6. Assignment Name: Salvage of submerged Trees in Volta Lake	**Name of Client:** Clark Sustainable Resource Developments
Narrative description of Project:	

Assist CSRD to develop appropriate environmental and social impact monitoring. **Status:** Ongoing	**5.4.5**

Similar Assignments Undertaken By VBRP

5.5 THE WATER RESOURCES COMMISSION (WRC)

5.5.1 **Introduction**

The Water Resources Commission is an agency of the Ministry of Water Resources, Works and Housing (MRWH) of the Republic of Ghana. The WRC will serve as the grant applicant, executing agency, and fiscal agent, disbursing AWF funds to the other partners. WRC is also an implementing partner.

5.5.2. **Institutional and Legal Status**

The Water Resources Commission (WRC) of Ghana submits this project proposal on behalf of the governmental and non-governmental partners in this project, as specified below. The WRC was established by an Act of Parliament i.e. Act 522 of 1996 is the government agency of the Republic of Ghana, charged with the regulation and management of the country's water resources and the coordination of policies in relation to them. The WRC will serve as the grant applicant, executing agency, and fiscal agent, disbursing AWF funds to the other partners pursuant to the requirements of the African Develop Bank's Disbursement Handbook and pursuant to contracts with the project partners that specify task assignments and resource commitments. The funding allocation and task assignment matrix is attached as Annex II. The WRC will assume full responsibility for the faithful execution of the project and management of the project funds according to the standards and criteria required by the African Development Bank.

The WRC main functions and activities (beyond the role it will play in this project) are as follows:

(a) Propose integrated water resources management plans for the utilization, conservation, development and improvement of water resources;
(b) Initiate, control and co-ordinate activities connected with the development and utilization of water resources;
(c) Grant water rights;
(d) Collect, collate, store and disseminate data or information on water resources in Ghana;
(e) Engage water user agencies to undertake scientific investigations, experiments or research into water resources in Ghana;
(f) Monitor and evaluate programmes for the operation and maintenance of water resources;
(g) Advice the Government on any matter likely to have adverse effect on the water resources of Ghana; and
(h) Advise pollution control agencies in Ghana on matters concerning the management and control of pollution of water resources.

5.5.3 **Organization and Management**

i). <u>Structure, Staffing and Management of the WRC</u>:

The Commission is composed of the major stakeholders involved in the water sector including representatives of institutions relating to Hydrological Services, Water Supply, Irrigation Development, Hydro power generation, Water Research, Environmental Protection, Forestry, Minerals, Traditional Chiefs, NGO's, and Women interests. This structure of the Commission provides a forum for integration, cooperation and collaboration of the different interests in the water sector.

The Commission generally supervises the WRC Secretariat which is headed by an Executive Secretary and supported by a team of full-time professional staff including the following: Water Resources Engineer; Water Resources Economist; Water Quality Specialist; Information Technology Specialist; Hydrogeologist (2); Ecologist (2); Legal Officer; Public Relations Officer; Accountant; and an

Administrative Officer. Furthermore, a Basin Officer is in charge of each of the three (3) established river basin offices. Middle level staff supports the professional staff. Currently, such middle level personnel are employed in the areas of compliance monitoring (2), planning (1) accounting (2), library services (1), and administration (1). WRC also benefits positively from the National Service Programme where organisations utilise the services of relevant professional graduates on an annual basis. Accordingly, WRC would make use of such resources in the execution of the project. WRC has permanent offices for its main secretariat in the national capital (Accra) and three decentralised basin secretariats located in two regional capitals (Koforidua and Bolgatanga) and a district capital (Tarkwa). These offices are equipped and fully functional.

ii) Financial Management, Governance and Capacity

The day-to-day internal control of WRC management operations is based on a well established and functioning financial system, the Navision Financial System, which conforms to the Ghana Government Financial Administration Act 654 of 2003.

However, the main existing system for the internal control of management operations is the periodic administrative and management reporting to the Commission by the Executive Secretary about the general progress in activities. It is the mechanism for obtaining approval and opinion on making adjustments in implementation if required. The reporting also facilitates the Commission's general monitoring requirements, including the financial status of WRC. This internal control system also applies to donor-supported programmes. It can be mentioned, that the WRC accounts have been well managed such that its annual accounts have been approved with only minor comments by the independent auditors appointed by government. The management of procurement procedures are managed transparently within the WRC. The internal mechanism for procurement using government or donor funds has generally been under the authority of an Entity Tender Committee, which operates under the rules and regulations of Public Procurement Act 663 passed in 2003.

iii) Financial Reporting and Auditing

The financial accounts of WRC are open and available to independent public and private external audit systems. Section 26 (2) of the Water Resources Commission Act 522 of 1996 stipulates that the books and accounts of the Commission, shall be audited annually by the Auditor General of Ghana or an auditor appointed by him within three months of the end of the immediately preceding financial year. The financial accounts of the Commission have accordingly on a yearly basis been made available and audited by an auditor appointed by the Auditor General. This procedure has been followed since WRC started its operations in 1999. Furthermore, copies of these audited accounts are submitted to the parent ministry, i.e. the Ministry of Water Resources, Works and Housing, which in turn submits them to Parliament as stipulated in Section 27 (1) of the WRC Act. The accounts of the WRC that relate to donor inflows are made available and audited appropriately by a private external auditor is appointed independently by the donor. The audited accounts submitted to the Ministry and subsequently to parliament are the consolidated accounts of government and donor funds to WRC.

5.5.4 **Work on Donor Funded Projects**

Three projects that serve as concrete illustrations and examples of WRC's capacity to carry out this proposed action are identified as follows -

i) **Support to the Water Resources Commission:**

Designed to support the WRC clarify its roles and functions towards IWRM and develop its operational tools as well as build capacity of staff and public awareness raising activities. This was a DANIDA

supported project for a 3-year period from 2001 to 2003. The total budget was EUR 1,700,000 made up of WRC administered budget of EUR 600,000 and International technical assistance of EUR 1,100,000.

ii) **Integrated Water Resources Management Component**

Another DANIDA supported 5-year project (2004-2008) under the Ghana Water and Sanitation Sector Support Program. The aim was to provide a further strengthening of the procedures and work routines of WRC towards the general aim of introducing IWRM at all appropriate levels of society. The total cost of the project was EUR 2,980,000. WRC administered budget was EUR 1,900,000 and International technical assistance was EUR 1,080,000.

iii) **Development of National and River Basin Integrated Water Resources Management (IWRM) Plans (2009 – 2011)**

The project is designed to develop national and river basin IWRM Plans. Other partners are the Water Research Institute (WRI); and Hydrological Services Department (HSD) of Ghana. It is being implemented under the European Commission's 9th European Development Fund with a total amount of EUR 1,798,400.

