PREPARATORY STUDY ON ACCRA PLAIN IRRIGATION DEVELOPMENT PROJECT

Pre-Feasibility Study Final Report

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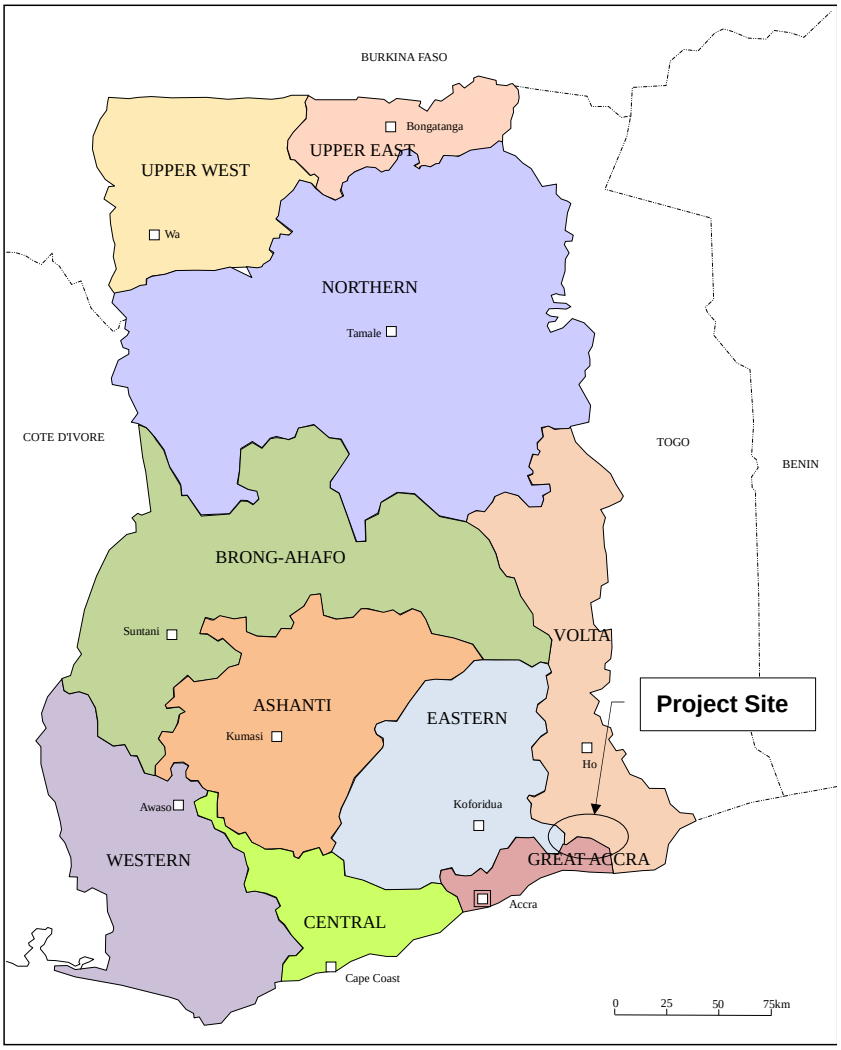
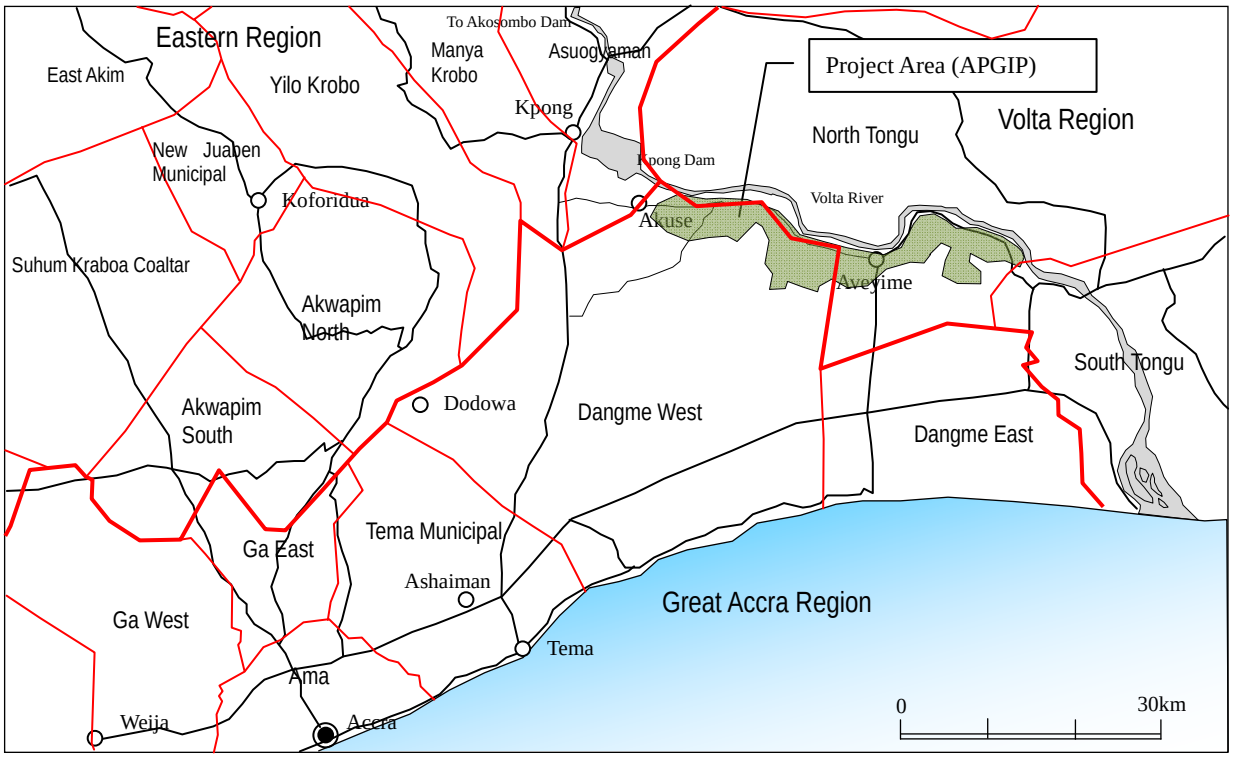
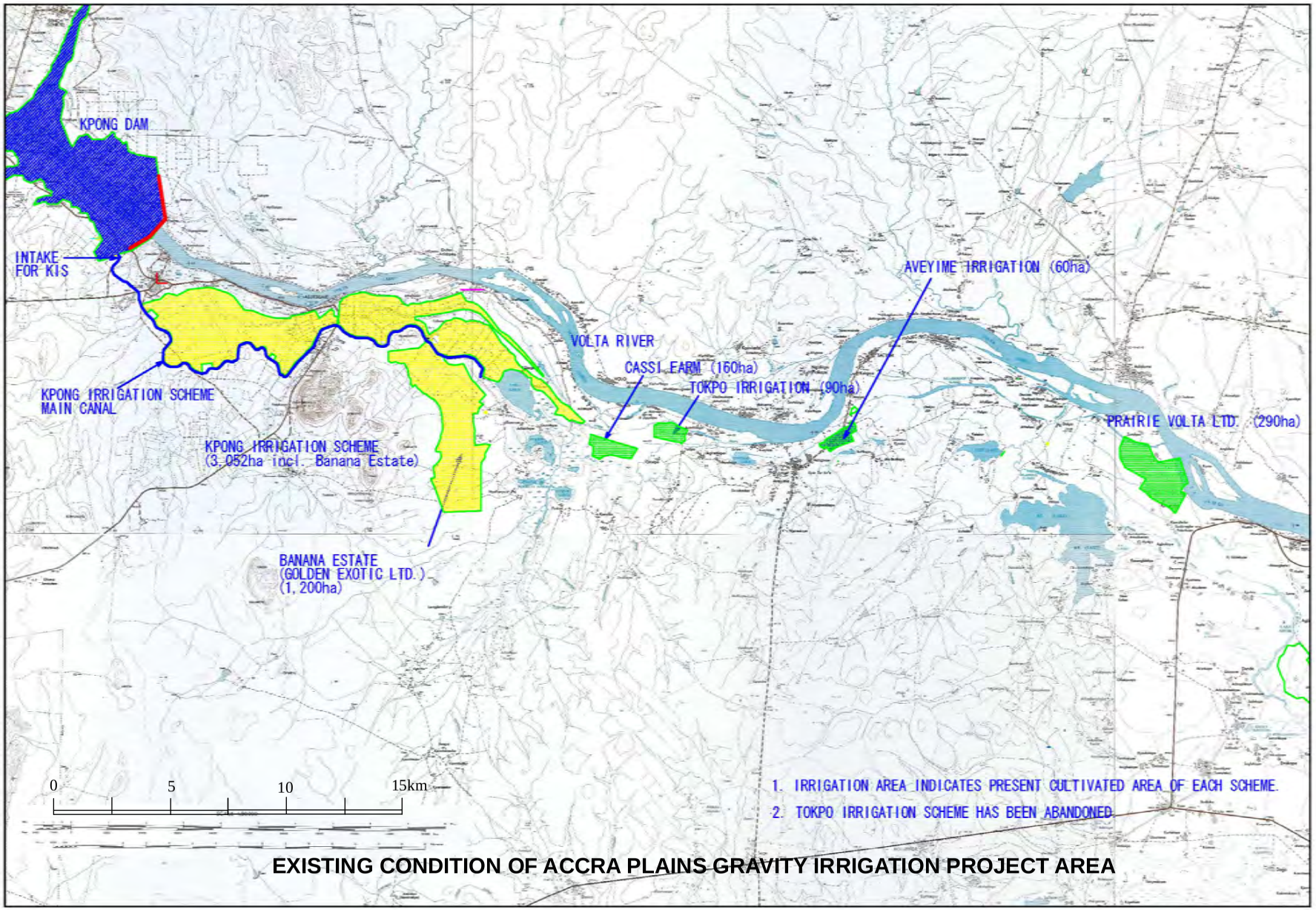
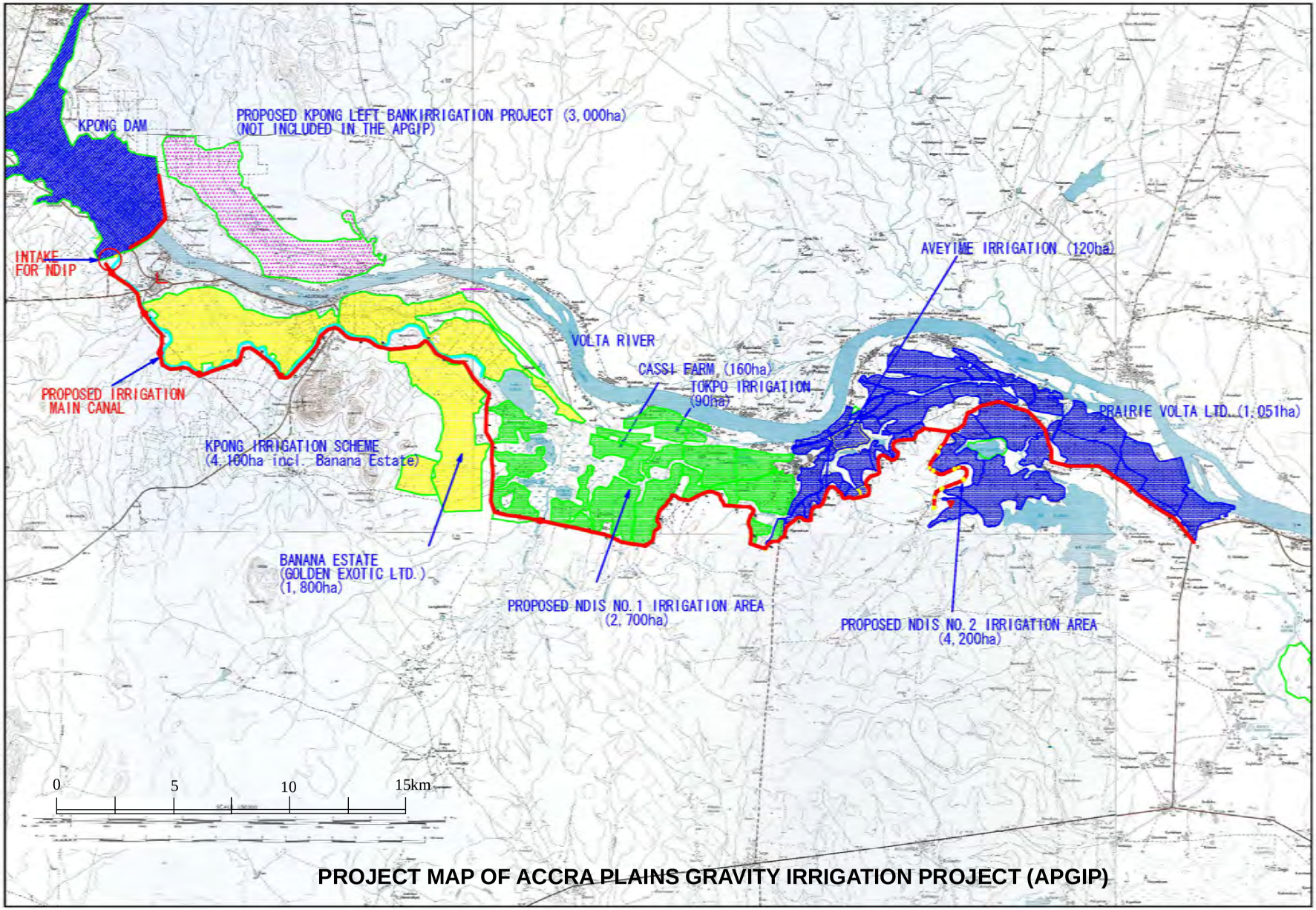




LOCATION MAP OF THE PROJECT SITE



EXISTING CONDITION OF ACCRA PLAINS GRAVITY IRRIGATION PROJECT AREA



PROJECT MAP OF ACCRA PLAINS GRAVITY IRRIGATION PROJECT (APGIP)

Summary of Accra Plains Gravity Irrigation Project

1. Introduction

1.1 Objectives of the Project

At this study stage, a pre-feasibility study is required on the basis of establishing a gravitational irrigation system in Accra plains in the right bank area of Volta River.

The scope of the work required for the study is explained in the following items:

- Technical study of gravity irrigation systems.
- Operation, maintenance and management of the project
- Project cost estimation
- Benefit estimation
- Economic analysis
- Financial analysis
- Environmental and social consideration

1.2 Activities of the Study Team

The study team focuses on five areas, namely irrigation development, infrastructure planning and design, organization and irrigation system management, agronomy agro-economy, and environment and social consideration. The study period for the pre-feasibility study for the Accra Plains Gravity Irrigation Project is from January 2011 to May 2011.

2. Project Area

2.1 Project Background

The Accra plains extend about 156,000 ha (approximately 200,000 ha) along the right bank of the lower Volta River. The feasibility study for the whole Accra plains area for irrigation development has been conducted from the year 2008 to 2010 with assistance provided by the Kuwait Fund (a grant of US$1.4 million). In June 2010, the feasibility study on the first prioritized area (relatively flat with 5,000 ha) in the Accra plains with a pump irrigation system was completed.

2.2 Hydro-meteorological Conditions

The country's warm, humid climate has an annual mean temperature of between 26°C and 29°C. Variations in the principal elements like temperature, rainfall, and humidity that govern the climate are influenced by the movement and interaction of the dry tropical continental air mass, or the harmattan, which blows from the northeast across the Sahara, and the opposing tropical maritime or moist equatorial system. Meteorological stations are located in Akuse and Aveyime in the project area at an elevation of 5 to 10 m above sea level. The mean monthly maximum temperature in March and August is 30.2°C in Akuse and 30.6°C in Aveyime, while the monthly minimum temperature is 26.7°C in both places. The annual rainfall in the Accra plains ranges from 850 to 1,400 mm as observed at the Akuse and Aveyime stations. The average annual rainfall is 1,046.8 mm in Akuse (1990–2010).

The command area is located along the Volta River, with its stretch of about 86 km from immediately

downstream of the Kpong dam to the river mouth. Akosombo dam is located at 25km upstream of the Kpong dam site. The river discharge is dominant, with enough released water for hydro power generation. Both the Akosombo and Kpong dams release about the same volume of water, enough to efficiently generate electric power.

As for the water level of the Kpong dam reservoir, the highest level is 16.97 m (2010) and the lowest is 13.92 m (1998). The water level of the Volta River constantly fluctuated from 2.5 to 4.0 m during the observation period of 1984 to 2010. A higher water level, 6.28 m, was observed in November 4, 2010. The rise was mainly caused by flood inflow to the Akosombo dam as well as to the Kpong dam.

Study for the Formulation for Irrigation Project in Africa was conducted by JICA in August 2010. During the course of the study in Ghana, the study team proposed a potential gravity irrigation project in the Accra plains, by taking irrigation water from the existing Kpong dam.

2.3 Water Resources

The major water resources in the area are the Volta River and several small rivers. The Volta River has two major water reservoirs: the Akosombo dam reservoir and the Kpong dam reservoir. The main function of the two dams is to generate hydro electric power. The Akosombo dam is 111 m tall, with a crest length of 660m, a reservoir storage volume of 148 km^3, and a surface area of 8,502 km^2. The dam utilizes 1,200 m^3/sec of water discharge to generate 1,020 MW of hydro electric power. The water is released into the Volta River and reaches the Kpong dam. The Kpong dam utilizes the same amount of water as Akosombo dam to generate 160 MW of hydro power. The storage capacity of the Kpong reservoir is 160 million m^3. The discharge for hydropower generation of 1,200 m^3/sec corresponds to 103.7 million m^3/day, which is about 65% of the Kpong reservoir storage capacity. The storage capacity of the Kpong reservoir can be filled up within about one and half days using the maximum water discharge from the Akosombo dam. The water level in the Kpong dam fluctuates according to the balancing of water inflow from the Akosombo dam and water release from the Kpong dam for hydroelectric power generation. The water level of the Kpong dam for the normal operation head pond is 14.75 m, whereas that of the high head pond is 17.7 m. The dam crest elevation is 18.75 m and that of the normal tail water downstream is 3.0 m. There are two existing intake structures for irrigation purposes: on at the right bank of the Kpong dam for the existing Kpong irrigation scheme, and one at the left bank for the Kpong left bank irrigation scheme, the construction of which has just begun under MiDA in March 2011 and covers an area of 2,000 ha. The intake capacity of each scheme is designed to be 7.2 m^3/sec.

2.4 Socio-economy

The project area extends mainly across three districts, i.e., Dangme West and Dangme East of the Greater Accra Region, and North Tongu of the Volta Region, the population of which is estimated at 126,450, 117,544, and 208,442 respectively as of 2010. The share of agriculture, animal husbandry, fishing and forestry in the economically active population is 50–52% in Dangme West and East, and 70% in North Tongu. The number of small-scale farmers living in the project area is estimated to be approximately 2,500 for the Kpong Irrigation Scheme (KIS) and 2,720 for the New Development

Irrigation Scheme (NDIS).

2.5 Soils

The major soils distributed in the project area extending along the right bank of the Volta River, are i) Gleyic Cambisols (Amo Series), ii) Eutric Vertisols (Tefle Series) and iii) Calcic Vertisols (Akuse Series). According to the FAO land evaluation system, the Amo Series and Tefle Series are assessed as highly suitable for rice cultivation, and the Akuse Series is assessed as moderately suitable.

2.6 Infrastructure

The roads are broadly classified into primary, secondary and feeder roads. The three districts covered by the project have a fair distribution of the road network, with almost every settlement connected to one of the roads. The primary roads are constructed of asphalt pavement and connect, Akuse, Aveyime and Mepe, the major towns in the project area. Gravel and sand materials are used for the secondary roads, but some of the feeder roads, with their clay pavement, are in a bad condition as they become slippery during the wet season.

The Danish International Development Agency (DANIDA) in cooperation with the Community Water and Sanitation Agency (CWSA) is supporting the provision and service of water and sanitation facilities to rural communities in the Greater Accra Region. The water supply scheme for the related districts of Dangme East, Dangme West, and North Tongu is located in some rural and small towns in the eastern part of the Great Accra Region. That water system takes its source from the Volta River and covers most of the project area with a conduit network. The water tap is located at a minimum walking distance to the standpipe, 500 m.

The major towns and villages in the project area are linked to the national electricity grid. At present, the major communities in the project area are connected to electricity under Self-Help Electrification Programmes (SHEP) 1, 2, 3

2.7 Agriculture

The gross area of APGIP is 11,570 ha and the existing irrigated rice fields account for 2,342 ha, 20% of the project area. The banana farm of Golden Exotics Ltd. is 1,200 ha in area, accounting for 10% of the project area. The largest land use category in the area is upland fields, occupying 4,441 ha or 38% of the project area, while the 2nd largest land use category is grassland, representing 3,061 ha and covering 26.5% of the project area. The primary crops in the project area are irrigated rice and bananas. Crop productivity in upland fields is very limited under the traditional and unstable rain-fed cultivation system.

2.8 Existing Irrigation System

In the project area, there are three existing irrigation systems managed by GIDA. Kpong Irrigation Scheme (KIS) was constructed to supply irrigation water to 1,955 ha in the Asutsuare area utilizing gravity and contribute to new development of 1,073 ha in the Akuse area. The Aveyime Irrigation

Project has a potential area of 120 ha, of which 60 ha has been developed. After rehabilitation of pump equipment, the irrigation was re-started in 2011. Tokpo Irrigation Project, which has a potential area of 91 ha, has not yet started irrigation because of a halt to the construction work.

2.9 Social and Environmental Conditions

There are seven culturally sensitive areas in the project area which may be affected by the development of the irrigation fields. All the communities in the project area have access to pipe-borne water through community standpipes provided under the Three District Water and Supply Scheme. Major river and lakes in the project area are the Volta River, Lake Mlangui (Mlangu), Keli, Aklamador (Kumikpo), Blanor (Bla botikope), and Blaque (Bla Botikope).

3. Project Planning

3.1 Basic Development Policy

The basic development concepts and some assumptions applied for the project formulation are enumerated as follows:

- The project shall be formulated for irrigated agriculture development.
- The proposed target crop for the project is rice, with double cropping.
- In order to save energy, and operation and maintenance costs, a rational irrigation system should be introduced utilizing canal lining and gravitational irrigation.
- Effective use of limited water resources
- Commerce-oriented agriculture
  Small-scale farmers, medium and large enterprises
- A sustainable irrigation project through a modernised management system for effective easy maintenance work (lining)
- Two scenarios for a project development plan for distribution of the project area for commercial and small holders;
  - Scenario 1: 50% of the project area to be allocated to commercial enterprises and government organized small-scale farmers (50% of the project area)
  - Scenario 2: 100% of the project area to be allocated to commercial enterprises

3.2 Agriculture Development Plan

3.2.1 Land Use Plan

As a basic development plan, the double cropping of irrigated rice is envisioned in the study. The future land use of the project area (APGIP) is as follows:

Land Use of the Project Area

Land Use Category	With the project		Without the project		Changes/Remarks
	(ha)	(%)	(ha)	(%)	
Irrigated rice field	9,038	82.2	2,903	26.4	KIS & NDIS (No. 1 & No. 2 Area)
Banana farm	1,800	16.4	1,200	10.9	Expansion of 600 ha
Irrigated upland field	162	1.5	162	1.5	No change, regardless of project
Upland Field	-	-	3,777	34.3	Converted to rice field

Grassland	-	-	2,958	26.9	Converted to rice field
Project area (net)	11,000	100	11,000	100	Project net area

3.2.2 Crop Production Plan

The crop production plans based on the cropped area and target yields, and the incremental crop production under the project are summarized below.

Crop Production Plans & Incremental Crop Production under the Project*

Crop/Area	With project		Without project		Increment	
	Cropped Area (ha)	Production (ton)	Cropped Area (ha)	Production (ton)	Cropped Area (ha)	Production (ton)
Irrigated Rice	15,974	87,003	2,714	11,748	13,260	75,255
- KIS	4,600	25,300	2,714	11,748	1,886	13,552
- NDIS	11,374	61,703	-	-	11,374	61,703
Irrigated Rice (Prairie)	2,102	11,561	2,102	11,561	0	0
Banana	1,800	72,000	1,200	48,000	600	24,000
Upland Crops	-	-	5,082	10,202	-5,082	-10,202

*No production changes assumed in Prairie Volta Farm even in the case of the-project

Under the project, the production increase of some 75,300 tons of paddies or 48,900 tons of rice is expected at the full development stage. The production volume accounts for about 8.5% of national rice consumption and for 13% of rice imports in Ghana in 2009/10. The production increase of bananas is estimated to be 24 thousand tons. However, compared to the case of not adopting the project, a decrease of some 10,000 tons of upland crops is estimated due to land use conversion to rice fields.

3.3 Irrigation and Drainage Plan

3.3.1 Water Resources Development Plan

In accordance with the results of the first discussion with VRA and GIDA on October 1, 2010, on the intake of irrigation water from the Kpong dam reservoir, the following three items have been agreed to by both authorities.

(1) VRA basically agreed to intake irrigation water directly from the Kpong Reservoir for the right bank area for the new irrigation scheme of about 10 m^3/sec.

(2) GIDA should carefully design intake structure when crossing the Kpong Dam body to prevent water leaks and should consider safety measures for the dam body on the basis of approval from VRA.

(3) VRA also pointed out, in the meeting on October 1, 2010, that the existing KIS intake should be activated and utilized as much as possible, since the existing KIS takes irrigation water at a rate of about 3.5 m^3/sec only, even though the maximum intake capacity was designed to be 7.2 m^3/sec.

The VRA basically agreed with the results and both authorities have signed the agreement. The agreement is shown in Annex B.

Water Intake Capacity from Kpong Dam

Irrigation scheme	Net irrigation area (ha)	Peak discharge (m^3/sec)	Annual average. intake volume (1000 m^3)	Annual average discharge (m^3/sec)	Reducing hydropower generation (MWH/year)	Opportunity cost (GHC 1000/year)
KIS	4,100	7.151	79,739.	2.528	2,370	78.2
NDIS	6,900	11.382	158,603.	5.029	4,714	155.6
Total (APGIP)	11,000	18.533	238,342.	7.558	7,084	233.8

3.3.2 Potential of the Norboyita Dam

According to the latest obtained DTM topographic map surveyed in the year 2010, the narrowest point at the elevation level of 15.0 becomes very wide—about 4 km—as shown in the above figure. The height of the dam would be about 12 meters. Accordingly the dam construction is much more costly than the river training work, hence, the dam construction plan is not recommended.

The siphon method can be applied to cross the Norboyita River, since the irrigation water from the Kpong dam is very clear and the main canal is lined by concrete so that no sediment load will be expected in the siphon area.

3.3.3 Alternative Study of the Irrigation Schemes

(1) New Intake Capacity and Alternative Study

The following 3 alternative studies have each been compared with the case of the existing KIS both with and without improvement of the existing main canal and the new development area of NDIS.

Case 1: New development area (NDIS) only, excluding existing KIP

Case 2: New development area (NDIS) and improvement of KIS by concrete lining of the main canals.

Case 3: Combined plan of new development area (NDIS) and KIS as one new main canal and existing KIP intake and canal are abundant.

Case-2 was selected for rehabilitation and development of KIS and NDIS from the economic point of view.

3.3.4 Water Requirement Analysis

Irrigation acreage of each irrigation scheme is shown in the following table. In KIS, a 20 ha fish pond has been considered to require the same amount of water as upland crops.

Irrigation Acreage in Irrigation Schemes

Irrigation Scheme	Paddy fields (ha)	Upland fields (ha)	Banana Farm (ha)	Total (ha)
KIS	2,259	41 (20)	1,800	4,100
NDIS	6,738	163	0	6,900
Total (APGIP)	8,997	203 (20)	1,800	11,000

Note: A 20 ha fish pond is included in the upland field.
Banana farm irrigation is carried out for 12 hours.

Peak and Average Discharge of Irrigation Schemes

Irrigation scheme	Peak discharge (m^3/sec)	Volume (1000 m^3)	Discharge (m^3/sec)	Increment discharge
KIS	7.151	79,739.	2.528	0.240
NDIS	11.382	158,603.	5.029	
Total	18.533	238,342.	7.558	0.240

3.3.5 Water Availability from Kpong Reservoir

Based on the analysed half monthly water level data, available water intake capacity was estimated adopting the approximation equation. Several severe years are selected to compare water availability from the Kpong dam and necessary water intake capacity as shown in Table B.2. As a result, available water will not be sufficient to intake due to a low water level for about one month in April or May in 1998 and 2007. The frequency of the water deficit is estimated at two times in the duration of twenty eight years, which corresponds to a 2/28 return period. The abnormal drought condition is estimated to occur once every fourteen years.

3.3.6 Reducing Hydro Power Generation

In order to estimate the negative benefit of power generation capacity caused by APGIP, the average discharge on the basis of the annual volume of intake has been calculated. The opportunity cost of water has been estimated as follows:

Reducing Hydropower generation caused by APGIP

Irrigation scheme	Average power generation loss (MWH)	Negative benefit (GHC × 1000)	Negative benefit (US$1000)
KIS improve	1,875	244	164
KIS increment	178	23	16
NDIS	3,730	485	326
Total (APGIP)	5,605	729	490

3.4 Environmental and Social Considerations

Related policies and regulations for the environmental and social considerations provided by the government of Ghana (GOG) are “The Ghana Environmental Assessment (EA) Regulations,” “The State Lands Act (Act 125) of 1963,” and “Environmentally Sensitive Areas” (ESAs). The policy of the JICA’s Guidelines for Environmental and Social Considerations (April 2010), hereinafter referred to as the “JICA Environmental Guideline” is explained in Paragraph 3.5.2. in the main text. An outline of the “World Bank (Safeguards Policies)” is provided in Paragraph 3.5.3.

3.5 Organization and Management Plan

A possible organization and management structure is discussed as a sample in the Study. A private scheme management company (SMC) is expected to be deployed for managing NDIS, while KIS would be operated by KIP striving to enhance its performance. SMC would operate and maintain

NDIS effectively and efficiently by self financing based on ISC collection so that farmers and farm enterprises in the project area would receive the full benefit, under the concession contract with GIDA/MoFA. SMC would provide paid services of agricultural support to small and medium-scale farmers as well as promoting a market-oriented mindset among farmers in the project area.

4. Facilities Plan

4.1 NDIS Facilities Plan

Irrigation water is supplied to farmland by gravity. The intake is installed in the right bank of the Kpong dam in consideration to the dam location and the alignment of the Akuse main canal of KIS. Irrigation blocks are broadly divided into two areas: NDIS No. 1 area and No. 2 area, which are bounded by Sege-Aveyime road. Appropriate diversion points are selected to supply irrigation water to each farm block or the most upstream block in a series of farm blocks.

	Structures	Canal length
1.	Main canal	69.1 km
2.	Secondary canal	115.5 km
3.	Pipeline (dia. 600 – 900 mm)	9.95 km
4.	Appurtenant structures, siphon, drainage culvert, check gate, spillway, emergency outlet, etc.	

Upstream of the hilly terrain along the right bank of the Volta River, swamp areas and ponds have been developed along the approximately 50 km distance between Akuse to the Prairie farm. The very gentle slope along the hilly area has been accelerating sediment deposition flowing out from the upstream drainage area. That is why arable areas with an elevation level lower than 5m have poor drainage, causing water logging that hinders agricultural farming, including rice cultivation. The drainage improvement work is implemented at several sites in the command area and outlets to the Volta River.

	Area in NDIS	Location	Length
1.	No. 1 area	Irrigation block 8-11	10 km
		No. 1 area outlet drainage	15 km
2.	No. 2 area	Lac Aklamador outlet	30 km

4.2 KIS Facilities Plan

The NIS irrigation system consists of gravity and pump lifting systems. The main features of KIS rehabilitation work are lining canals with concrete and adding more check gates, spillways, emergency outlets, etc.

	Irrigation canal	Discharge	Length
1.	Akuse main canal	7.2 – 4.1 m^3/sec	16.2 km
2.	South lower level canal	3.88 m^3/sec - end (1.46 m^3/sec downstream of pump station)	5.3 km
3.	North lower level canal	0.46 m^3/sec - end	5.1 km
4.	Distributary Z		8.1 km
5.	Distributary Y		3.0 km
6.	High level canal	2.42 m^3/sec	5.6 km

The insufficient drainage canal slope causes water logging in farmland in KIS. In addition, heavy weeding in the drainage canal also causes insufficient flow capacity of the canal. It is therefore necessary to improve the drainage condition.

	Location	Length
1.	Lupu main drain	5.0 km
2.	Lupu-Klebwe outfall	1.0 km
3.	Klebwe outfall	1.5 km
4.	Sopa drain	2.5 km
5.	Sopa- Kasu link drain	2.0 km
6.	Kasu outfall drain	1.5 km
7.	Kasu drain outlet	2.0 km
8.		10.0 km
9.		9.0 km

4.3 On Farm Development

Paddy fields are developed in 10 ha (200m × 500m) blocks in principle. Farm roads 4.0 m wide, as well as 0.5m × 0.5m on-farm canals and drainage canals are provided by the project. Top soil shall be repeatedly moved to the vicinity field.

4.4 Workshops for Agricultural Support and OMM

The proposed plants and equipment are shown in Table G.3 and G.4 in Annex G. The plants and equipment for agricultural support are to be progressively installed as rice production increases thanks to the progress of the project. The plants and equipment for OMM deployed for the project would be operated and maintained in the mechanical workshop of each project. The existing KIS workshop would be used as it is and a new workshop would be developed for NDIS.

5. Initial Environmental Examination (IEE)

5.1 Comparative Examination of Alternatives

The cases of adopting the project and of not adopting it are compared. Adopting the project may be one way to enhance food security and develop agro-based industries. However, the project area is a plain, and there may be adverse impacts on the environment. If the project is not adopted, there may be no adverse impacts on the environment, but deciding to not adopt the project may not be in line with Ghana’s agricultural policy on food security and the millennium development goal for reduction of hunger.

5.2 Possible Adverse Environmental and Social Impact

The possible adverse environmental and social impact that may be caused by adopting the project is reviewed. At the present stage, no serious impact is expected. This is because no involuntary resettlement is expected at the present stage since the dam reservoir is not constructed, and irrigation canals don’t pass by existing communities. A new irrigation water intake from the Kpong Dam might not have the serious problem of salt intrusion downstream of the Volta River, but some effects are expected, such as soil erosion and water pollution.

5.3 Mitigation and Monitoring for Key Impacts

Assumed mitigation measures for possible adverse environmental and social impacts are reviewed. They are shown in Annex F, Table F.2. These possible adverse impacts can be avoided, minimized and mitigated, if the proponent can implement timely action and take proper measures at the planning phase, construction phase, and operation phase.

5.4 Additional Study for Next Feasibility Study

An additional study on environmental and social considerations leading up to the next Feasibility Study is proposed, covering: (1) an environmental impact assessment study covering the whole project area, (2) public consultation meetings, (3) an environmental study on the value and importance of wetlands, and (4) consideration of an effective and feasible monitoring plan.

6. Possible Options of Organization and Management

Possible options for organizing and managing APGIP were examined, and a scenario based on the option was applied in this study in order to provide some materials for starting discussion.

6.1 Land Ownership

Land of the existing KIP area is owned by GIDA/GOG and allocated to farmers under the lease contract. For NDIS, there are two options, i.e., one is following the same process as KIS, and the other is that GIDA will acquire long-term land-lease holdings with exclusive attorneyship by paying premiums and arranging land-lease contracts between land owners and users.

6.2 Irrigation Users

There will be no changes in irrigation users or the land allocation agreement of KIP.

The irrigation users invited to NDIS will be categorized into three farmer types, i.e., small-scale, medium-scale, and large-scale farm.

NDIS Irrigation Users: Farmer Types

Object	Self consumption and commercial	Commercial	
Farmer Type	Small-scale	Medium-scale	Large-scale
Farming Type	Self consumption / local market or functioning as out-grower of agribusiness	Domestic market	Domestic/ export agribusiness
Size	1–2 ha Represented by 1.5 ha	10–30 ha Represented by 20 ha	One unit: 50–100 ha
Support Services	Full or partial support services are necessary		Not necessary/ individual

6.3 Development of Land and Irrigation Infrastructure

The land for NDIS will be divided into a number of secondary blocks, of which the size is expected to be 100–300 ha depending on the geographical and irrigation network conditions. Each secondary

block would be categorized as either a *Private Development Block* or *Public Development Block* depending on the type of development.

Private Development Blocks: to be developed through the initiative and investment of the private sector, such as the agribusiness enterprise (large-scale farm). Within a block, large-scale farms will occupy 70% of the land for their own farming, and the remaining 30% will be allocated to small-scale farmers, which are expected to perform as out-grower farmers or contract farmers under the large-scale farms.

Public Development Block: to be developed by the government (GIDA). Of the land, 70% will be allocated to small-scale farmers and 30% will be allocated to medium-scale farmers.