5.6 THE NATURAL HERITAGE INSTITUTE (NHI) & EXPERTS FROM THE PURDUE UNIVERSITY ENERGY CENTER, USA

5.6.1 Introduction

The Natural Heritage Institute (NHI), a non-profit, non-governmental organization, specializes in restoring ecological functions in developed river systems. NHI occupies a wholly unique role in this project. NHI initiated and organized this project as a regional component of a Global Dam Re-optimization project, which includes other regional components in Nigeria, China (Yellow, Yangtze and Pearl River basins), India (Krishna river basin), South America (Parana-La Plata River basins) and (probably) Kenya (the Tana River Basin). Each of the regional components consists (or will consist) of a partnership of the local dam operators, river basin commissions, governmental planning and regulatory agencies, local and international NGOs with special expertise, and local university experts. NHI will coordinate these regional components and distill and pool the outputs into a global learning process that will result in a "toolkit" of dam re-operation tools and techniques that will be widely disseminated and propagated around the world. At this point, NHI has contributed over $1 million USD of its own funds in the design and organization of the Ghana project and the other regional components. NHI has been working now for three years in developing and designing this project. The tasks in the work plan for which NHI would part of the teams are a continuation of this previous work. All of the regional projects, including the Ghana component, have in common a basic framework of analytic tasks. Each will include:

- a process for determining the flow requirements to restore impaired ecosystems, livelihoods and food production systems;
- creation of a state of the art hydrologic planning model;
- creation of an irrigation system, hydropower system and/or flood management system model;
- creation of an economic optimization model;
- a trial demonstration of the resulting re-operation plan;
- contributions to a global learning process.

Uniquely among the partners, NHI possesses experience in orchestrating all of these elements together into an integrated and coherent project. For the past 20 years, we have done this work comprehensively in hydropower systems throughout the US, in irrigation and flood management systems in the Central Valley of California, in the bi-national river system that defines the U.S.-Mexican border, in the Okavango River system in southern Africa, and throughout continental Africa for the World Bank, to name a few

examples. A more complete resume of NHI's projects can be reviewed at www.n-h-i.org, and in the dedicated project websites: www.global-dam-re-operation.org; www.riogrande-riobravo.org; www.conjunctiveuse.org; and www.agwatercon.org. NHI will be part of teams for specific task elements of the work plan, for which we have unique expertise and experience. As is NHI's standard practice, we will draw upon the talents of our staff, directors and affiliates, as well as other partners in the task teams, to carry out the tasks in the work plan for the Ghana component.

ROLE ON AKOSOMBO AND KPONG DAM PROJECT

5.6.2 **Background of Team Leaders**

i) **Unique Capabilities of Paul Preckel, F. Thomas Sparrow and Brian Bowen**

Paul Preckel, F. Thomas Sparrow, and Brian Bowen are uniquely qualified and equipped with the experience and analytical tools necessary to carry out the tasks specified under Activity 3 – "Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility", together with VRA. Dr. Preckel is Professor of Agricultural Economics at Purdue University where he teaches a Ph.D. level course in mathematical programming. He is also the Faculty Director of the Indiana State Utility Forecasting Group and Faculty Director of the Power Pool Development Group, both in the Energy Center of Discovery Park at Purdue University. Dr. Sparrow is Professor Emeritus of Industrial Engineering at Purdue University and former Director of both the Indiana State Utility Forecasting Group and the Power Pool Development Group. Dr. Bowen holds a Ph.D. in Industrial Engineering from Purdue University and also is a former Director of the Power Pool Development Group at Purdue. These experts in the Power Pool Development Group have been involved with electricity generation and transmission infrastructure planning in Africa for over 15 years. Early work focused on providing analytical support during negotiations of the 12-nation Southern Africa Power Pool (SAPP) by simulating electricity trade among members. The SAPP agreement was signed in December of 1995, and has fostered greater cooperation and trust among the 12 national utilities. Details regarding the development of SAPP and its impact may be found on the Energy Center's Global Partnerships website at Purdue University(http://www.purdue.edu/discoverypark/energy/centers/globalpartnerships.php). Based on the success of that work, the Power Pool Development Group performed similar analyses for the Economic Community of West African States (ECOWAS) Energy Ministers. Details of the history of the project and related proposals, publications, and presentations may be found on the Global Partnerships website. The planning model that these experts built for ECOWAS will now be utilized for the power grid planning element of this Dam Re-optimization project for the Lower Volta. More recent work on India (Bowen, B.H., D. Canchi, V.A. Lalit, P.V. Preckel, F.T. Sparrow, and M.W. Irwin, 2009. "Planning India's Long-term Energy Shipment Infrastructures for Electricity and Coal," Energy Policy, In Press) has assessed long-term plans and policy alternatives for expansion of electricity infrastructure in India. Given this history, the team is uniquely endowed with the capabilities and analytical tools needed to perform Task 3 under the Volta River Basin Dam Re-operation Project. If the project did not have the benefit of the grid operations model that this team has already created, it would need to construct such an analytical tool from scratch, which would be very expensive and inefficient.

In addition to this related work, the team has also been involved with the study of the issues related to hydroelectric dam reoperation along the lines of the project proposal. This work includes the development and testing of a simplified prototype model of the optimization of investments in generation and transmission resources to minimize the incremental costs of operating the dam as a run of river (or near run of river) facility. This basic concept of the model was presented at a conference in 2008 (Preckel, P.V. , F.T. Sparrow, B.H. Bowen, Z. Yu, D.J. Gotham, R. Z. Yang, 2008. "Preserving Low Cost Electricity While Improving the Riverine Environment: A Case Study of Ghana's Akosombo Dam Complex," presented at the IEEE Power Engineering Society General Meeting, Pittsburgh, Pennsylvania, July 23, 2008 pp. 1-6), and a stylized implementation of the model was presented at another conference in

2009 (Preckel, P.V., F.T. Sparrow, B.H. Bowen, Z. Yu, D.J. Gotham, 2009. "Preserving Low Cost Electricity while Improving the Riverine Environment: Part Two – Model Results," presented at the IEEE Power Engineering Society General Meeting, Calgary, Alberta, July 26-30). Thus, the work proposed for Task 3 represents a continuation of the work that has been an ongoing collaboration by the team members over the past fifteen years.

ii) Unique Capabilities of **Daniel Peter Loucks**

Daniel P. Loucks is a director of the Natural Heritage Institute and its leading expert on hydrologic modeling. Dr. Loucks has been on the faculty of the School of Civil and Environmental Engineering, Cornell University since 1965 where he directs research in the development and application of economics, ecology and systems analysis methods to the solution of environmental and regional water resources problems. He has authored numerous articles and book chapters in these subject areas, including the two textbooks in water resource systems planning and analysis that are now the most widely used in the world. Dr. Loucks has also served as a Research Fellow at Harvard University (1968); an Economist at the Development Research Center of the World Bank (1972-73); a Research Scholar at the International Institute for Applied Systems Analysis (1981-1982); and a Visiting Professor at the Massachusetts Institute of Technology (1977-78), the University of Colorado in Boulder (1992), the University of Adelaide in South Australia (1992), the Aachen University of Technology in Germany (1993 and 1995), the
Technical University of Delft in the Netherlands (1995), and the University of Texas in Austin (2000). Since 1969 he has advised intergovernmental organizations of the United Nations, the World Bank, and NATO involved in regional water resources development planning in Asia, Australia, Eastern and Western Europe, the Middle East, Africa, and Latin America. Loucks has served on various committees and boards of the National Research Council of the U. S. National Academy of Sciences. The American Society of Civil Engineers awarded Loucks the Huber Research Prize in 1970 and the Julian Hinds Award in 1986. He is a Fellow in the American Geophysical Union (AGU) and in the International Environmental Modeling and Software Society, and is a distinguished member of ASCE. In 1975 he received a Fulbright-Hayes Fellowship to lecture in Yugoslavia. He has chaired various committees in professional societies in civil engineering, geophysical science, and operations research. He serves as an associate editor and as a member of editorial boards of several professional journals in the U.S. and in Europe. He was elected to the National Academy of Engineering in 1989. He received Distinguished Lecture Awards by the National Research Council of Taiwan in 1990 and 1999, an EDUCOM Award for software development in 1991, the Senior U.S. Scientist Research Award from the German Alexander von Humboldt Foundation in 1992, the Warren A. Hall Medal from the Universities Council on Water Resources in 2000, the Grand Prix International de Cannes, de l'Eau in 2005 and the Biennial Medal of the International Environmental Modeling and Software Society in 2008. Currently Loucks is an advisor in the development of the Decision Support System for the World Bank's Nile Basin Initiative, in groundwater management research in South Australia, in the modeling of new multi reservoir systems in Iran, in modeling the hydrology in South Florida's Everglades Region, and in the development of improved water quality models and methods for long-term infrastructure capacity planning in the absence of reliable historical hydrologic data due to climate change.

iii) **Unique Capabilities of Gregory A. Thomas**

Thomas is the president of the Natural Heritage Institute. During his 20 years at NHI he has organized and led several multi-disciplinary project teams that have demonstrated the feasibility of re-operating reservoirs in conjunction with groundwater banks to improve environmental flows, increase irrigation water supply, reduce flood risks, and buffer the effects of climate change. These projects have been conducted in the Central Valley of California and in the water system that defines the U.S. - Mexican border. Thomas has designed, organized and launched the Global Dam Re-optimization project to investigate and demonstrate a suite of tools and techniques for restoring impaired ecosystems, human

livelihoods and food production systems without reducing irrigation, hydropower and flood control benefits. This program is fully developed and ready for implementation in Nigeria, Ghana and China, and components in India, Latin America and Eastern Africa are under development. Thomas has worked in developing country settings on environmental restoration for over 30 years, including the Pacific Islands, China, India, Mexico, Chile, Brazil, and many countries in Southern, Western and Eastern Africa.

5.6.3 **Project Activities and Tasks**

i) Environmental flow process & modeling (under Activity 1)

For these tasks, NHI will lead a team, comprising of WRI TNC, IWMI, CAW, EPA, and the University of Stuttgart, in defining and characterizing the historic (pre and post dam) hydrology, including rainfall and runoff patterns and the floodplain and wetland hydrodynamics, in order to construct target flow hydrographs to restore both ecosystem processes and the sediment regime in the estuary and the coastal system. This will provide the inputs (among many others) to populate the hydrologic planning model that will be used to evaluate various re-operation scenarios. NHI's Director, Dr. Daniel P. Loucks will supervise this task, with research contributions by other NHI staff. Dr. Loucks unique qualifications for this task are set forth above.

ii) Building Dam and River Basin Operations Models

For these tasks, NHI in collaboration with VRA, will take the lead responsibility for building the planning model, including evaluating how best to build upon and incorporate the models and data sets that have already been created by others and building the capability to analyze the effects that climate change will have on system hydrology. The design of the analytic tool(s) will be vetted in a workshop of the entire partnership as well as the Volta Basin Authority, the GEF-UNEP Trans-boundary Volta River Basin project, the GLOWA project, and IUCN's Project for Improving Water Governance in the Volta Basin (PAGEV initiative). The other project partners that will be included in the team are the VRA, WRC, VBA, University of Stuttgart, and IWMI. NHI Director Dr. Daniel P. Loucks will lead and supervise this task. His unique credentials in building system wide hydrologic planning models is documented below.

iii) Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility (Activity 3)

For tasks under this activity, VRA and experts from Purdue University's Energy Center (Paul Preckel, F. Thomas Sparrow, and Brian Bowen) will take the lead responsibility for building the model of the power generation and distribution system, including evaluating how best to build upon and incorporate the models and data sets that have already been created by the VRA and others, to evaluate the technical and economic feasibility. The design of the analytic tool(s) will be vetted with the project team and stakeholders. The other project partner that will be included in the team is the Ministry of Energy. Paul Preckel, F. Thomas Sparrow and Brian Bowen of Purdue will play the lead role for this element. This work is a continuation of the power supply and demand modeling that Purdue's Energy Center has been doing for the past several years for the West African Power Pool arm of ECOWAS. NHI will coordinate the task on hydrologic modeling. The unique qualifications of the experts are set forth above.

iv) Global Learning Program

As noted above, a prime objective of the project, above and beyond bringing the Lower Volta River back to life, is to contribute to a program of global learning. NHI, as the organizer of the global program, together with WRC and VRA, will distill all of the lessons learned in each component into a global information system that will be widely disseminated and propagated into further reoperation experiments all over the world. This information system will include instructions on creating the requisite analytical tools, methods for screening and selecting the best prospects for beneficial reoperation, methods for organizing the requisite local collaborative, techniques for improved management of the irrigation, hydropower and flood control system, for which the dams are the storage elements.