6.4 Scenario Applied in the Study

The overall land distribution to each farmer type will be decided by the allocation of public and private blocks, which shall be decided in consideration of marketability and the business plans of the invited large-scale farms as well as the government policy. In the study, the scenario that 50% of secondary blocks would be allocated to private development blocks and the remaining 50% would be allocated to public development blocks, was applied. The allocation of agricultural land to each category in the scenario is summarized as shown below:

Agricultural Area Allocated to Categories in the Scenario

Farm Type	NDIS Newly Developed (ha)	NDIS Existing Large Farms (ha)	KIS (ha)	Total (ha)
Small-scale	2,800	-	2,300	5,100
Medium-scale	900	-	-	900
Large-scale	2,000	1,200	1,800	5,000

7. Cost Estimation

7.1 Project Implementation

The construction site is composed of NDIS and KIS areas. The construction work is broadly classified into the construction of the intake, canal construction and land development in NDIS, and concrete lining work in KIS. In addition, both projects include drainage improvement work. The construction of the project office, workshop, garage for OM machinery and equipment, rice dryers and rice storage is categorized as architectural work. The procurement of OM and agricultural machinery and equipment is also included in the project.

7.2 Implementation Plan and Schedule

The original contracts are divided into several packages, including one for building work, and another for procurement of OM, agricultural machinery, and equipment. Considering the urgent need to rehabilitate the existing KIS irrigation systems, the packages are recommended to be carried out in parallel with the main canal construction of NDIS in the extent of the Akuse main canal and the south low level canal. As to the canal construction work, including the secondary canal of NDIS, there is no obstructive factor for the construction. The contracts of three to four packages are recommended considering the management capacity of the local contractors.

Considering the appropriate construction capacity of the heavy machinery for the earth work, mainly the compaction of the embankment and concrete production capacity of the mixing plant, three years and two years are required to complete the work of NDIS and KIS rehabilitation works respectively, including the period for mobilization and demobilization. Bidding for the procurement of OM, agricultural machinery and equipment shall be announced at an earlier time to ensure an assembly and shipping period for the machinery of at least eight months.

7.3 Project Cost

The construction cost is composed of the direct construction cost, indirect cost, OM facility and equipment, agricultural equipment, land acquisition and compensation, administration, engineering services, physical contingency, and price contingency, as well as the tax. Project cost is summarized below.

Project Cost (NDIS)

	Description	Amount (GHC × 1000)		Remarks
I.	Construction Cost			
	1. Main irrigation canal construction	31,507.4		
	2. Secondary canal construction	19,772.8		
	3. Drainage work	361.8		
	4. Land development	19,223.2		
	5. Warehouse, building work	2,467.1		
	Total (1+2+3+4+5)	73,332.3		
	6. Temporary cost	1,466.6	2	% of (1+2+3+4+5)
	7. Site expense	7479.9	10	% of (1+2+3+4+5+6)
	8. Overheads and profit	6,582.3	8	% of (1+2+3+4+5+6+7)
	Total I.	88,861.1		
II.	Procurement cost for OM equipment	4,976.0		
	Total (I+II)	93,837.1		
III.	Administration cost	938.4	1	% of (I+II)
IV.	Engineering services	4,691.9	5	% of (I+II)
	Total (I+II+III+IV)	99,467.4		
V.	Physical contingency	4,973.4	5	% of (I+II+III+IV)
VI.	Price contingency	10,428.7	2	% per year of (I+II+III+IV)
	Total project cost	114,869.5		

Note: The cost of agricultural machinery/equipment (GHC 3,542,700) and land acquisition is excluded from the table.

Project Cost (KIS)

	Description	Amount (GHC × 1000)		Remarks
I.	Construction Cost			
	1. Akuse main canal	6,035.2		
	2. South lower level canal work (by pump station)	658.6		
	3. South lower level canal work (downstream of pump station)	649.8		
	4. North lower level canal work	525.1		
	5. Distributary Y canal work	251.9		
	6. Distributary Z canal work	762.6		
	7. High level canal work	1,373.7		
	8. Gate installation, including concrete work	581.6		
	9. Drainage work	977.1		
	10. Dryer, rice storage work	1,313.7		
	Total (1 to 10)	13,129.3		
	11. Temporary cost	262.6	2	% of (sum of 1 to 10)
	12. Site expense	1,339.2	10	% of (sum of 1 to 11)
	13. Overheads and profit	1,178.5	8	% of (sum of 1 to 12)
	Total I.	15,909.6		
II.	Procurement cost for equipment			
	1. Procurement of OM equipment	2326.7		
	2. Procurement of agricultural machinery	2339.0		
	Total II.	4,665.7		
	Total (I+II)	20,575.3		
III.	Administration cost	364.7	2	% of (I+II)
IV.	Engineering services	911.8	5	% of (I+II)
	Total (I+II+III+IV)	21,851.8		
V.	Physical contingency	975.6	5	% of (I+II+III+IV)
VI.	Price contingency	1,747.5	2%	of (I+II+III+IV)
	Total project cost	24,574.9		

Note: Land acquisition cost is excluded from the table.

7.4 Annual Operation and Maintenance Cost, and Replacement Cost

(1) OM cost

The cost for annual operation and maintenance at the full development stage are estimated at about GHC 1.40 million (Direct cost) for NDIS and GHC 0.71 million (Direct cost) for KIS, but the cost of machinery and equipment depreciation is excluded. The OM cost is comprised of the costs for salaries and wages of project staff, and running and maintenance costs such as fuel and lubricant for the irrigation facilities. OM cost for the irrigation facilities consists of rehabilitation of the concrete lining, gravel pavement repair, weeding, etc.

Annual OM costs above are equivalent to about 1.6% and 4.5% of the construction cost of each project.

(2) Replacement cost

Intake and division gates require replacement within the project's useful life because the facilities have a shorter useful life than civil works. The cost is estimated at about GHC 1.23 million for replacement after ten years for the small gates and GHC 0.36 million for the large gates of NDIS. Similarly, the cost is estimated at GHC 0.27 million for replacement for the small gates after ten years, and GHC 0.04 million for the large gates of KIS. OM, agricultural machinery, and equipment are also replaced after ten consecutive years of use.

7.5 Preliminary Estimation of Irrigation Service Charges (ISC)

ISC comprises three components, i.e., the land rent fee, water fee, and development fee. ISC is to be set to cover the necessary OM cost of the irrigation system. The expected price level of ISC was estimated preliminarily in the study, as well as the on-farm OM cost and required development cost of farmland as shown in Table 7.6.6. The estimated price levels of ISC are 243 GHC/ha-year in KIS and 276 GHC/ha-year in NDIS for small and medium-scale farms, and 322 GHC/ha-year in KIS and 431GHC/ha-year in NDIS for large-scale farms.

8. Project Evaluation

8.1 Economic & Financial Evaluation

The results of economic evaluation of the Project are summarized as follows:

Economic/Financial Evaluation & Sensitivity Analysis

	Economic Analysis		Sensitivity Analysis (EIRR %)			
Project/Scheme	EIRR (%)	B/C Ratio	Case 1	Case 2	Case 3	Case 4
KIS	20.8	1.8	20.1	18.9	20.3	18.3
NDIS	19.3	1.7	17.9	17.7	18.1	17.0
APGIP	19.8	1.7	18.6	18.1	18.8	17.4

Case 1: Construction cost 10% up, Case 2: Irrigation & drainage benefit (crop production benefit) 10% down,
Case 3: Irrigation water supply (construction work) 1 year delay Case 4: Target yields for paddies about 10% down

On the basis of the estimated irrigation service charges under the project, the capacity-to-pay of small-scale farms (KIS: 1.0 ha/farm & NDIS: 1.5 ha/farm) is examined. Net surpluses of GHC 4,510 (92% of net return) in KIS and GHC 5,280 (88% of net return) in NDIS are expected under the project.

This reveals that beneficiary farmers can fully shoulder the annual irrigation service charges (OMM cost & others) and interest levied on farm credit services.

8.2 Socio-economic Impact

In addition to the huge impact of the incremental production of paddies (i.e. 75,300 tons/year) or rice (i.e. 48,900 tons/year) and the impact of savings of foreign exchange of some US$ 25.6 million at the full-development stage and onward to the national economy, the creation of employment opportunities of about 393,000 man-days/year is anticipated under the project.

9. Conclusion and Recommendations

9.1 Conclusion

The proposed gravitational irrigation system of the Accra Plains Gravity Irrigation Scheme taking water from the Kpong Dam has strong potential for development and will be technically and economically feasible for the pre-feasibility-level study. Construction costs as well as operation and maintenance costs will be almost half of the pump irrigation scheme.

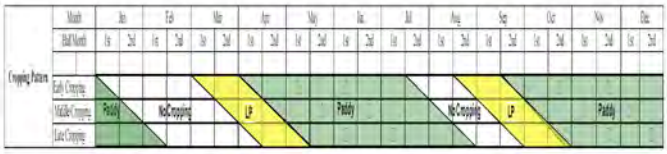
9.2 Recommendations

The development of Accra plains for irrigated agriculture will be the flagship project in the GOG as mentioned in important policies. We recommend that a full feasibility study be performed as soon as possible together with the implementation of the project.

10. Summary Table of the APGIP

The following pages show the summary of the Accra Plains Gravity Irrigation Project. The unit of construction costs and other related costs and benefits shown in the table is U.S. dollars.

Summary Table of the APGIP

No.	Items	Sub-items	KIS	NDIS No.1 Area	NDIS No.2 Area	NDIS Total	APGIP
1	**Present Land Use (ha)**		(ha)	(ha)	(ha)	(ha)	(ha)
	Irrigated Rice Field		1,852	0	490	490	2,342
	Banana Farm		1,200	0	0	0	1,200
	Irrigated Upland Field			162	0	162	162
	Upland Field		600	1,420	2,421	3,841	4,441
	Grass Land		448	1,200	1,413	2,613	3,061
	Others		210	58	96	154	364
	Total		4,310	2,840	4,420	7,260	11,570
2	**Population**						
		Local Administrtaion	Dangme West Distrct	Dangme West and North Tongu Distric			
	Administration	Population of District (2010)					
		North Tongu					208,442
		Dangbe West					126,450
		Dangbe East					117,544
		Number of small farmers	2,500			2,720	5,220
3	**Irrigation Area (Net Area) (ha)**		(ha)	(ha)	(ha)	(ha)	(ha)
	Existing Irritaion Area						
	- Paddy Field		1,852		490	490	2,342
	- Upland Crop			162		162	162
	- Banana Farm		1,200				1,200
	Total		3,052	162	490	652	3,704
	Projected Net Irrigation Area						
	- Paddy Field		2,300	2,538	4,200	6,738	9,038
	- Upland Crop			162		162	162
	- Banana Farm		1,800			0	1,800
	Total		**4,100**	**2,700**	**4,200**	**6,900**	**11,000**
	Cropping Calendar						
	Double Cropping of Paddy						
	Irrigation Efficiency	Paddy Field	0.612	0.689	0.689	0.689	
		Banana Farm	0.729				
	Design Capacity of Intake (m3/sec)		**7.2**			**11.3**	**18.5**
	Annual Average Intake Discharge (m3/sec)		2.528			5.029	7.558
	Annual Average Intake Volume (1000 m3)		79,739			158,603	238,342
4	**Facility**						
	Main Canal Length (km)		43.3			69.1	112.4
	Secondary Canal Length (km)					115.5	115.5
	Lateral Canal and On-farm (ha)		0			6,450	6,450
	Drainage Canal		8.2			33.50	41.70
5	**Annual Crop Production**						
	Annual Crop Production (without-project)	Paddy	11,748	0	0	0	11,748
	(ton/year)	Upland Crops	1,566	3,706	4930	8,636	10,202
		Banana	48,000			0	48,000
	Annual Crop Production (with-project)	Paddy	25,300	27,535	34,166	61,701	87,001
	(ton/year)	Upland Crops					
		Banana	72,000	0	0	0	72,000
	Crop Production (annual increment)	Paddy	13,552	27,535	34,166	61,701	75,253
	(ton/year)	Upland Crops	-1,566	-3,706	-4,930	-8,636	-10,202
		Banana	24,000	0	0	0	24,000
		Prairie Volta (with & without)			11,561 t/year		

Summary Table of the APGIP

No.	Items	Sub-items	KIS	NDIS No.1 Area	NDIS No.2 Area	NDIS Total	APGIP
6	**Irrigation Management System**						
	Irrigation Management Body		KIP	Scheme Management Company (SMC)			
	Farmers Cooperative		Osudoku Cooperative	New Farmer's Cooperative			
				Secondary Groups under Farmer's Cooperative in Public Development Block			
				WUAs in Private Development Block			
7	**Construction Cost**		Exchange Rate	1.0 US$ =	1.49 GHC		
I.	Construction Cost		(1000 US$)				
	1.	Main irrigation canal construction	7,274.2		21,145.9	28,420.1	
	2.	Secondary canal construction	0.0		13,270.3	13,270.3	
	3.	Drainage works	655.8		242.8	898.6	
	4.	Land development	0.0		12,901.5	12,901.5	
	5.	Warehouse, building works	881.7		1,655.8	2,537.5	
		Total (1+2+3+4+5)	8,811.6		49,216.3	58,027.9	
	6.	Temporary cost	176.2		984.3	1,160.5	
	7.	Site expense	898.8		5,020.1	5,918.9	
	8.	Overhead and profit	790.9		4,417.7	5,208.6	
	Total I.		10,677.6		59,638.3	70,315.9	
II.	Procurement cost for O&M equipment		3,131.3		3,339.6	6,470.9	
	Total (I+II)		13,808.9		62,977.9	76,786.8	
III.	Administration cost		244.8		629.8	874.6	
IV.	Engineering services		611.9		3,148.9	3,760.9	
	Total (I+II+III+IV)		14,665.6		66,756.6	81,422.3	
V.	Physical contingency		654.8		3,337.9	3,992.6	
	Total Project Cost		**15,320.4**		**70,094.5**	**85,414.9**	

Unit Construction Costs per hectare

I.	Construction Cost		(US$/ha)				
	1.	Main irrigation canal construction	1,774.2		3,064.6	2,583.6	
	2.	Secondary canal construction	0.0		1,932.2	1,206.4	
	3.	Drainage works	159.9		35.2	81.7	
	4.	Land development	0.0		1,869.8	1,172.9	
	5.	Warehouse, building works	215.0		240.0	230.7	
		Total (1+2+3+4+5)	2,149.2		7,132.8	5,275.3	
	6.	Temporary cost	43.0		142.7	105.5	
	7.	Site expense	219.2		727.5	538.1	
	8.	Overhead and profit	192.9		640.2	473.5	
	Total I.		2,604.3		8,643.2	6,392.4	
II.	Procurement cost for O&M equipment		763.7		484.0	588.3	
	Total (I+II)		3,368.0		9,127.2	6,980.6	
III.	Administration cost		59.7		91.3	79.5	
IV.	Engineering services		149.3		456.4	341.9	
	Total (I+II+III+IV)		3,577.0		9,674.9	7,402.0	
V.	Physical contingency		159.7		483.7	363.0	
	Total Project Cost		**3,736.7**		**10,158.6**	**7,765.0**	

8 Operation and Maintenance Costs per Year

Operation & Mnaintenance Costs	1000 US$			
Irrigation Area (ha)	4,100		6,900	11,000
Main Canal	306.2		513.4	819.6
Secondary Canal	Included above		258.0	258.0
Project Staff	167.8		167.8	335.6
Total	**474.0**		**939.2**	**1,413.2**

Operation and Maintenance Costs per hectare per Year

Operation & Mnaintenance Costs	US$/ha			
Irrigation Area (ha)	4100		6900	11000
Main Canal	74.7		74.4	74.5
Secondary Canal	0.0		37.4	23.5
Project Staff	40.9		24.3	30.5
Total	**115.6**		**136.1**	**128.5**

Summary Table of the APGIP

No.	Items	Sub-items	KIS	NDIS			APGIP
				No.1 Area	No.2 Area	Total	
9	**Economic Evaluation**						
	Annual Financial Incremental Benefit at Full	Without-project	14,044	1,545	5,688	7,233	21,277
	Development (GHC 000)	With-project	24,579	12,208	18,847	31,055	55,634
	(Incremental Net Production Value)	Increment	10,535	10,663	13,159	23,822	34,357
	Economic Evaluation						
	EIRR		20.8%	–	–	19.3%	19.8%
	B/C		B/C = 1.8			B/C = 1.7	B/C = 1.7
	Financial Evaluation						
	FIRR		21.6%			14.7%	16.8%
	B/C		B/C = 1.9			B/C = 1.3	B/C = 1.4

10 Comparison of Construction Costs between Pump Irrigation (APIP) and Gravity Irrigation (APGIP) Systems

Construction Cost

Items	Pump	APGIP	KIS	NDIS
Total Area (ha)	5,000	11,000	4,100	6,900
Total Direct Cost (1000 US$)	99,140	76,787	13,809	62,978
Engineering (1000 US$)	1,983	3,761	612	3,149
Administration (1000 US$)	496	875	245	630
Construction Environmental (1000 US$)	1,707	-	-	-
Physical Contingency (1000 US$)	2,479	3,338	655	3,993
Grand Total (1000 US$)	105,804	85,415	15,320	70,095

Note: Items for Pump is derived from the F/S Report of APIP 5,000ha in 2010

Operation and Maintenance Cost

Items	Pump	APGIP	KIS	NDIS
Total Area (ha)	5,000	11,000	4,100	6,900
O & M Cost (1000 US$)	1,070	1,078**	306**	772**
Energy Cost of Pumping (1000 US$)	925	-	-	-
Labour Cost (1000 US$)	18*	336	168	168
Total O&M Cost (1000 US$)***	2,013	1,414	474	940
Depreciation cost of O&M machinery/equipment	-	490	156	334
Total O&M Cost (1000 US$)	2,013	1,904	630	1,274

* Labour cost for pumping plan is estimated 10 labours with 150$/month manpower costs.

** Maintenance cost of road maintenance by gravel pave is included.

Unit Construction Costs per hectare

Items	Pump	APGIP	KIS	NDIS
Total Area (ha)	5,000	11,000	4,100	6,900
Total Direct Cost (US$/ha)	19,828	6,981	3,368	9,127
Engineering (US$/ha)	397	342	149	456
Administration (US$/ha)	99	80	60	91
Construction Environmental (US$/ha)	314	-	-	-
Physical Contingency (US$/ha)	496	363	160	484
Grand Total (US$/ha)	21,161	7,765	3,737	10,159
Ratio to the Pump Irrigation	1.000	0.367	0.177	0.480
Ratio to APGIP	2.725	1.000	0.481	1.308

Unit O & M Cost per hectare

Items	Pump	APGIP	KIS	NDIS
Total Area (ha)	5,000	11,000	4,100	6,900
O & M Cost (US$/ha)	214	98	75	74
Energy Cost of Pumping (US$/ha)	185	-	-	-
Labour Cost (US$/ha)	4	31	41	24
Total O & M Cost (US$/ha)	403	129	116	136
Ratio to Pump Irrigation	1.00	0.32	0.29	0.34
Ratio to APGIP	3.12	1.00	0.90	1.05
Depreciation cost of O&M machinery/equipment	-	86	38	48
Total O & M Cost (US$/ha)	403	215	154	184
Ratio to Pump Irrigation	1.00	0.53	0.38	0.46
Ratio to APGIP	1.87	1.00	0.72	0.86

Economic Evaluation (EIRR)

Items	Pump	APGIP	KIS	NDIS
Normal EIRR (%)	21.1	19.8	20.8	19.3
10% cost increased (%)	18.2	18.6	20.1	17.9
10% benefit decreased (%)	18.1	18.1	18.9	17.7

Note:

"Construction Environmental ($1000)" in the tables above means the costs of mitigation, such as educational campaigns regarding public health, distributing insecticide treated nets in the project-affected communities, undertaking screening and treatment of bilharzias, and distributing 2,000 boxes of free condoms. This is derived from the F/S Report of APIP 5,000 ha in 2010.

PREPARATORY STUDY ON ACCRA PLAIN IRRIGATION DEVELOPMENT PROJECT

PRE-FEASIBILITY STUDY
FINAL REPORT

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Glossary of Acronyms

Acronyms	Orthography
ADB	Agriculture Development Bank
AEA	Agricultural Extension Agent
AESD	Agricultural Engineering Services Directorate
AfDB	African Development Bank
AgSSIP	Agriculture Sector Services Improvement Project
APGIP	Accra Plains Gravity Irrigation Project (by JICA)
APIP	Accra Plains Irrigation Project (by Study for Pump Irrigation)
CAADP	The Comprehensive Africa Agriculture Development Programme
CARD	Coalition for African Rice Development
CSIR	Council for Scientific and Industrial Research
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EP	Environmental Permit
EPP	Emergency Preparedness Plan
ESAs	Environmentally Sensitive Areas
FAO	Food and Agriculture Organization
FAPIM	Farmers' Participation in Irrigation Management
FASDEP II	Food and Agriculture Sector Development Policy
FBOs	Farmer-based Organizations
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GHC	Ghana Cedi (Currency Unit)
GIDA	Ghana Irrigation Development Authority
GOG	Government of Ghana
GPRS	Ghana/Growth Poverty Reduction Strategy
GSGDA	(Medium-term National Development Policy Framework:) Ghana Shared Growth and Development Agenda, 2010–2013
GSS	Ghana Statistical Services
GWCL	Ghana Water Company Limited
IAIA	International Association for Impact Assessment
ICOUR	Irrigation Company of Upper Region
IDA	Irrigation Development Authority (Same as GIDA)

Acronyms	Orthography
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
ISC	Irrigation Service Charge
JICA	Japan International Co-operation Agency
KIP	Kpong Irrigation Project Office (Right Bank)
KIS	Kpong Irrigation Scheme
KLIP	Kpong Left Bank Irrigation Project
LI	Legislative Instrument
MDAs	Ministries, Departments and Agencies
METASIP	Medium Term Agriculture Sector Investment Plan, 2011–2015
MiDA	Millennium Development Authority
MFEP	Ministry of Finance and Economic Planning
MoEST	Ministry of Environment, Science and Technology
MoFA	Ministry of Food and Agriculture
NDIS	New Development Irrigation Scheme
NEPAD	New Partnership for African Development
NHIL	National Health Insurance Levy
NPV	Net Production Value
NWP	National Water Policy
ODA	Official Development Assistance
OMM (OM)	Operation, Maintenance and Management (Operation and Maintenance)
OM&R	Operation Maintenance and Repair
PIC	Project Implementation Committee
PPP	Public Private Partnership
PMU	Project Management Unit
SFIP	Small Farms Irrigation Project
SMC	Scheme Management Company
SRID	Statistics, Research and Information Directorate, MoFA
SSIDP	Small-scale Irrigation Development Project
TV	Training & Visit
VAT	Value Added Tax
VBA	Volta Basin Authority
VRA	Volta River Authority
WB	World Bank
WRC	Water Resources Commission

Terminology

Name of Irrigation Schemes

- The project name is “Accra Plains Gravity Irrigation Project (APGIP).” The project consists of two separate irrigation schemes for improvement of the existing Kpong Irrigation Scheme (KIS) and New Development Irrigation Scheme (NDIS). The name of the project has been selected to distinguish it from the former feasibility study on the pump irrigation scheme of the Accra Plains Irrigation Project (APIP) by Studi Consultants.

- The NDIS consists of the No. 1 and No. 2 Areas. The No. 1 Area includes Cassi Farm, Tokpo, and the Norboyita area, which is the 2nd priority area studied by APIP F/S and covers 200,000 ha. The No. 2 Area includes the 1st priority area studied by APIP F/S (5,000 ha covered by pump irrigation) and the Prairie Volta Ltd. rice farm area.

- The report title utilized has been “Preparatory Study on Accra Plain Irrigation Development Project,” which is the name of the contract with JICA.

- STUDI Report 200,000 ha: Detailed Feasibility Study of Accra Plains Irrigation Project 200,000 ha, Final Report, June 2010

- STUDI Report 5,000 ha: Feasibility Study of the Accra Plains Irrigation Project Detailed Feasibility Study for the 5000 ha Final Report, June 2010

- 1US$ = 1.49 GHC

Chapter 1

Introduction

Chapter 1 Introduction

1.1 Background

1.1.1 National Development Plan

Agriculture and Irrigation development policies and strategies under the National Development Plan are as follows.

(1) Medium-term National Development Policy Framework:
Ghana Shared Growth and Development Agenda (GSGDA), 2010–2013

A phased irrigation plan of the Accra plains is mentioned as the flagship irrigation project within the period, subject to the results of on-going technical studies being undertaken by a team of experts. Also, as CAADP of NEPAD recommends, the allocation of at least 10% of government expenditure and the provision of selective subsidies for the agricultural sector for the procurement of inputs were also mentioned.

(2) CAADP Compact

The CAADP Compact was signed on October 28, 2009. The government of Ghana aims to implement a mid-term investment plan in the agricultural sector based on the FASDEPII with the Economic Community of West African States (ECOWAS) within the framework of CAADP. In 2007, the Ministry of Food and Agriculture formulated FASDEP II, with the following targets:

1) Capacity building of MFA staff and strengthening of the MFA organization,
2) Promotion of agricultural credit,
3) Development, spread, and utilization of suitable agricultural techniques,
4) Improvement of social infrastructures,
5) Promotion of selected crops, and
6) Improvement of access to markets

(3) Medium-term Agriculture Sector Investment Plan (METASIP) 2011–2015

Output 1.6.1: The irrigation schemes' productivity has increased by 25%, and intensification by 50% will be achieved by 2015

In order to increase the efficiency of irrigation schemes, the following set of activities have been planned for implementation:

1) To rehabilitate 50 breached dams in the Greater Accra and Volta Region.
2) To enhance the skills of GIDA staff for consultative participatory project identification, planning, implementation, monitoring and evaluation.
3) To train extension workers on irrigation and water management techniques and skills so as to enable them to undertake irrigation extension, and also train them on participatory methods in dealing with farmers as well as market extension.
4) To build the capacity of water user associations in agricultural water management and their obligations as major beneficiaries (group formation and benefits, irrigation methods and maintenance, multiple use of water-culture-based fisheries, business management skills,

etc).

5) To undertake comprehensive management needs assessment for existing large irrigation schemes.
6) To establish participatory management systems in large-scale irrigation schemes.

Output 1.6.4: Feasibility studies for large-scale irrigation projects in the country will be updated by 2012 and funds for implementation sourced by 2012.

The following activities are planned to accelerate the pace of scheme development:

1) To update the feasibility study of 500,000 ha of large-scale irrigation projects and undertake detailed studies and design for 200,000 ha.
2) To conduct studies into mapping irrigation potential and prepare bankable projects for the country.
3) To prepare investment plans for irrigation of the Accra Plains Irrigation Project.
4) To source funds for implementation of the projects by 2012.
5) To start construction of projects by 2013.

It is, however, necessary to also plan in the long-term to develop large-scale irrigation systems in large irrigable areas such as the Afram Plains, several valleys in the northern and southern savannas, and accelerate the ongoing development efforts in **the Accra Plains**.

The estimated incremental cost of implementation for all six programmes of the agricultural sector investment plan for both MoFA and other agriculture related MDAs for the five years is GHC 1,532.4 million.

(4) The Coordinated Programme of Economic and Social Development Policies, 2010–2016

The agriculture sector is expected to be a major driver of growth in the economy in the medium term. Growth and development of the sector is expected to lead to structural transformation of the economy through the modernization evident in food security, employment and reduced poverty. This will be achieved through the implementation of the Food and Agriculture Sector Development Policy (FASDEP II) and the corresponding Medium Term Agriculture Sector Investment Plan (METASIP). Major planned agriculture initiatives for the medium term include:

• Promotion of irrigation-based agriculture with the rehabilitation of existing schemes, other water management technologies, and phased development of the Accra Plains, which is the “Flagship” project.

(5) President John Evans Atta Mills’ delivered the State of the Nation Address on 17th February 2011

President John Evans Atta Mills on February 17 delivered his third State of the Nation Address to

Parliament, which dealt with his government's achievements. The president's address was in accordance with Articles 2 and 36 (5) of the 1992 Constitution, which mandate the President to deliver a State of the Nation Address. President Mills' address was titled, **"Raising Ghana to the Next level,"** and he gave the nation a thumbs-up, saying **"The state of the nation is good."** The president focused on the economy, agriculture, employment, youth development, education, health, housing, security, governance, corruption, and other national and international matters. President Mills said his government would continue to invest in human resources, key infrastructure, and development of the oil and gas sector, as well as in the **modernisation of agriculture and related processing activities.** Modernization of agriculture, enhanced food security and creating job opportunities along the entire agricultural value chain are priorities of this Administration. There have been notable increases of maize, rice, sorghum, plantain and yam production. The goal of this Administration—to make locally produced food more abundant and affordable—is on course. The implementation plan for the National Irrigation Policy will be completed and launched during 2011. The first phase of **the Accra Plains Irrigation Project**, covering an area of about 5000 hectares will be implemented to promote double, and where possible, triple cropping of vegetables and cereals. The Youth in Agriculture Programme has chalked up some degree of success, and its scope will be expanded this year.

1.1.2 TICAD-IV

"The Yokohama Declaration" has been adopted to provide a road map for support of African growth and development under the TICAD IV (4th Tokyo International Conference on African Development) on May, 2008. In the sector of agriculture and rural development, the development, rehabilitation and maintenance of water resources management infrastructure has been promoted, aiming at expanding the irrigated area within five years. The Government of Japan has proposed construction and rehabilitation work covering 100,000 ha for the irrigation systems, including small-scale irrigation schemes in the Yokohama Action plan. Based on this understanding, the Japan International Cooperation Agency (JICA), in partnership with the Alliance for a Green Revolution in Africa (AGRA), launched an initiative now known as the "Coalition for African Rice Development" (CARD). CARD promotes the three major agro-ecology approaches for rice cultivation in Africa: "irrigated fields," "rain-fed lowlands," and "rain-fed uplands." CARD prioritizes the rehabilitation of existing irrigation facilities for rain-fed lowlands.

African countries have been improving the productivity of the agriculture under the CAADP. Improvement of access to irrigated agriculture is recognized in "sustainable land management and water control", which is one of four specific thrusts in the CAADP.

Under this circumstance, the Government of Japan took the initiative to launch rehabilitation of the irrigation facilities in the SAA in cooperation with other donor countries. However due to insufficient information, the irrigation development policy and strategy of each country, and the on-going and planning schedule of related irrigation projects by international donors hinders the proper project formulation of the irrigation development.

1.1.3 National Strategy and Plan Related to Irrigation

To achieve the Irrigation Policy Goals—"*To achieve sustainable growth and enhanced performance of irrigation contributing fully to the goals of the Ghanaian agriculture sector*" as outlined in the Growth and Poverty Reduction Strategy, the Irrigation Policy proposes the following objectives .

1) Performance and growth.
2) Socio-economic inclusion.
3) Responsible production.
4) Enhanced services

To realize the objective of "Performance and Growth," the policy set specific sub-objectives corresponding to the policy implementation strategy.

- To raise productivity of agricultural water for irrigation, livestock watering and aquaculture.
- To enhance the production potential of ongoing irrigation activities
- To develop new irrigation areas according to demand and feasibility
- To establish appropriate funding mechanisms for public irrigation
- To increase private sector investment in irrigation

In order to implement these sub-objectives, the responsibility is given to GIDA as a central agency. At present, a sufficient budget for managing the "Public (Formal) Irrigation Project" has not been allocated. In item (b) of the sub-objectives, the increase of direct budgetary allocation to GIDA is stipulated as a strategic action. In addition, chapter 6 of the policy mentions organizational reform of GIDA. In this regard, it is highly expected that GIDA will be strengthened financially and organizationally.

1.1.4 Agriculture in Ghana

(1) Agriculture Sector

The agriculture sector is the main economic sector in Ghana, accounting for 34.5% of GDP (2009) and 45% of total export earnings of traditional commodities in 2007 (Economic Survey, GSS, 2005–2007). Such figures are the 2nd highest among all the economic sectors, following the mining sector. The sector is also the main sector of employment, providing jobs for 53% of the economically active population in the country (2005/06). Further, most of the crops produced in the country are consumed domestically; hence, the sector plays a decisive role in national food security. Taking account of the sector in the national economy in the future, the government of Ghana established the policy of giving the highest priority to developing the sector.

(2) Land Use

The country has a land surface area of 238,500 km^2. Out of the total area, 13.6 million ha (57%) are used for agricultural purposes and 6.9 million ha (54% of the agricultural land area) are under cultivation. Within the areas under cultivation, the real extent of irrigated fields is extremely limited,

currently at about 29,804 ha or 0.41% of the area under cultivation.

Table 1.1.1 Agricultural Land Use in Ghana (2010)

Land Use Category	Area (km^2)	%	
1. Agricultural land area	136,282	57.1	100
Area under-cultivation	73,115		54
- Area under-irrigation (ha)	(29,804 ha)		(0.41)
Area not under-cultivation	63,167		46
2. Non-agricultural land area	91,256	38.3	-
3. Water surface	11,000	4.6	-
Total land area	238,538	100	-

Source: Agriculture in Ghana, Facts & Figures (2009), MoFA

(3) Food Crop Production

The food crop production in the country from 2007 to 2009 indicates substantial growth, as shown in the following table.

Table 1.1.2 Cropped Area and Production of Major Food Crops in Ghana (2007–2009)

Crops	Cropped Area (1000 ha)			Production (1000 MT)			Yield in 2009 (t/ha)
	2007	2008	2009	2007	2008	2009	
Maize	790	846	954	1,220	1,470	1,620	1.7
Sorghum	208	276	267	155	331	350	1.3
Rice/paddies	109	133	162	185	302	391	2.4
Cassava	801	840	886	10,218	11,351	12,231	13.8
Yams	324	348	379	4,376	4,895	5,778	15.2
Others	726	746	737	5,148	5,401	5,549	7.5
Total	2,958	3,189	3,385	21,302	23,750	25,919	7.7

Source: Agriculture in Ghana, Facts & Figures (2009), MoFA

The growth rates of maize, paddy and cassava production from May 2003 to September 2007 are respectively estimated at 5.6%, 6.8% and 4.5% by MoFA.

(4) Industrial Crop Production

The production of industrial crops in the country from 2000 to 2009 indicates substantial growth, as shown in the following table.

Table 1.1.3 Production of Major Industrial Crops in Ghana (2003–2009)

Unit: × 1000 tons

Crops	2003	2004	2005	2006	2007	2008	2009	Average
Cocoa	496.8	737.0	599.3	740.5	614.5	680.8	710.6	654.2
Coffee	0.34	0.48	0.27	0.16	0.30	2.02	0.52	0.58
Rubber	10.9	12.3	13.6	13.6	15.3	14.1	19.1	14.1
Shea nuts	n.a.	n.a.	n.a.	n.a.	28.0	30.0	31.4	29.8
Oil Palm [1]	1,640.1	1,686.8	1,712.6	1,737,9	1,684.5	1,896.8	2,103.6	1,780.3

[1]: Production of fresh fruit bunches Source: Agriculture in Ghana, Facts & Figures (2009), MoFA

Cocoa products form the 2nd most important traditional export commodity, following gold, in the country.

(5) Livestock

The major livestock are cattle, sheep, goats, and poultry (MoFA), and their populations as of 2009 are shown in the following table.

Table 1.1.4 Livestock Population in Ghana (2009)

Unit: × 1000

Item	Cattle	Sheep	Goats	Pig	Poultry
Population in 2009	485	390	442	521	43,320
Index (1997=100)	114	146	174	150	273

Source: Agriculture in Ghana, Facts & Figures (2009), MoFA

(6) Food Balance and Import of Food Crops

The food balance of major commodities (rice & maize) in 2009/10 is estimated by MoFA as shown in the following table.

Table 1.1.5 Food Balance of Rice and Maize (2009/10)

Unit: MT

Commodity	Domestic Supply [1]	Import	Total Supply	Consumption	Net Surplus
Rice	204,000	384,000	588,000	576,480	11,380
Maize	1,134,000	34,000	1,168,000	1,052,000	116,000

[1]: Domestic supply involves- seed requirements, livestock feed & waste Source: Agriculture in Ghana (2009), MoFA

In the case of maize, self sufficiency was attained in the reported period of 2009/10; however, some 380,000 tons of rice were imported to satisfy domestic consumption in the period. Cereal imports of about 780 thousand tons on average are recorded in the country, as shown below.

Table 1.1.6 Cereal Imports in Ghana from 2005–2009

Unit: 1000 MT

Commodity	2005	2006	2007	2008	2009	Average
Rice	485	390	442	395	384	419
Wheat	370	254	332	337	330	325
Maize	55	7	1	64	34	32
Total	910	651	775	796	714	776

Source: Agriculture in Ghana (2009), MoFA

Some 650,000 to 910,000 tons of cereals, mostly rice and wheat, were imported from 2005 to 2009. The average rice import volume in the period was 419,000 tons. The consumption of rice in the country is on an increasing trend and the estimated per-capita consumption as of 2005 is 15.1 kg/person (in the food balance presented earlier, per-capita consumption is estimated to be 24.1 kg/person).

Table 1.1.7 Per-capita Consumption of Rice in Ghana

Unit: kg/capita

Item	1990	1995	2000	2005
Per Capita Consumption	13.3	13.9	14.5	15.1

Source: Agriculture in Ghana (2009), MoFA

The slated population growth and increase of per-capita rice consumption brought about by the improvement of living standards and progress of urbanization will further expand rice consumption in the country.