5.7 UNIVERSITY OF STUTGARD

András Bárdossy is Professor at the Institute of Hydraulic Engineering (Chair of Hydrology and Geohydrology), University of Stuttgart. He studied mathematics in Budapest, received a PhD. in Mathematics 1981 as well as a PhD. in civil engineering in 1993. Between 1981 and 1994 he gained research and practise experience at various international institutes and companies. He worked as private consultant from 1982-1986. He was research associate professor at the department of civil engineering at the University of Waterloo, Canada from 1986 – 1987, researcher at the University of Karlsruhe from 1988-1993 and became professor for hydrology and geohydrology at the University of Stuttgart in 1994. He is chief editor of Journal of Hydrology and associate editor of Water Resources Research (WRR), Hydrology and Earth System Science (HESS) and Hydrology Research. He is the author of more then 100 ISI research papers. In 2006 he received the Darcy Medal from the European Geophysical Union for his work in statistical hydrology.

Silke Wieprecht is Professor at the Institute of Hydraulic Engineering (Chair of Hydraulic Engineering and Water Resources Management), University of Stuttgart. She studied civil engineering at Technical University Munich and received a PhD in civil engineering in 1998. From 1997 to 2000 she worked as consultant engineer in the field of constructional water researches, hydraulics and hydrology specialized in river morphology and sediment transport. In 2000 she became head of the department "River Morphology" at the Federal Institute of Hydrology. She had an interim research position at Beijing University at the Institute for Environmental Engineering in 2002 and got the professorship in 2003 at Stuttgart University. She is member of the review board of the International Journal of Sediment Research and author of more than eighty papers about sediment transport, eco-hydraulics and related topics.

In the last 15 years a great number of different research projects were carried out at the Institute of Hydraulic Engineering. The projects included basic research problems and real life applications too. The financial support came from the European Union, the German Science Foundation, German Ministry for Research and Development and from other governmental and private organizations.

Prof. Bardossy has a wide experience especially in the field of hydrologic-meteorological modelling in areas of low data density. E.g. research projects such as water balance modelling in the Chirchik basin (Uzbekistan) or hydrological modelling of the Kokcha river (Afghanistan) were carried out in data sparse regions. Different models using remotely sensed and global datasets were developed for the reliable assessment of the elements of the water cycle.

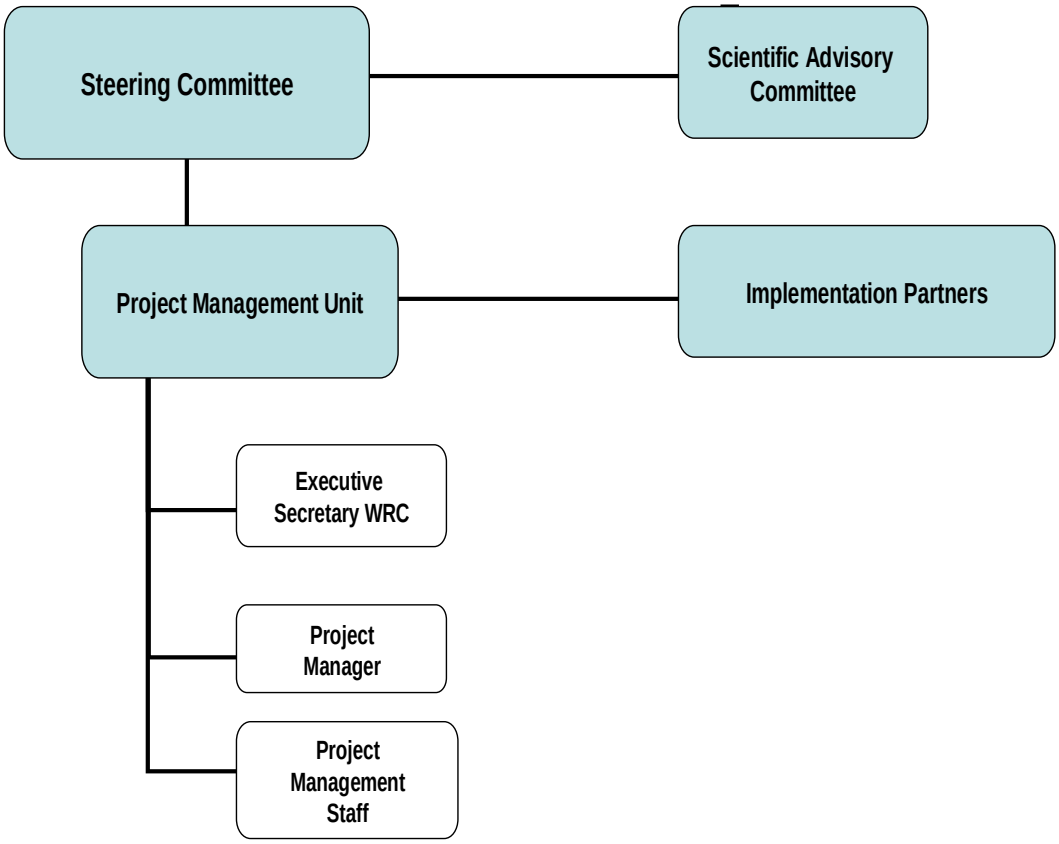
Since years Prof. Wieprecht is intensively working in the field of eco-hydraulics. Under her direction a coupled morphologic-environmental model based on a Fuzzy-tool was developed. It is applicable esp. in cases were no precise quantitative data is available. With the help of this tool effects of changes in hydrology, hydraulics and morphology on the ecological situation of a river can be modelled only by descriptive and qualitative parameters. It was applied already in numerous smaller but also larger rivers like the River Rhine or Danube in Germany or the Upper Volta River investigating the influence of the Bui Hydro Power Plant on the river system (research project).

Two other projects were carried out in the larger neighbourhood of the planned project area:

- Assessment of water availability for the city of Ibadan (Nigeria) and
- Rainfall runoff modelling for water management in the Oueme basin (Benin) in the framework of the EU sponsored project RIVERTWIN (A Regional Model for Integrated Water Management in Twinned River Basins).