1.2 Objectives of the Project

This study aims to study and clarify the following major objectives on the basis of the framework of pre-feasibility study level.

(1) To determine the proposed irrigation area of the Volta River right-bank areas that extend from the existing Kpong irrigation scheme (KIS) to the Norboyita area, Aveyime area, 1st priority area studied by APIP F/S, and up to the Prairie Volta Rice Farm area on the basis of geographical and topographical conditions and based on the proposed gravitational irrigation system taking irrigation water from existing Kpong Reservoir,
(2) To negotiate and obtain approval from VRA, which controls the Akosombo dam and Kpong dam, to intake irrigation water directly from the existing Kpong Reservoir necessary for new irrigation water capacity covering the abovementioned irrigation areas,
(3) To determine the possibility of the existing KIS to be included in the APGIP or not from the technical, social and economical points of view,
(4) To establish and formulate a gravity irrigation system and to estimate adequate construction costs including operation, maintenance and management costs and benefits of the project, and evaluate technical, social and economical viability,
(5) To predict sound countermeasures against possible environmental and social impacts,
(6) To analyse the possible application of PPP for the implementation, operation and management of the proposed project on the basis of the GOG policy for promoting commercial agriculture, and
(7) To evaluate and propose whether the substantial full feasibility study and the project implementation are viable or not.

According to the results of the pre-feasibility study, commercial agricultural development will be proposed to introduce the private sector to the project area. It will be necessary to introduce an advanced management system enabling a sustainable irrigation management system and to prolong the total lifecycle of facilities in large-scale irrigation schemes on the basis of introducing the private sector to water users and having small holders, medium-scale farmers and large-scale enterprises participate in market-oriented agriculture. Project evaluation will be considered from the social, environmental and economic points of view.

1.3 Scope of Works

At this stage, a pre-feasibility study is required on the basis of establishing a gravitational irrigation system in the Accra Plain right-bank area of the Volta River.

The scope of the works required for the study is explained in the following items.

- Technical study of gravity irrigation systems.
- Operation, maintenance and management of the project

- Project cost estimation
- Benefit estimation
- Economic analysis
- Financial analysis
- Environmental and social consideration

1.3.1 Irrigation Development

(1) Survey on the Accra plains service area and proposing a route for the irrigation main canal

Geographical conditions of potential irrigation areas in the Accra plain are investigated from the viewpoints of land and water availability, and the potential of the proposed irrigable area. The existing F/S in the pump irrigation plan of the Accra plains is compared with the proposed gravitational irrigation system.

Information on the current situation of large-scale commercial farms located in the study area is collected and studied for irrigation system design, including an alternative study.

(2) Survey on water use and management

Information on the current situation of water use and management of the existing irrigation schemes are collected, analysed and reflected in the irrigation system design, e.g., planning of diversion work, secondary and tertiary canal, and on-farm facilities.

(3) Preparation of the study and reporting to GIDA, JICA and WB Office

In accordance with the progress of the study of each expert, the results of the study and output will be compiled in the “Field Completion Report.” The report will be submitted and explained to GIDA, the JICA Ghana Office and WB Ghana Office.

1.3.2 Infrastructure Design and Planning

(1) Survey on Accra plains service area

The entire irrigation system in the Accra plains area is studied from the viewpoints of land and water availability, and the potential of the proposed irrigable area.

(2) Detailed survey on existing irrigation system

Information on the current situation of large-scale commercial farms located in the study area will be collected and studied for the purpose of irrigation system design, including alternative study.

(3) Survey on water use and management

Information on the current situation of water use and management in the study area is collected and analysed to reflect irrigation system design, e.g., planning of diversion work, secondary and tertiary canals, and on-farm facilities.

(4) Preliminary design of the irrigation system

Alternative cases are studied, aiming at a comparison of irrigation systems from technical and

economic viewpoints. The study focuses on the following points:

a) Hydraulic and structural design

Hydraulic calculation is conducted to examine the hydraulic profile of the irrigation canal. Canal appurtenant structures, such as aqueduct, conduit, division structure, and spillway, are also included in the design. GIDA shall assist the team in making a plan of canal alignment, irrigation block plan (diversion points), and land acquisition plan.

b) Quantitative calculation

Quantitative calculation is conducted to estimate the project cost of each alternative plan and final proposed plan. An earthmoving plan, machinery schedule, and concrete procurement plan are studied to correctly estimate the project cost. In addition, an appropriate dewatering plan for the Kpong dam intake site is proposed considering the hydraulic generation schedule of the Kpong dam and water use for the existing irrigation systems of the Kpong Right Bank Irrigation Project.

c) Cost estimate

i) Cost estimate by alternative study

Project cost shall be roughly estimated by the alternative study of proposed irrigation systems. Since the operation and maintenance costs of the Accra Plains First Priority Area has been estimated, the project cost shall include practicable operation and maintenance costs to enable comparison of the cost-benefit ratio under identical conditions.

ii) Cost estimate for proposed plan

Project cost for the appropriate plan is estimated based on current labour and material costs. Cost estimate guideline of Ghana and GIDA shall be explained to the Study team.

d) Necessary data for irrigation system design

GIDA is requested to collect necessary data for the irrigation system design.

- Topographic map (1:50,000, 1:25,000)
- Contour map with its interval of 1.0m by digital data
- Information of existing irrigation project
- Design criteria, design report and drawings introduced in other irrigation projects in Ghana
- Cost estimate of a similar irrigation project

e) Topographic survey

Information on the topography along the canal profile is necessary, especially for the design of the drainage crossing section of the canal.

1.3.3 Farmer's Organization and Enterprises / Management of Irrigation System

(1) Survey on management of irrigation system in other areas

Information on the structure and current situation of management of irrigation systems in other areas is collected and analyzed in order to confirm the applicable management structure of the irrigation system. Information on the current situation of large-scale commercial farms located in the study area is collected and analyzed as a basis of confirming the needs and possible management structure of the irrigation system.

(2) Survey on water use and management of small-scale farmers

Information on the current situation of water use and management of small-scale farmers located in the study area is collected and analyzed as a basis of confirming the needs and possible management structure of the irrigation system.

(3) Study on services provided by irrigation systems

Services to be provided by the irrigation system are examined from the needs of water users and are prioritized in the study. The cost for the proposed service is also estimated. Services are studied from the aspect of the needs of both larger-scale commercial farms and small farms.

(4) Study on water fee

The expected water fee tariff is examined through confirming the current situation of farm management and the financial condition of the farmers' group, individual farmers and enterprises which carry on agricultural business in the study area.

(5) Study on necessary support by the Government

Necessary support for the management of the irrigation system by the Government of Ghana is studied from technical and financial aspects. The cost of the proposed support is estimated as well.

(6) Study on the concept and structure of operation and management of the system

Based on the results of the survey and studies mentioned above, the concept and structure of operation and management of the system, including the roles and responsibilities of stakeholders such as the government, enterprises and farmers' organization, are studied. The possible options of the management structure are shown as a conclusion.

1.3.4 Environmental and Social Considerations

1) Confirmation of environmental and social conditions of the target areas
2) Confirmation of legal framework of Environmental and Social Considerations (ESCs) in Ghana
3) Collection of existing reports and data on ESCs study in the target areas
4) Conduct site survey on ESCs
5) Analysis of ESCs study, and advice on relevance, such as the necessity of the irrigation development project in terms of ESCs

1.3.5 Agricultural Economy & Agricultural Development Plan

(1) Present Condition of the Project Area

Agricultural land use, agro-demography, land tenure & holdings, soils, crop production, crop budget (production costs), farm economy, marketing & post-harvest facilities, agricultural support services, and constraints and agricultural development concepts are studied and analysed.

(2) Agricultural Development Plan for the Project

The land-use plan, proposed cropping pattern, anticipated crop yields, crop-production plan, proposed farming practices, crop budget for the case of adopting the project, farm economy, and agricultural support services are studied and analysed.

(3) Project Evaluation

Evaluation procedures, project economic benefits, project economic costs, economic evaluation & sensitivity analysis, financial evaluation, indirect and intangible benefits.

1.3.6 Expected Output

This study aims to show the possible alternative plan of the irrigation system in the right bank of the Volta River. The following issues are expected to be clarified through a field survey and discussion with related organizations.

- Alternative plans for the irrigation system and estimate of the project area for gravity irrigation
- Project cost of each plan
- Operation and maintenance plan for the system on the basis of introducing the private sector.
- Project justification and evaluation
- Preparation and submission of Field Completion Report
- Preparation and submission of Final Preparatory Report

1.4 Activities of the Study Team

The study team consists of five members, each responsible for irrigation development, infrastructure planning and design, organization and irrigation system management, agronomy agro-economy, or environment and social consideration. The study period for the Pre-Feasibility Study for the Accra Plains Gravitational Irrigation Scheme is from January 2011 to May 2011.

Chapter 2

Present Condition of the Project Area

Chapter 2 Present Condition of the Project Area

2.1 Project Background

2.1.1 Former Study of the Project

The Accra Plains extend about 156,000 ha (approximately 200,000 ha) along the right bank of the lower Volta River. The feasibility study for the whole area of the Accra plains for irrigation development has been conducted from 2008 to 2010 with assistance from the Kuwait Fund (a grant of US $1.4 million). In June 2010, the feasibility study on development of pumping irrigation in the first prioritized area (relatively flat with 5,000 ha) was carried.

According to the F/S, the 1st priority area (5,000 ha) was originally planned to be irrigated by the pumped water from the Volta River. The total cost is estimated at US $106 million; the construction cost per unit area is US $21,160/ha and the OM cost is estimated at US $400/ha then the total cost with OM is around US $21,560/ha. The EIRR is estimated at 21.1%. The proposed major crops are paddy rice, cowpeas, maize, onions, peppers, tomatoes, soybeans, and fodder. The study didn't introduce a gravitational irrigation system. The development plan introduced in the study F/S is quite risky, because of the high cost and the difficulties in development, operation and maintenance of the pumping-up operation. The WB also made a comment on the same matters.

2.1.2 Study for the Formulation of an Irrigation Project in Africa by JICA

In accordance with the TICAD-IV statement, JICA sent study teams to four selected countries, namely Ghana, Mali, Uganda and Zambia, from June to September 2010, and carried out "Study for the Formulation for Irrigation Projects in Africa" to find potential irrigation projects.

During the course of the study in Ghana, the study team proposed a potential gravity irrigation project within the Accra Plains Irrigation Development Project, taking irrigation water from the existing Kpong Dam. The most critical point of the project is the availability of additional irrigation water from the existing Kpong Dam. The preliminary discussion was made with VRA and GIDA in October 2010, and VRA basically approved the taking of an additional 10.0 m^3/sec of irrigation water. Consequently, it is possible to adopt a gravitational irrigation system for the right-bank area of the Volta River.

2.2 Hydro-Meteorological Conditions

2.2.1 Climatic Conditions

The country's warm, humid climate has an annual mean temperature between 26°C and 29°C. Variations in the principal elements like temperature, rainfall, and humidity that govern the climate are influenced by the movement and interaction of the dry tropical continental air mass, or the harmattan, which blows from the northeast across the Sahara, and the opposing tropical maritime or moist equatorial system.

The extent of drought and rainfall varies across the country. To the south of the Kwahu Plateau, the heaviest rains occur in the Axim area, in the southwest corner of Ghana. Farther to the north, Kumasi

receives average annual rainfall of about 1,400 mm, while Tamale in the drier northern savannah receives rainfall of 1,000 mm per year. From Takoradi eastward to the Accra Plains, including the lower Volta region, rainfall averages only 750 mm to 1,400 mm a year.

Temperatures are usually high at all times of the year throughout the country, but at higher elevations temperatures are more comfortable. In the far north, temperature highs of 31°C are common. The southern part of the country is characterized by generally humid conditions. This is particularly so during the night, when 95 to 100 percent humidity is possible. Humid conditions also prevail in the northern section of the country during the rainy season. During the harmattan season, however, humidity drops as low as 25 percent in the north.
（Referred to: http://countrystudies.us/ghana/31.htm）

2.2.2 Meteorological Conditions

(1) Temperature

Meteorological stations are located in Akuse and Aveyime in the project area at an elevation of 5 m to 10 m above sea level. The mean monthly maximum temperature in March is 30.2°C in Akuse and 30.6°C in Aveyime, and the monthly minimum temperature in August is 26.7°C in both stations.

Table 2.2.1 Monthly Mean Temperature

(Unit: °C)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Akuse	28.4	30.1	30.2	29.8	28.9	27.8	26.9	26.7	27.5	28.0	28.5	28.3
Aveyime	29.3	30.6	30.6	30.0	29.1	27.6	26.8	26.7	27.5	28.2	29.0	29.1

Source: Ghana Meteorological Service Department

(2) Rainfall

The annual rainfall in the Accra Plains ranges from 850 mm to 1,400 mm as observed at the Akuse and Aveyime stations. The average annual rainfall is 1,046.8 mm in Akuse (1990–2010). The average annual rainfall of 913.2 mm observed in Aveyime is slightly lower compared to that in Akuse.

Table 2.2.2 Monthly Average Rainfall

(Unit: mm)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Akuse	16.6	27.7	86.2	118.4	164.1	166.8	96.5	41.2	100.6	126.9	72.6	27.4	1,046.8
Aveyime	15.4	21.7	70.7	130.7	142.0	137.7	64.3	31.1	74.6	109.8	65.0	21.9	913.2

Source: Ghana Meteorological Service Department

Less annual rainfall is expected in the eastern part of the Accra Plains, as shown on Fig. 2.2.1. This tendency may be caused by the coastal climate along the Gulf of Guinea.

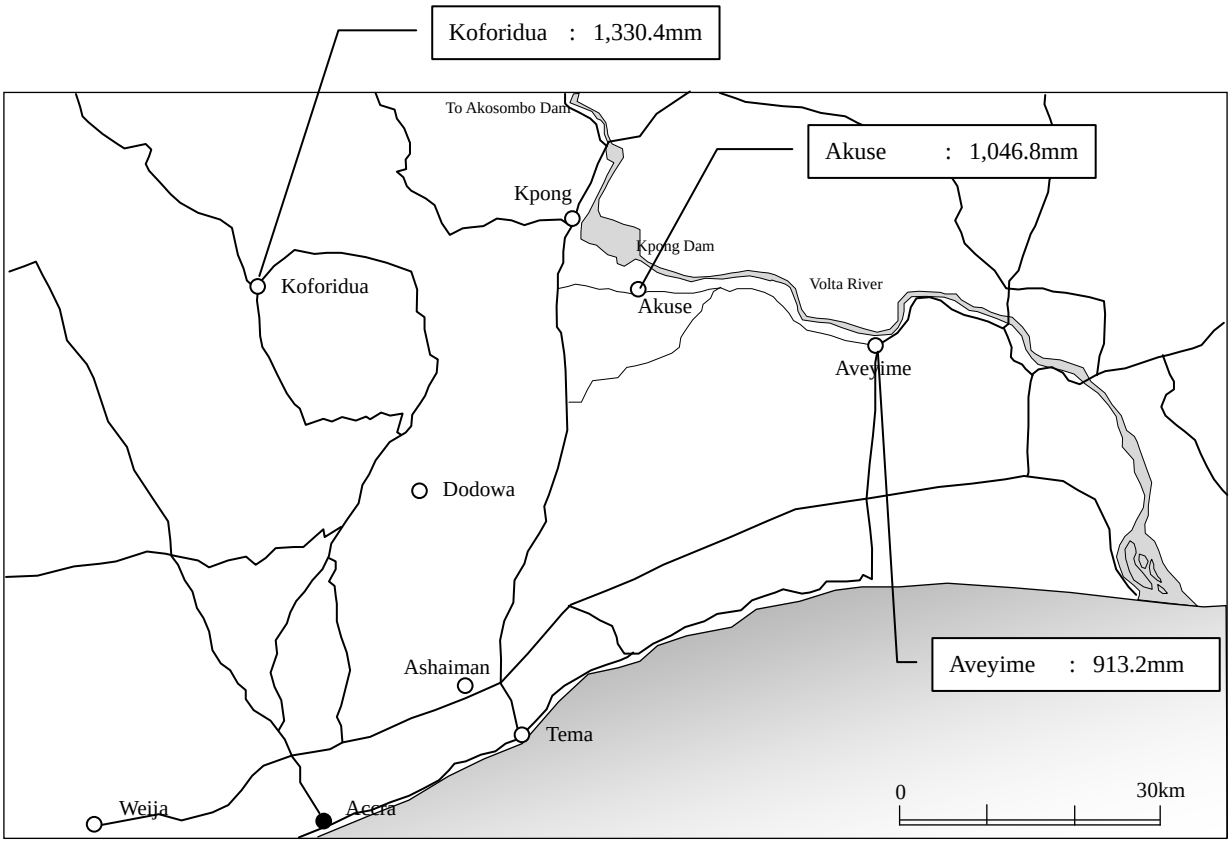


Fig. 2.2.1 Location of Meteorological Observation Stations and Annual Rainfall

(3) Other meteorological conditions

1) Evaporation

The average annual pan-evaporation ranges from 1,430mm to 1,600mm, and the average is 1,526 mm in Akuse. Monthly pan-evaporation is high from January to March, and low from June to August.

Table 2.2.3 Average Annual Pan-Evaporation

(Unit: mm)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Akuse	163.0	178.4	161.5	141.1	121.8	95.3	87.8	92.7	105.2	115.8	126.8	133.9	1,526.0
Aveyime	159.5	168.8	153.9	138.9	118.4	83.8	88.1	91.6	100.3	113.4	128.7	140.3	1,478.6

Source: Ghana Meteorological Service Department

2) Sunshine duration

Table 2.2.4 Average Daily Sunshine Duration

(Unit: hr)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Akuse	5.3	6.5	5.9	6.6	6.6	5.1	4.2	3.7	5.0	6.9	7.4	6.7	5.3
Aveyime	5.6	7.3	6.2	7.3	6.8	5.4	4.7	4.4	5.4	7.3	7.8	7.3	5.6

Source: Ghana Meteorological Service Department

3) Relative humidity

Table 2.2.5 Average Annual Mean Related Humidity

(Unit: %)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Akuse	68.5	68.6	72.0	75.9	80.0	83.2	82.2	80.4	81.0	81.9	80.4	75.4
Aveyime	71.5	72.1	74.8	77.7	80.5	84.0	82.9	82.8	81.6	82.2	79.8	75.8

Source: Ghana Meteorological Service Department
Note: Average relative humidity observed at 6:00 and 15:00

4) Wind speed

Wind speed was not observed at the Aveyime station.

Table 2.2.6 Average Annual Mean Wind Speed

(Unit: m/sec)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Akuse	1.1	1.5	1.6	1.6	1.2	1.2	1.5	1.6	1.3	1.0	0.8	0.9
Aveyime	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Ghana Meteorological Service Department

2.2.3 Hydrological Conditions

The command area is located along the Volta River with its stretch of about 86 km from immediately downstream of the Kpong dam to the river mouth. The Akosombo dam is located 25 km upstream of the the Kpong dam site. The river discharge is dominant, with enough released water for hydro power generation. The released water volume of both the Akosombo and Kpong dams is almost the same, enabling efficient generation of electric power. Water-level data observed at the Kpong dam and Volta River immediately downstream of the dam indicates that:

(Kpong Dam reservoir)

1) Inflow of the Kpong dam is about 1,200 m^3/sec.
2) The water level of the Kpong dam is almost constant, but slightly fluctuates depending on the balance of inflow and outflow. The highest and lowest water level is 16.97 m (2010) and 13.92 m (1998), respectively.
3) A period of lower water level of the Kpong dam reservoir was recorded in 1998 and 2007.

(Volta River)

4) The water level of the Volta River constantly fluctuated from 2.5 m to 4.0 m in the observation period of 1984 to 2010.
5) A higher water level was observed, at. 6.28m, in November 4, 2010, and for the next 21 days the water level continued to be 4.0 m or higher. The rising of the water level was mainly caused by flood inflow to the Akosombo dam as well as the Kpong dam.

2.3 Water Resources

2.3.1 Existing Reservoirs

The major water resources in the area are the Volta River and several small rivers. The Volta River has two major water reservoirs, namely the Akosombo dam reservoir and Kpong dam reservoir. The main function of the two dams is to generate hydro electric power.

The Akosombo dam is 111 m tall, with a dam crest length of 660m, a reservoir storage volume of 148 km^3, and surface area of 8,502 km^2. It generates hydro electric power by utilizing 1,200 m^3/sec of water discharge to generate 1,020 MW of power and then releases water into the Volta River, which subsequently reaches the Kpong dam.

Hydropower generation at the Kpong dam utilizes the same amount of water as the Akosombo dam to generate 160 MW of power. The storage capacity of the Kpong reservoir is 160 million m^3. The 1,200 m^3/sec of water discharged during hydropower generation corresponds to 103.7 million m^3/day, which is about 65% of the Kpong reservoir storage capacity. The storage capacity of the Kpong reservoir can be filled up within about one and half days with the maximum water discharge from the Akosombo dam. The water level in the Kpong dam fluctuates depending upon the balance of water inflow from Akosombo dam and water release from Kpong dam for hydroelectric power generation. The water level of the Kpong dam for the normal operation head pond is 14.75 m, whereas that of the high head pond is 17.7m, and the dam crest elevation is 18.75m and the normal tail water elevation downstream is 3.0 m. There are two existing intake structures for irrigation purposes—one at the right bank of the Kpong dam for the existing Kpong irrigation scheme and one at the left bank for Kpong left-bank irrigation scheme. Construction for the Kpong left-bank irrigation scheme began in March 2011, covering 2,000 ha under MiDA. Both intake capacities are designed to be 7.2 m^3/sec.

As for the water resources for irrigating the Accra plains, it is easy to intake water from the Volta River directory down stream of the Kpong dam. However, the water level in the Volta River is about 3.0 m, which is too low to irrigate the Accra plains, with their elevation of. 5.0 to 20.0 m, without a pump. There is, though, an advantage in using a pump for irrigation. The site of the pump station can be selected as near as possible to the irrigation area so that the leading canal length will be minimised. In order to utilise a pump for irrigation, pump equipment with a delivery pipe and energy for operating the pump are required. As a result, the operation and maintenance costs, and perhaps even the construction cost is higher in comparison with a gravity irrigation system. The former study for the Accra Plains Irrigation Project utilized a pump for irrigation for the 1st priority area of 5,000 ha.

As for a gravity irrigation system, higher elevation than the beneficial area of water level is required in the water source point to deliver irrigation water to the lower elevation beneficial area. For the

water resources for a gravity irrigation system, the Kpong dam reservoir water will be used for the source of irrigation water supply, like the existing KIS. But the water level of the reservoir is limited to within 14 to 15. The elevation of the beneficial area should be lower than the elevation. There will also be a critical limitation in using the Kpong reservoir water for irrigation, because the reservoir water is mainly utilized for hydroelectric power generation; when irrigation water is taken from the reservoir directly, the power generation capacity will be reduced.

In August 2010, the JICA Study Team for "Formulation of an Irrigation Project in Africa" proposed to negotiate with VRA on taking irrigation water from the Kpong reservoir. A meeting was held at Akuse VRA Office on October 1, 2010, between VRA and GIDA to discuss the possibility of direct water intake of about 10 m^3/sec for irrigation from the Kpong reservoir. As a result, VRA in principle approved the taking of water at a rate of about 10 m^3/sec for irrigation with some conditions on the method of intake, canals crossing the dam body, etc. During the course of the Pre-F/S, further study was made for negotiation with VRA in detail, and the contents of the further studies are shown in paragraph 3.4.

2.3.2 Rivers in the Project Area

In the project area, several river courses flow into the Volta River, the catchment areas of which are about 100 to 110 km^2 at most. One of the largest catchment areas is the Norboyita River, midstream of which lies a potential dam site, near Forkope Village. The catchment area is estimated to be 95 km^2 at the proposed dam site. However, according to the newly obtained digital terrain model topographic map surveyed in 2010, the contour line of 15 m elevation is very much different (about 7.5 m lower) than that shown on the 1/50,000 topographic map surveyed in 1973. As a result, the proposed dam body length was estimated to be about 700 meters in the 1/50,000 topographic map but it will expanded by more than 2 km according to the newly obtained DTM map. The potential of the proposed dam construction is discussed in paragraph 3.4. Most of the other rivers in the project area are too small to utilise to supplement irrigation water, and almost no water is available during the dry season.

2.4 Socio-economy

2.4.1 Population

(1) Population

The project area extends across mainly 3 districts, i.e., Dangme West and Dangme East of the Greater Accra Region, and North Tongu of the Volta Region. The NDIS area is mainly constituted by Dangme West and North Tongu District, but a limited part is located in the Dangme East District. The KIS area is mainly located in the Dangme West District, and Yilo Krobo of the Eastern Region also constitutes a very limited part. The population of these three major districts is projected as shown below:

Table 2.4.1 Population of the each District

District	2030*	2010*	2000	1984	Growth Rate (%) 1984-2000
Dangme West	215,737	126,450	96,809	63,141	2.6
Dangme East	187,322	117,544	93,112	64,135	2.3

North Tongu	532,696	208,442	130,388	61,552	4.6

*Projected populations are based on the 2000 Population and Housing Census

Most of the settlements in the project area are rural in terms of population and function. The only exceptions to this general classification are Battor (3,070) and Mepe (4,108), which are urban in terms of population and function. Aveyime (2,028) is urban in terms of population but elements of a rural agrarian economy are manifest within the spatial configuration, housing characteristics and economic life of the town. The populations of communities in the NDIS area are shown below:

Table 2.4.2 Population in NDIS Area by Community

North Tongu District		Dangme West District		Dangme East District	
Community	Projected Population in 2011	Community	Projected Population in 2011	Community	Projected Population in 2011
Aveyime	2,028	Topko	115		
Mepe	4,108	Volivo	425		
Degorme	1,286	Atabui	42		
Mafi Devime	1,608	Duffor	45		
Atitekpo	2,039	Kotokor	36		
Aklamador	998	Adakope	82		
Dekpoe	509	Agbaveanu	122		
Akraya	577	Tsunkpo	86	N.A.	N.A.
Kpogadzi	766	Agbekotsekpo	149		
Mafi Dove	1,903	Kasunya	102		
Kelekor	175	Nyapianya	112		
Aflokope	474	Klebusey	116		
Nutekpo	416				
Manya	922				
Lasivenu	629				
Ranch	135				
Tehe	469				
Battor	3,070				
Total	22,112	Total	1,432	Total	N.A.

Projection was made by base year of 2010.

Source: Agricultural Extension Services, MoFA.

The number of small-scale farmers in the NDIS area could not be accurately estimated without a detailed survey, so the number was estimated by distributing the data in the STUDI Report 20,000 ha area-proportionally. According to the estimate, 2,720 small-scale farmers live in the NDIS, and approximately 2,500 live in the KIS area.

Table 2.4.3 Estimated Number of Small-scale Farmers in NDIS Area

DU*	Area of DU (ha)	Number of small-scale farmers in DU	Within project Area (ha)	Estimated number of small-scale farmers in project area
3-1	4,418	1,767	1,700	680
4-1	1,671	668	1,000	400
5-1	5,286	2,114	3,000	1,200
6-1	9,845	3,938	1,100	440
Total			6,800	2,720

*: Development unit applied in STUDI Report 20,000 ha. The number does not include the KIP area.

Source: Number of small-scale farmers in the project area is estimated by the study team based on data in STUDI

Report 20,000 ha.

(2) Ethnicity

The local populace in the project area is made up from several ethnic groups: Ga-Dangmes, Ewes, Akans, Guan, and Mole Dagbani. The Ga-Dangme group is the majority in the Dangme West and Dangme East District, and the Ewe group accounts for more than 90% in the North Tongu District.

Table 2.4.4 Ethnicity in Related Region and Districts

Region and Districts	Rank-1		Rank-2		Rank-3		Rank-4	
Greater Accra Region	Akan	(39.8%)	Ga-Dangme	(29.7%)	Ewe	(18.0%)	Mole Dagbani	(5.1%)
Dangme West District	Ga-Dangme	(77.8%)	Ewe	(12.3%)	Akan	(4.9%)	Mole Dagbani	(1.6%)
Dangme East District	Ga-Dangme	(85.9%)	Ewe	(5.6%)	Akan	(5.1%)	Mole Dagbani	(1.2%)
Volta Region	Ewe	(68.5%)	Guan	(9.2%)	Akan	(8.5%)	Gurma	(6.5%)
North Tongu District	Ewe	(90.5%)	Akan	(5.3%)	Guan	(1.5%)	Ga-Dangme	(1.5%)

Source: Population and Housing Census 2000, Ghana Statistic Service

(3) Economic character of the district

The economically active population, the ratios of the employed and unemployed members of such population, and the share of occupations in the agriculture and related sector in 2000 are shown below. The unemployed ratio is 7.0–8.9 % in the three districts. The agriculture and related sector accounts for approximately 50% of occupations in Dangme West and Dangme East District. The share in the North Tongu District is 70%.

Table 2.4.5 Economically Active Population and Related Features

Region and District	Economically active population in 2000 (15 years and older)	Employed (%)	Unemployed (%)	Share of Occupations in agriculture, animal husbandry, fishing & forestry (%)
Greater Accra Region	1,377,903	86.6	13.4	9.1
Dangme West	41,887	91.1	8.9	50.2
Dangme East	40,462	93.0	7.0	52.3
Volta Region	697,752	92.5	7.5	59.7
North Tongu	54,922	92.7	7.3	70.0

Source: Population and Housing Census 2000, Ghana Statistic Service

2.4.2 Land Tenure

Land in the NDIS area can be categorized under two traditional types of ownership: stool land and family lands. The principal actors involved in the land acquisition process as mandated by tradition in the NDIS area are: the chief head, who is the principal signatory and is supported by the stool father, the secretary for stool land, the family head, who is supported by the secretary, and a family member for family lands[1].

In the KIS area, the government has land ownership for the project area which had been acquired at

[1] The STUDI Report 5,000ha, June 2010

the time of development. Farmers who are members of the Osudoku Cooperative rent land according to the Land Allocation Agreement made with KIP. Farmers have the duty to pay annual land rent to KIP, which is included in the irrigation service charge.

2.5 Soils

2.5.1 Soil Distribution

The soil study covering the project area was made in detail under the Detailed Feasibility Study of Accra Plains Irrigation Project for 200,000 ha carried out by Studi International. Based on the study, the soil map of the 200,000 ha, at a scale of 1:25,000, and the soil map of the 1st Priority area, at a scale of 1:5,000, were prepared by classifying soils at the soil-series level. According to the soil study and maps, major soils distributed in the project area, a low lying area of 200,000 ha extending along the right bank of the Volta River, are as shown in the following table and figure.

Table 2.5.1 Major Soils in the Project Area

Soil Series	Soil Type (FAO, 1990)	Soil Formation
Amo Series	Gleyic Cambisols	Soils developed over recent mixed alluvium
Tefle Series	Eutric Vertisols	Soils developed over recent mixed alluvium
Akuse Series	Calcic Vertisols	Soils developed from basic gneiss

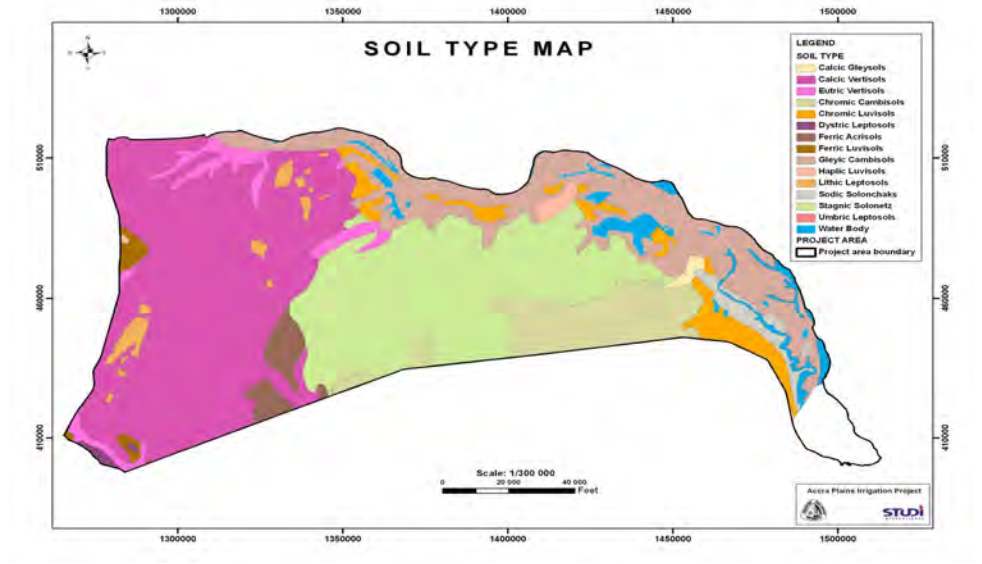


Fig. 2.5.1 Soil Map of the 200,000 ha

(Source: Detailed Feasibility Study of Accra Plains Irrigation Project 200,000 ha)

(a) Amo Series (Gleyic Cambisols)

The soils are distributed extensively along the Volta River and occupy the flood plains of the river. The soils cover almost the entire Project area, as shown in the soil map. The soils are derived from alluvial materials transported from the higher catchment areas of the river basin and local tributaries from the black clay belt. The soils are deep, grey mottled brown or red clays, occurring on lower levees. The soil profile is made of dark greyish brown silt loam underlain with layers of greyish-brown and yellowish-brown mottled silty clay and reddish-brown mottled silty clay at the bottom of the solum.

(b) Tefle Series (Eutric Vertisols)

The soils are distributed at the southern part of the Kpong Irrigation Scheme (KIS) to a limited extent. The soils are derived from alluvial materials transported from the higher catchment areas of the river basin as is the case for the Amo Series. The soils consist of dark grey brown silt clay top soil which cracks vertically when dry and is underlain with yellowish and olive-brown mottled clay containing manganese concretions. The sub-soils have a very hard prismatic structure.

(c) Akuse Series (Calcic Vertisols)

The soils derived from weathered materials of basic hornblende gneiss are black cracking, heavy clays. The soils are deep (60–100 cm), very dark grey to black cracking, heavy clay. The soil solum is clayey throughout with impeded internal drainage. The profile is made up of about 25 cm of dark grey to very dark grey clay loam with medium-sized crumbs. The sub-soils are grey to dark grey cracking clay with a very coarse sub angular structure and contain frequent to abundant calcium carbonate coated gravel, soft and hard manganese and iron concretions. The soils shrink and crack deeply when dry and swell when wet.

(d) Soil Chemical Characteristics

Major chemical properties of the soils are summarized in the following table.

Table 2.5.2 Chemical Properties of Major Soils in the Project Area

Soil Series	pH	CEC (meq)	N (%)	OC (%)	Available K_2O (ppm)	ESP (%)
Amo Series	5.8	17.6	0.21	2.1	22	6.1
Tefle Series	6.5	25.4	0.18	1.8	248	3.5

Source: Studi Report 5,000 ha; properties of surface soils [1]: Organic matter content

2.5.2 Land Suitability

The land suitability of the project area was assessed in the 200,000 ha Study based on the FAO System (Framework for Land Evaluation). The land suitability of major soils distributed in the area is evaluated as follows.

Table 2.5.3 Land Suitability of Major Soils in the Project Area

Soil Series	Land Suitability Rating by Crop			
	Rice	Maize	Vegetables	Banana
Amo Series	S2	N1	S3	N1
Tefle Series	S2	N1	S3	N1
Akuse Series	S1	S2	S2	S2

S1: highly suitable, S2: moderately suitable, S3: marginally suitable, N1: currently not suitable
Source: Detailed Feasibility Study of Accra Plains Irrigation Project 200,000 ha

There are some discrepancies between the land evaluations of the Studi Report 200,000 and the Studi Report 5,000 ha. A detailed soil study will be required in the F/S Study to confirm the land suitability of the soils in the project area.

2.6 Infrastructure

2.6.1 Roads

(1) Dangme West District

The district has a road network about 252 km long, 40 % of which is surfaced, while the rest consists of feeder roads. Tracks and footpaths also link the villages. The total road network when compared to other districts appears to have a good spatial distribution. Apart from the central portion of the district, which is devoid of roads, the district is linked together fairly well. The national trunk roads are in an appreciably good condition. Most of the feeder roads that give access to the more rural centres are unsurfaced and need regular resurfacing, especially after the wet season.

(2) Dangme East District

The total length of the road network is about 172 km. The network is made up of primary roads (28 km), secondary roads (20.2 km), and feeder roads (123.3 km), which are fairly distributed through the district, with almost every settlement connected to a road. However, most of the road network, especially the feeder roads, is in a bad condition, with some roads becoming undriveable during the wet season. The roads linking the Songor lagoon area and Koluedor to the northern part of the district are in a bad condition.

(3) North Tongu

The road network in the district is in a poor condition, although there are ongoing efforts by the central government to make the roads more driveable. A number of feeder roads and bridges are currently undergoing construction or rehabilitation. When completed they will make the district generally more accessible. In particular, they will significantly reduce the motoring distance from Adidome to the industrial town of Juapong, and will also make towns such as Volo and Dorfor Adidome more accessible.

2.6.2 Water supply

The Danish International Development Agency (DANIDA) in cooperation with the Community Water and Sanitation Agency (CWSA) is supporting the provision of water and sanitation facilities and service to rural communities in the Greater Accra Region. The water supply scheme for the related Districts of Dangme East, Dangme West and North Tongu is located in some rural and small towns in the eastern part of the Greater Accra Region and Volta Region. The water system takes its source from the Volta River.

The water system was designed as a conventional treatment plant system. The old method of sedimentation, slow sand filtration and disinfection is used in the purification of the water. The service population is estimated to grow at a rate of 2.8% in the design period of 10 years. The water tap is located at a minimum walking distance to a standpipe of 500 m. The transmission and distribution systems consist of a network of pipelines of varying sizes between 50 mm to 250 mm in diameter.

To promote sustainability and complete the concept of community ownership and management, the

Three District Water Supply Project is under the management of a Water and Sanitation Development Board through a Private Operator. The Water Board is responsible for the operation and maintenance of the water scheme, whereas the various water and sanitation committees take responsibility for each community linked to the scheme.
Water supply systems have been well developed in the project not only in the towns of Akuse, and Aveyime, but also in their surrounding small communities, together with the electric supply.

Road and water supply networks are illustrated in Fig. 2.6.1.

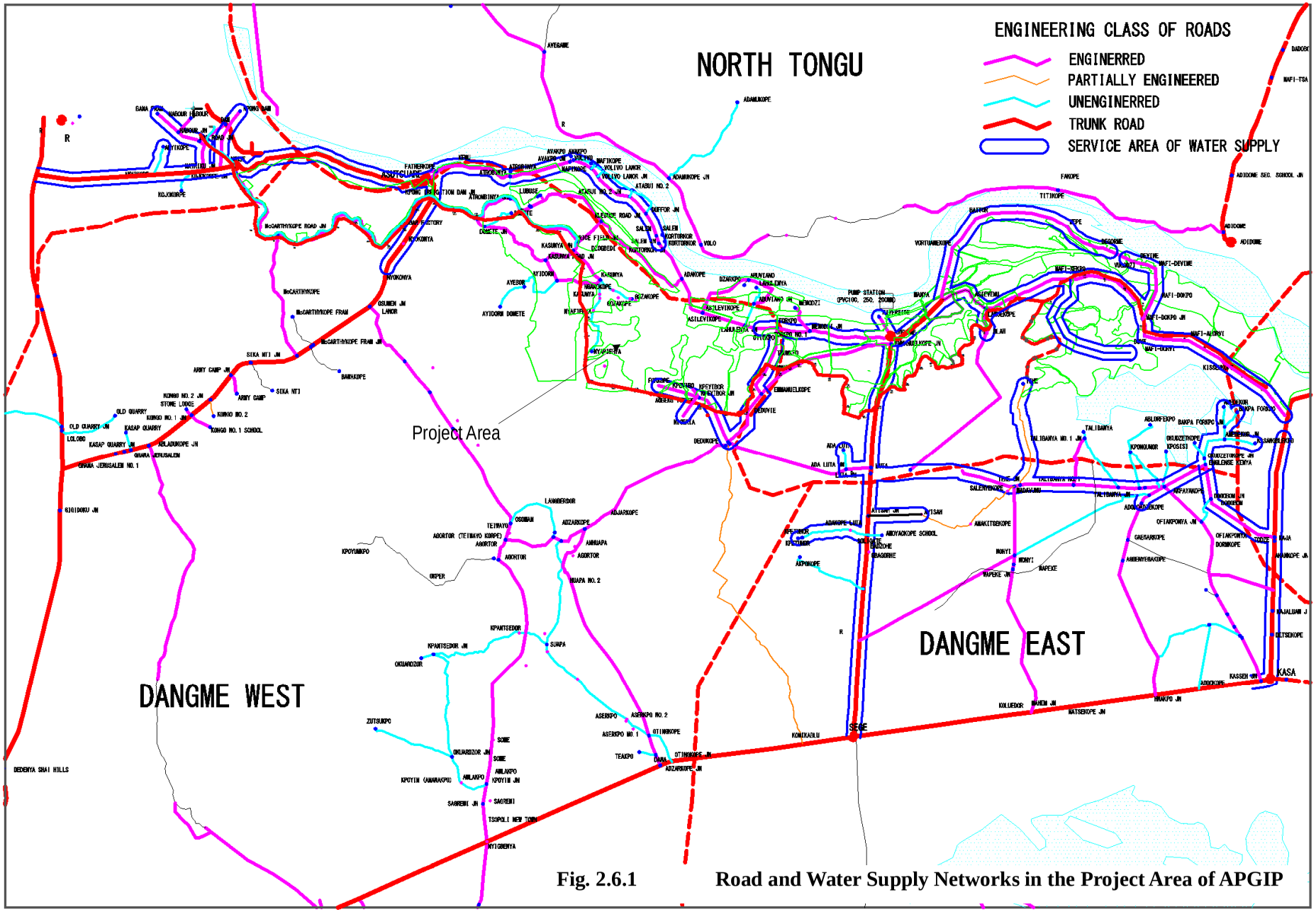


Fig. 2.6.1 Road and Water Supply Networks in the Project Area of APGIP

2.6.3 Electricity

(1) Dangme West District

About 30% of the 231 settlements in the district are linked to the national electricity grid. However, plans are underway for some other communities to be connected within the next 3 years under the Self Help Electrification Project. Most of the major towns in the district are supplied with electricity from the national grid. These include Dodowa, Prampram, Asutsuare, Dawhenya, Afienya, Dorymu, Old Ningo, Kordiabe, New Ningo and Agomede.

(2) Dangme East District

The District has been linked up to the national electricity grid. At present the major communities have been connected to electricity under the Self-Help Electrification Programme (SHEP) and the 1, 2, 3, Programme. About 28 communities have been earmarked for connection under the SHEP 4 programme.

(3) North Tongu

Adidome; Akyemfo, Battor, Mepe, Mafi Kumase Asiekpe and Juapong are currently supplied with hydroelectric power. The extension of electric power to towns and villages outside the District capital is dependent on community self-help, but through the rural electrification programme the lines are being extended and very soon most of the major settlements will have electricity.

2.7 Agriculture

2.7.1 General

Agriculture, crop production and livestock, are the primary economic activities in the project-related districts, and in the North Tongu District, agricultural-sector employment accounted for 71.4% of total employment opportunities in 2000 (2000 Population & Housing Census, GSS, 2005). Crop production in the districts from 2006 to 2008 was as follows.

Table 2.7.1 Production of Major Crops in Project Districts (average of 2006 to 2009)

District	Item	Crop				
		Maize	Rice	Cassava	Pepper	Okro
Dange West	Cropped Area (ha)	731	1,801	1,429	2,274	1,860
	Production (ton)	683	2,269	15,669	4,391	7,330
North Tongu	Cropped Area (ha)	1,341	1,400	2,606	-	-
	Production (ton)	1,619	3,005	23,260	-	-
South Tongu	Cropped Area (ha)	1,384	103	2,293	-	-
	Production (ton)	1,513	158	21,873	-	-
	Average Yield (t/ha)	1.1	1.6	9.6	1.9	3.9

Source: SRID, MoFA

The livestock sub-sector is another important economic activity in the districts

2.7.2 Present Agricultural Land Use

The present land use in the project area was studied at the reconnaissance level based on colour

photographs at a scale of 1/50,000 taken from the air in December, 2010, a ground truth survey, and information provided by KIP and private agri-business firms operating in the project area. The present agricultural land use in KIS and NDIS is estimated as follows:

(1) KIS

Table 2.7.2 Present Land Use of KIS Area

Block/Land Use Category	Area (ha)	%	%	Current Use/Remarks
KIS				
1. Irrigated rice field	1,852	76	43	Currently irrigated rice fields
2. Grass land	448	19	10	Once-developed uncultivated rice field
3. Others	120	5	3	Right-of-way, etc.
Sub-total	2,420	100	56	
Golden Exotics Farm				
1. Banana farm	1,200	63	28	Developed area
2. Upland field	600	32	14	Target area for expansion
3. Others	90	5	2	Right-of-way, etc.
Sub-total	1,890	100	44	
KIS Area (gross)	4,310	-	100	

As shown, KIS covers a total area of 4,310 ha, or about 37% of the whole project area. The irrigated farmland (irrigated rice field & banana farm) accounts for 3,052 ha or 71% of the KIS area. Upland fields occupy 600 ha or 14% of the area, whereas grassland and other land accounts for respectively 448 ha or 10% and 120 ha or 3%. The area of existing irrigated rice fields extends for 1,852 ha, accounting for 43% of the KIS Area, and the banana farm occupies 1,200 ha or 28%. The farm started planting in 2005 and the production of bananas in 2006. The current upland field of 600 ha of the Golden Exotics Farm is scheduled to be developed immediately after the irrigation water supply under the project.

(2) NDIS

Table 2.7.3 Present Land Use of NDIS Area

Block/Land Use Category	Area (ha)	(%)	(%)	Current Use/Remarks
No. 1 Area + No. 2 Area				
1. Upland fields	3,309	55	46	Used for seasonal crop production
2. Grassland	2,562	43	35	Used for grazing
3. Others	113	2	2	Right-of-way, etc.
Sub-total	5,984	100	83	
Prairie Volta Farm				
1. Irrigated rice fields	490	44	7	
2. Upland fields	532	48	7	Used for seasonal crop production
3. Grassland	51	5	1	Used for grazing
4. Others	33	3	-	Right-of-way, etc.
Sub-total	1,106	100	15	
Cassi Farm				
1. Irrigated upland fields	162	95	2	Centre pivot irrigation
4. Others	8	5	-	Right-of-way, etc.
Sub-total	170	100	2	
NDIS (gross)	7,260	-	100	

The gross area of NIDS is 7,260 ha, or about 63% of the whole project area. Irrigated farmland, and irrigated rice fields and upland fields, account only for 490 ha or 7% and 162 ha or 2% of the NIDS Area, respectively. Upland fields occupy 3,841 ha or 53% of the area, grassland occupies 2,613 ha or 36%, and others 154 ha or 2%. The Prairie Volta Farm occupies 1,106 ha or 15% of the area. Upland fields and grassland in the farm is scheduled to be developed as irrigated rice fields from 2011 to 2012. Centre pivot irrigation is introduced in Cassi Farm.

(3) Project Area (Accra Plains Gravity Irrigation/APGIP)

The overall features of the present land use of the project area, comprising KIS and NDIS, are summarized as follows:

Table 2.7.4 Present Land Use of the Project Area

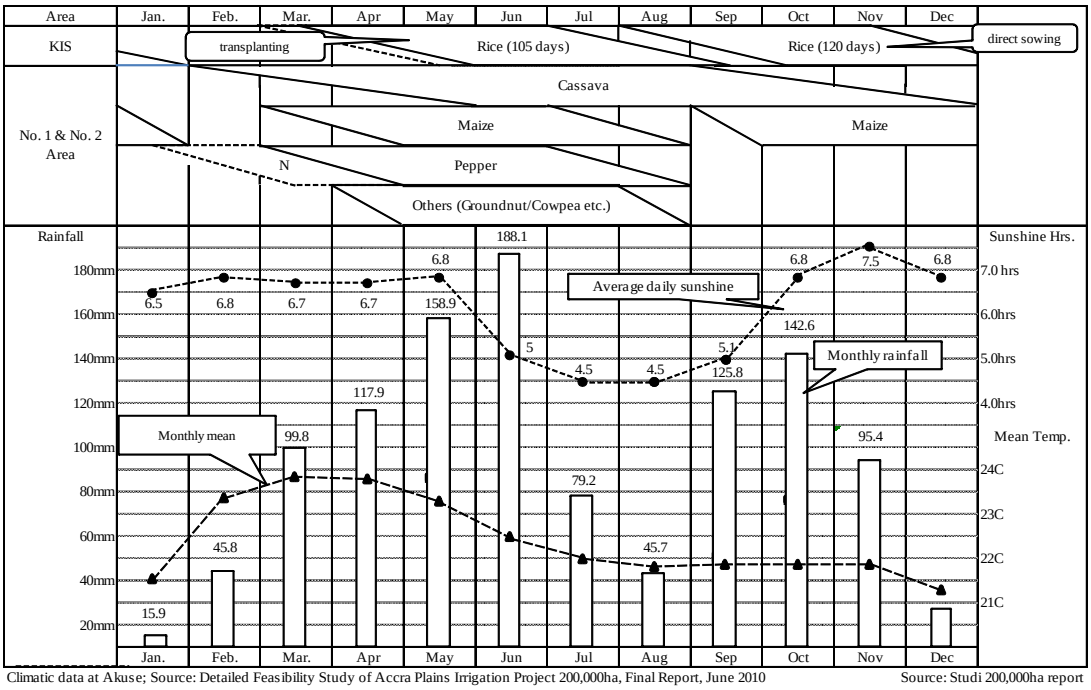
Land Use Category	Area (ha)	(%)	Current Use/Remarks
1. Irrigated rice fields	2,342	20.2	KIS & Prairies Volta Farm
2. Banana farm	1,200	10.4	Golden Exotics Farm
3. Irrigated upland fields	162	1.4	Cassi Farm
4. Upland fields	4,441	38.4	Used for seasonal crop production
2. Grassland	3,061	26.5	Used for grazing
3. Others	364	3.1	Right-of-way, etc.
Project Area (gross)	11,570	100	

The gross area of APGIP is 11,570 ha and the existing irrigated rice fields account for 2,342 ha or 20% of the project area. The banana farm of Golden Exotics Ltd. covers 1,200 ha and accounts for 10% of the area. The largest land use category in the area is upland fields, occupying 4,441 ha or 38%, and the 2nd largest land use category is grassland, representing 3,061 ha or 26.5%. Almost all the land under the two land use categories (upland fields and grassland) will be converted into irrigated rice

fields under the project.

2.7.3 Prevailing Cropping Calendar

The prevailing cropping calendar in the project area is estimated based on the current cropping pattern in KIS, STUDI Report 200,000 ha, and the field survey conducted by the Study Team as follows.



Climatic data at Akuse; Source: Detailed Feasibility Study of Accra Plains Irrigation Project 200,000ha, Final Report, June 2010 Source: Studi 200,000ha report

Fig. 2.7.1 Present Prevailing Cropping Calendar in the Project Area

2.7.4 Crop Production

The present crop productions in the Project Area are estimated by irrigation scheme as follows.

(1) Kpong Irrigation Scheme (KIS) Area

Major crops in the area are irrigated rice in KIS and bananas in Golden Exotic Farm. Double cropping of rice is practiced by small-scale farmers in KIS and the annual cropping intensity is estimated to be 147%. In the Golden Exotics Farm, 1,200 ha of banana estate is established and the annual production is estimated to be nearly 48,000 tons. The majority of products are exported to Europe (France, England, Germany, etc.). Major crops in upland fields are cassava, followed by maize, peppers, cowpeas, and groundnuts. Maize cultivation is reported to be carried out both in major and minor seasons. Productivity of upland crops is low due to traditional subsistence farming and the instability of rainfall distribution. The present crop production in the area is estimated as follows:

Table 2.7.5 Present Crop Production in KIS Area

Block/Land Use Category/Crop	Area (ha)	Cropped Area (ha) [1]	Yield (t/ha)	Cropping Intensity (%)	Production (ton)	Remarks
KIS						Yields estimated based on a sample survey by the JICA Study Team
1. Irrigated rice fields	1,852					
- Irrigated rice/major season		1,274	4.7	69	5,988	
- Irrigated rice/minor season		1.440	4.0	78	5,760	
Annual		2,714	4.3	147	11,748	
Golden Exotic Farm						
1. Banana farm	1,200					
- Bananas [2]		1,200	48	100	48,000	Estimated yield
2. Upland field [3]	600	780	-	130	1,566	Cassava, maize, etc.

[1]: Average of 2006 to 2010; source KIP [2]:Estimated

[3]: Assuming cropping intensity of cassava (50%), maize (30%), and peppers (20%) in the major and maize (30%) in the minor season

(2) NDIS

No irrigation fields except the irrigated rice field of Prairie Volta Farm and centre pivot irrigation field of Cassi Farm exist in the NDIS area. Major crops in upland fields are similar to those in the KIS area and productivities are low. The Prairie Farm was established in 2008 and started rice production from 2010. Rice production in the farm is carried out under a fully mechanized farming system with heavy duty farm machinery, and use of aircraft for cultivation was attempted in 2011. The farm possesses a large-scale rice mill with a paddy processing capacity of 10t/hour. Cassi Farm was started in 2010, and maize and soybeans were cultivated to date. Pepper is another candidate crop of the farm. The crop production features in the area are estimated as follows:

Table 2.7.6 Present Crop Production in NDIS Area

Block/Land Use Category/Crop	Area (ha)	Cropped Area (ha)	Yield (t/ha)	Cropping Intensity (%)	Production (ton)	Remarks
No. 1 + No. 2 Area						
1. Upland field [1]	3,841					
- Cassava/major season		1,922	3.5	50	6,727	
- Maize/major season		1,152	1.2	30	1,382	
- Pepper/major season [2]		768	0.7	20	538	Pepper/others
- Maize/minor season		1,152	1.2	30	1,382	
Annual		4,994	-	130	10,029	
Prairie Volta Farm						
1. Irrigated rice fields	490					
- Irrigated rice/major season		490	4.0	100	1,960	Roughly estimated figure
- Irrigated rice/minor season		490	4.0	100	1,960	
Annual		980	4.0	200	3,920	
Cassi Farm	162	-	-	-	-	Maize/soybesns

[1]: Assuming cropping intensity of cassava (50%), maize (30%), and peppers (20%) in the major and maize (30%) in the minor season

[2]: Represented by pepper

(3) Project Area (Accra Plains Gravity Irrigation Project/APGIP)

The crop production features in the project area, combining the features of the KIS area and NDIS area, are summarized in the following table.

Table 2.7.7 Present Crop Production in the Project Area

Block/Land Use Category/Crop	Area (ha)	Cropped Area (ha)	Yield (t/ha)	Cropping Intensity (%)	Production (ton)	Remarks
1. Irrigated rice fields/rice	1,852	2,714	4.3	147	11,748	
2. Irrigated rice fields/Prairie	490	980	4.0	200	3,920	Estimated figure
Sub-total	2,342					
3 Banana farm	1,200	1,200	40	100	48,000	Estimated figure
Irrigated upland fields	162	-	-	-	-	
Upland field	4,441	5,774	-	130	11,595	

As shown, the primary crops in the project area are irrigated rice and bananas. Compared with the cropped area of some 5,800 ha, crop productivity in upland fields is very limited under the traditional and unstable rain-fed cultivation system.

2.7.5 Prevailing Farming Practices

(1) Kpong Irrigation Scheme (KIS) Area

In the KIS area, irrigated rice cultivation is exclusively practiced under a double cropping system in a major (March to September) and minor season (August to January). In the major season, the transplanting method is the prevailing practice, while in the minor season direct sowing is prevalent primarily because of the limited duration between the two cropping seasons and the shortage of farm machinery for land preparation. Major varieties of rice are Marshall, aromatic rice, and Jasmine. The annual cropping intensity in the area is estimated at 147%, as stated earlier, which is rather low, possibly due to an insufficient water supply, poor drainage, and a limited farm labour force. Further, as the results of the sample survey conducted by the JICA Study Team show, heavy application of fertilizer (over 600kg/ha on average) in the area are reported by sample farmers. In the area, land preparation work is almost exclusively carried out by power tillers.

Based on the results of the sample survey conducted by the Study Team and the information provided by KIP (especially crop budget data), current prevailing rice farming practices in the KIS area are summarized as follows:

Table 2.7.8 Prevailing Rice Farming Practices in KIS Area

Farming Practices	Major Season	Minor Season
Land Preparation	tilling & crossing by power tiller	tilling & crossing by power tiller
Seeding Rate 1/	range: 50 - 146 kg/ha; average: 68 kg/ha	range: 63 - 200 kg/ha; average: 111 kg/ha
Planting Method	transplanting (random planting prevail)	broadcasting in flooded field (pre-germinated seed)
Fertilization 1/	basal, 1st top dressing & 2nd top dressing average: NPK 341, Urea: 147, SA: 176 kg/ha	basal, 1st top dressing & 2nd top dressing average: NPK 302, Urea: 203, SA: 178 kg/ha
Agro-chemical Use	herbicide & insecticide applied	herbicide & insecticide applied
Harvesting	manual	manual
Threshing	use threshing box & manual	use threshing box & manual
Drying	sun drying	sun drying

Source: Sample survey conducted by the JICA Study Team & KIP

(2) New Developed Irrigation Scheme (NDIS) Area

In upland fields in the project area, various crops are cultivated mainly in the major season and partly in the minor season under a traditional, unstable and low-productive rain-fed farming system. Major crops include cassava, maize, cowpeas, groundnuts, and pepper. Land preparation by 4-wheeled tractors under machinery hiring services is common in the area.

Based on Studi Report 200,000ha, prevailing farming practices in upland fields in NDIS are roughly categorized as follows:

Table 2.7.9 Prevailing Farming Practices in Upland Field in NDIS Area

Farming Practices	Prevailing Practices
Cropping Pattern	cassava/maize/pepper/cowpea/groundnut
Land Preparation	plowing/harrowing once by machinery hiring service
Seeding Rate	maize: 25kg/ha (local), pepper: 250g/ha (improved)
Planting Method	manual drilling (maize/cowpea/groundnut), pepper (planting seedling)
Fertilization 1/	proportion of farmers use fertilizer: about 40% (Studi Report)
Agro-chemical Use 1/	proportion of farmers use chemicals: about 40% (Studi Report)
Harvesting	manual
Threshing/Shelling	manual
Drying	sun drying
Yield Level	cassava: 3.5t/ha, maize: 1.2t/ha, pepper: 0.7t/ha (dry)

1/: Volume of fertilizer application appear to be very limited

Source: Studi Report 200,000ha & field survey by the JICA Study Team

(3) Agri-business Farms

The Golden Exotics Banana Farm started planting in 2005 and the harvesting of bananas started in 2006. The production system of the farm appears to be highly advanced; drip irrigation systems are installed and liquid fertilizer is applied through the system.

The development of the Prairie Volta Farm started in 2008 and current yield levels are estimated at about 4 t/ha. Heavy farm machinery is introduced in the farm. In the development of large-scale rice fields, no topsoil preservation has been introduced and lower yield levels than expected are attributed to the removal of topsoil. The Cassi Farm was developed in 2010 and the production of maize, soybeans, and peppers is envisioned under the center pivot irrigation system.

2.7.6 Net Production Value (NPV) under Present Conditions

The crop budgets per ha of farmland in the KIS and NIDS are estimated as shown in Annex D-1. The NPVs (net production values) per ha by land use category and the same by irrigation scheme and irrigation block and are estimated based on the crop budgets as shown in Annex D-2. The NPV under the present condition is estimated at GHC 14.2 million, 5.9 million and 20.1 million, respectively, for KIS, NDIS and APGIP. The same by land use category is as summarized in the following table.

Table 2.7.10 Annual NPV by Land Use Category under Present Condition in the Project Area

Block/Land Use Category	Area	Crop	Annual NPV/ha (GHC)	Annual NPV (GHC'000)
1. Irrigated rice field (KIS)	1,852	Irrigated rice	2,442	4,523
2. Irrigated rice field (Prairie)	490	Irrigated rice	2,440	1,196
2. Banana farm (Golden Exotic) [1]	1,200	Banana	7,404	8,885
3. Irrigated upland field (Cassi)	162	Maize/soybeans	-	-
4. Upland field (NDIS & KIS) [2]	4,441	[1]	843	3,743
5. Grass land [3/]	3,061	Grazing	580	1,775
Total;	11,206		-	20,122

[1]: Estimated [2]: Cassava/maize/pepper etc. [3]: Source – Studi Report 200,000ha

The NPV per ha of grassland used for grazing is estimated to be GHC 580/ha[2] based on the Studi 200,000ha Report.

2.7.7 Farm Economy

Access to farm economic data for the project area was limited to the results of sample survey conducted under the Studi Report 200,000ha.[3] According to the report, the average monthly income of sample farmers (110 samples) is reported to be GHC 333 per month and an annual income of GHC 4,000 per farm household is roughly estimated.

2.7.8 Agricultural Support Services

(1) Agricultural Research

The principal agricultural research institutes in Ghana, which are placed under the jurisdiction of Council for Scientific and Industrial Research (CSIR) of Ministry of Environment, Science and Technology, are as follows:

Table 2.7.11 Agricultural Research Institute in Ghana

Research Institute	Major Research Theme/Activity
Crop Research Institute (CRI)	Cereal, legume, tuber crop, and industrial crop production in the tropical rain forest area (Kumasi)
Food Research Institute (FRI)	Processing, storage, marketing & utilization of farm products (Accra)
Savanna Agricultural Research Institute (SARI)	Production technology, breeding, and farming system in the savannah area (Tamale)
Oil Palm Research Institute (OPRI)	Oil & coconut palm production and processing (Kade)
Soil Research Institute (SRI)	Rational utilization of land, soil management, prevention of desertification (Kumasi)
Animal Research Institute (ARI)	Animal health, husbandry, and livestock management (Accra)
Plant Genetic Research Institute (PGRI)	Study on use & conservation of plant genetic resources (Bunso)

In addition, research activities in cacao, coffee, cashew nut and other nuts are carried out by Cacao Research Institute under Cacao Marketing Board, and agricultural experimental or research activities are conducted by technical directorates of MoFA and national universities.

[2] NPV of grazing land is estimated as follows (based on page 379 of Studi Report 200,000ha):
Grazing NPV for 142,170ha is GHC 41,314,000, assuming 50% of such area consists of grazing land
GHC 41,314 thousand/71,085ha = GHC 580/ha; NPV of grazing land/year

[3] Sample survey on 110 farmers conducted in Dangle West & East, North & South Tongu district

(2) Extension Services

(a) Extension System

The agricultural extension services in Ghana are provided under the jurisdiction of DAES (Directorate of Agricultural Extension Services) of MoFA and field services are carried out by the Regional Food and Agriculture Offices at the regional level and District Agriculture Offices at the district level. Extension services are rendered under a TV (training & visit) system and the services are basically provided by AEA (Agricultural Extension Agent) through FBOs (Farmer Based Organizations). The service area of AEA is called the "operational area" and one AEA is posted in the operational area. The number of farmers per operational area and the extent of each area depend on the characteristics of the region or district.

The envisaged criteria for the deployment of extension staff in the country is as follows:

Table 2.7.12 Deployment of Extension Staff

Area	No. of Operation Areas	No. of Extension Staff Posted
District	2−3 zones, 16−24 operation areas	16−24 AEAs, 2-3 supervisors
Zone	8 operation areas	8 AEAs & 1 supervisor
Operational Area	Service area of AEA	1 AEA

Major activities of AEA include demonstration, farmer training, field guidance/training, a farmer field day and organization of FBO (Farmer Based Organization).

Recently an extension program called "Youth in Agriculture Programme" (YIAP) was launched to encourage participation of youth in agriculture production. YIAP has 4 components: i) crops/block farm, ii) livestock & poultry, iii) fisheries/aquaculture and iv) agribusiness. Under the block farm, YIAP provides tractor service and farm input on interest-free credit. The block farm system was started in 2008 and some 47,000 farmers working 10,000–11,000 ha received the benefits in 2009 and 80,000 farmers working 47,000 ha did in 2010.

(b) Extension Services in the Project Area

The agricultural extension services in the Project area are provided by the Dangme West, North Tongu and South Tongu District Agriculture Offices and KIP (Kpong Irrigation Project). The field level extension services are basically provided by the field extension staff—AEAs—posted in their operational areas. In KIS, both AEAs and KIP extension staff are providing such services. In KIS, a total of 4 extension personnel (3 AEAs and 1 KIP extension staff) are deployed. In the NDIS Area, 2 AEAs and 1 supervisor (SMS/Subject Matter Specialist) from the Dangme West Agriculture Office and 3 AEAs and 1 supervisor from the North Tongu Agriculture Office are posted.

The extension system in Ghana is a TV (Training & Visit) system, and services are rendered through FBOs (Farmer Based Organizations). One AEA covers 6 to 8 FBOs in Dangme West District and 3 FBOs in North Tongu District. The organization structure of the Dangme West District Agriculture Office (District Agriculture Development Unit) is as shown in the following figure.

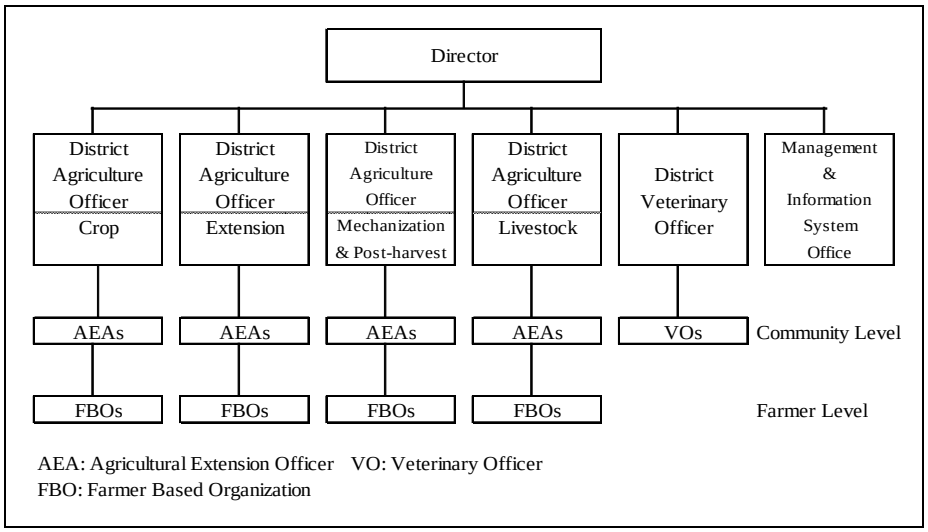


Fig. 2.7.2 Organization of Dangme West District Agriculture Office

Basic extension activities of AEAs include: farmer training, establishment of demonstration fields with farmers, field guidance, formation of FBOs and field data collection. Major constraints for extension services reported by the 2 district offices are: insufficient deployment of AEAs, insufficient budgets for the services, and insufficient transportation means.

(c) Field Extension Services Coverage in & around the Project Area.

The Studi Report for 200,000ha (results of sample survey) indicates the field extension services coverage in and around the project area as follows:

Table 2.7.13 Field Extension Services Coverage in & around the Project Area

Item	Sample Survey Result
Farmers receiving advice from AEA (sample No. 78)	Receiving: 71%, not receiving: 29%
Farmers attending demonstration activities (sample No. 107)	Attending: 53%, not attending: 47%
Frequency of AEA visit (sample No. not known)	Regular: 20%, weekly: 12%, fortnightly: 46%, once a while: 22%

Source: Studi Report 200,000ha

3) Farm Input Supply

(a) Fertilizer & Agro-chemical

In Ghana, fertilizers and agro-chemicals are basically imported and the prevailing channels of such farm inputs are: importer - distributor – distributor's depot/retailer in rural center/town - farmer. In and around the project area there are several retailer shops handling farm inputs in rural centres/towns.

Currently, fertilizers are supplied at subsidized rates to farmers through the rural distributors' depots or retailers. The current subsidized rates of major fertilizers and import volumes of the same in the country are as follows:

Table 2.7.14 Subsidized Prices of Fertilizers & Fertilizer Import

Fertilizer	Non-subsidized Price	Subsidized Price	Fertilizer Import
15-15-15	GHC 56/50kg	GHC 27/50kg	197,600 tons
Urea	GHC 51/50kg	GHC 25/50kg	25,000 tons
Sulfate of Ammonia	GHC 38/50kg	GHC 18/50kg	4,600 tons

[1]: As of April 2011 [2]: Import volume in 2009 (Agriculture in Ghana, Facts & Figures (2009), MoFA

The subsidy will be continuously provided to farming communities in the future in both cases of adopting the project and not adopting the project. The import volume of the three fertilizers amounts to some 227,000 tons in 2009.

(b) Seed Production and Distribution

The seed production and distribution system of grains and legumes in Ghana is illustrated as shown in the following figure.

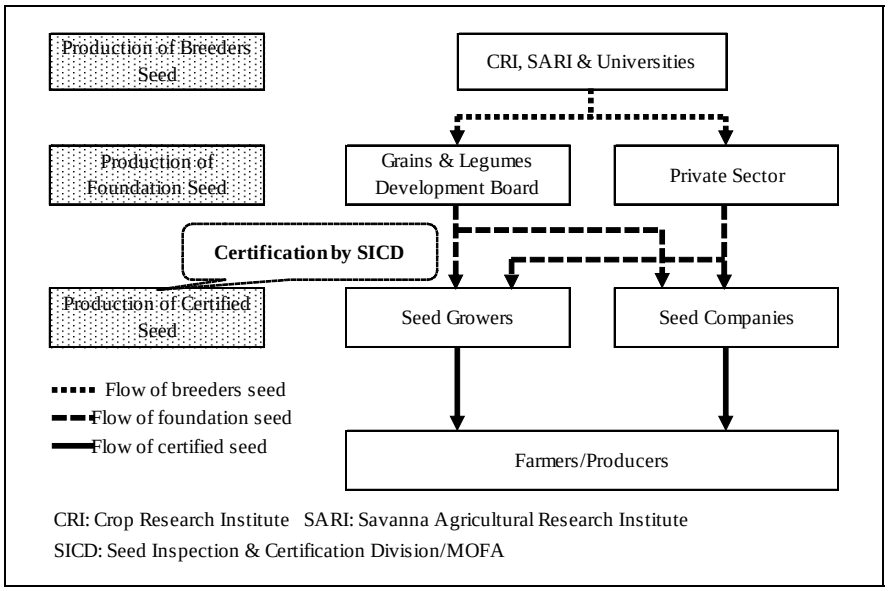


Fig. 2.7.3 Grain & Legume Seed Production & Distribution System in Ghana

In 2010, there were 453 rice seed growers in the country and they produced some 3,900 tons of seeds in 1,650 ha of seed farms. The primary rice seed production region is the Upper West region followed by the Northern Region and Upper East Region. In KIS, there are 13 rice seed growers.

(4) Farm Credit

(a) Credit Facilities

The primary formal lending institutions of farm credit in Ghana are Agricultural Development Bank (ADB) and the rural (& community) banks (RCBs). ADB provides lending services to all farming communities of small holders, large scale and agri-business farms. The bank has 51 branch offices and 13 farm loan office/agencies in the country. In the project area, one farm loan office is established in Asutsuare, and the Tema branch office and Ashaiman agency also cover the area. RCBs are banks

established by rural communities and their main customers are small holders, especially cacao farmers. Currently, there are 130 RCBs in the country. In the project area, a branch of Dangme Rural Bank in Asutsuare, Dangme West District, the head office of Mepe Rural Bank in Mepe, and a branch office of North Tongu Rural Bank in Bottor, North Tongu District are operating farm credit services; however, their farm credit services appear to be rather limited.

The terms and conditions of the farm credit provided by the ADB are as follows:

Table 2.7.15 Terms & Conditions of ADB Agricultural Credit

Eligible groups of credit	Individual, group of individuals, cooperative society, limited liability company
Credit Amount	Short term: long term: GHC 50,000.- or more (negotiable)
Interest rate	Short term credit (< 12 months): base rate 21.95% + processing fee 2%; total 23.95%
	Long term credit (12 months – 3 years): base rate 21.95% + processing fee 2%; total 23.95%
Security/collateral	Necessary (guarantee by guarantee companies cover 75% of credit amount; fee 2.5% of credit amount)
Others	Having account with ADB

Source: ADB, Accra Head Office

The terms and conditions of the farm credit provided by RCBs in the Project area are similar to those of ADB, except for the interest rates. The current interest rate for short-term farm credit of the rural banks operating in the area is 28%.

The accessibility to those formal lending institutions appears to be limited in many cases for small holders, and informal sources for farm credits such as relatives, friends and traders are prevailing in rural areas. Further, an informal saving & credit system called “susu” plays an important role in farm credit in the areas.

(b) Access to Farm Credit in & around the Project Area.

In KIS area, irrigation beneficiary farmers are formed into an agricultural cooperative society and have access to farm credit provided by ABD. However, in the NDIS area, accessibility to farm credit appears to be very limited. The Studi Report 200,000ha (results of sample survey) indicates that the farmers in and around the project area have access to the following farm credit:

Table 2.7.16 Farmers Access to Farm Credit in & around the Project Area

Item	Sample Survey Result
Farmers receiving credit for farming (sample No. 108)	Receiving: 46%, not receiving: 54%
Farmers having access to some form of credits (sample No. 108)	Having access: 46%, no access: 72%
Source of credit (sample No. 50)	Formal institution: 28%, informal institutions: 72%
Use of farm credit (sample No. 51)	Land preparation: 94%, seed/seedling: 78%

Source: Studi Report 200,000ha

As shown, informal institutions are main providers of farm credit in & around the project area as, except for ADB and a few rural banks, commercial banks are not interested in providing credit to farmers and because of stiff conditions to receive credit from formal lending institutions.