In that perspective the research team, consisting of Prof. Bardossy, Prof. Wieprecht and their researchers, offers a unique expertise in hydrology, hydraulics and ecology in data scarce areas. This experience and the developed models provide a good basis for the modelling work in the project: **Reoperation of Akosombo Dam to reintroduce ecosystem functions and human livelihoods in the Lower Volta River in Ghana.**

Annex 6: PROJECT MANAGEMENT ORGANOGRAM



Annex 7: Procurement Plan for Goods and Services

Procurement Plan - Supply of Goods **Annex 7**

Initial 18 Months

Country / Organization: Ghana/Water Resources Commission (WRC)
Project : Reoptimization of Operations of Akosombo and Kpong Dams on the Volta River, Ghana (ROAKD)
Grant:

	Basic Data							Bid Document Procurement by PIU		Preparation and submission of bids by bidders		Bid Evaluation		Contract Finalization				Deliverable/close-out
Description of Item*	**Lot Number**	**Bid Document Reference Number**	**Estimated Amount in Euro ' 000**	**Procurement Mode**	**Pre-or-Post Qualification**	**Prior or Post Review**	**Plan Vs Achieved**	**BD Completed date**	**Non Objection date**	**Issues of bids date**	**Bid Submission and opening deadline**	**Evaluation Report Completed**	**Non objection Date**	**Contract Amt in Euro '000**	**Contract Award**	**Contract Signature Date**	**Contract Approval in SAP**	**Contract End**
01. Vehicle (4X4) for M & E & Supervision		WRC-ROAKD/IFB-GDS-NCB/02-2010/01	33.8	Shopping	Post	Post	**Plan**	16-07-2010	N/A	30-07-2010	30-08-2010	30-09-2010	N/A		14-10-2010	3-Nov-10		3/12/2010
							Achieved											
02 Laptops, Accessories, Office Equipment & Furniture		WRC-ROAKD/IFB-GDS-SHP/02-2010/01																
02(i) Laptops & Accessories,	Lot 1	WRC-ROAKD/IFB-GDS-SHP/02 -2010/01(i)	5.86	Shopping	Post	Post	**Plan**	31-05-2010	N/A	30-06-2010	15-07-2010	13-08-2010	N/A		27-08-2010	16-09-2010		18-10-2010
							Achieved											
Equipmet-Photocopier, Fax, Printer, Scanner	Lot 2	WRC-ROAKD/IFB-GDS-SHP/02-2010/01(ii)	7.75	Shopping	Post	Post	**Plan**	31-05-2010	N/A	30-06-2010	15-07-2010	13-08-2010	N/A		27-08-2010	16-09-2010		18-10-2010
							Achieved											
02(iii) Office Furniture-Filing Cabinets	Lot 3	WRC-ROAKD/IFB-GDS-SHP/02-2010/01(iii)	1.51	Shopping	Post	Post	**Plan**	31-05-2010	N/A	30-06-2010	15-07-2010	13-08-2010	N/A		27-08-2010	16-09-2010		18-10-2010
							Achieved											
03 Other Goods		WRC-ROAKD/IFB-GDS-SHP/02-2010/03	1.5	Shopping	Post	Post	**Plan**	1-Oct-10	N/A	15-10-2010	01-11-2010	15-10-2010	N/A		1-Nov-10	15-11-2010		15/12/2010
							Achieved											
Total Cost			50.42				**Plan**											
							Achieved											

Annex 7 **Procurement Plan - Services (Component I -Reoperation & Reoptimization Study)**

Initial 18 Months

Country / Organization: Ghana/Water Resources Commission (WRC)

Project : Reoperation of Operations of Akosombo and Kpong Dams on the Volta River, Ghana

Grant:

	Basic Data					Expression of interest (EOI)		Terms of reference (TOR)		Shortlist (SL)			Request for proposals (RFP)		Submission of proposals			Evaluation of proposals Technical (T) and Financial (F)						Contract finalization/administration				Deliverable/close-out
Description of Services*	**Mode of Selection**	**Lump-sum or time-bassed contract**	**Estimated Cost in Amount in Euro '000**	**Prior or Post review**	**Plan Vs Achieved**	**Publication date**	**Deadline date**	**Preparation Date**	**Non Objection Date**	**Prepared date**	**Non objection Date**	**Plan Vs Achieved**	**Prepared**	**Non Objection date**	**Proposals Issue Date**	**Submission of propossals deadline**	**Opening of T-Proposals deadline**	**Technical evaluation completed**	**Non Objection date**	**Opening of F-Proposals dated**	**Combined evaluation Completed**	**Non Objection combined evaluation**	**Plan Vs Achieved**	**Contract Amount in Euro '000**	**Contract Award Date**	**Contract Signature Date**	**Contract Approval in SAP**	**Contract End**
COMPONENT I-REOPERATION & REOPTIMIZATION STUDY																												
Activity 1 -Defining Restoration Flow Targets to Restore Ecological Functions & Livelihoods																												
1.1 Consultancy services Downstream Community Consultations	Single Source Selection(SSS)	Lump Sum	44.35	Post	**Plan**	N/A		03-05-2010		N/A		**Plan**	03-05-2010	N/A	10-05-2010	31-5-2010	Jun 1 2010		N/A		18-06-2010	N/A	**Plan**		25-06-2010	1/7/2010		30-09-2010
					Achieved							**Achieved**											**Achieved**					
1.2 Consultancy services Specification and quantification of objectives	SSS	Lump Sum	15.64	Post	**Plan**	N/A		01-06-2010		N/A		**Plan**	01-06-2010	N/A	07-06-2010	28-6-2010	01-07-2010		N/A		21-07-2010	N/A	**Plan**		4/8/2010	9/8/2010		9/11/2010
					Achieved							**Achieved**											**Achieved**					
1.3 Consultancy services Environmental flow process & modeling; Agro-ecology	SSS	Lump Sum	56.98	Post	**Plan**	N/A		03-06-2010		N/A		**Plan**	03-06-2010	N/A	10-06-2010	01-07-2010	03-07-2010		N/A		22-07-2010	N/A	**Plan**		6/8/2010	13/8/2010		13/09/2010
					Achieved							**Achieved**											**Achieved**					
1.4 Consultancy services: Basin hydrological modeling	SSS	Lump Sum	58.83	Post	**Plan**	N/A		03-06-2010		N/A		**Plan**	03-06-2010	N/A	10-06-2010	01-07-2010	03-07-2010		N/A		22-07-2010	N/A	**Plan**		6/8/2010	13/8/2010		13/2/2011
					Achieved							**Achieved**											**Achieved**					
1.5 Consultancy services: Flow requirements for Aquatic biodiversity, Groundwater recharge & trends in use; & Construct Restoration Flow Hydrographs	SSS	Lump Sum	51.8	Post	**Plan**	N/A		09-06-2010		N/A		**Plan**	09-06-2010	N/A	15-06-2010	07-07-2010	10-07-2010		N/A		31-07-2010	N/A	**Plan**		12/8/2010	19/8/2010		19/2/2011
					Achieved							**Achieved**											**Achieved**					
1.6 Consultancy services: Flow requirements for fisheries; & Coastal system study	SSS	Lump Sum	51.53	Post	**Plan**	N/A		25/6/2010		N/A		**Plan**	25/6/2010	N/A	2/7/2010	22/7/2010	23/7/2010		N/A		13/8/2010	N/A	**Plan**		20/8/2010	27/8/2010		27/2/2011
					Achieved							**Achieved**											**Achieved**					
1.7 Consultancy services: Fluvial geo & hydrodynamic modeling	SSS	Lump Sum	48.37	Post	**Plan**	N/A		23/6/2010		N/A		**Plan**	23/6/2010	N/A	30/6/2010	17/7/2010	19/7/2010		N/A		9/8/2010	N/A	**Plan**		16/8/2010	23/8/2010		23/2/2011
					Achieved							**Achieved**											**Achieved**					
1.8 Consultancy services: Design of adaptive management program	SSS	Lump Sum	18.03	Post	**Plan**	N/A		10/10/2010		N/A		**Plan**	10/10/2010	N/A	13/10/2010	3/11/2010	4/11/2010		N/A		19/11/2010	N/A	**Plan**		26-11-2010	7/1/2011		30/6/2011
					Achieved							**Achieved**																
Total Cost					**Plan**							**Plan**											**Plan**					
					Achieved							**Achieved**											**Achieved**					