2.7.9 Major Agricultural Facilities

Major agricultural facilities in and around the project area include: rice mill, storage facility and drying facilities. The results of inventory on such facilities are as follows:

Table 2.7.17 Agricultural Facilities in & around the Project Area

Place/Owner	Facility	No.	Capacity/Size/Remarks
KIP	Rice mill	3	500kg paddy/hr x 3 units, Yanmar
	Warehouse	2	10,000 tons & 5,000 tons
	Rice dryer	6	500 kg paddy x 3 units
			2,000 kg paddy x 3 units
	Drying floor	45	7.2 x 7.2 m x 45 floors
Prairie Volta Farm	Rice mill	1	10 ton paddy/hr.
	Silo	8	1,500 ton paddy x 8 units = 12,000 tons
Cassi Farm	Silo	4	500 ton grain x 4 units = 2,000 tons
	Warehouse	1	16 x 75 m
Others	Rice mill	32	mostly capacity 500 kg paddy/hr owned & operated by individual

Source: Inventory survey by the JICA Study Team

According to Studi Report 200,000ha, about 54% of sample farmers possess some kind of storage facilities at home. Most common storage facilities they own are traditional ones.

2.7.10 Marketing

(1) Prevailing Marketing System of Paddies & Rice in Ghana[4]

About 65% of rice for consumption was supplied with imported rice in Ghana in 2009/10 (refer to Table 1.1.5). There are many actors in the imported rice commodity chain, such as importers, wholesalers, large-scale consumers including hotels & restaurants, and large & small retailers. Generally, imported rice is sold in big central markets and local or satellite markets. In major cities, where there is demand and the purchasing power is high, the price of rice (imported rice) is high. On the other hand, in rural areas where there is limited demand for rice, the price of rice is relatively low. The consumer preference for taste is fragrant rice, whether it is produced locally or imported, and one of the major criteria making the consumer buy imported rice is its cleanliness. The rapid urbanization in Ghana as well as the growth of per capita income will lead to a rapid increase in rice consumption in the country.

The prevailing marketing channels of paddies and rice in Ghana are reported as follows in the Study on the Promotion of Domestic Rice in the Republic of Ghana, JICA, 2008.

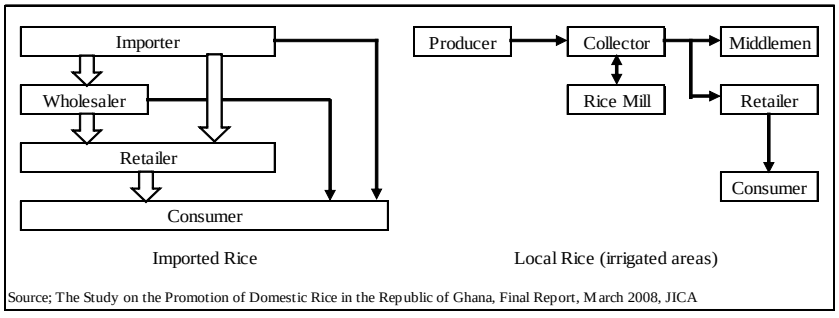


Fig. 2.7.4 Prevailing Marketing Channel of Rice

[4]: Source: The Study on the Promotion of Domestic Rice in the Republic of Ghana, Final Report, March 2008, JICA

(2) Prevailing Marketing System in the Project Area

Traders play an important role in the marketing of farm products in and around the project area. Traders operating in the project area can be categorized into internal traders and external traders. The internal traders are those who reside in & around the area, and the external traders are those coming from outside of the area. Traders generally specialize in the commodities they purchase, such as pepper tomatoes, cassava, and rice. Apart from buying from the farm gate and home, traders purchase products from daily and weekly markets in the area. The price of commodities purchased by them is basically determined by the supply and demand of commodities in particular seasons. Marketing or buying centres in and around the area include Asutsuare, Akuse, Avehime, Mepe and Bottor.

The prevailing marketing channel of paddies in the KIS area is: farmer – traders from Kumasi & Takwa (mostly market women). Traders from Kumasi usually take paddies back to the Kumasi area and mill them there, on the other hand, traders from Takwa mill paddies in the KIS area and take the rice to their places. In the KIS area, there are 32 small rice mills. Milling capacities of the rice mills are mostly around 4 tons of paddies per day. Because of the limited supply of products and the seasonal nature of supply, such mills are operated far below their processing capacities.

Processing of cassava into dough (dried tube) or gari (cassava flour), and pepper to dried & grinded pepper is commonly practiced by producers before marketing. According to Studi Report 200,000 ha, some portions of pepper and okra produced in & around the area are exported through traders. On the other hand, the Natriku Womens Association based in Akuse started trading chilli peppers in 2006 and okra in 2007. The association exports such products on behalf of member producers.

(3) Wholesale Market Prices of Rice

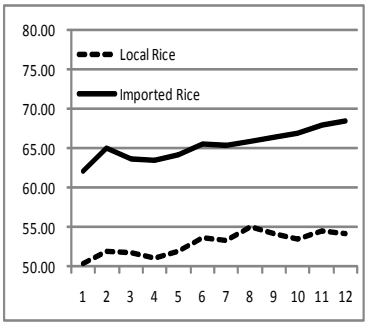
The differences in market prices of local rice and imported rice are reported in the rice market of the country as shown below.

Table 2.7.18 Monthly Average Wholesale Prices of Local and Imported Rice

Unit: GHC/50kg

Commodity	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Local Rice (2010)	52.81	54.03	52.83	52.64	53.36	54.63	54.46	55.76	53.23	53.54	55.55	55.48	54.03
Local Rice (2009)	48.04	49.77	50.70	49.50	50.64	52.89	52.05	54.44	55.06	53.54	53.43	52.89	51.91
Local Rice (2008)	59.71	65.00	61.41	60.85	62.37	62.90	63.90	64.75	65.31	65.02	64.45	64.53	63.35
Imported Rice (2010)	64.48	64.95	65.92	66.15	66.15	68.22	66.92	66.93	67.48	68.77	71.35	72.60	67.49
Imported Rice (2009)	59.71	65.00	61.41	60.85	62.37	62.90	63.90	64.75	65.31	65.02	64.45	64.53	63.35
Imported Rice (2008)	42.97	43.70	45.17	47.54	56.17	59.99	61.79	60.53	60.89	61.92	62.28	61.53	55.37
Average of 2009 & 2010													
Local Rice	50.43	51.90	51.77	51.07	52.00	53.76	53.25	55.10	54.15	53.54	54.49	54.19	52.97
Imported Rice	62.10	64.98	63.66	63.50	64.26	65.56	65.41	65.84	66.39	66.90	67.90	68.56	65.42

Source: : Marketing Services Unit, SRID (MOFA)



Differences of about 20% in the price between local and imported rice are observed in the table. The expected production of quality rice under the project will result in premium prices for rice produced in the project area.

2.7.11 Agricultural Mechanization

The agricultural mechanization in the country has been promoted under the Agricultural Mechanization Centres (AMSEC) program of MoFA (Agricultural Engineering Services Directorate/AESD). Under the program, AESD supply farm machinery to companies or cooperatives that are qualified by the Directorate to be established as farm machinery services providers or as agricultural mechanization centres. The providers will have supplies of tractors, accessories and trailers from the Directorate at subsidized rates. The basic conditions of the supply are:

Subsidy	33% of machinery CIF prices subsidized
Down Payment	50% of machinery prices (50% × 67% of CIF prices)
Instalment Payments	3 to 5 years install payment (50% × 67% of CIF prices)

The program started in 2007 and a total of 84 AMSECs had been established in the country by the end of 2010 and organized into the National Association of Agric Mechanization Service Center Operators (NAAMSECO). In the project-related district of Dangme West, one AMSEC is established.

The number of tractors (mostly medium sized/60-65HP ones) in the project-related districts is reported to be 22 in Dangme West, 4 in North Tongu and 9 in South Tongu (Studi Report 200,000ha).

2.8 Existing Irrigation Systems

2.8.1 Irrigation Systems

(1) Kpong Irrigation Project

(a) Irrigation system

KIS was constructed to supply irrigation water to 1,955 ha in the Asutsuare irrigation scheme and new development area of 1,073 ha in the Akuse area by gravity. The main features of KIS were composed of the irrigation canal construction in the Akuse and the Asutsuare low level and high level areas. The high level area has been cultivated for bananas under the Golden Exotic Ltd. for the last three years.

i) Main supply canal

The main irrigation canal (Akuse main canal) is 16.2 km long and originated from the existing irrigation outlet in the Kpong dam right embankment to the diversion point of the Northern and Southern Lower Level Canals. The canal slope is limited to 1:10,000 due to a limited fall available between the Kpong dam outlet to the tail area. The canal was designed for a full intake water discharge capacity of 7.21 m^3/sec between 0 Km to 2.20 Km, where a major distributaries group is required to serve Branch AK/C2 and the northern part of the Akuse area. There are a total of six branch canal offtakes in the Akuse area. The offtakes are comprised of vertical lift gate cross regulators linked to the check gates (movable weir head regulators). The check gates are located immediately upstream of the six siphons crossing major drainage canals.

ii) Low level canal

The lower level canal is composed of the northern low level canal (NLLC) and the Southern low level canal (SLLC) to supply water to the downstream area of the KIS. NLLC and SLLC are diverted immediately downstream of the Akuse main canal. SLLC is diverted to the Distributaries Y and Z.

iii) High level canal

The high level irrigated area is located at SLLC to supply irrigation water to the elevated area through the high level pump station. The high level area is utilized for the banana estate under the administration of Golden Exotic Ltd.

iv) Night storage reservoir

Night storage reservoirs were constructed in the Akuse and high level areas. In the Akuse command area, night reservoirs are located at the lateral canals of AK/C2, AK/C3, AK/C4 and AK/C5 to hold the total daily irrigation requirements for each lateral canal. During the 12-hour daytime operation, lateral canals draw water from the night storage reservoirs. A total of five night reservoirs were constructed along the high level canal.

v) Lateral canal

The infield layout has been based on the 24 ha standard watercourse unit comprising of 24 paddy basins of 1.0 ha each. Field laterals are designed for 12-hour operation with a standard discharge of 75 lit/sec., which is equivalent to about 1.5 lit/sec/ha over 24 hours.

(b) Beneficiaries and Farmers Organization

The current water users of KIP are categorized into four groups, i.e., small-scale rice farmers (1,852 ha), banana estate (1,200 ha), fish-pond users (28 ha), and vegetable farmers whose farms are out of the project area (40 ha). The majority of the beneficiaries are small-scale farmers holding approximately 2,052 ha, of which the share of land developed is 2,052 ha. As for small-scale rice farmers, residents of the communities of the project area and people from the submerged area of the Kpong dam site were settled and allocated 1 ha of farmland by the land allocation committee of the project.

(c) Organization and Management Structure

The Kpong Irrigation Scheme is managed by KIP, which is a substantial unit of GIDA for project management. Even though KIP was expected to be operated and maintained autonomously in terms of finance at the design stage, the budgetary allocation from GIDA had been continued from the beginning of the project up to now. KIP has four core function units in its administration: project management, field operations, maintenance, and finance and administration. The number of total staff members is 101 in 2010, of which 8 are seconded to GIDA Headquarters.

(d) Operation and Maintenance of Irrigation System

The demarcation of responsibility for operation and maintenance of the irrigation system are as follows.

- The project (KIP): Operating and maintaining the irrigation system from the intake to secondary canals, main and secondary drainage, access road and other major facilities.
- Farmers: Operating and maintaining the lateral canals as well as lateral drainages.
- Banana estate: Operating and maintaining the pump station and irrigation system after the pump.

(e) Services and Activities

The services provided by KIP, apart from the operation and maintenance of irrigation system are as follows:

- Agricultural extension
- Machinery service (Tractor service has been stopped now, but a construction machinery service and caring service are provided to farmers.)
- Facilitation of agricultural credit
- Seed production and sales

(f) Irrigation Service Charge

Irrigation service charge (ISC) is charged to water users and collected by KIP directly based on the contracts between users and KIP. ISC is charged to areas without consideration of crop type; however, the price is decided depending on the purpose and condition of water users, i.e., 120.00 GHC/ha/year for the full irrigable area (in case of small-rice farmers), 39.60 GHC/ha-year for water access out of the commanded area with a pump (in case of vegetable farmers) and 133.00 GHC/ha/year to the aquaculture area (in case of fishery-pond users) individually. ISC consists of a land rent fee, project development fee, irrigations fee, and management fee. As for the banana estate, a concession fee including ISC is charged under the contract with GIDA, and the fee is paid to GIDA. The recovery of ISC is as low as 45% in 2010, which is almost the same as the national average of 53.5%.

The detailed information on the management of KIP is attached in Annex E.1.

(2) Other Irrigation Project

(a) Aveyime Irrigation Project

The project site is a three-hour drive from Accra via Sege. The national road runs from Accra to Sege, and a road with asphalt pavement connects Sege and the site spreading along the lower Volta River. The road condition is good. The scheme is a pump irrigation system completed in 1975. The water source is the lower Volta River. Japan was involved in the initial construction stage, and JICA studied the feasibility of rehabilitation of the project in 1997. The potential area is 120 ha and developed area is 60 ha.

The irrigation system was abandoned because of a breakdown of the pumps in 1998. After that, the

project was rehabilitated by AgSSIP (World Bank program) in 2005. After pumping up irrigation water, it is stored in a night storage reservoir. From the reservoir, the main and secondary canals convey the water by gravity. The major crop is expected to be paddy rice at the beginning of irrigation restart, and in the future, farmers intend to introduce pepper.

Testing of the pump system was done at the beginning of 2011 and minor repair work for the night reservoir and canals are underway at the moment. It is expected to start cultivation in March with 60 ha of paddy fields. Because of the high cost of pump operation, farmers intend to minimize use of pump water. Thus, farmers delay their cropping calendar so that they can utilize rain in April and May as much as possible.

Because AIP has just started irrigation services, ISC has not yet been charged so far. The price of ISC will be decided after ascertaining the results of the first crop. Even though AIP is designed to provide agricultural support services, such as marketing and credit, those services are not in sight so far.

(b) Tokpo Irrigation Project

This project is located at a distance of 10 km to the west of Aveyime. The road is unpaved, with a dirt surface. The potential area is 91 ha, of which 68 ha has been developed by 404 farmers (236 males and 168 females). This scheme was completed in 2005 under SSIDP of AfDB. Unfortunately, the scheme has not yet started irrigation services.

After pumping up irrigation water, it is stored in a night storage reservoir. From the reservoir, the conveyance canal and secondary canals deliver the water by gravity. The conveyance canal connects the No. 1 and No. 2 reservoirs. Major crops are paddies and vegetables.

The project was left uncompleted because of loan expiration. Farmers feel strong indignation with the unfinished situation, because they cooperated with the project by not farming during the construction period. Land levelling work was not conducted. This makes cultivation difficult. Land reclamation is another critical issue. It is not expected that farmers would conduct reclamation where the utilization of cattle for working is uncommon.

(3) Other Large-scale Irrigation Users

Other large-scale irrigation users, which are private large-scale farms, operating in the project area are summarized below. Detailed information on each user is shown in Annex E.2.

(a) Golden Exotics Farm

The Golden Exotics Farm is operated by Golden Exotics Ltd., which is a local subsidiary of a French company named “La Compagnie Fruitiere” (LCF). The Golden Exotics Farm has irrigation land approximately 1,200 ha in KIS and produces bananas for export. The farm takes irrigation water from the secondary canal of KIS by pump. A drip irrigation system is applied over the entire farm. The land of the farm is rented by the government (GIDA) under the concession contract, including the

irrigation system.

(b) Prairie Volta Farm

The Prairie Volta Farm is operated by Prairie Volta Ltd., which is a funded by joint investment between USA and Ghana, of which 30 % was received from the Government of Ghana, 30% from Ghana Commercial Bank, and 40% from Prairie Texas Cooperated. The Prairie Volta Farm operates large-scale rice cultivation with irrigation water taken from the Volta River by pump. The cropped area was 290 ha in 2010, whereas the farm size is approximately 1,300 ha. After pumping up, irrigation water is delivered to each plot by a gravity canal system developed by the farm. The farm is equipped with a large-scale drying-milling-storage facility with a capacity of 60,000 MT/year.

(c) Cassi Farm

The Cassi Farm was established in 2009 as a private company with investment by Ghanaian capital. The farm takes water from the Volta River by pump and delivers it to the fields with a pressurized system, with approximately 2 km from the river to the field. A centre pivot irrigation system, which uses pressured water from the Volta River, is introduced to cultivate maize, soy beans, and vegetables. The irrigated area covered 160 ha in 2010.

(d) Volta River Estate Farm (Site-D)

Volta River Estates Ltd, which has shareholders from Agrofair—a fairtrade organisation from the Netherlands—and other shareholders are from within Ghana. Volta River Estate has 4 banana estates in the Northern and Greater Accra regions, of which the total area is 370 ha. One of the estates, Site-D (120ha), is located next to the KIP project area. The farm takes water from the Volta River by pump and applies it to crops by a micro sprinkler system in the field. Because Site-D is close to the river and the pump is connected to the micro sprinkler system, there is no need for water from KIP or APGIP.

(e) N&D Organic Farms

N&D Organic Farm is a Ghanaian privately-operated company established in 2008, which produces bananas by organic cultivation. The farm is located next the KIP project area. In 2010, 8ha were cropped, whereas the total farm size is 50 ha. Currently, the farm cultivates crops by rain because the irrigation system is under development. Because the farm is close to the Volta River and the elevation of the farmland is high, the farm is planning to install a pump in the Volta River. There is no need for water from KIP or APGIP.

2.8.2 Farmers Organization and WUA

(1) Farmers Organization in Irrigation Project

The farmer’s organization is registered based on the Cooperative Societies Degree, 1968, N.L.C.D. 251and Cooperative Societies Regulations, 1968, L.I. 604. According to the Regulation of GIDA, it is prescribed that all the farmers for each project shall establish a Farmer’s Cooperative Society (Farmers Cooperative). The Farmers Cooperative is required to:

- Reprint its members in all transactions both with private and government agencies concerning the Project.
- Participate in the business of the Management of the Project
- Participate in the operation and maintenance of irrigation facilities, and
- Act as an arbitrator in disputes involving members of the Farmers Cooperative.

As described above, the Farmers Cooperative in the GIDA irrigation project has the role and responsibility as a Water Users Association (WUA) and, in general, WUAs are not established in addition to cooperatives. By organizing all farmers in the project, it is expected that the Farmers Cooperative would play a role in overall farming activity covering crop production and marketing as well as irrigation and water management.

(2) Osudoku Agricultural Cooperative Society Limited

Osudoku Agricultural Cooperative Society Limited (Osudoku Cooperative) was established to organize all farmers in KIS and it was registered based on the Cooperative Societies Decree, 1968, No.252 on 2003. The purposes of the establishment mentioned in the by-laws were:

- To promote unity in all aspects among the family groups on the project
- To assist others in terms of cultivation and marketing of the farm produce
- To promote scientific methods of rice farming
- To educate farmers on the urgent needs and benefits as a farmer
- To liaise between the lateral groups, the branch canals, KIP management, and farmers and the financing bank
- To seek relief service to all farmers on the project

There are approximately 2,500 members of the Osudoku Cooperative, but some of them have retired from farming and only the name remains the same. Joining the Osudoku Cooperative was a condition in the land allocation agreement to obtain farmland in KIS. The Osudoku Cooperative has an executive committee acting as the governing body of the management structure. The executive committee is presently made up of 11 members, consisting of the president, vice president, secretary, vice secretary, treasurer, vice treasurer, two organizers, and three other members. The committee members are elected from the branch canal group. The financial sources of the Osudoku Cooperative are the membership fee and commission on the Osudoku Cooperative marketing of rice. The major roles and activities of the Osudoku cooperative are:

- Implementation of water management (water distribution) under the leadership of Block Leaders and Lateral Leaders,
- Organizing communal work and mechanical work for maintaining lateral canal and drainage,
- Cooperative marketing of rice,
- Facilitation of ADB credit access,

- Group purchasing of agricultural input, and
- Organizing communal work for harvesting.

The demarcation of maintenance of irrigation infrastructure is in such a way that the Osudoku Cooperative would take responsibility for the lateral level canal and drainage, and KIP would be responsible for the remaining matters. Maintenance work at the lateral level is usually conducted in January and June, and is carried out mainly through member's communal work led by the Block and Lateral Leaders. In cases where mechanical work is necessary, the Osudoku Cooperative would rent machinery from KIP.

Currently, no accurate water management is applied in the KIP irrigation system. Lateral blocks within the secondary or branch canal start to take water simultaneously when it is available in the canal. Within the lateral block, farmers take water step-by-step from the lower reach to the upper reach, in principle. There are many cases when farmers face difficulty in following such regulations due to broken or malfunctioning gates, or other problems.

Farmers who benefit from a certain lateral canal have formulated a lateral group, which is a basic unit for the operation and maintenance of the lateral canal. There are approximately 200 Lateral groups in KIS. The Lateral leader is elected by members to manage and lead the lateral group. Several lateral groups gather to formulate a block of laterals and the Block leader is elected. Block leaders are considered as key people for coordinating and adjusting issues on water use and maintenance work among farmers. In the case of occurrences of problems or conflicts, Block leaders have a discussion with the branch canal executive, who is in charge of management at the branch canal level within the Osudoku Cooperative. Branch canal executives participate in PMU meetings at KIP, representing the Osudoku Cooperative and reporting on the irrigation and farming, and on the coordination of the irrigation schedule, maintenance schedule and other services of KIP.

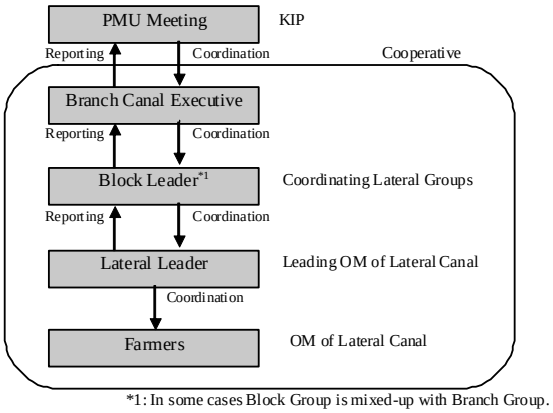


Fig. 2.8.1 Structure of Water Management by Farmer's Participation

The Osudoku Cooperative is currently not even playing the role it was designed to perform, due to:

- Mistrust between the members and their executives
- Executives do not understand the roles and functions of the Osudoku Cooperative
- Executives could not educate members for them to know they are partial owners of the Osudoku Cooperative
- The by-laws of the Osudoku Cooperative were not effectively implemented.

(2) Aveyime Farmers Cooperative and Marketing Society Limited

The Aveyime Farmers Cooperative and Marketing Society Limited (Aveyime Cooperative) was established in 1977 for the Aveyime Irrigation Project, and it was re-organized and registered as it is in 2005 to cope with the rehabilitation project. Because the rehabilitation was just completed this year and farmers are will carry out the first cropping since irrigation was halted 13 years ago, the Aveyime Cooperative has not started full-scale functioning.

The Aveyime Cooperative comprises 90 members. The executive committee, which consists of nine members (the chairman, vice chairman, secretary, treasurer, organizer and another four members), is the managing body of the Aveyime Cooperative.

The demarcation of operation and maintenance is such that the project takes the responsibility for the pump, main canal, main drainage, etc., and farmers take the responsibility for maintenance at the lateral level. Block leaders will be appointed by the Aveyime Cooperative to operate the check gates in the irrigation system. The pump will be operated by the operator deployed by the project. The price of ISC has not yet been decided because neither the project nor farmers have any idea of the cost for running the pump at the moment. The decision is scheduled to be made after the first crop, based on the result of the actual cost.

(3) Tokpo-Noyami Farmers Association

The Tokpo-Noyami Farmers Association was established in 2002 in order to organize the beneficiary farmers of the Tokpo Irrigation Scheme funded by AfDB. Because the project had been stopped during the construction stage, farmers have not started irrigation agriculture yet. The members of the Association are eager to complete the construction and to start irrigation as soon as possible.

2.9 Social and Environmental Conditions

Social and environmental conditions were reviewed based on the Final Report of the Feasibility Study of the Accra Plains Irrigation Project, June 2010, GIDA, STUDI International.

2.9.1 Social Environment

(1) Local Populace

There are three districts in the project area: Dangme East, Dangme West and North Tongu District. The local populace in the project area is made up several ethnic groups. These are Mafis, Dangmes, Krobos, Ewes and Akans.

The predominant ethnic group in Dangme East District is the Ga-Dangme (85.9%). The next largest ethnic groups are the Ewe (5.6%) and the Akan (5.1%). The predominant ethnic group in Dangme West District is the Ga-Dangme (77.8%). The next largest ethnic groups are the Ewe (12.3%) and the

Akan (4.9%). The predominant ethnic group in North Tongu District is the Ewe (90.3%). The next largest ethnic groups are the Akan (5.9%) and the Ga-Dangme (1.3%). There are no indigenous people in the project area.

Most of the settlements in the project area are marked as rural in terms of population and function. The only exceptions to this general classification are Battor (13,203) and Mepe (8,096), which are urban in terms of population and function. Aveyime (7,258) is urban by population but elements of a rural agrarian economy manifest within the spatial configuration, housing characteristics, and economic life of the town.

Table 2.9.1 Population of each District

Name of District	1984	2000	2010*	2030*	Growth Rate (%) 1984-2000
Dangme East	64,135	93,112	117,544	187,322	2.3
Dangme West	63,141	96,809	126,450	215,737	2.6
North Tongu	61,552	130,388	208,442	532,696	4.6

*Projected population are based on 2000 Population and Housing Census

(2) Local Resources

(a) Local Resources

Fuel wood is a major source of energy for cooking among households in the project zone. Rivers, lakes, and creeks in the project's sphere of influence also provide households in the project area with water for domestic purposes. The rivers, creeks, and lakes are sources of fish and water for domestic purposes, and a means of transportation for the local population.

The trees also support the local building industry. In addition, some of the trees and shrubs have medical value. The leaves of *Azadirachta indica* (Nim Tree) are used to cure malaria/fever. Ceiba is used to cure asthma, dysentery and menstrual bleeding, among others. The grass cover also supports livestock production as the grasses such as Brachiaria falcifera provide excellent grazing grounds for herbivores.

(b) Culturally Sensitive Areas (Sacred Groves and Rock)

There are seven culturally sensitive areas within the project area which may be affected by the development of the irrigation fields. Out of the seven, six are sacred groves covering an area of about one acre each, while the remaining one is a sacred rock. Seven culturally sensitive areas are located in North Tongu District. The locations of the culturally sensitive areas measured by GPS are shown in Table 2.9.2.

Table 2.9.2 Location of culturally sensitive areas within the project zone

Culturally Sensitive Areas	Community	Location (by GPS)	
Harmpe (Horpe) sacred grove	Near Kelekor	N: 06.04424	E: 000.44387
Kumi sacred grove (site 1)	Near Kumipo	N: 06.04968	E: 000.43375
Kumi sacred grove (site 2)	Near Kumipo	N: 06.05052	E: 000.43209
Agorgorme sacred grove (site 1)	Near Kelekor	N: 06.03916	E: 000.44828
Agorgorme sacred grove (site 2)	Near Kelekor	N: 06.03915	E: 000.44901
Yafikpo (Anyafoekpo) sacred grove	Near Ntepor (Nyafoekpo)	N: 06.02373	E: 000.43340
Kpedinyi Rock/Stone	Near Bla Botikope	N: 06.03546	E: 000.41091

(3) Public Facilities/Social Institutions

(a) Education

There are public primary and junior high schools within the proposed project area.

(b) Water and Sanitation

The water bodies that are infected with disease vectors serve as a source of drinking water for some households in the project area. Therefore, potable water is supplied to all the communities in the project area.

All the communities in the project area have access to pipe-borne water through community standpipes provided under the Three District Water and Supply Scheme. The project is being implemented by the Community Water and Sanitation Agency in the Dangme West District, Dangme East districts, and North Tongu District.

(4) Economy

Rain-fed farming and fishing are major economic activities.

Fishing is one of the economic activities among the inhabitants of communities along the Volta River. The creeks and lakes provide avenues for fishing and aqua-culture, but currently fish landings from these sources are insignificant due to siltation and invasion caused by aquatic weeds. Traditional methods of fishing including trapping, and the use of cast nets, and hooks and lines.

(5) Public Health and Sanitation

(a) Health Facility

The Catholic Hospital located at Battor is the only health facility in the project area. This specialised facility serves communities within the project's sphere of influence as well as patients from the Accra-Tema metropolis and other settlements on the Accra plains.

(b) Sanitary Condition

Some households drink water from non-pipe sources, such as lakes, creeks and the Volta River. In the rural communities, the use of pit latrines and open defecation are widely practised. The lack of sanitation facilities and the use of natural water bodies for domestic purposes are linked to the incidence of diarrhoeal diseases in the project area.

(c) Major Diseases

The major diseases reported at the Battor Catholic Hospital are malaria, gynaecological conditions, and hypertension. Bio-statistics from the District Health Management Team in Adidome support the high prevalence of malaria, hypertension and gynaecological disorders in the project district. Also, the top ten causes of morbidity in the district include water and sanitary-related diseases such as diarrhoea and worm infestation. The prevalence of HIV/AIDS in the North Tongu district is low (0.69%). The highest prevalence rate ever recorded in the district was 2.69%, in 2004.

2.9.2 Natural Environment

(1) Topography and Geology

(a) Topography

The project lies within the coastal savannah climatic region.

(b) Geology

The Amo and Tefle series are the most dominant soil types in the project area. Clay and sandy clay are the major constituents of these series.

(2) Flora and Fauna, National Park

(a) Flora

The project area is part of the coastal savannah vegetation zone, which is also referred to as the coastal scrub and grass zone. This zone is characterised by grass interspersed with scrubs and short trees. Trees in the project area are the major source of fuel wood (fire wood) for households in the project zone. Charcoal burning is also being undertaken on a small scale by women in the project zone, using off-cuts from these trees. Rare species have not been reported.

(b) Fauna

The following species are likely to be found in the project area. Rare species have not been reported:

Birds:

Bubulcus ibis (Cattle egret), *Corvus albus* (Hooded Crow), *Neophron monachus* (Hooded Vulture), Milvus milvus (Red Kite) and *M. Migrans* (Black Kite).

Mammals:

Xerus erythropus (West African Ground Squirrel), *Cricetomys gambianus* (Giant Rat), *Rattus rattus* (House Rat), *Lemniscomys striatus* (Spotted Grass Mouse) and *Heliosciurus gambianus* (Gambian Sun Squirrel), *Thryonomys swinderianus* (Grass cutter).

Reptiles:

Agama agama (Rainbow Lizard), *Naja nigricolis* (Spitting Cobra), *Dasypeltis fasciatus* (Egg eating Snake), *Bitis arietans* (Puff Adder), *Bufo regularis* (Common Toad).

Fish:

These water bodies have a number of fish varieties, including *Claris Senegalensis (Mudfish)*, *Egeria Radiata* (Oyster) and *Hydrocyon Brevis* (Tiger Fish).

(c) National Park

The project area is not located in a National Park or Protected Area.

(3) Lakes and River system

The project area has a number of water bodies. These include lakes, creeks and seasonal streams. Major water bodies in the project's sphere of influence are the Volta River, Lake Mlangui (Mlangu), Lake Keli, Lake Aklamador (Kumikpo), Lake Blanor (Bla botikope) and Lake Blaque (Bla Botikope). The construction of the Kpong and Akosombo Hydroelectric Dams upstream reduced the tidal level of the Volta River, leaving behind lakes and creeks in a natural depression within the original riverbed. The water bodies are drying up due to the lack of flood water from the Volta River and the declining rainfall.

(4) Climate

(a) Temperature

The average annual temperature for Akuse is 22.4°C. The warmest month is March, with a mean monthly temperature of 23.9°C in Akuse. The coldest month is August, corresponding to the rainy season, with an average temperature of 21.8°C for Akuse.

(b) Rain

The major rainy season is between March and July, while the minor season occurs between September and October. The mean annual rainfall over the period from 1961 to 2007 for Akuse is 1,148.4mm. The maximum and minimum annual rainfalls are 1,961mm (1966) and 563mm (1975) respectively.

2.9.3 Pollution

(1) Water Quality

According to the Environmental Impact study of the Accra plains (5,000 ha), nine water bodies within the project area were sampled to determine the physical, chemical and biological parameters, as baseline data.

In terms of turbidity, four water bodies were within the World Health Organization (WHO) limit of 5 NTU, and five water bodies were above the WHO limit. The levels of ammonia, nitrates, sulphates and phosphates are within the WHO guidelines.

(2) Air quality

According to the environmental impact study of Accra plains (5,000 ha), air quality assessment was carried out at the four settlements within the project area.

A PM_{10} (Particulate Matter) Minivolt Sampler was used, and values between 27.8 $\mu g/m^3$ and 55.6 $\mu g/m^3$, which is within the EPA (Environmental Protection Agency) guideline of 70 $\mu g/m^3$, were measured.

(3) Noise

According to the environmental impact study of Accra Plains (5,000 ha), noise assessment was carried out at the four settlements within the project area.

A Quest Suite Professional high precision integrated/logging sound level meter was used, with measurement results showing that night time noise levels for three sampling points were within the EPA guideline of 48 dB (A). One sampling point was 50.7 dB (A), which is above the EPA guideline.

Chapter 3

Project Planning

Chapter 3 Project Planning

3.1 Constraints for Development

Constraints for development of irrigation and water management are as follows:

- Dependence of agriculture on poor and erratic rainfall.
- Inefficient use of existing irrigation systems.
- High development and running costs of irrigation systems.
- Low productivity on existing irrigation schemes.
- Delay in completion of design and implementation of some large irrigation schemes.
- Low capacity of staff engaged in irrigated agriculture.

3.2 Basic Development Policy

The basic development concepts and some assumptions applied for the project formulation are enumerated as follows:

- The project shall be formulated as an irrigated agriculture development project.
- Proposed target crop for the project is rice with double cropping.
- In order to save energy as well as operation and maintenance costs, a rational irrigation system should be introduced by canal lining and also a gravitational irrigation system.
- Effective use of limited water resources
- Commercial oriented agriculture
- Small scale farmers, medium-large scale enterprise
- Sustainable irrigation project through a modernised management system for effective and easy maintenance work
- Two scenarios for the project development plan for distribution of the project area for commercial and small holders are as follows:

  Scenario 1: 50% of the project area is to be allocated to commercial enterprises and the other 50% is to be allocated to government-organized small-scale farmers.
  Scenario 2: 100% of the project area is to be allocated to commercial enterprises.

3.3 Agricultural Development Plan

3.3.1 Land Use Plan

In the Study, the introduction of double cropping for rice is envisaged in the project area, except for the existing agri-business farms and the areas demarcated for future expansion by the farms. The future land use under the with-project conditions by irrigation scheme—the Kpong Irrigation Scheme (KIS), New Developed Irrigation Scheme (NDIS), and the project (APGIP)—are as follows:

(1) KIS

The future land use of KIS in the case of adopting the project is planned in accordance with the irrigation development plan as follows:

Table 3.3.1 Land Use of KIS in Case of Adopting the Project

Scheme/Land Use Category	With-project Area ha	With-project Area %	Without-project Area ha	Without-project Area %	Changes/Remarks
KIS					
1 Irrigated rice field	2,300	53	1,852	43	increase of 448ha
1 Grassland			448	10	converted to rice field
1 Others	120	3	120	3	right-of-ways etc.
Sub-total	2,420	56	2,420	56	
Golden Exotics Farm					
1 Banana farm	1,800	42	1,200	28	existing banana farm
2 Upland Field			600	14	upland field/newly developed area
3 Others	90	2	90	2	upland field/right-of-ways etc.
Sub-total	1,890	44	1,890	44	
KIS Area Total (gross)	4,310	100	4,310	100	

Under the project, the area of irrigated rice fields will increase by 448 ha to 2,300 ha upon the conversion of currently uncultivated rice fields into irrigated fields. Further, a new banana farm covering 600 ha is planned to be developed by converting upland fields, bringing the total area for banana farms to 1,800 ha.

(2) NDIS

The future land use in the NDIS in the case of adopting the project is planned in accordance with the irrigation development plan as follows:

Table 3.3.2 Land Use in NDIS in Case of Adopting the Project

Scheme/Land Use Category	With-project Area ha	With-project Area %	Without-project Area ha	Without-project Area %	Changes/Remarks
1 Irrigated rice field	5,687	78			newly developed rice fields
2 Upland Field			3,309	46	converted to rice field/right-of-ways
3 Grassland			2,562	35	converted to rice field/right-of-ways
4 Others	297	4	113	2	right-of-ways etc.
Sub-total	5,984	82	5,984	82	
Prairie Volta Farm	with & without		Present		
1 Irrigated rice field	1,051	15	490	7	existing & new irrigated rice fields
2 Upland Field			532	8	converted to rice field/right-of-ways
3 Grassland			51	1	converted to rice field/right-of-ways
4 Others	55	1	33	0	right-of-ways etc.
Sub-total	1,106	16	1,106	16	
Cassi Farm	170	2	170	2	irrigated upland field 162ha & others 8ha
NDIS Area Total (gross)	7,260	100	7,260	100	

As shown in the table, the development of 5,687ha of irrigated rice fields is envisaged under the project by converting upland fields and grassland. No land use changes are assumed in Prairie Volta Farm and Cassi Farm, regardless of whether the project is adopted or not, as the land use at the farms

under the project are the same as the future land use planned without the project. In the Prairie Volta Farm, the irrigated rice fields are scheduled to be expanded by 561 ha from 2011 to 2012, bringing the total area of rice fields to 1,051 ha in the case of adopting the project.

(3) Project Area

The overall features of the future land use of the project area in the case of adopting the project are as follows:

Table 3.3.3 Land Use of the Project Area in Case of Adopting the Project

Scheme/Land Use Category	With-project Area ha	With-project Area %	Without-project Area ha	Without-project Area %	Changes/Remarks
1 Irrigated rice field	7,987	69	1,852	16	KIS, No. 1 Area & No. 2 Area
2 Irrigated rice field /Prairie	1,051	9	1,051	9	no change from without-project condition
Sub-total	9,038	78	2,903	25	
3 Banana farm	1,800	16	1,200	10	expansion of 600ha
4 Irrigated upland field	162	1	162	1	no change from without-project condition
5 Upland Field			3,777	33	converted to rice field
6 Grassland			2,958	26	converted to rice field
Sub-total	1,962	17	8,097	70	
Project Area (net)	11,000	95	11,000	95	project net area
7 Upland/Grassland			206	2	converted to right-of-ways
8 Others	570	5	364	3	right-of-way etc.
Project Area (gross)	11,570	100	11,570	100	project gross area

Under the project, the development of 6,135ha of new irrigated rice fields is planned and the total area of rice fields will be expanded to 9,038ha, including 1,852ha of existing rice fields in KIS and 1,051ha of rice fields in the Prairie Volta Farm, part of which are to be developed even if the project is not adopted. In addition, 600ha of banana farm will be developed in the Golden Exotics Farm under the project, as mentioned earlier.

3.3.2 Target Crop & Planned Cropping Pattern

(1) Target Crop

As a basic development plan, the double cropping of irrigated rice in the irrigation schemes is envisioned under the present study based on the following reasons.

- Rice imports in Ghana in 2009 reached about 384,000 tons. An expansion of rice imports is projected due to the increase of per capita rice consumption because of the progress of urbanization, income growth, and population growth. The production of domestic rice under the project will significantly contribute to food security in the country and to foreign currency savings.
- Most soil in the project area is very suitable for rice compared with other crops, as discussed in section 2.4. The suitability of soil for other crops, upland crops and vegetables, is low because of the clay texture and wetness hazard.

- No serious constraints are anticipated in the marketing of products (paddy & rice) because of

increasing demand for rice and the huge import volume of rice, and because of the non-perishable nature of the products.

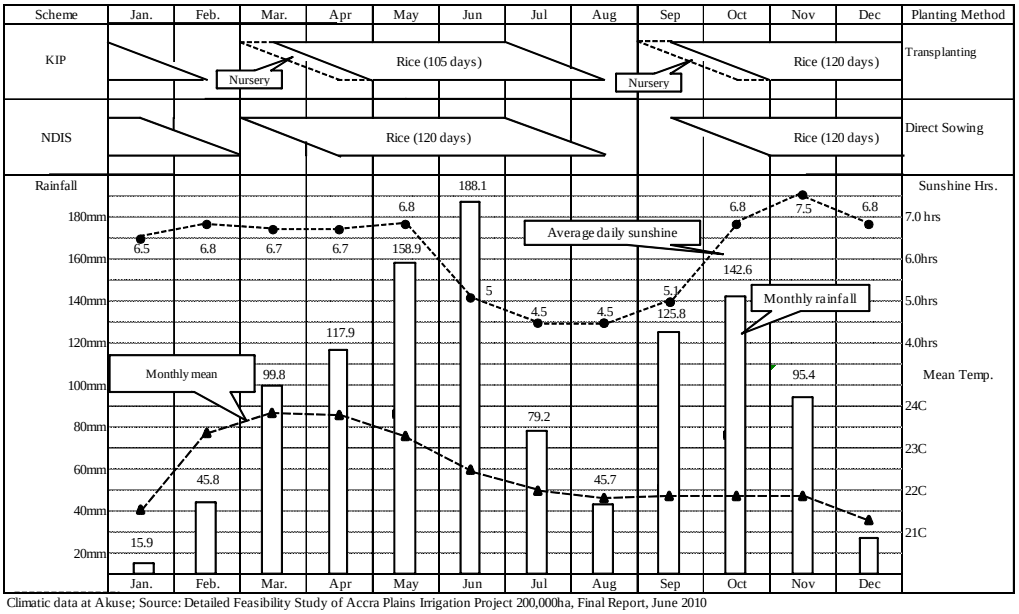
- In the KIS scheme, the double cropping of rice is successfully practiced.

The target crop was selected to formulate a basic development plan; therefore, for the final crop selection in the project area, the intentions of beneficiaries, farmers and private sectors, should be duly considered. Further, there are some discrepancies between the land evaluations of Studi Report 200,000ha and Studi Report 5,000ha. A detailed soil study is required in the F/S Study to finalize crop selection for the project.

In the existing agri-business farms, the crops selected for future production by individual farms are expected to be bananas at Golden Exotics; maize, soybeans, etc. at Cassi Farm; and irrigated rice at Prairie Volta Farm.

(2) Planned Cropping Patterns

The planned cropping patterns of double cropping of rice in the irrigation schemes are as illustrated in the following figure.



Climatic data at Akuse; Source: Detailed Feasibility Study of Accra Plains Irrigation Project 200,000ha, Final Report, June 2010

Fig. 3.3.1 Planned Cropping Patterns

3.3.3 Proposed Farming Systems

As discussed in the development concepts, crop production in the newly irrigated areas will be carried out by three types of farms: small-scale, medium-scale, and large-scale farms. The basic farming system is the same in all three types and the double cropping of irrigated rice is envisaged as shown in the proposed cropping pattern. However, the proposed farming systems could be categorized into small-scale, medium-scale, and large-scale farming systems in line with the different farm mechanization levels as follows:

Table 3.3.4 Proposed Farming System

Farm Size	Producer/ Operator	Farming System/Mechanization Level	
		Cropping Pattern	Farming Practices
KIS (small-scale)	Individual	Double cropping of rice in major & minor season	Transplanting/partially mechanized (land preparation)
Small-scale	Individual		Direct sowing/partially mechanized (land preparation/ harvesting)
Medium-scale	Individual		Direct sowing/moderately mechanized (land preparation /harvesting/others)
Large-scale	agric-firm		Direct sowing/highly to fully mechanized

In the KIS, it is assumed that the existing farming system and production practices will be continued in the case of adopting the project (transplanting/partial mechanization).

3.3.4 Crop Production Plan

(1) Target Yields

The target yields of irrigated rice under the project were estimated based on the current and/or target yield levels of the KIS, Ashaiman Irrigation Scheme, Prairie Volta Farm, and the potential yield estimated by MoFA. Such reference yield levels are as shown in the following table.

Table 3.3.5 Reference Yield Levels of Irrigated Rice

Place/Source	Source	Yield Level
Ashaiman Irrigation Project (small-scale farm/transplanting)	Target yield of the Project	5.5 t/ha (major & minor season)
KIS (transplanted farms) (small-scale farm)	Sample survey major season yield level [1]	3.7–8.9 t/ha (avg. 4.7 t/ha)
	KIS yield survey (appeared to be yield levels of advanced farmers)	5.8 t/ha
Prairie Volta Farm (large-scale)	Maximum yield level in the 1st year after development	5.4 t/ha
(direct sowing)	Target yield of the Farm	5.0–6.0t/ha
MoFA [2]	Potential yield	6.0 t/ha

[1]: Results of sample survey by the Study Team [2]: Source: Agriculture in Ghana, Facts & Figures (2009), MoFA

The target crop yields at the full development stage are planned by irrigation schemes on the basis of the yield levels stated above as follows:

Table 3.3.6 Target Yields under the project

Scheme	Crop	Planting Method	Season		Remarks
			Major	Minor	
KIS (small-scale farm)	Irrigated rice	Transplanting	5.5 t/ha	5.5 t/ha	Paddy yield
NDIS - Small-scale Farm	Irrigated rice	Direct sowing	5.0 t/ha	5.0 t/ha	Paddy yield
- Medium-scale Farm	Irrigated rice	Direct sowing	5.5 t/ha	5.5 t/ha	Paddy yield
- Large-scale Farm	Irrigated rice	Direct sowing	6.0 t/ha	6.0 t/ha	Paddy yield
Banana Estate*	Bananas	Annual: 40t/ha (current yield level)			
Cassi Farm*	Maize/soybeans		Not available		
Prairie Rice Farm*	Irrigated rice	Direct sowing	5.5 t/ha	5.5 t/ha	Paddy yield

*: crop yields estimated by the farms

(2) Crop Production Plan

The planned cropped areas by irrigation scheme (double cropping of irrigated rice) and the crop

production plans in the case of adopting the project are estimated based on the cropped area and target yields are shown in Annex D-3 and are summarized as below.

Table 3.3.7 Crop Production Plan in the Project Area

Crop	Area (ha)	Cropped Area (ha)	Yield (t/ha)	Production (ton)
Irrigated rice [1]				
KIS	2,300	4,600	5.5	25,300
NDIS	5,687	11,374	-	61,703
- Small-scale Farm	2,844	5,688	5.0	28,440
- Medium-scale Farm	853	1,706	5.5	9,383
- Large-scale Farm	1,990	3,980	6.0	23,880
Total	7,987	15,974	-	87.003
Bananas (Golden Exotics Farm) [2]	1,800	1,800	40	72,000
Irrigated rice (Prairie Volta Farm) [1]	1,051	2,102	5.5	11,561
Upland crops (Cassi Farm)	162	-	-	-

[1]: paddy production [2]: banana production

(3) Incremental Crop Production

Under the Project, the production increase of some 75,300 tons of paddies, or 48,900 tons of rice, is expected at the full development stage. The production volume accounted for about 8.5% of national rice consumption in 2009/10 and for 13% of rice imports in Ghana in the same period (refer to Table 1.1.5). When the volume of imported rice in Ghana could be reduced by the said incremental production volume, the expected savings of foreign currency will amount to US$25.6 million (estimated based on the import parity price of rice applied in the economic evaluation in Chapter 8). The production increase for bananas is estimated to be 24 thousand tons. However, the decrease of some 10,000 tons of upland crops compared to the case of not adopting the project due to the conversion of land use to rice fields is estimated. The incremental crop production under the project is estimated as shown in the following table.

Table 3.3.8 Incremental Crop Production under the Project*

Crop/Area	With-project		Without-project		Increment	
	Cropped Area (ha)	Production (ton)	Cropped Area (ha)	Production (ton)	Cropped Area (ha)	Production (ton)
Irrigated Rice						
KIS	4,600	25,300	2,714	11,748	1,886	13,552
NDIS	11,374	61,703			11,374	61,703
- No. 1 Area	5,076	27,537	-	-	5,076	27,537
- No. 2 Area	6,298	34,166	-	-	6,298	34,166
Project	15,974	87,003	2,714	11,748	13,260	75,255
Irrigated Rice (Prairie)	2,102	11,561	2,102	11,561	0	0
Bananas	1,800	72,000	1,200	48,000	600	24,000
Upland Crops	-	-	5,082	10,202	-5,082	-10,202

*: No production changes are assumed in Prairie Volta Farm between with the cases of adopting the project and not adopting it

3.3.5 Net Production Value (NPV) in Case of Adopting the Project

The crop budgets per ha under the project in KIS and NIDS are estimated as shown in Annex D-4 and

5. The financial NPVs (Net Production Values) per ha by land use category and the same by irrigation scheme and irrigation block are estimated based on the crop budgets as shown in Annex D-6 and the incremental NPV in both the cases of adopting the project and of not adopting it are estimated as shown in Annex D-7 and summarized as follows:

Table 3.3.9 Incremental Financial NPV between W/P & W/O

Unit: GHC '000

Scheme	Under Project NPV [1/]	W/o Project NPV	Incremental NPV
KIS	24,579	14,044	10,535
NDIS	31,055	7,233	23,822
- No. 1 Area	12,208	1,545	10,663
- No. 2 Area	18,847	5,688	13,159
APGIP	55,634	21,277	34,357

[1/]: NPV at full development stage & onward

As shown, the incremental net production value under the project amounts to GHC 34.4 million at the full development stage (2022). The NPV attained in the project area under the project will reach about 2.6 times the amount of the present NPV in the Project area. The NPV, excluding NPVs of private firms in the Area, is expected to be 4.4 times the amount of the present NPV (GHC 38.6 million & 8.7 million, respectively).

3.4 Irrigation and Drainage Plan

3.4.1 Water Resources Development Plan

From 2008 to 2010, a feasibility study on 5,000ha of the first priority area in the Accra Plains Irrigation Project by a pumping irrigation system has been conducted under the assistance of the Kuwait Fund. According to the study results, the project cost will be more than 20,000 US$/ha which is too high an investment cost for irrigation. The Accra Plains Gravity Irrigation Project is proposed, aiming to provide an alternative or countermeasure plan to the development of Accra plains by comparing with the above-mentioned pumping irrigation system. Accordingly, the water resource for the gravitational irrigation system has been proposed to use/intake water directly from the existing Kpong Dam Reservoir on the basis of an agreement from VRA. The advantages of using/intaking water from the reservoir are that an EL of 15.0 m—sufficient for gravitational irrigation to reach the first priority area—can be maintained by the pumping irrigation of APIP and that clear irrigation water with no suspended material can be obtained due to the large-scale de-silting basin in the Akosombo dam and Kpong dam. The clarity of the water will be more than 1 meter and there is no need for countermeasures to sedimentation.

In accordance with the results of the first discussion with VRA and GIDA on October 1, 2010, on the intake of irrigation water for irrigation from the Kpong dam reservoir, the following 3 items have been agreed between both authorities.

(1) The rate of intake of irrigation water directly from the right bank of the Kpong reservoir shall be

about 10 m^3/sec for the new irrigation scheme.

(2) The intake structure shall be designed carefully, to secure safety at the point where the intake crosses the Kpong dam and to prevent water leaking, on the basis of approval from VRA.

(3) The present intake capacity of 7.2 m^3/sec shall be utilized to the maximum (at present water intake is only 3.5 m^3/sec).

Based on the above-mentioned meeting, three alternative plans were considered, and the second meeting was held on March 1, 2011, at the VRA engineering office in Akuse. At the meeting, the two authorities discussed the following four matter and reached agreement regarding them.

(1) The level of new water intake for NDIS was set at EL.14.8m, which is the same level as the irrigation scheme in the left bank.

(2) In order to prevent dam-body cutting, the location of a new intake was selected at about 100 m outside of the dam body abutment on the right bank side.

(3) The maximum intake capacity was set at 11.3 m^3/sec based on the irrigation acreage and water requirement analysis.

(4) As for the existing Kpong Irrigation Scheme, the rehabilitation of the main canal by lining it with concrete and the expansion of the area of paddy fields and the banana farm were agreed upon to reduce water loss and maintenance cost for effective utilization of the water. The proposed intake capacity for KIS is estimated to be 7.2 m^3/sec, considering the expansion of paddy fields and the banana farm. As the result, the total intake capacity from the existing Kpong dam will become 18.5 m^3/sec.

The VRA basically consented to these conditions and both authorities signed an agreement. The agreement is shown in Annex B.

At the meeting, VRA requested GIDA to calculate the annual average water intake from the Kpong dam, as the average intake discharge will affect the opportunity cost of hydro-electric generation in the Kpong hydropower station. Also, VRA suggested that GIDA study daily water level fluctuation in the reservoir, as it affects water intake capacity from the dam. VRA provided daily water level data of the Kpong Reservoir from 1984 to 2010.

The third meeting was held on April 4, 2011, at the VRA engineering office at Akuse. Half-month water requirements have been analyzed using Avayime daily rainfall data from 1990 to 2010. Careful study has been made to finalize irrigation acreage for KIS (4,100ha) and NDIS (6,900ha). Annual average intake capacity during that 21 year period for KIS and NDIS has been estimated. Based on the daily average intake discharge from the Kpong dam, the opportunity cost of hydro power generation has also been estimated.

Table 3.4.1 shows the peak intake capacity, the annual average intake capacity, and opportunity cost of hydropower generation of the Kpong Reservoir as the major water resources of APGIP.

Table 3.4.1 Water Intake Capacity from Kpong Dam

Irrigation Scheme	Net irrigation area (ha)	Peak discharge (m^3/sec)	Annual Ave. intake volume (1000 m^3)	Annual average discharge (m^3/sec)	Reducing hydropower generation (MWH/year)	Opportunity cost (GHC × 1000/year)
KIS	4,100	7.151	79,739.	2.528	2,370	78.2
NDIS	6,900	11.382	158,603.	5.029	4,714	155.6
Total(APGIP)	11,000	18.533	238,342.	7.558	7,084	233.8

3.4.2 Potential of the Norboyita Dam

Crossing the Norboyita River along the route of the main canal is the most difficult issue in the project, because the catchment area of the river is about 100 km^2 and a tributary with a 110 km^2 catchment area joins the Norboyita River. The flood pain of the river spreads about 2 to 3 km wide. The water surface elevation of the proposed main canal is estimated to be about 12 m starting from the Kpong dam intake (EL 14.8 m), and the canal is about 30 km, running on a slope of 1:15,000. In order to reach the main canal up to the first priority area and the Prairie Volta area, the canal slope should be kept as gentle as possible to save water losses caused by siphoning and the structure should be checked. Because the main canal length is estimated to be more than 60 km and the elevation difference between the intake site (EL 14.8 m) to the first priority area (EL 10.0 m) is estimated to be only about 4.8 m, the average slope of the canal is estimated to be 4.8/60,000 = 1/12,500. It is necessary to consider how to cross the river by comparing siphoning and aqueduct. In the case of siphoning, there is more water loss than aqueduct. In order to adopt the aqueduct method, it is necessary to provide a sufficient cross section area to be able to pass the flood peak discharge of the river under the main canal aqueduct. The flood peak discharge can be estimated by

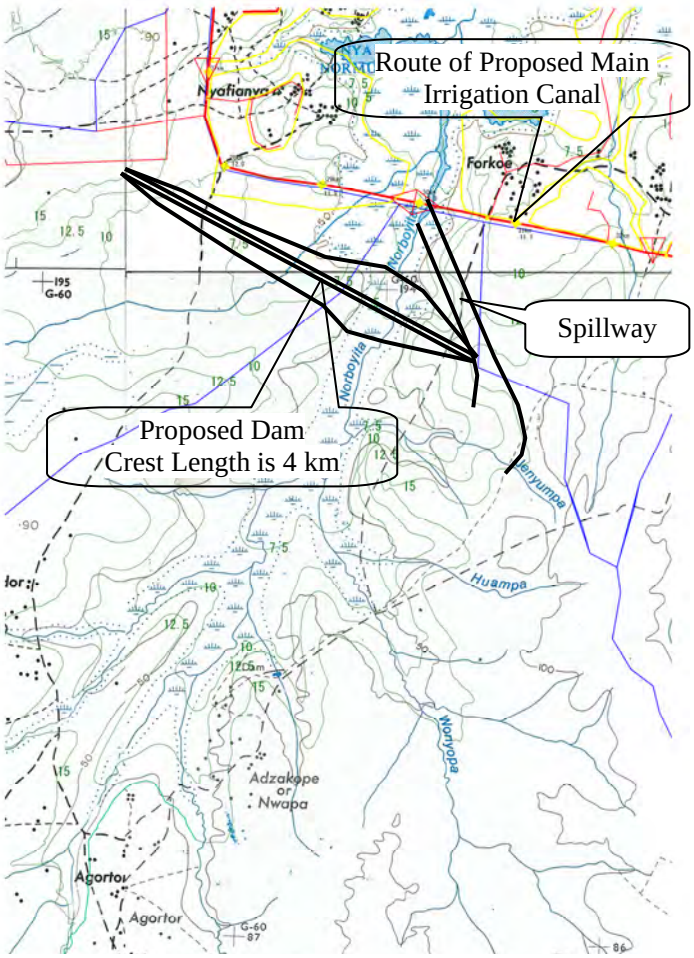


Fig. 3.4.1 Location Map of Norboyita Potential Dam Site

following the simplified equation from Figure 12-19: Flood Q10 (m^3/sec)/Francou-Rodier, p. 246, F/S 5,000ha Q10 = 0.35 × A, where Q10 is the 10 year return period flood discharge (m^3/sec) and A is the catchment area (km^2). The catchment area at the crossing point of the river is 210 km^2, and Q10 = 0.35 × 210 = 73.5 m^3/sec.

It is necessary to secure the safety of the proposed aqueduct with respect to flood discharge, and also to conduct river course training work to excavate a river channel to connect to the Volta River. The total length from the crossing point of the main canal to the Volta River is about 3 km.

On the other hand, an alternative option would be to construct a flood protection dam upstream of the main canal crossing point in order to store flood peak discharge. In the 1/50,000 topographic map, the narrowest point for dam construction is only about 500 meter wide on the dam embankment at the elevation of 15.0 m. However, according to the latest obtained DTM topographic map surveyed in 2010, the narrowest point of EL.15.0 becomes very wide, 4 km, as shown in the above figure. The height of the dam is estimated to be about 12 m. Accordingly, dam construction is considered to be much more costly than the river training work, therefore the dam construction plan is not recommended.

With regard to the siphon method, irrigation water from the Kpong Dam is very clear and the main canal is lined by concrete, so that no sediment load will be expected in the siphon area. In the case of an emergency, the siphon section is large enough, about 2 × 2 m with double sections, to be cleaned manually. The length of the siphon, 500 m, is sufficient to cross the river, and both sides of the approaches can be embanked with protection by riprap. Stone pitching can be used to protect that part of the siphon of the river section from flood damage.

3.4.3 Comparison of Three Development Plans

Basically the gravitational irrigation system should be introduced with deep consideration given to the reduction of energy consumption for sustainable irrigation system operation and management. Hence, the canal should be lined to make maintenance work easier. Drainage improvement and keeping the outlet of the river course to the Volta River should be considered. It is necessary to provide farm roads for effective farming activities and secure market accessibility.

The proposed irrigation scheme can be named “Accra Plains Gravity Irrigation Project” (APGIP).

(1) New Intake Capacity and Alternative Study

The following three options have been compared among the existing KIS with and without the improvement of the existing main canal and the new development area of NDIS.

Case 1: New development area (NDIS) only, excluding existing KIP

Case 2: New development area (NDIS) and improvement of KIS by concrete lining of the main canal.

Case 3: Combined plan of new development area (NDIS) and KIS, as one new main canal and existing KIP intakes and canals are abundant.

The proposed options are shown in the following Fig.3.4.2.

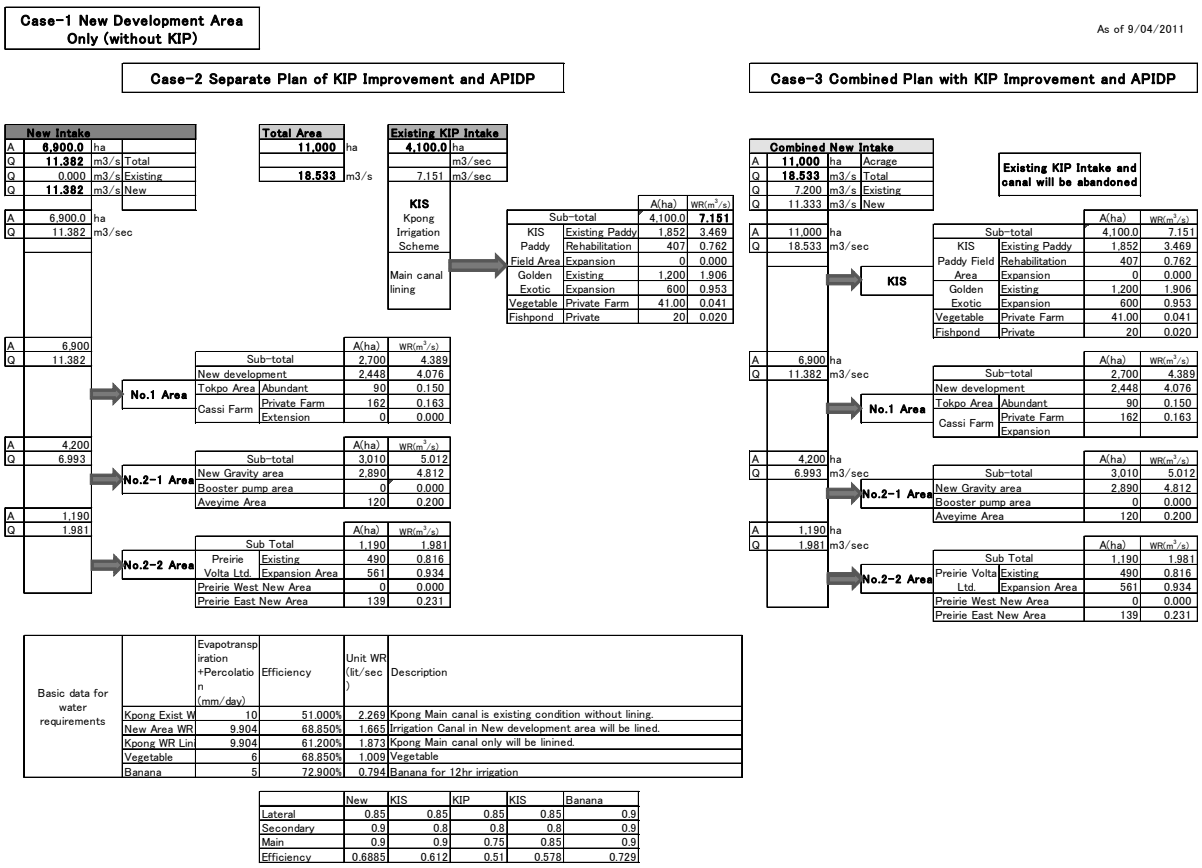


Fig. 3.4.2 Comparison of the Development Plan

Case-1 will not be accepted by KIS beneficially as well as GIDA, because there are so many places to be rehabilitated in KIS. Also, it is necessary to reduce water loss and maintenance cost of the main canals by concrete lining.

From the viewpoint of Environmental and Social Considerations (hereinafter called “ESCs”), farmers in NDIS can receive benefits from irrigation development, but farmers in the existing KIS may not receive benefits from irrigation development. Therefore, misdistribution of benefits may occur

Case-2 is a separate plan of existing KIS and a new development area. The existing KIS is rehabilitated as a single system, and is accompanied by development of a new intake for NDIS. This plan will be the best plan to utilize the existing KIS intake and main canal while minimizing water loss from the main canal and maximizing irrigation acreage by concrete lining. A new intake site can be proposed, separate from the existing KIS intake, at the outside of the Kpong Dam body.

From the viewpoint of ESCs, farmers in both NDIS and existing KIS can receive benefits from irrigation development. Therefore, benefits can be distributed equally

Case-3 will make the management of the irrigation system easier by unifying the existing KIS and NDIS as one new development area. But it would be a great waste to abolish the existing KIS intake and main canal, which were constructed in 1983 and 1998, respectively.

From the viewpoint of ESCs, farmers in both NDIS and the existing KIS can receive benefits from

irrigation development. However, existing KIS facilities, such as water intake and the main canal, need to be abolished. In this case, construction waste will be generated. Thus, Case 3 has a greater negative impact than Case 2.

Case	Advantages	Disadvantages
Case-1	Simple and easy OMM	KIS left behind.
Case-2	Activate KIS by rehabilitation Save water by lining canal Save OM costs	Double irrigation canal system should be constructed. Cost will be high.
Case-3	One irrigation system with single canal system makes OMM easy. Construction costs will be reduced by construction of a single canal.	Existing KIS intake and main canals should be abolished. Existing KIS facilities were constructed 12 years ago, and facilities can still be used by rehabilitation.

In order to activate and effectively utilize the existing KIS, the main irrigation canal should be lined so as to reduce water loss as well as operation and maintenance costs. The benefits from the rehabilitation of KIS are expected to be sufficient enough to cover the investment cost of the rehabilitation work. Accordingly, Case 2 is the most recommended of the three cases and has been selected as the final format of the proposed irrigation system. However, this JICA study includes a pre-F/S stage and the proposed acreage and intake discharge might be subject to change during the full Feasibility Study stage, which will be performed within one or two years.

With the adoption of gravitational irrigation, the route for the main irrigation canal has been studied as shown in Fig. C.1. The new intake from the Kpong dam needs to be constructed outside the dam body in the right bank area. The depth of reservoirs will be 2–3 m, so it will be possible to construct the intake structure through dry work by using sheet piles for temporary work. For the route of the main canal, the existing KIS main canal can not be utilized because the elevation of the water surface of the existing KIS main canal is 14.0 m, which is about 80 cm lower than the proposed new irrigation canal. The existing KIS irrigation canal is not lined with a trapezoidal section. In order to reduce canal seepage loss and the loss accompanying expansion of the irrigation area, the canal should be lined with concrete.

(2) Potential New Irrigation Areas

Downstream of KIS, there is a wide wetland area with low elevation. It will be possible to introduce paddy cultivation by improving the drainage system of the Norboyita River. According to the former F/S report on the Accra Plains Project for 200,000ha, this area has been categorized as a Priority 2 area with high potential for irrigation. However, the elevation of the area is rather low, so the route for the main canal should be selected to pass through a high elevation area. Downstream, the route will arrive at APIP 1st Priority Area (5,000 ha), and further down stream at the Prairie Volta rice farm area. In order to effectively improve and enlarge the potential irrigation area within the wetlands in the Norboyita River, drainage system improvement will be required for connection to the Volta River. Accordingly, the Norboyita area, which is named “No. 1 NDIS Area,” can be included in the

beneficial area of APGIP. The area is relatively large, encompassing 2,000 to 3,000 ha.

In order to elongate the gravitational irrigation area up to the Accra plains 1st priority area and the Prairie Volta rice farm area, a canal slope of 1:15,000 will be required. The distance of the 1st priority area from the Kpong dam is about 60 km. Based on the F/S of the 1st priority area for pump irrigation, the elevation of the Accra plains 1st priority area is about 20 m at the highest point and about 5 m at the lowest. It will be almost impossible to irrigate the whole area with a gravitational irrigation system, because the elevation of the intake point at Kpong dam is about 15m. The possible irrigation area, which is lower than 10 m, using gravity irrigation is estimated to be about 3,000 ha. From this, the targeted area for gravitational irrigation is 3,000 ha and the rest of 2,000 ha can be irrigated by using a terminal booster pump. Another option is to exclude areas higher than 10 m and instead include the privately owned rice farming area downstream. Pump irrigation requires a pump and related equipment, and the energy cost for operation, and therefore lifetime cost, is generally more expensive than gravity irrigation. In this study, therefore, a gravity irrigation system can be introduced in the whole irrigation area. The required average slope of the proposed main canal can be estimated as follows: (EL 15.0m – EL.10.0m)/60 km = 5m/60,000m = 1/12,000. Considering the head loss of siphoning across rivers, however, the average slope of the main canal will be estimated as about 1: 15,000 for the proposed new irrigation canal.

(3) Potential Net Irrigation Area

The APGIP consists of two irrigation schemes, namely KIP and a new development area called “New Development Irrigation Scheme” (NDIS). The NDIS area consists of two areas: the No. 1 Area and the No. 2 Area. The No. 1 Area is made up of the Norboyita Block. The No. 2 Area encompasses the territory from down stream of KIS up to the Prairie Volta Farm, and can be divided into the No. 2-1 Area (Accra 1st priority area) and the No. 2-2 Area (Prairie Volta area), as shown in Fig. C.2. The whole area of APGIP with the layout of the proposed new main irrigation canal of 70 km is shown in Fig. C.2., and the water requirement of each case is shown in Table B.1.

In order to secure maximum utilization of the existing KIS Intake capacity of 7.2 m^3/sec, improvement of the main canal of the existing KIS through concrete lining, expansion of the Golden Exotic Banana Plantation area, and rehabilitation of 400 ha of paddy fields in KIS were proposed. If these proposed improvements are made, the KIS area will become 4,100 ha and the intake discharge will be 7.151 m^3/sec.

The newly developed part of the total area will be 6,900 ha and the capacity of new intake will be 11.382 m^3/sec. The total area of the APGIP is 11,000 ha and total intake discharge will be 18.533 m^3/sec, of which 7.151 m^3/sec is the existing KIP Intake capacity.

Based on photographs and DTM (Digital Terrain Map) with 1 m and 5 m contour lines provided by VRA for EPP analysis, present land use area and the routes of the main and secondary canals together with irrigation blocks have been studied. As a result, the total net irrigation area for APGIS will be 11,000ha, made up of the 4,100 ha of the Kpong Irrigation Scheme (KIS), and the 6.900 ha of NDIS

(No. 1 Area: 2,700 ha; No. 2 Area: 4,200 ha).

3.4.4 Improvement of Kpong Irrigation Scheme (KIS)

In the KIS area, the existing irrigation area for paddies is 1,852 ha, with an extra 407 ha becoming available upon expansion through rehabilitation of the irrigation and drainage system. There is 41 ha of private vegetable farms obtaining irrigation water from the KIS and also 20 ha of fish ponds located in the KIS area, which get water from the KIS canal. According to the information from Golden Exotics, another 600 ha of banana farm will be developed in the KIS area in the future.

Based on the information collection and inventory survey on KIS facilities, the lining of main irrigation canals was proposed. Improvement of drainage by the rehabilitation was also been proposed.

Details on the length of the canal for drainage improvement and quantity of work are shown above in this chapter.

3.4.5 New Development Irrigation Scheme (NDIS)

The new development irrigation scheme (NDIS) has been divided into the No. 1 Area and No. 2 Area, with the No. 2 Area consisting of the No. 2-1 Area in the mainly 1st priority area in the APIP study and the No. 2-2 Area mainly in the Prairie Volta area.

In the No. 2-1 Area, Aveyime pump irrigation is under construction. Considering reduction of the cost for operation and maintenance, the area will be irrigated by this gravity irrigation scheme. The lower, flat area in the 1st priority area covering 2,890 ha will also be incorporated in the project area.

In the No. 2-2 Area, the existing 490 ha of paddy fields in the Prairie Volta area are already irrigated by diesel pump operation getting water from the Volta River. The company is planning to expand their paddy fields by 561 ha in the future.

The net irrigation area for each irrigation scheme is shown in the following Table.

Table 3.4.2 Irrigation Acreage of APGIP (ha)

Crops	KIS (ha)	NDIS (ha)			APGIP (ha)
		No. 1 Area	No. 2 Area	Sub total	
Paddy fields	2,300	2,538	4,200	6,737	9,038
Upland crops	0	162	0	162	162
Bananas	1,800	0	0	0	1,800
Total	4,100	2,700	4,200	6,900	11,000

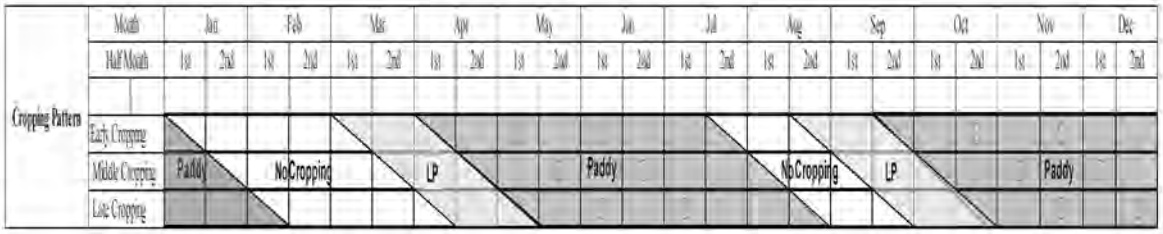
3.4.6 Water Requirement Analysis

(1) Analysis of Water Requirement for Irrigation

(a) Cropping Calendar

KIS consists of a paddy field area and banana farm area. The proposed cropping calendar for double cropping in paddy fields is shown below. In the banana farm, a drip irrigation system is introduced for 12 hours per day.

Table 3.4.3 Proposed Cropping Calendar for Paddies



(b) Irrigation Efficiency

In KIS, the main canal will be improved by concrete lining in order to reduce canal loss and maintenance cost. The main and secondary canal in NDIS will also be lined with concrete. The irrigation system for the banana farm is drip irrigation, running 12 hrs/day to maintain irrigation efficiently. The estimated irrigation efficiency by scheme is shown in the table below.