Procurement Plan - Services (Component I)

Initial 18 Months

Country / Organization: Ghana/Water Resources Commission (WRC)

Project : Reoperation of Operations of Akosombo and Kpong Dams on the Volta River, Ghana

Grant:

	Basic Data					Expression of interest		Terms of reference		Shortlist			Request for proposals		Submission of proposals			Evaluation of proposals Technical (T) and Financial (F)						Contract finalization/administration				Deliverable/ close-out
Description of Services*	Mode of Selection	Lump-sum or time-bassed contract	Estimated Cost in Amount in Euro '000	Prior or Post review	Plan Vs Achieved	Publication date	Deadline date	Preparation Date	Non Objection Date	Prepared date	Non objection Date	Plan Vs Achieved	Prepared	Non Objection date	Proposals Issue Date	Submission of propossals deadline	Opening of T-Proposals deadline	Technical evaluation completed	Non Objection date	Opening of F-Proposals dated	Combined evaluation Completed	Non Objection combined evaluation	Plan Vs Achieved	Contract Amount in Euro '000	Contract Award Date	Contract Signature Date	Contract Approval in SAP	Contract End
Activity 1 -Defining Restoration Flow Targets to Restore Ecological Functions & Livelihoods (cont'd)																											
1.9 Consultancy services: Literature review - environ. & livelihood flow	Single Source Selection(SSS)	Lump Sum	11.9	Post	Plan	N/A		28/6/2010		N/A		Plan	28/6/2010	N/A	5/7/2010	26/7/2010	27/7/2010		N/A		17/8/2010	N/A	Plan		23/8/2010	31/8/2010		30/9/2010
					Achieved							Achieved											Achieved					
1.10 Consultancy services: Final restoration flow	SSS	Lump Sum	24.56	Post	Plan	N/A		25/7/2011		N/A		Plan	25/7/2011	N/A	1/8/2011	19/8/2011	22/8/2011		N/A		6/9/2011	N/A	Plan		13/9/2011	20/9/2011		20/10/2011
					Achieved							Achieved											Achieved					
Activity 2 -Constructing & Evaluating Operational Scenarios to Achieve the Target Flows																											
1.11 Consultancy services: Construct Volta Basin simulation	SSS	Lump Sum	174.66	Prior	Plan	N/A		11/10/2010	25/10/2010	N/A		Plan	1/11/2010	12/11/2010	15/11/2010	30/11/2010	1/12/2010	20/12/2010	12/1/2011	15/1/2011	1/2/2011	15/2/2011	Plan		1/3/2011	7/3/2011		7/3/2012
					Achieved							Achieved											Achieved					
1.12 Consultancy services: Construct operations optimization model; Climate change model inputs; & Formulation of optimal scenarios	SSS	Lump Sum	275.27	Prior	Plan	N/A		14/10/2010	29/10/2010	N/A		Plan	5/11/2010	17/11/2010	20/11/2010	5/11/2010	6/12/2010	20/12/2010	12/1/2011	15/1/2011	6/2/2011	20/2/2011	Plan		5/3/2011	12/3/2011		12/3/2012
					Achieved							Achieved											Achieved					
3 Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility																											
1.13 Consultancy services: Modelling power generation & distribution	SSS	Lump Sum	41.31	Post	Plan	N/A		3/7/2010		N/A		Plan	3/7/2010	N/A	11/7/2010	3/8/2010	4/8/2010		N/A		25/8/2010	N/A	Plan		31/8/2010	9/9/2010		9/9/2012
					Achieved							Achieved											Achieved					
Activity 5-Estimating the Effects of Reoperation of Akosombo & Kpong Dams on Public Health																											
1.14 Consultancy services: Estimate effects on public health	SSS	Lump Sum	44.98	Post	Plan	N/A		30/6/2010		N/A		Plan	30/6/2010	N/A	8/7/2010	29/7/2010	30/7/2010		N/A		21/8/2010	N/A	Plan		27/8/2010	6/9/2010		6/9/2011
					Achieved							Achieved											Achieved					
Total Cost					Plan							Plan											Plan					
					Achieved							Achieved											Achieved					

Procurement Plan - Services (Component II-Project Management & Co-ordination)

Initial 18 Months

Country / Organization: Ghana/Water Resources Commission (WRC)

Project : Reoperation of Operations of Akosombo and Kpong Dams on the Volta River, Ghana

Grant:

	Basic Data					Expression of interest		Terms of reference		Shortlist			Request for proposals		Submission of proposals			Evaluation of proposals Technical (T) and Financial (F)						Contract finalization/administration				Deliverable/ close-out
Description of Services*	Mode of Selection	Lump-sum or time-bassed contract	Estimated Cost in Amount in Euro '000	Prior or Post review	Plan Vs Achieved	Publication date	Deadline date	Preparation Date	Non Objection Date	Prepared date	Non objection Date	Plan Vs Achieved	Prepared	Non Objection date	Proposals Issue Date	Submission of propossals deadline	Opening of T-Proposals deadline	Technical evaluation completed	Non Objection date	Opening of F-Proposals dated	Combined evaluation Completed	Non Objection combined evaluation	Plan Vs Achieved	Contract Amount in Euro '000	Contract Award Date	Contract Signature Date	Contract Approval in SAP	Contract End
COMPONENT II - PROJECT MANAGEMENT & COORDINATION																												
1.15 Project Manager for PMU	QCBS-National Short Listing	Lump Sum	61.46	Post	Plan	2-May-10	20-May-10	20-May-10	31-May-10	2-Jun-10	16/6/2010	Plan	16/6/2010	1-Jul-10	7-Jul-10		1-Aug-10				15-Aug-10	1-Sep-10	Plan		16-Sep-10	30-Sep-10		30-Jun-13
					Achieved							Achieved											Achieved					
1.16 Consultants for Mid-Term Review	QCBS-Regional Short Listing	Lump Sum	31.55	Post	Plan	7-Sep-11	30-Sep-11	30-Sep-11	N/A	20-Oct-11	N/A	Plan	24-Oct-11	N/A	27-Oct-11	27-Nov-11	28-Nov-11	15-Dec-11	N/A	16-Dec-11	9-Jan-12	N/A	Plan		16-Jan-12	30-Jan-12		27-Feb-12
					Achieved							Achieved											Achieved					
1.17 Consultants for Project Completion Report	QCBS-Regional Short Listing	Lump Sum	24.04	Post	Plan	1-Feb-13	20-Feb-13	20-Feb-13	N/A	24-Feb-13	N/A	Plan	1-Mar-13	N/A	7-Mar-13	31-Mar-13	1-Apr-13	15-Apr-13	N/A	16-Apr-13	30-Apr-13	N/A	Plan		12-May-13	30-May-13		30-Jun-13
					Achieved							Achieved											Achieved					
Total Cost					Plan							Plan											Plan					
					Achieved							Achieved											Achieved					

Annex 8 : Implementation Plan

	Activities & Tasks	2011				2012				2013				2014				Contract /Task Period - Months
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
	COMPONENT I REOPERATION REOPTIMIZATION STUDY																	
1	**Defining Flow Targets to Reintroduce Ecological Functions & Livelihoods**																	
1	*Project Start-up Activities*																	
1.01	*Downstream Community Consultations*																	3
1.02	*Specification and quantification of objectives*																	1
1.03	*Environmental flow process & modeling:*																	3
1.04	*Basin hydrological modeling*																	6
1.05	*Flow requirements for fisheries*																	3
1.06	*Flow requirements for aquatic biodiversity*																	6
1.07	*Agro-ecology*																	3
1.08	*Fluvial geo & hydrodynamic modeling*																	6
1.09	*Coastal system study*																	6
1.10	*Groundwater recharge & trends in use*																	6
1.11	*Literature review - environ. &*																	0.5

	livelihood flow																		
1.12	*Construct target flow hydrograph(s)*																		1
1.13	*Design of adaptive management program*																		6
1.14	*Final target flow*																		0.5
2	**Constructing & Evaluating Operational Scenarios to Achieve the Target Flows**																		
2.01	*Construct Volta Basin simulation*																		12
2.02	*Construct operations optimization model*																		12
2.03	*Climate change model inputs*																		1
2.04	*Formulation of optimal scenarios*																		12
3	**Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility**																		
3.01	*Modelling power generation & distribution*																		18
3.02	*Hydrological model selection & sequencing*																		6
3.03	*Selection of optimal operation scenarios*																		1
4	**How to Evaluate the Operationally Feasible Scenarios for Economic Feasibility**																		
4.01	*Economic feasibility analysis*																		1
4.02	*Ecosystem valuation*																		1

4.03	*Construct cost-benefit model*																	2
5	**Estimating the Effects of Reoperation of Akosombo & Kpong Dams on Public Health**																	
5.01	*Estimate effects on public health*																	12
6	**Experimental Reoperation Demonstration and Monitoring**																	
6.01	*Formulation of reoperation experiment*																	2
6.02	*Conduct the experiment*																	6
6.03	*Monitoring reoperation experiment*																	6
6.04	*Governance & institutional analysis*																	6
7	**Global learning Project**																	
	Global database and training																	9
	Publications and dessimination of results																	9
8	**COMPONENT II PROJECT MANAGEMENT & COORDINATION**																	
8.01	**Services**																	
	Project Manager (full time)																	36
	Mid - Term Review																	1
	Project Completion Report																	1

8.02	**Goods**																		
	Vehicle (4x4) for monitoring and evaluation																		1
	Computer(s) Lap Tops																		1
	Computer accessories -UPS, etc.																		1
	Photocopier																		1
	Fax machine																		1
	Printer																		1
	Filing cabinet																		1
	Other goods																		1
8.03	**Operating Costs**																		
	-Water Resources Engineer																		18
	-Accountant																		18
	-Procurement Officer																		18
	- Basin Officer																		18
	-Water Resources Lawyer																		18
	- Secretary																		18
	- Accounts Clerk																		18

	- Driver																		16
	PSC and other Committee (meetings)																		
	Per Diem																		
	Vehicle running and maintenance costs																		
	O & M of equipment																		
	Consumables - office supplies																		
	Other services - communications, utilities, etc.																		
	Office facility - WRC																		
	General operating costs																		

Key

Procurement Process

Contract /Task Period

Part -time Project Staff

Annex 9: Terms of Reference for Project Manager

The main responsibility of the Project Manager would be to oversee the implementation of all assests of the Project and be fully responsible for its day to day management. He/she will report directly to the Chairman of the Project Steering Committee.

Specific responsibilities will include but not limited to the following:-

i) Coordinate and supervise all activities of the PMU, and liaise with AWF;
ii) Meet with the Project Steering Committee (PSC) twice per year to receive guidance on project implementation policy. Liaise with the WRC and other Implementing Partners (IPs) and AWF on matters of policy and project administration;
iii) Coordinate the activities of Implementing Partners, to ensure effective delivery of project results. Promote collaboration with other partners, including the private sector, in the implementation of the project;
iv) Appraise relevant PMU staff on regular basis on job performance and otherwise, in consultation with WRC;
v) Undertake procurement of goods and services in accordance with AWF procurement rules, procedures and guidelines;
vi) Prepare and submit Annual Work Plan and Budget (AWPB) for the upcoming year for approval by the Project Steering Committee and on the basis of the AWPB manage the PMU. Ensure timely and appropriate reporting on progress and problems of project implementation including Quarterly and Annual Progress Reports;
vii) Serve as Secretary of the Project Steering Committee and the Scientific Advisory Committee and ensure execution of any decisions approved by the Committees.
viii) Undertake any other responsibility that will ensure smooth and effective implementation of project;

Qualifications

- At least MSC in water resources management civil engineering or related science together with postgraduate qualification or proven specialised training Project Management
- At least five years experience in the co-ordination of donor-funded projects entailing leadership qualities;
- Proven teambuilding, networking, presentation and communication skills.