Table 3.4.4 Irrigation Efficiency table for Irrigation Schemes

Canal	NDIS	KIS(Imprv)	KIP(Exist)	Banana
Lateral	0.85	0.85	0.85	0.9
Secondary	0.9	0.8	0.8	0.9
Main	0.9	0.9	0.75	0.9
Efficiency	0.6885	0.612	0.510	0.729

(c) Unit Water Requirement

Net water requirement for paddy fields is estimated on the basis of the modified Pennman Method, adopting daily rainfall data in Aveyime from 1990 to 2010 for 21 years. The results are shown in the Attached Table-B.1.

(d) Required amount of water for APGIP

In accordance with the acreage of each irrigation scheme and irrigation efficiencies, irrigation gross water requirements have been estimated.

1) Irrigation Acreage

Irrigation acreage of each irrigation scheme is shown in the following table. In KIS, 20 ha of fish ponds has been considered in estimating the necessary water, the same area considered for upland crops.

Table 3.4.5 Irrigation Acreage in Irrigation Schemes

Irrigation Scheme	Paddy field (ha)	Upland field (ha)	Banana farm (ha)	Total (ha)
KIS	2,259	41 (20)	1,800	4,100
NDIS	6,738	163	0	6,900
Total (APGIP)	8,997	203 (20)	1,800	11,000

Note: A fish pond of 20 ha is included in the upland field.
Banana farm irrigation is 12 hours.

2) Amount of Required Water for Irrigation Schemes

In accordance with the above-mentioned factors, gross irrigation water requirement that is intake capacity from the Kpong Dam has been estimated for KIS, NDIS, and the total of them is shown in Table-B.2 and water intake pattern for selected years is shown in Fig. B.1.

As mentioned above, banana farm irrigation runs for 12 hours per day, the volume of necessary water for bananas is estimated to be half of the water requirement.

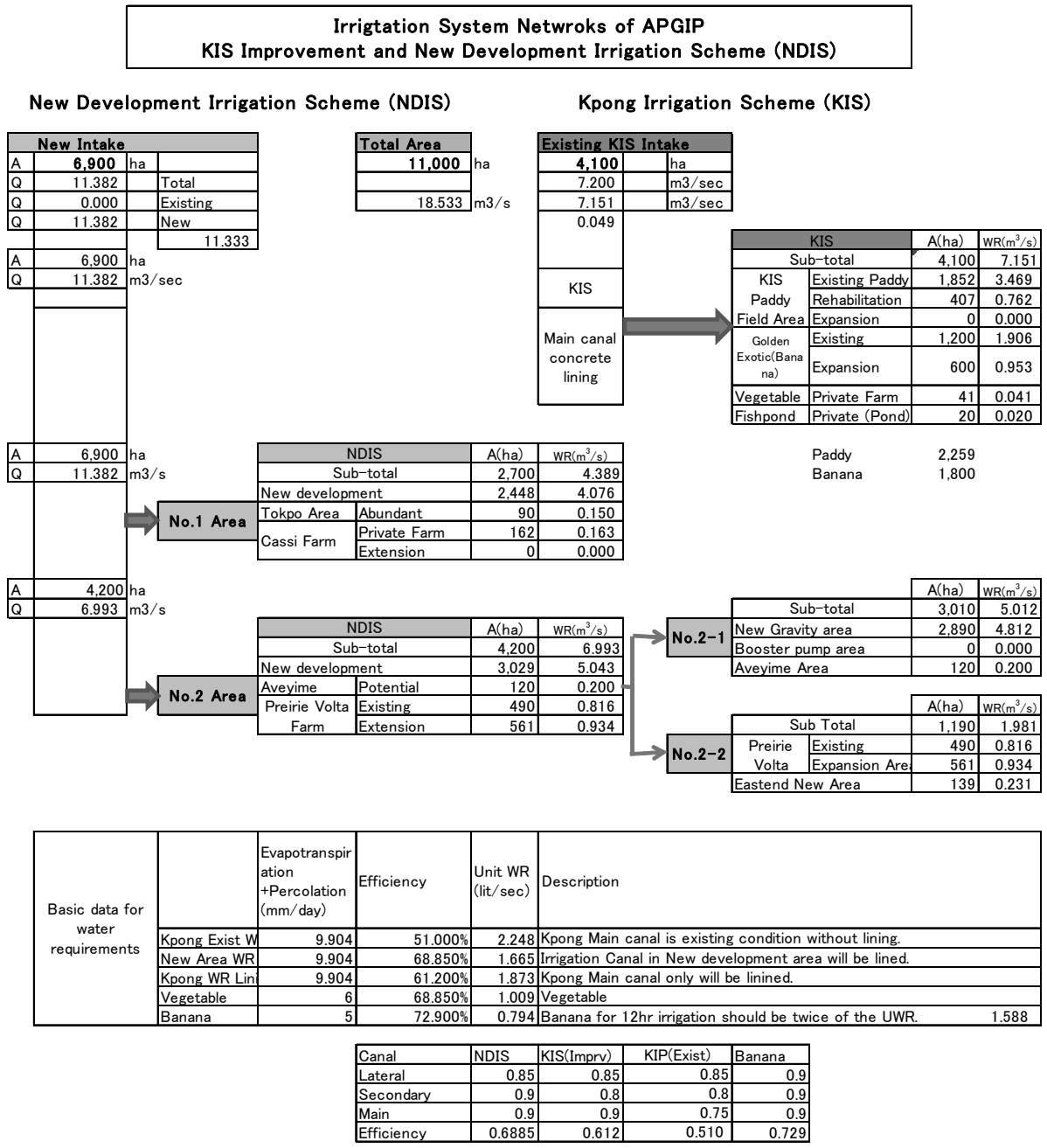
As for the existing condition of KIS, there is no intake data, only gate opening data. The existing irrigation acreage of KIS is estimated to be 3,093 ha, of which paddy fields cover 1,852 ha, banana farm 1,200 ha and private upland fields 41 ha. The ratio of the area is 3,093/4,100 = 0.754. Accordingly, the amount of current water intake will be 75.4% of the KIS's planned water intake. However, the existing irrigation canal is not lined and the water intake after the concrete lining will be 1.2 times the volume of the existing water intake (61.2/51.0 = 1.2). Therefore, the amount of water intake after lining will be 95% of the planned water intake (0.754 × 1.2). Accordingly, the water intake is estimated to be 2.288 m^3/sec (2.528 m^3/sec × 0.905), and the increment of the water intake is 0.240 m^3/sec (2.528–2.288).

The results are summarized as follows:

Table 3.4.6 Peak and Average Discharge of Irrigation Schemes

Irrigation Scheme	Peak Discharge (m^3/sec)	Annual Average Volume (1000 m^3)	Average Discharge (m^3/sec)	Increment Discharge (m^3/sec)
KIS	7.151	79,739.	2.528	0.240
NDIS	11.382	158,603.	5.029	
Total	18.533	238,342.	7.558	0.240

Based on the proposed irrigation network, the maximum water intake capacity and water requirements, considering the irrigation efficiency for each cropping area and type, are shown in the following Fig. 3.4.3.



Basic data for water requirements		Evapotranspiration +Percolation (mm/day)	Efficiency	Unit WR (lit/sec)	Description	
	Kpong Exist W	9.904	51.000%	2.248	Kpong Main canal is existing condition without lining.	
	New Area WR	9.904	68.850%	1.665	Irrigation Canal in New development area will be lined.	
	Kpong WR Lin	9.904	61.200%	1.873	Kpong Main canal only will be linined.	
	Vegetable	6	68.850%	1.009	Vegetable	
	Banana	5	72.900%	0.794	Banana for 12hr irrigation should be twice of the UWR.	1.588

Canal	NDIS	KIS(Imprv)	KIP(Exist)	Banana
Lateral	0.85	0.85	0.85	0.9
Secondary	0.9	0.8	0.8	0.9
Main	0.9	0.9	0.75	0.9
Efficiency	0.6885	0.612	0.510	0.729

Fig. 3.4.3 Irrigation System Networks of APGIP

3.4.7 Water Availability from Kpong Reservoir

(1) Intake Canal Capacity of NDIS

For the proposed main irrigation canal for NDIS, as shown in Fig. C.1, water depth to discharge has been calculated according to the Manning formula and the approximation equation is derived by the method of least squares, as shown in Table B.2.

(2) Water Fluctuation of Kpong Reservoir

The data of daily water level data from 1984 to 2010 was obtained from VRA. The half-monthly

average water level has been analysed based on the data of daily water level, because water requirement analysis is estimated on a half-monthly basis.
The average monthly water level from 1984 to 2010 and annual maximum, minimum and average water level are shown in Fig B.2.

Daily water level fluctuation curves are shown in Fig. B.3 for selected years in 1998, 2007 and 2008, together with the elevation of irrigation canals of KIS and NDIS.

(3) Water Balance Analysis of Available Water and Water Requirement

Based on the analysed half-monthly water level data, available water intake capacity was estimated adopting the approximation equation. Several severe years are selected to compare water availability from the Kpong dam and necessary water intake capacity, as shown in Table B.3. As a result, available water was sufficient to intake due to the low water level for about one month in April or May in 1998 and 2007. The frequency of the water deficit is estimated to be twice in the duration of 28 years, which corresponds to a 2/28 return period. Abnormal drought conditions are estimated to occur once every 14 years.
In order to find daily water fluctuation and available water intake, daily analysis has also been made as shown in Table B.3. According to the analysis of daily water availability, most of the water levels of the Kpong dam are very high compared with the designed water level of the new irrigation canal, 14.8m. Therefore, careful operation of intake gates is required. It will be necessary to introduce an automatic water intake control system for both the new intake and KIS intake.

3.4.8 Hydro Power Generation Reducing

In order to estimate the negative benefit of power generation capacity with respect to the opportunity cost of water caused by APGIP, average discharge on the basis of annual volume of intake was calculated. Based on the factors of plant efficiency and hydropower generation cost at the power plant obtained from VRA, the opportunity cost of irrigation water was estimated as an annual average condition.
The estimated negative benefits of KIS and NDIS are summarised as follows:

Table 3.4.7 Reducing Hydropower generation caused by APGIP

Irrigation Scheme	Average Power generation loss (MWH)	Negative Benefit (1000 GHC)	Negative Benefit (1000 US$)
KIS improve	1,875	244	164
KIS increment	178	23	16
NDIS	3,730	485	326
Total (APGIP)	5,605	729	490

3.5 Environmental and Social Considerations

3.5.1 Environmental and Social Considerations in Ghana

(1) The Ghana Environmental Assessment Regulations

The Environmental Assessment Regulations, Legislative Instrument 1652, was promulgated in 1999 to give complete legal status to the Ghana Environmental Impact Assessment procedures. The Regulations require that all development activities likely to impact adversely on the environment must be subject to an environmental assessment. The objective of the legislative instrument is to ensure that such development activities are carried out in an environmentally sound and sustainable manner. It prohibits the commencement of an undertaking (including agriculture sector projects and investments) without both prior registration and an environmental permit.

The requirements of the legislative instrument, however, place enormous responsibilities on all players in the development of Ghana. The nature of the responsibilities varies from stakeholder to stakeholder, such as policy makers, implementing or regulatory agencies, planning authorities, financial intermediaries, institutions providing training, or consultants providing services in EIA, depending on their statutory functions, areas of jurisdiction, and interests.

The procedure of EIA is as follows:

-A proponent who wants to obtain an environmental permit shall submit an application to the central office of EPA in the case where the project is categorized into the undertakings in Schedule 2 in the Regulations or to the Region Office in the case of the undertakings in Schedule 1.

- EPA notifies the proponent of the result of screening within 25 working days after receiving the application. EPA issues a screening report stating whether the application, i) is approved, or ii) is rejected, or iii) requires a preliminary environmental assessment, or iv) requires an environmental impact assessment

- The proponent who is required to conduct a preliminary environmental assessment shall submit a preliminary environmental statement to EPA. An environmental impact assessment is required unless the EPA grants approval.

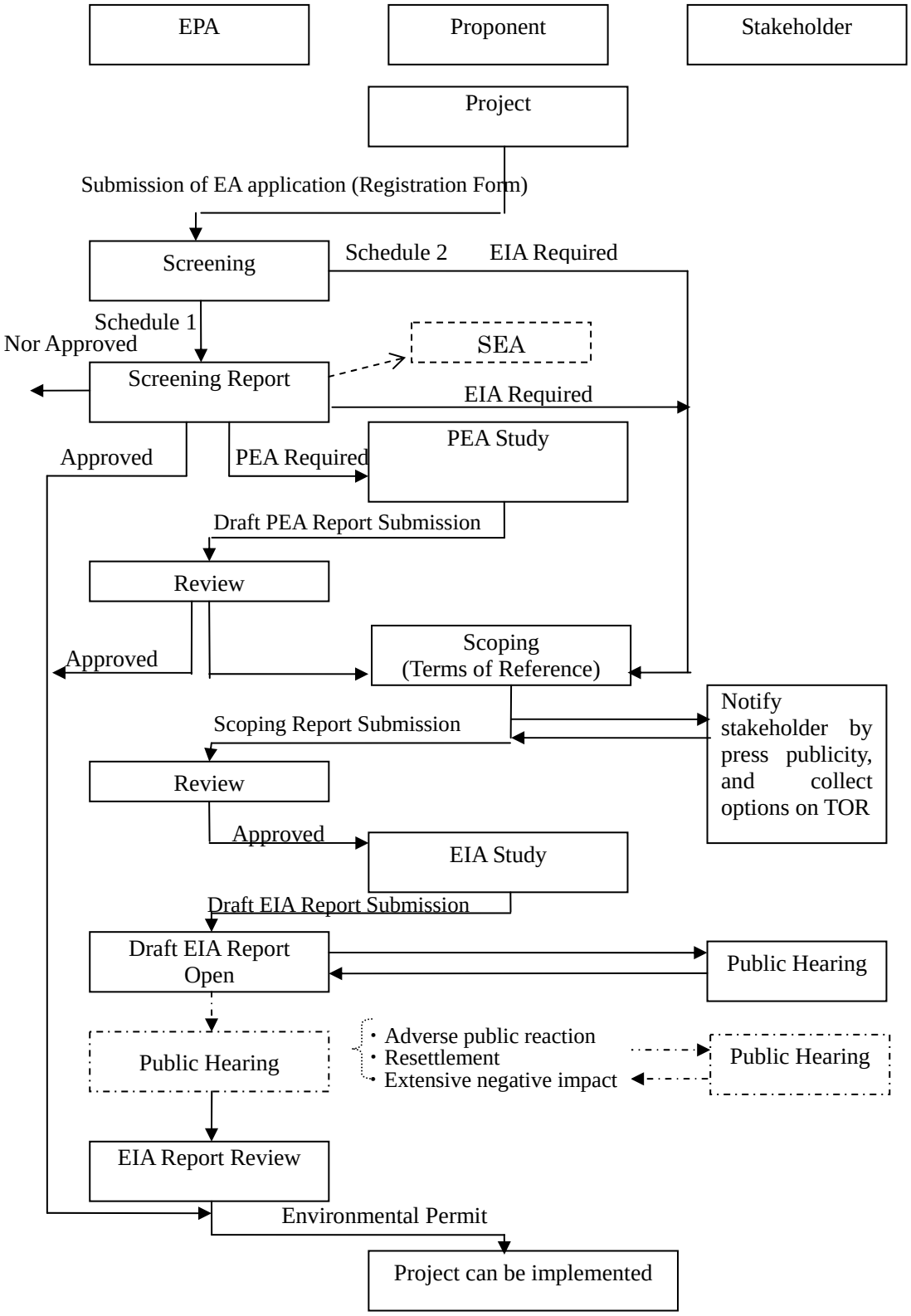
-The proponent who is required to conduct an environmental impact assessment shall carry out scoping and prepare terms of reference, then submit a scoping report to the EPA, including the terms of reference and the opinions expressed at the stakeholder meetings or public consultations, and notify relevant Governmental Offices and local people of such submission by press publicity to collect opinions on the terms of reference.

- The EPA shall open EIA to the public through the Region Office of the EPA and stakeholders' opinions should be collected.

- The EPA shall hold a public hearing in cases where there appears to be great adverse public reaction, or that the project will involve resettlement of communities, or that the project could have extensive and far reaching effects.

- The EPA issues an environmental permit after reviewing and approving the EIA, and the proponent can implement the project after finishing registration of the project.

- The EIA procedure shall be finalized within 90 days from the date of receipt of the completed application form, not including the period for preparation of EIA and a public hearing.



EIA: Environmental Impact Assessment
PEA: Preliminary Environmental Assessment
SEA: Strategic Environment Assessment
TOR: Terms of Reference

Figure 3.5.1 Procedure of EIA

(2) State Lands Act (Act 125) of 1963

Under the State Lands Act (Act 125) of 1963 any person who will suffer loss or damage to his or her property as a result of the project will receive compensation. This applies to owners of the lands that will be used as burrow and sand pits and other land uses for the project. The procedure to be followed during land acquisition and compensation payment for work camps, the pumping station, offices, reservoir sites, rural roads, canals, and drains are summarised as follows:

- Identification of individual land owners and affected properties;
- Liaison with each district assembly, environmental protection agency (EPA) and other institutional stakeholders to facilitate negotiations with land owners; and
- Compensation and acquisition of lands, including the preparation of documentation for the acquired lands.

(3) Environmentally Sensitive Areas (ESAs)

The Ghana Environmental Assessment (EA) Regulations, LI 1652 of 1999 attempted to provide adequately for biodiversity and related sensitive resources consideration in EIA by classifying certain areas as environmentally sensitive. The application of Environmentally Sensitive Areas (ESAs) in Ghana's EIA Procedures for over a decade has revealed some important shortcomings in the list and its utility value, especially in screening. The general observation is that in its attempt to provide comprehensively for biodiversity and related resources consideration in EA, the whole area of Ghana has virtually been classified as "environmentally sensitive." This has not helped in the desire to achieve effective protection and conservation of biological and other sensitive resources in Ghana. (Source: Capacity Building in biodiversity for Impact Assessment, May 2006, International Association for Impact Assessment, EPA).

The Environmental Protection Agency (EPA) conducted a study with financial support from the International Association for Impact Assessment (IAIA) to develop a modified, appropriate and better defined set of ESAs. The exercise led to the modification of the ESAs list and a reduction from 12 areas to 8 clearly-defined and precise ESAs, as follows:

(a) All areas declared by law as Wildlife Conservation Areas (including National Parks, Resource Reserves, Wildlife Reserves, Strict Nature Reserves, Ramsar Sites and Wildlife Sanctuaries), Forest Reserves, or Globally Significant Biodiversity Areas.

(b) Areas which constitute the natural habitat of any threatened (endangered, data deficient and vulnerable), rare, or endemic flora and fauna.

(c) All known historical, cultural, archaeological, and scientific sites that are of public interest.

(d) All areas known to be prone to natural environmental disturbance, such as coastal erosion, flooding, geological hazards (including earthquakes, tremors, and landslides), and radioactive emissions.

(e) Hilly areas with gradients greater than 45 degrees and prone to erosion, rock falls, mudslides, or landslides.

(f) Areas of land adjoining water bodies, a minimum distance of 50 m from the bank of the water body.

(g) Water bodies (surface or ground) characterized by one or more of the following conditions:
1) Tapped or abstracted for domestic purposes;
2) Water within a controlled and/or protected area;
3) Supports wildlife and fish;
4) Head waters.

(h) Mangrove area/forest characterized by one or more of the following conditions:
1) Adjoining mouth/estuary of a river/stream system;
2) Habitat for wildlife;
3) Spawning ground for fish;
4) Near or adjacent to traditional fishing ground;
5) Acting as a natural buffer against shore erosion, strong winds or for storm floods.

(4) Water Resources Commission

Water Resources Commission (WRC) was established by a Parliamentary Act (Act 522 of 1996) as the overall body responsible for water resources management in Ghana. WRC is made up of 15 members, including the chairman, the executive secretary, a chief and two other persons, one of whom shall be a woman. The rest are representatives of ten (10) institutions, including GIDA, VRA and EPA. WRC regulates and manages the utilization of water resources in Ghana. All people utilize water resources based on the strategy for Integrated Water Resources Management (IWRM) for the sustainable utilization of the nation's water resources. At present, VRA has utilized water resources from Volta River for hydro-electric power generation. As far as water utilization for NDIS (New Development Irrigation Scheme) is concerned, GIDA has already obtained basic consent from VRA.

3.5.2 JICA's Guidelines for Environmental and Social Considerations (April 2010)

Japan's ODA Charter states that in formulating and implementing assistance policies, Japan will take steps to assure fairness. This will be achieved by giving consideration to the conditions of the socially vulnerable and to the gap between the rich and poor, as well as the gaps among various regions in developing countries. Furthermore, when implementing ODA, great attention will be paid to factors such as environmental and social impacts on developing countries.

JICA, which is responsible for ODA, plays a key role in contributing to sustainable development in developing countries. The inclusion of environmental and social costs in development costs and the social and institutional framework that makes such inclusion possible are crucial for sustainable

development. Internalization and an institutional framework are requirements for measures regarding environmental and social considerations, and JICA is required to have suitable consideration for environmental and social impacts.

Democratic decision-making is indispensable for environmental and social considerations. It is important to ensure stakeholder participation, information transparency, accountability, and efficiency, in addition to respect for human rights, in order to conduct an appropriate decision-making process.

In this context, with respect to human rights and in view of the principles of democratic governance, the measures for environmental and social considerations are implemented by ensuring a wide range of meaningful stakeholder participation and transparency of decision-making, as well as by working for information disclosure and by ensuring efficiency. Governments bear the responsibility for accountability, but at the same time stakeholders are responsible for their comments.

Owing to the issues discussed above, JICA always considers environmental and social impacts when implementing cooperation projects.

Difference between “Ghana’s Environmental Assessment Regulations” and “JICA Environmental Guideline” is as follows. As far as matters to be addressed in the environmental statement are concerned, there are no items concerning resettlement, or ethnic minorities and indigenous peoples in “Ghana’s Environmental Assessment Regulations.” However, other items are included. In case resettlement is expected in the course of the project cycle, World Bank Safeguard Policy is said to be applied.

3.5.3 World Bank (Safeguard Policy)

Safeguard policies play an important role in enhancing positive outcomes of development projects, or the benefit-side of the equation. Several policies require meaningful consultation with, and participation by, affected people during the design, preparation, and implementation of World Bank-financed projects—a requirement that has often been at issue in projects reviewed by the Inspection Panel. The appropriate implementation of the World Bank's safeguard policies plays a central role in ensuring the effectiveness, sustainability and positive development impact of its projects and programs.

Social safeguard policies on involuntary resettlement and indigenous people aim to promote inclusion of the most vulnerable groups and protect involuntarily displaced persons and indigenous peoples. These two policies can be used as entry points to address social issues involved in investment lending operations, and to mitigate and compensate adverse impacts on indigenous peoples and persons displaced by development projects.

The World Bank's Operational Policy 4.12: Involuntary Resettlement is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks

and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts.

It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement.

The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to World Bank appraisal of proposed projects.

The World Bank Safeguard Policies concern the following: Environmental Assessment, Natural Habitats, Pest Management, Indigenous Peoples, Physical Cultural Resources, Involuntary Resettlement, Forests, Safety of Dams, Projects on International Waterways, Projects in Disputed Areas.
(Source: http://web.worldbank.org).

3.6 Organization and Management Plan

There are various alternative options for the organization and management structure of the project, in consideration of public and private partnership (PPP) as mentioned in Chapter 6. In this section, a possible organization and management structure is discussed as a sample in the case that a private scheme management company would be commissioned under the concession contract where major infrastructure are developed by the government. Even though this section figures out details of the structure, it will not limit alternatives of applicable PPP mechanisms, which shall be decided by the government of Ghana based on discussion among the stakeholders as well as the consideration of the development policy of the sector. The government of Ghana is currently preparing the National PPP Policy. The project is expected to be managed by GIDA because it requires technical skills and experience in irrigation development. The project shall be implemented following the guidelines shown in the National PPP Policy, under the technical and administrative support of MOFA and MOFEP.

3.6.1 Project Management Organization

(1) Organizational Structure

The project would be implemented and managed through GIDA with the chief executive of GIDA having overall responsibility. A Project Implementation Committee (PIC) would be formulated to establish the policy and supervise the overall implementation of the project. The PIC would be chaired by the chief executive of GIDA, and includes representatives of related ministries and stakeholders, i.e., Ministry of Food and Agriculture, Ministry of Financing and Economic Planning, local administrative organizations, Farmer’s Cooperatives, etc.

The Accra Pain Gravity Irrigation Project (APGIP) comprises the rehabilitation of the Kpong

Irrigation Scheme (KIS) and the development of the New Developed Irrigation Scheme (NDIS), which are individual irrigation schemes. Even though both schemes have different situations, that is, one is the rehabilitation of an existing irrigation scheme where beneficiaries have already taken root, and the other is a new development of an irrigation scheme where beneficiaries are recruited and settled by the project, it is recommended to set up a unified PIC in consideration of the requirements of close connection in the implementation of both schemes, especially during the construction stage. It is also recommended to set sub-committees under the PIC for each project as well.

Regarding the management structure of NDIS, there are two options: one is direct management by GIDA and the other is introducing a private sector entity to be the scheme management company, which shall be decided by GIDA based on careful discussion among stake holders. In this study, the management structure was examined under the condition of introducing the private sector.

Under the PIC, the Project Management Units (PMUs) of each project would undertake the implementation and management of the projects. KIP would function as a PMU of the rehabilitation of KIS and manage the scheme as it is. As for NDIS, a new organization of PMU directly assigned by GIDA is to be formulated and given the responsibility for supervising implementation, coordination of land allocation, facilitation of formulating a Farmer's Cooperative, and any other duties for preparing settling farmers and enterprises. After completion of initial stage work by GIDA-PMU, a private scheme management entity (Scheme Management Company: SMC) would be deployed under the concession of GIDA and take over the responsibilities for management of the irrigation scheme. GIDA-PMU would be absorbed into GIDA Headquarters and become the unit which takes responsibility for monitoring and controlling the project after taking over from the Scheme Management Company.

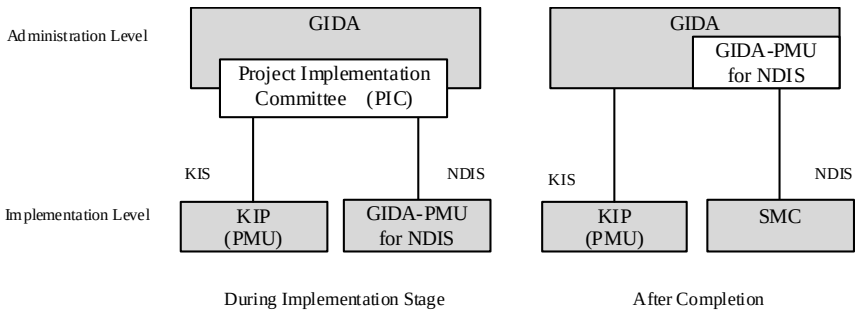


Fig. 3.6.1 Organization Diagram of Administration and Implementation

(2) KIP

The current KIP organization structure, which comprises units of project management, financial and administration, maintenance and field operation, is well designed and set up to provide necessary functions of irrigation scheme management. However, it is required to enhance the function and improve its performance to deal with the improved irrigation system after rehabilitation. Major issues to be improved include the following:

- Improvement of water management by KIP

  KIP is required to implement accurate and adequate water management based on water measurement and records of distributed water in the main and secondary canal system. When an irrigation area is used intensively and the system is in full use after rehabilitation, it is a concern that lower-reach beneficiaries may face difficulty in receiving water without appropriate water management in the system. Thus, KIP would secure a fixed number of water bailiffs and increase their capacity to ensure that the project's infrastructure is operated and maintained effectively and efficiently.

- Increase of guidance and instruction to farmers regarding water management (enhancement of Lateral Group)

  In parallel with the improvement of water management by KIP, it is necessary to improve water use practice of farmers in the lateral canal. In order to ensure effective use of water, fair and appropriate water distribution, and good coordination between farmers, it is required to increase guidance and instruction to farmers, and to develop the capacity of block leaders and lateral leaders, who are leading farmers. For this purpose, KIP would concentrate on developing the capacity of water bailiffs and extension officers as well as secure a budget for increasing their day-to-day communication with farmers (including for motorbikes and fuel).

- Strengthening capacity of machinery

  Old and malfunctioning plants and equipment are to be renewed, and plants and equipment are to be increased, in order to maintain the function of the irrigation system through adequate and timely maintenance work by KIP. Excavators for creeks and drainage canals, plants and equipment for road maintenance, and machinery that local farmers can rent for lateral maintenance would be equipped at the KIP workshop.

- Reviewing Irrigation Service Charge

  The current price system of irrigation service charge is not set to cover the necessary cost of system operation and maintenance. The price system shall be set based on the necessary cost. It is strongly recommended to review and revise the price system as well as to transfer the concession fee of the banana farm into KIP's internally-generated fund from GIDA's revenue.

- Increase Recovery of Irrigation Service Charge

  Even though it is clear that both KIP and farmers shall be delegated responsibility to low recovery of ISC, it is required for KIP to take the first step in order to solve this effectively. KIP would assure sufficient water delivery on time (show its ability), show the use of collected ISC clearly, and assure allocation of a part of ISC for maintenance for lateral canals.[7] The allocation of ISC to lateral maintenance is to be delivered by providing machinery service instead of cash. Making a point on transparency would contribute to farmers' becoming aware of what they are paying for directly. This would also help farmers to gain a better understanding of the financial requirements of the project.

[7] According to the regulation of KIP, the collected ISC is to be allocated 10% for GIDA administration, 80% for the project, which will be used for maintaining infrastructures, and 10% for maintaining lateral by farmers.

In consideration of farm economy, it might be difficult to quickly change the situation in which the KIP staff is burdened by GIDA budget allocation. However, it is to be considered that part of the human expense is to be allocated to a large-scale commercial banana farm according to the water use amount. It is clear that the irrigation system is required to be operated and maintained by the budget recovered by ISC, including human expense for management, in order to ensure sustainable operation. Thus, it is recommended to increase ISC to cover all costs gradually in future.

(3) GIDA-PMU for NDIS

(a) Roles and Responsibilities during Implementation Stage

GIDA-PMU for NDIS would be a representative of GIDA during the implementing period of the project. The major roles and responsibilities are:

- To recruiting and allocate land to small-scale and medium-scale farmers as well as large-scale farms in a fair and equitable manner, in cooperation with the Land Allocation Committee,
- To facilitate farmers formulating Farmers' Cooperatives and a sub-structure for water management (Secondary Block and Lateral Group),
- To invite a large-scale farm entity in place and adjust business contents
- To conclude a Land Allocation Agreement with small-scale and medium-scale farmers, and a concession contract with large-scale farms,
- To manage long-term land lease contracts with land owners,
- To balance the conflicting interests of stake holders by leading the Stake Holders Committee
- To control and supervise construction work

In order to fulfil the roles above, GIDA-PMU would comprise its organization by project management, financial and legal administration, engineering, and agriculture. Under the major units, contract management, agriculture and commercial, extension and Farmer's Cooperative, design and construction supervising, etc. would be deployed.

(b) Roles and Responsibilities after Take-over

After transferring responsibilities to the Scheme Management Company (SMC), GIDA-PMU would be absorbed and function as a unit responsible for project management within GIDA Headquarters. The major responsibilities are:

- To manage concession contracts with SMC
- To monitor and evaluate project management of SMC
- To manage long-term land lease contracts with land owners and to control payment of land rent fees from SMC
- To make policy decisions for the project management under the Project Implementation Committee, and to balance the conflicting interests of stake holders through leading the Stake Holders Committee

After transferring, GIDA-PMU would scale down the organization and concentrate contract management and monitoring. In order to fulfil the above roles, GIDA-PMU would deploy project management, financial and legal administration, monitoring unit (engineering and agriculture).

(4) Scheme Management Company

(a) Roles and Responsibilities

In this study, it is assumed that the private business entity entrusted to operate and maintain the irrigation scheme, which is called the Scheme Management Company (SMC), is hired by GIDA. SMC would operate and maintain the irrigation scheme effectively and efficiently so that farmers and farm enterprises in the project area would receive full benefits, under the concession contracts with GIDA. SMC would operate and maintain the scheme sustainably by self financing based on ISC collection. SMC would provide paid services of agricultural support to small and medium-scale farmers as well. Leading farmers to become market oriented in the project area is also expected. The roles and responsibilities of SMC are:

- Coordinating irrigation and a water distribution schedule among the secondary block level as well as operating water distribution of the main and secondary canals[8]
- Maintaining the main and secondary canals,[9] and the drainage system, as well as maintaining plant and equipment for maintenance
- ISC setting and collection
- Monitoring and evaluation of operation and maintenance of the lateral block level by farmers, enhancing the maintenance activity of the Lateral Group, and providing mechanical service for lateral maintenance
- Technical extension and monitoring, and evaluation of farming activity of small-scale and medium-scale farmers
- Providing agricultural machinery service to small and medium-scale farmers
- Providing post harvesting service to small-scale farmers
- Marketing
- Arranging contracts with seed farmers and providing rice seed to small and medium-scale farmers
- Facilitating small farmers to access farming credit, such as ADB credit
- Facilitating to formulate and enhance Farmer’s Cooperatives
- Reporting to GIDA-PMU

(b) Expected Organization of Scheme Management Company

The Scheme Management Company (SMC) shall propose how it will be an optimum organization to fulfil the roles and responsibilities above in the field. Some expectations of the organization are discussed here.

8 In case of the large-scale farm block, SMC will take responsibility to deliver water up to the boundary of the block.

9 In case of the large-scale farm block, SMC will take responsibility to maintain the canal up to the boundary of the block.

In consideration with its role and responsibility, SMC would have four piers in its organization, i.e., project management, financial and administration, engineering management, and agriculture and commercial management.

Project management: Responsible for overall coordination of the project activities under the cooperation of chiefs of core sections. A monitoring and evaluation unit would be set under the project management, which would be responsible for monitoring the performance of the project as well as the operation of a management information system. A Stake Holders Committee, composed of project management, representatives of Farmers Cooperatives, representatives of farming enterprises, the District Office of the Agricultural Extension Services, and other stakeholders, would be set up in order to balance the conflicting interests of the stake holders and give advice for project management.

Financial and administration management: Responsible for preparation of the detailed budgets, supervising expenditure, and preparing and submitting regular financial reports to the project management, as well as for overall issues of human resources and office services. The contract for irrigation service and collection of ISC are also covered by the financial and administration management.

Engineering management: Responsible for the efficient and effective delivery of water through the main and secondary canal as well as coordination and adjustment of a water distribution schedule based on the irrigation schedule of farmers/farms. Regular Stake Holders Meetings shall be held under the management for coordinating the water distribution schedule and the maintenance plan among stakeholders. Another important responsibility is the overall maintenance function of irrigation and drainage facilities and other infrastructures, as well as the maintenance of plants and equipment. Water bailiffs are to monitor farmers' activities for OM in the lateral block, and to provide instruction thereon, as well as to operate the main and second canal systems.

Agriculture and commercial management: Responsible for extension service, machinery service, post harvest and marketing, and facilitation of credit. Under the extension service, input materials and seed supply would be covered as well as facilitating the activities of farmers' cooperatives. Post harvest and marketing would have a close relationship with large-scale farms and enterprises in the project area, and would arrange services to cover small and medium-scale farmers.

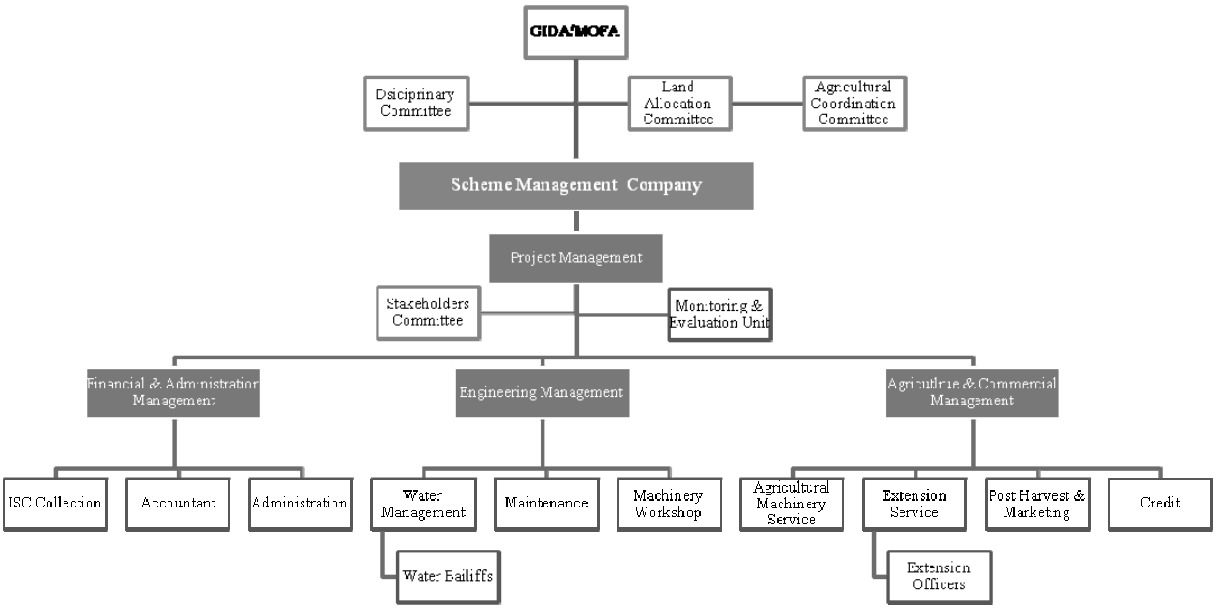


Fig. 3.6.2 Sample Organization Chart of the Scheme Management Company

(c) Irrigation Service Charge and Financial Support to SMC

Farmers and farming enterprises would conclude contracts for service provided by SMC, including irrigation water service. SMC would decide the price of ISC based on its business plan under the approval of GIDA-PMU.