Remuneration: Attractive

Job Location: Accra

Job Duration: Three years renewable yearly on the basis of performance

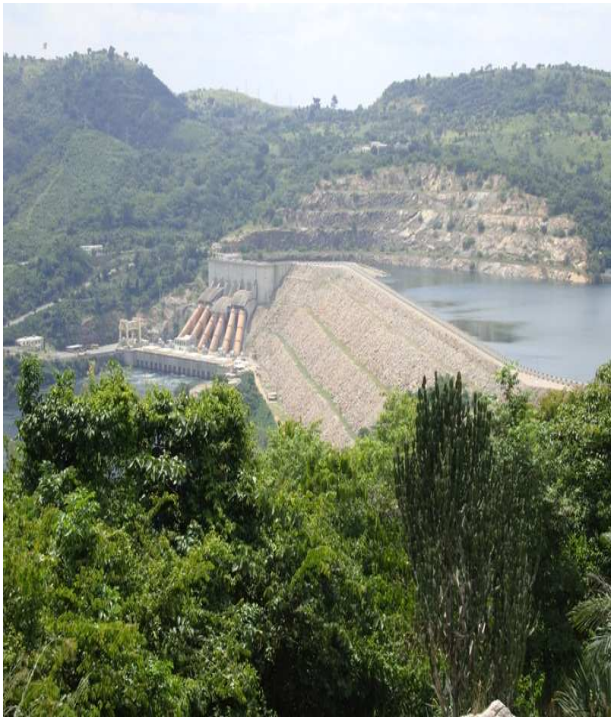
Annex 10: LIST OF GOODS AND SERVICES

Annex 10 **LIST OF GOODS AND SERVICES**

(Euro ' 000)

CATEGORIES OF EXPENDITURE	AWF				Ford Foundation				Others *(In Kind)				Total			
1. Goods	F.E	L.C	Amt	%	F.E	L.C	Amt	%	F.E	L.C	Amt	%	Amt	%	F.E	L.C
1.1 Vehicle	–	33.8	33.8	100	–	–	–	–	–	–	–	–	33.8	1.18	–	33.8
1.2 Office Equipment & Furniture	–	9.26	9.26	100	–	–	–	–	–	–	–	–	9.26	0.32	–	9.26
1.3 Laptop & Computers	–	5.86	5.86	100	–	–		–	–	–	–	–	5.86	0.21	–	5.86
1.4 Other Goods	–	1.5	1.5	100	–	–	–	–	–	–	–	–	1.5	0.05	–	1.5
Subtotal Goods	**–**	**50.42**	**50.42**	**100**									**50.42**	**1.77**		**50.42**
2 Services																
2.1 Studies																
2.1.1Defining Restoration Flow Targets to Restore Ecological Functions & Livelihoods	102.55	245.14	347.69	90.83	–	–	–	–	35.1	–	35.1	9.17	382.79	13.39	137.65	245.14
2.1.2 Constructing & Evaluating Operational Scenarios to Achieve the Target Flows	258.75	91	349.75	73.252	–	–	–	–	–	127.71	127.71	26.75	477.46	16.70	258.75	218.71
2.1.3 Construct a Model of the Power Generation & Distribution System (Grid) to Evaluate Technical & Economic Feasibility	101.41	37.56	138.97	78.732	–	–	–	–	–	37.54	37.54	21.27	176.51	6.17	101.41	75.1
2.1.4 How to Evaluate the Operationally Feasible Scenarios for Economic Feasibility	–	76.63	76.63	100	–	–	–	–	–	–	–	–	76.63	2.68	–	76.63
2.1.5 Estimating the Effects of Reoperation of Akosombo & Kpong Dams on Public Health	7.67	37.31	44.98	100	–	–	–	–	–	–	–	–	44.98	1.57	7.67	37.31
2.1.6 Experimental Reoperation Demonstration and Monitoring	68.66	163.14	231.8	27.686	–	–	–	–	–	605.46	605.46	72.31	837.26	29.28	68.66	768.6
2.2 Mid - Term Review	27.61	3.94	31.55	100	–	–	–	–	–	–	–	–	31.55	1.10	27.61	3.94
2.3 Project Completion Report	15.02	9.02	24.04	100	–	–	–	–	–	–	–	–	24.04	0.84	15.02	9.02
2.4 PMU Project Manager	–	67.61	67.61	100	–	–	–	–	–	–	–	–	67.61	2.37	–	67.61
Subtotal Services	**581.67**	**731.35**	**1313.02**	**61.97**						**770.71**	**805.81**	**38.03**	**2118.83**	**74.10**	**616.77**	**1502.1**
3 Operating Cost				–												
3.1 Operating Costs, Studies: documentation, meetings etc	27.36	51.17	78.53	100	–	–	–	–	–	–	–	–	78.53	2.75	27.36	51.17
3.2 Operating Costs for Training & Capacity Building - Global Learning Programme	64.08	67.38	131.46	55.03	37.57	–	37.57	15.73	47.32	22.54	69.86	29.24	238.89	8.36	148.97	89.92
3.3 Operating Cost for project management activities, per diems, workshops, operations & maintenance of equipment and vehicles and general operating cost	57.84	199.54	257.38	69.053	–	–	–	–	–	115.35	115.35	30.95	372.73	13.04	57.84	314.89
Subtotal Operating Cost	**149.28**	**318.09**	**467.37**	**67.72**	**37.57**	0.00	**37.57**	**15.73**	**47.32**	**137.89**	**185.21**	**26.84**	**690.15**	**24.15**	**234.17**	**455.98**
Total Project Cost	**730.95**	**1099.86**	**1830.81**	**64.03**	**37.57**	**0.00**	**37.57**	**1.31**	**47.32**	**908.60**	**991.02**	**34.66**	**2859.40**	**100.00**	**850.94**	**2008.46**

Annex 11: Photos from Appraisal Mission



OVERVIEW OF THE AKOSOMBO DAM INTAKE AND PEN STOCKS

MEETING BETWEEN APPRAISAL TEAM AND VRA STAFF AT AKOSOMBO

VISIT TO THE CONTROL ROOM OF THE AKOSOMBO PLANT

VISIT TO THE GENERATING PLANT AT AKOSOMBO

AKOSOMBO HYDROPOWER INTAKE

WEED INFESTED AREA ON THE VOLTA RIVER AT ADA

APPRAISAL TEAM CALLS ON COMMUNITY CHIEF AND ELDERS AT ADA