ISC shall be set to cover all costs for operation and maintenance, including management fees of SMC. ISC also includes development fees for recovering the development cost of the irrigation and drainage system, which shall be charged fully or partly according to type of beneficiary. It is essential to make clear the detailed breakdown and background of pricing in order to increase farmers awareness and understanding of ISC.

ISC would be collected based on the secondary block, the representative of farmers or farm enterprises would collect ISC from block members and pay SMC. SMC shall have the authority to stop water delivery when the users do not pay for ISC.

SMC manages its business by self financing, in principle, based on the ISC collection. However, it is also to be noted that it is difficult to maintain the business during the start-up period of the project because a delay in receiving ISC income or low recovery is expected at that time. Thus, it is necessary to consider that the government would give financial support to SMC at the beginning of the project, which would last up to three years. The possible support to SMC is providing a soft loan for operating capital.

3.6.2 Farmers and Users Participation

(1) Role of Farmers and Users in Management of the Irrigation System

The principal of demarcation of roles between project and farmers/enterprises (users) is as follows.

In the case of the small or medium-farm block, the project is responsible for OM of the main and secondary canal and drainage, as well as infrastructures such as the access road, and the farmers take responsibility for the operation and maintenance of canals and drainage at the lateral level.

In case of the large-scale farm block, the project is responsible for OM of the main and secondary canal up to the boundary of the block and drainage, and enterprises (farms) take responsibility for OM in the block

The details of roles in the management of irrigation system vary between small and medium-scale farms and large-scale farms (enterprises).

(a) Role of small-scale farmers and medium-scale farmers

- To coordinate the irrigation schedule among farmers at the lateral and branch/secondary level. Participate in coordination meetings at the scheme level (PMU Meeting for KIS and Stake Holders Meeting for NDIS).
- To operate the irrigation system and carry out water distribution at the lateral level
- To implement maintenance work at the lateral level
- To balance the conflicting interests of stake holders at the lateral and branch/secondary level in

cooperation with water bailiffs. Reporting to the Stake Holder Committee, if necessary.
- To monitor water use and maintenance work at the lateral and branch/secondary level, and report to the project through water bailiffs
- To monitor the farming activity in the lateral and branch/secondary level, and report to the project through the extension officers

(b) Role of large-scale farms (enterprises)
- To coordinate the irrigation schedule among farms in the secondary block. Participate in coordination meetings at the scheme level (Stake Holders Meeting for NDIS).
- To operate the irrigation system and carry out water distribution in the secondary block
- To implement maintenance work in the secondary block
- To balance the conflicting interests of stake holders in the secondary block in cooperation with water bailiffs. Reporting to the Stake Holder Committee, if necessary.
- To monitor the water use and maintenance work in the secondary block and report to the project through water bailiffs
- To report the farming activity in the secondary block to the project through extension officers

(2) Farmers Cooperative and WUA

(a) KIS

The Osudoku Agricultural Cooperative Society Limited (Osudoku Cooperative) has been formulated to cover all small holders in KIS. The Cooperative has a function of WUA as well as to act as a Farmer Based Organization (FBO) in the project area. Osudoku Cooperative would enhance its activity, both in the WUA function and FBO function, to cope with the increasing responsibility accompanying full use of the irrigation system after rehabilitation. Regarding the WUA function, it is required to enhance the Lateral Group as well as the Branch/Block Group to manage minute water distribution and maintenance work.

(b) NDIS

According to the GIDA Regulation (L.I.), a Farmers Cooperative would be established by all farmers of NDIS, which would be based on the Cooperative Society Degree, 1968. Large-scale farms (enterprises) would not be included in the Farmers Cooperative from the viewpoint of the concept of a cooperative.

The Secondary Block is considered as an individual hydraulic block from the aspect of water management. In NDIS, farmers' and users' participation in the irrigation scheme would be fulfilled by two lines according to the type of Secondary Block. In a case where the Secondary Block is developed by the public sector, farmers within it would formulate a Secondary Group as a key sub-structure of the Farmers Cooperative. The group would function as a WUA and take responsibility for the distribution schedule within the Secondary Block, and the operation and maintenance of the irrigation system at the lateral level. Under the leading of the Secondary Block Leader, Lateral Groups would carry out operation and maintenance activity in the field. The Lateral

Leader would organize communal work among the lateral members for maintenance work as well as arrangement of renting machinery if necessary. Coordination among Lateral Groups is the responsibility of the Secondary Block Leader. ISC would be collected by the person in charge of the Secondary Group and paid to SMC.

In a case where the Secondary Block is developed by the private sector, large-scale farms would be key for the management of the irrigation system within the block. Large-scale farms and small-scale farms would formulate the WUA in the Secondary Block. The WUA would take responsibility for coordinating the distribution schedule, and for operating and maintaining the system. Small-scale farmers would formulate the Lateral Group, and carry out operation and maintenance at the lateral level.

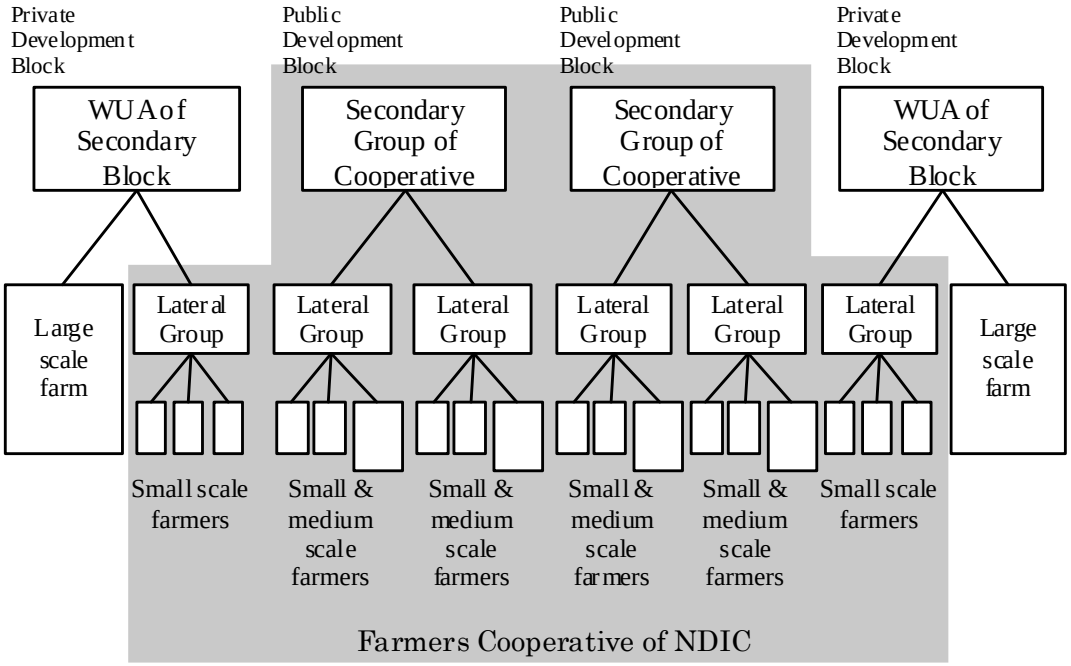


Fig. 3.6.3 Organization Diagram of Water Management in Farmers/Farms Level

The existing Farmers Cooperatives in the project area of NDIS, i.e., Aveyime Irrigation Farmers Cooperative and Marketing Society Ltd, and Tokpo-Noyami Farmers Association, which has been established for a certain irrigation scheme, are to be absorbed into the Farmers Cooperatives of NDIS and expected to function as a Secondary Group.

Chapter 4

Facilities Plan

Chapter 4 Facilities Plan

4.1 Facilities Plan of NDIP

4.1.1 Intake Facility at Kpong Dam

The intake facility is installed at the right bank of the Kpong dam, in consideration of the dam location and alignment of the Akuse main canal of KIS. The location and plan of the intake facility are shown in Fig. C.1 in Annex C. The following are prominent features of the intake:

Table 4.1.1 Intake Facility

Items		Descriptions
1.	Intake gates	2.0m × 2.0m × 3 sluice gates by electric operation Design intake capacity: 11.3 m^3/sec Canal bed elevation: 12.80m Design water level: 14.80m Water depth: 2.00 m (Variable due to the daily fluctuation in the reservoir water level of the Kpong dam
2.	Head race channel	W7.8m x H2.3m (Concrete lining)
3.	Road culvert (Dam axis)	W4.0m × H2.5m × L18m

4.1.2 Irrigation System

Irrigation water is supplied to the farmland by gravity. As shown in Fig. C.2, irrigation blocks are broadly divided into two, i.e., NDIS No. 1 area and No. 2 area, bounded by Sege-Aveyime road. Appropriate diversion points are selected to supply irrigation water to each farm block or the most upstream of a series of farm blocks. The locations of the irrigation blocks and each command area are shown in Fig. C.3, C.4.

4.1.3 Drainage System

As hilly terrain continuously lies along the right side bank of the Volta River, swamp areas as well as swampy ponds have been developed upstream of the hilly area for about 50km from Akuse to the Prairie farm. A very gentle slope along the hilly area has been accelerating deposition of sediment flowing out from the upstream drainage area. Therefore, arable areas lower than EL 4 to 5 m are in poor drainage condition, thus water logging hinders agricultural farming, including rice cultivation. Outflow points to the Volta River are shown in Fig. C. 5.

It is proposed to widen the outflow points to the Volta River to increase flow capacity of the natural streams. In addition, widening of the drainage canal/stream is also an effective method to mitigate the inundation condition in the proposed farm area.

A large drainage area is located upstream of the Norboyita area and Aveyime. The drainage capacity has been estimated on the basis of flood discharge analysis, as mentioned in Paragraph 3.4.2. The flood peak discharge can be estimated by following a simplified equation taken from Figure 12-19: Flood Q10 (m^3/sec)/Francou-Rodier, p. 246, APIP F/S 5,000 ha: $Q10 = 0.35 \times A$: where Q10 is the 10 year return period flood discharge (m^3/sec) and A is the catchment area (km^2). The flood discharge of small rivers crossing the proposed main irrigation canal has also been estimated with the same equation.

4.1.4 Irrigation Canal

The main and secondary canals are constructed with a canal slope of 1:15,000 for the open canal. The average canal slope is about 1:10,000 because slightly large friction loss is considered in the siphon culverts and check gate sections. The hydraulic profile is shown in Fig. C.6 (1). Canal alignment is basically along the contour line to minimize earth moving volume. Sections of the main and secondary canals are indicated in Fig. C.7. The Main canal is planned in parallel with the existing Akuse main canal and the South Lower Level Canal of KIS (0–17 km: pump station to High Level Canal). At the crossing points with drainage channels, the siphon structure is proposed to structurally conform to the existing KIS canal. A longer siphon of about 500 m is proposed at the crossing section of two drainage channels at the Norboyita area (30 km) to secure a wider flow section of these drainage channels. The siphon culvert is 2.5 m wide and 2.5 m high with double culverts to minimize friction loss (in this case, velocity is about 1.1 m/sec and friction loss is 0.25 m). Drainage culverts are proposed at drainage crossing sections downstream of the 30 km siphon because relatively small drainage flow is expected. The structure of the siphon is shown in Fig. C.8. Instead of a siphon, an aqueduct may be constructed in wider swampy areas. (See Fig. C.9 (4) for reference)

Secondary canals are located along the contour line to minimize earth volume. Secondary canals are extended to farm areas of 20 to 30 ha in principle. Lateral canals convey irrigation water to farm areas of 10 ha. Surfaces of the main and secondary canals, with a flow capacity of more than 0.1 m^3/sec, are lined with concrete 0.1m or 0.07 m thick. Lateral and on-farm canals are earth canals. Table 4.1.2 shows the features of the canals.

Table 4.1.2 Prominent Features of the Project (NDIS)

	Items	Description	Lining	Length / sites
1.	Main irrigation canal	Concrete lining		69.1 km
1.1	Section 1 (11.3 m^3/sec)	No.0 – No. 27+200	(t=0.1m)	27.2 km
1.2	Section 2 (10.5 m^3/sec)	No.27+200 – No. 37+600	(t=0.1m)	10.4 km
1.3	Section 3 (9.0 m^3/sec)	No.37+600 – No. 39+200	(t=0.1m)	1.6 km
1.4	Section 4 (7.5 m^3/sec)	No.39+200 – No. 45+400	(t=0.1m)	6.2 km
1.5	Section 5 (6.0 m^3/sec)	No.45+400 – No. 55+800	(t=0.1m)	10.4 km
1.6	Section 6 (4.0 m^3/sec)	No.55+800 – No. 58+600	(t=0.1m)	2.8 km
1.7	Section 7 (2.5 m^3/sec)	No.58+600 – No. 62+400	(t=0.07m)	3.8 km
1.8	Section 8 (1.5 m^3/sec)	No.62+400 – No. 67+300	(t=0.07m)	4.9 km
1.9	Section 9 (0.5 m^3/sec)*	No.67+300 – No. 69+100	(t=0.07m)	1.8 km
2.	Secondary irrigation canal	Concrete lining (t=0.07m)	(t=0.07m)	115.5 km
2.1	Section 1 (1.0 m^3/sec)	Concrete lining	(t=0.07m)	11.8 km
2.2	Section 2 (0.8 m^3/sec)	Concrete lining	(t=0.07m)	4.0 km
2.3	Section 3 (0.6 m^3/sec)	Concrete lining	(t=0.07m)	1.0 km
2.4	Section 4 (0.5 m^3/sec)	Concrete lining	(t=0.07m)	4.6 km
2.5	Section 5 (0.4 m^3/sec)	Concrete lining	(t=0.07m)	37.6 km
2.6	Section 6 (0.2 m^3/sec)	Concrete lining	(t=0.07m)	52.1 km
2.7	Section 6 (0.1 m^3/sec)	Concrete lining	(t=0.07m)	4.4 km

Note: *Main canal Section 9 is classified in "Main canal" in the report.

In addition to the secondary canal listed above, pipeline canals with their total length of 9.95 km shall be installed to supply irrigation water to the farm blocks located far from the main canal. The location of the pipeline canals are shown in Fig. C.11, Annex C. Since the water head between the main canal and the irrigation area is small, i.e., about 3.0 m, relatively large diameters of the conduits, 800 mm to 900 mm is required.

4.1.5 Flow Control Facilities

Water control facilities such as spillways and emergency outlets are installed immediately upstream of the siphons and check gates. The typical structure of the spillways and emergency outlets are shown in Fig. C.10, in Annex C.

Check gates are installed at intervals of about 3 km in the main canal and 2 km in the secondary canal in NDIS. The water level is controlled by gate opening. Spillway and emergency outlet channels are installed immediately upstream of the gates and siphons from the viewpoint of safety.

Regarding bridges for local residences, in addition to those for cattle, five canal bridge culverts parallel to the KIS canal and 16 culverts in NDIS are installed for this purpose. The intervals between these culvert bridges are about 3 km in both schemes. The bridge culverts are located in the inter section with existing roads, in principle. Flow control facilities and other appurtenant structures are listed below.

(NDIS)

Transverse structures				
1. Drainage culvert	:	28	sites	(W 2.0 m × H 2.0 m × 1)
2. -Do-	:	4	sites	(W 2.0 m × H 2.0 m × 2)
3. Road culvert (Intake site)	:	1	sites	(W 4.0 m × H 2.5 m × 2)
4. -Do- (Main canal)	:	5	sites	(W 4.0 m × H 2.5 m ×2) including KIS
5. -Do- (Main canal)	:	9	sites	(W 3.0 m × H 2.5 m × 2) including KIS
6. -Do- (Main canal)	:	6	sites	(W 2.0 m × H 2.0 m × 2)
7. -Do- (Main canal)	:	10	sites	(W 2.0 m × H 1.5 m × 1)
8. -Do- (Secondary canal)	:	33	sites	(W 2.5 m × H 1.5 m × 1)
9. -Do- (Secondary canal)	:	203	sites	(W 2.0 m × H 1.0 m × 1)
Check gate				
1. Main canal	:	14	sites	(W 2.0 m ×H 2.0m × 2 or 1)
2. Secondary canal	:	237	sites	(W 1.0 − 1.2 m × H 1.0 m × 1)
Division gate				
1. Main, secondary canal	:	215	sites	(W 0.5 m × H 0.5 m × 1)
Spillway, outlet	:	10	sites	

4.1.6 Drainage Canal

A large drainage area is located upstream of the Norboyita and Aveyime areas. Drainage improvement downstream of the Norboyita area is not encouraged from the viewpoints of conservation of the natural conditions of the swampy area. Heavy sediment flow from the drainage area of more than 200 km^2 is also one of the reasons not to recommend the drainage improvement work in the area. Higher flow velocity by the drainage improvement work accelerates erosion of the riverbed materials, eventually a huge amount of dredging work to secure drainage flow capacity would cause financial difficulties. The drainage improvement work is implemented at several sites in the command area and outlets to the Volta River. River-widening work is shown in Table 4.1.3, and in Fig. C.12, in Annex C.

Table 4.1.3 Drainage Improvement Work (NDIS)

	Area in NDIP	Location	Descriptions	Flood discharge (m^3/sec)	Length (km)
1.	No. 1 area	Irrigation blocks 8–11	Drainage canal is installed in the farm area to fix drainage channel	10	10
		No. 1 area outlet drainage	Existing drainage channel is widened to increase flow capacity.	5	15
2.	No. 2 area	Lac Aklamador outlet	Existing drainage channel is widened to increase flow capacity.	15	15
		Lac Aklamador outlet 1		10	10
		Lac Aklamador outlet 2		5	5

4.1.7 Road Networks

The project provides additional road net works along the main and secondary irrigation canal as a farm to market road. In addition, farm roads are also constructed basically along 10 ha paddy fields for transportation of the agricultural input as well as agricultural machinery and equipment. These roads are available to transport the OM machinery.

4.1.8 Rural Development Facilities

Rural infrastructures, such as roads, the electric grid, and water supply systems, have been well equipped in the NDIP area, especially along the regional roads along the Volta River. It is, however, necessary to conduct further study when a large settlement is expected and when population growth is beyond the development plan of the related three District Governments.

4.2 Facilities Plan of KIS

4.2.1 Intake Facility from Kpong Dam

The intake facility is located at the right bank of the Kpong dam. The Location is shown in Fig. C. 13 in Annex C. The following are prominent features of the intake facility:

Table 4.2.1 Intake Facility

	Items	Descriptions
1.	Intake gates	W 2.2 m × H 1.52 m × 1 sluice gates by manual operation Design intake capacity: 7.2 m^3/sec
2.	Head race channel	W 1.25 m × H 1.25 m (Concrete culvert) Canal bed elevation: 12.00 m
3.	Spillway	W 4.0 m , crest elevation of 14.00 m

Since the intake facility has sufficient capacity, there is no need to rehabilitate the intake. Maximum intake capacity is estimated to be about 7.2 m^3/sec when the water level is at the average operational elevation of about 15.0 m. Stop-log gates are also equipped at the intake site, thus maintenance of the gate is carried out well by VRA.

4.2.2 Irrigation System

The irrigation system of KIS consists of gravity and pump lifting systems. The main features of KIS

are the irrigation canal construction in low and high level areas in Akuse and Asutsuare. The high level area has been cultivated for a banana plantation under Golden Exotic Ltd. for the last three years. Fig. C. 13 indicates the whole system layout of KIS. Irrigation canals of a total length of 43.4 km are as follows:

Table 4.2.2 Canal System of KIS

Irrigation canal	Discharge	Length (km)	Canal protection
1. Akuse main canal	4.1–7.2 m^3/sec	16.2	Earth lining
2. South lower level canal	3.88 m^3/sec–end (1.46 m^3/sec downstream of pump station)	5.3	-do-
3. North lower level canal	0.46 m^3/sec–end	5.1	-do-
4. Distributary Z		8.1	-do-
5. Distributary Y		3.0	-do-
6. High level canal	2.42 m^3/sec (at present, Golden Exotic Ltd.)	5.6	-do-

Source: KIP office, GIDA (Edited by JICA)

Night storage reservoirs are located in the Akuse and high-level areas. In the Akuse command area, night reservoirs are located at the lateral canal of AK/C2, AK/C3, AK/C4 and AK/C5 to hold the total daily irrigation requirements for each lateral canal. During the 12 hours of daytime operation, lateral canals draw water from the night storage reservoirs. A total of five night reservoirs were constructed along the high level canal, but since 24-hour irrigation has became practicable, night reservoirs have not been utilized. Meanwhile, night reservoirs are effectively utilized for the pressurized irrigation system (micro drip system) at the banana estate along the high level canal. The reservoirs are essential to constantly supply irrigation water to the farm due to a shortage and fluctuation of the water supply through the Akuse Main Canal.

As explained above, the maximum flow discharge of 7.2 m^3/sec has not been diverted due to a shortage of flow capacity of the irrigation canal. The shortage of the flow capacity is due to the narrow flow area of the canal caused by sedimentation, especially downstream of the diversion point of the south and north lower level canals. It is therefore necessary to protect the canal with concrete lining to secure flow capacity. Check gates located immediately upstream of the siphons have been well maintained.

4.2.3 Drainage System

An insufficient drainage canal slope corresponding to the natural terrain causes water logging in the farmland in KIS. In addition, the narrow and unstable maintenance road along the drainage canal hinders smooth mobilization of machinery and equipment. Heavy weeding in the drainage canal also causes insufficient flow capacity of the canal. It is therefore necessary to improve drainage conditions.

4.2.4 Irrigation Canal

Existing irrigation canals are lined with concrete to secure flow capacity. Table 4.2.3 shows details of

the lining work.

Table 4.2.3 Canal Lining Work of KIS

	Location	Station	Width (m)	Height (m)	Lining (m)	Length (km)
1.	Akuse main canal	(CH 0.0–1.40km)	4.7	2.10	0.10	1.40
		(CH1.40–2.23km)	4.7	2.25	0.10	0.83
		(CH 2.23–5.88km)	4.7	2.25	0.10	3.65
		(CH 5.88–7.70km)	4.0	2.05	0.10	1.82
		(CH 7.70–12.69km)	3.5	2.20	0.10	4.99
		(CH 12.69–16.10km)	3.5	2.00	0.10	3.41
2.	South Lower Level Canal	(CH 0.000–2.201km)	4.57	1.70	0.10	2.21
		(CH 2.201–3.259km)	3.96	1.30	0.10	1.33
		(CH 3.259–5.286km)	3.96	1.00	0.10	2.03
3.	North Low Level Canal	(CH 1.25–1.50km)	3.35	0.75	0.10	0.25
		(CH 1.591–2.344km)	2.44	0.80	0.07	0.75
		(CH 2.344–2.940km)	1.83	0.85	0.07	0.60
		(CH 2.940–3.351km)	1.52	0.90	0.07	0.41
		(CH 3.351–4.553km)	1.22	0.95	0.07	1.20
		(CH 4.553–6.437km)	0.91	0.85	0.07	1.88
4.	Distributary Z	(CH 0.00–0.544km)	2.13	0.85	0.07	0.54
		(CH 0.544–3.769km)	1.83	0.85	0.07	3.23
		(CH 3.769–4.229km)	1.52	0.90	0.07	0.46
		(CH 4.229–6.759km)	1.22	0.60	0.07	2.53
		(CH 6.759–8.130km)	0.91	0.70	0.07	1.37
5.	Distributary Y	(CH 0–0.346km)	1.52	0.85	0.07	0.35
		(CH 0.346–0.732km)	1.22	0.90	0.07	0.39
		(CH 0.732–1.149km)	1.22	0.55	0.07	0.42
		(CH 1.184–2.031km)	0.91	0.80	0.07	0.847
		(CH 2.058–3.074km)	0.91	0.50	0.07	1.02
6.	High Level Canal	(CH 0–2.080km)	3.50	1.70	0.10	2.08
		(CH 2.080–5.035km)	3.00	1.50	0.10	2.96
		(CH 5.035–5.615km)	2.50	1.30	0.10	0.58

Note: Canal dimensions are taken from the contract drawing of KIP.

The canal section of the rehabilitation (concrete lining) adheres fundamentally to the original design section for the reasons below even though a smaller section can maintain sufficient flow capacity with improvement of the roughness coefficient by the concrete lining. The concrete lining is extended to approximately 0.2–0.3m above the design water surface. The earth surface free board is additionally maintained according to the original design free board depth of about 0.7 m.

1) Because of the existing division gates, the siphons don’t need to be rehabilitated, from an economical point of view, so the canal section shall conform to the original design to avoid a change of the hydraulic conditions.

2) In the case where the canal section is reduced corresponding to the roughness coefficient improvement, it is necessary to fill earth materials below the canal bed and behind the side slopes. It is preferable not to place concrete lining material on the filling materials so as to avoid cracks and uneven settlement caused by consolidation of the materials by water weight (20 kN/m^2).

A hydraulic profile in the cases of unlined and lined irrigation canals are indicated in Fig. C.6.(2) and C.6.2.(3), respectively. The water level shall be controlled by the check gates located immediately upstream of the siphons and additional check gates in the south and north low level canals.

4.2.5 Flow Control Devices

Flow control devices are listed below. Check gates are additionally installed in the south and north low level canals to maintain the water level. The water level is controlled by gate opening. Spillways and emergency outlet channels are installed immediately upstream of the gates and siphons from viewpoint of safety.

Regarding bridges for not only cattle but for local residences too, five canal bridge culverts parallel to the KIS canal are planned to be installed for this purpose.

(KIS)

Check gate

1.	Main canal	:	1	site	(W 2.0 m × H 2.0 m × single)
2.	-Do-	:	11	sites	(W 1.5 m × H 1.5 m × single)

Division gate

1.	Main canal	:	10	sites	(W 1.5 m × H 1.5 m × single)
2.	-Do-	:	35	sites	(W 1.0 m × H 1.0 m × single)

Spillway, outlet : 7 sites

4.2.6 Drainage Canal

Table 4.2.4 shows details of the drainage work. The locations of the drainage improvement work are indicated in Fig. C. 14 in Annex C.

Table 4.2.4 Drainage Improvement Works

	Location	Descriptions	Flood discharge (m^3/sec)	Length (km)
1.	Lupu main drain	Existing drainage channel is widened to increase flow capacity.	5	5.0
2.	Lupu-Klebwe outfall		5	1.0
3.	Klebwe outfall		5	1.5
4.	Sopa drain		3	2.5
5.	Sopa- Kasu link drain		5	2.0
6.	Kasu outfall drain		5	1.5
7.	Kasu drain outlet		15	2.0
8.				10.0
9.				9.0

4.3 Land Development

As shown on the figure below, paddy fields are developed to cover 10 ha (200 m × 500 m) in principle. Farm roads 4.0 m wide, and 0.5 m × 0.5m on-farm canals and drainage canals are provided by the project. About 3,000 m^3 of earth moving is required for the land levelling work. Top soil shall be repeatedly moved to the vicinity field. Compaction by bulldozer carried out ten times effectively improves permeability of the paddy field comprised of sandy materials. Furrows shall be constructed by man-power.

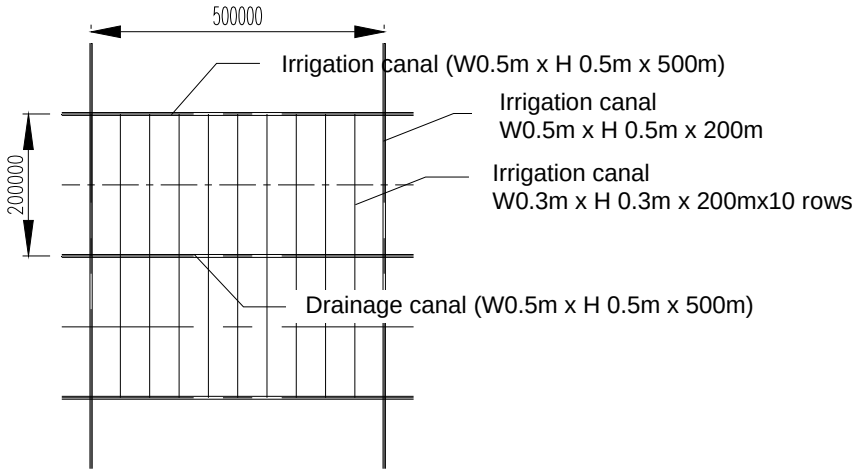


Fig. 4.3.1 Plan of Land Development

4.4 Workshops for Agricultural Support and OMM

4.4.1 Plant and Equipment for Agricultural Support Service

(1) Basic Concept of Agricultural Support Service

Currently, most of the GIDA irrigation project, including KIP, provides agricultural support service, as mentioned below. In general, farming machinery, post harvest, and marketing services are provided through a combination of project work, farmer's organization, and private sector. Due to the limitation of capacity of public service and private actors, including private millers, the needs of farmers are complimented by farmers who own extra tractors, middlemen, traders, etc.

- Technical extension
- Farming machinery service (land preparation, harvesting, carting)
- Input supply service (fertilizer, chemicals, seeds, etc.)
- Post harvest service (Drying, rice husking and milling)
- Marketing service (storage, packing and sales)
- Farming credit (facilitation for access to ADB credit)

Large-scale farms are used to covering all farming and marketing activities by their own means as well as preparing initial investment. They are also expected to provide some services, such as post harvest and marketing, to neighbouring small and medium-scale farms. Especially within the Private Development Block, small-scale farmers are expected to be involved in the out-grower system of

large-scale farms (Agribusinesses), which will provide necessary support from extension to marketing services under the contract. Thus, the project will consider only small-scale and medium-scale farms in the Public Development Block. Small-scale farmers in the Public Development Block are expected to be recruited from the community and primarily lack experienced in irrigation agriculture as well as rice production. They require agricultural support service to begin and continue their farm management.

Medium-scale farmers are expected to be experienced in irrigation agriculture and to have prepared agricultural machinery using their own capital, at least a tractor with an attachment for land preparation. This class of farmer is expected to act as anchor farmers in the project area who will contribute to enhancing the capability of farm management for neighbouring small-scale farmers through technical extension, providing mechanical service, and marketing, as well as water management within the secondary/lateral block.

1) Extension Service

Technical extension service is provided by the project and it targets both small-scale and medium-scale farmers. The extension work will be carried out in combination with day-to-day communication between farmers and extension officers, and events such as technical seminars and field demonstration. The farmer association will be expected to be a receiver of extension service as well as a coordinator of recipient farmers. Medium-scale farmers are expected to complement the activity of the extension officers through day-to-day communication with small-scale farmers.

2) Machinery Service

Land preparation (tractor service), carting service and harvesting service are considered to be provided by agricultural support service. Due to their limited capital, small-scale farms need to be supported in all mechanizations. Medium-scale farms are expected to have a tractor, but rice combine harvesters are rather difficult to introduce at the beginning stage.

Currently, mechanical service is provided by existing private service providers, such as private Agricultural Mechanization Services Centres (AMSECs) and individual tractor owners in and around the project area. The capacity of machinery service of the private sector is expected to increase due to such factors as existing private service providers' increasing their amount of machinery through capital increase, new private service providers coming from outside the project area, middle-scale farms (anchor farms) and large-scale farms (agribusiness) providing service with extra capacity of machinery, and some farmers starting to introduce machinery by applying the governmental subsidy. In the project, it is assumed that 50% of needs will be satisfied by the private sector, and that the project is necessary to meet the remaining 50% of needs.

3) Input Supply Service

Input supply service is usually provided in combination with agricultural credit.

4) Post Harvest Service

Small-scale farmers are drying paddies using sun light on the ground. In order to reduce loss in drying work as well as to increase work efficiency, drying floors are to be allocated at an accessible distance from farms. A simple warehouse or shelter is to be equipped for each drying floor to shelter the plants from rain as well as to regulate the regular rice commodity chain. After controlling moisture, paddies will be transferred to a processing station or sale-collection point of a rice company, medium or large-scale farm in the project, private service provider, etc. A small milling unit for self-consumption rice is to be equipped at each drying floor shelter, as well.

Medium-scale farms are expected to equip the necessary space, warehouse, and dryer if necessary, within their farms. Milling service is expected to be provided by the private sector, such as large-scale commercial farms in and around the project area, as well as private rice millers, intermediaries, traders, wholesalers, etc.

5) Agricultural Credit

Agricultural credit is essential to keep farm management going, especially for small-scale farms. Currently, agricultural credit is mainly provided by Agricultural Development Bank (ADB). According to the experience in KIP in recent years, farmers are eager to have agricultural credit for inputs (seed, fertilizer, and chemicals) but it is difficult for many farmers to access credit due to a lack of collateral. Actually, only 336 farmers qualified for ADB credit in the major season of 2010, which covers approximately 300 ha, whereas the total cultivated area is 1,652 ha.

The project is expected to facilitate farmer's access to agricultural credit, though it is not realistic that the project will provide credit directly. The block farm program may be enhanced by MoFA and the project may endorse collateral for ABD credit for small-scale farms.

Table 4.4.1 Agricultural Support Service Necessary to be provided by the Project

Service Contents	Public development block		Private development block	
	Small-scale farm	Medium-scale farm	Small-scale farm	Large-scale farm
1. Extension service	■	■		
2. Machinery Service				
2-1. Land Preparation	●	–		
2.2. Harvesting	●	▲		
2-3. Carting	●	–		
3. Input Supply Service	●	▲	–	–
4. Post Harvest Service			Provided by large-scale farm	Provided by himself
4-1 Drying	●	▲		
4-2. Rice Milling	●	▲		
5. Marketing Service				
5-1. Storage, Packing and Sales	●	–		
6. Agricultural Credit				
6.1. Facilitation to ADB credit	■	–		

■: Provided by the project

●: Provided by the project in combination with local private service provider
▲: Partially provided by the project in combination with local private service provider
－: Not necessary to be provided by the project

(2) Plant and Equipment for Agricultural Support Service

In order to estimate necessary plants and equipment for agricultural support service, the following conditions and assumptions were applied:

1) Extension Service

In the newly developed area, one extension officer is assigned to each group of two secondary blocks (public developed block) with a transportation means such as motorbike. At the beginning stage of the project, it is necessary to assign additional staffs to enhance the officers' activity in order to support farmers beginning their irrigation agriculture by closer communication. In the existing KIS area it is necessary to increase the number of extension officers due to the enlargement of the irrigation area and to provide the required accurate water management.

2) Machinery Service

Land preparation (tractor service) and carting service:

- Small-scale farms are to be the target of land preparation and carting service.
- Existing private service providers in and around the project area, which consist of private AMSECs and individual tractor owners, as well as farmers with their own machinery, will occupy 50% of the land preparation and carting work of small-scale farms.

Harvesting service (Rice combine harvester):

- Small and medium-scale farms are to be the targets of harvesting service by the project.
- Existing private service providers and farmers with their own machinery, as well as manpower, will occupy 50% of the harvesting work of small and medium-scale farms.

3) Post Harvest Service

Drying floor: Drying floors are to be allocated at an accessible distance from small-scale farms. In consideration of the work distance and transportation means of farmers, which is carting by tractor or handcart, drying floors are designed to be allocated for each 50 ha of paddy fields. A small rice milling unit for self consumption is to be equipped at each drying floor.

The estimated plants and equipment for agricultural support service are shown in Table G.3 in Annex G. The plants and equipment will be scheduled to be installed according to the increase of rice production by the progress of the project.

4.4.2 Plant and Equipment for Maintenance Work

The responsibilities for the maintenance of infrastructure of the irrigation schemes would be demarcated principally in such a way that:

- The projects (KIP and SMC) would take responsibility for intake facility, main and secondary canals, main and secondary drainage, other main infrastructures such as roads,
- Small and medium-scale farmers would take responsibility for lateral-level facilities, including canals and drainages,
- Large-scale farms would take responsibility for all on-farm facilities.

The amount of major facilities to be maintained in the irrigation schemes are:

KIS

- Intake facility 1
- Main canal 16.2 km (concrete lined)
- Secondary canal 27.1 km (concrete lined)
- Main drainage 48.4 km, of which 8.4 km would be rehabilitated in the project
- Road and others

NDIS

- Intake facility 1
- Main canal 69.1 km (concrete lined)
- Secondary canal 115.5 km (concrete lined)
- Main drainage 33.5 km, of which 8.4 km would be rehabilitated in the project
- Road and others

In order to keep the function of the irrigation scheme as designed, and secure appropriate water distribution to each farm, it is essential to maintain the facilities effectively and efficiently. Because of huge amount of facilities to be maintained, it is essential for projects to equip adequate plants and equipment for maintenance work. It is necessary to provide mechanical service under the contract to small and medium-scale farmers and Farmers Cooperatives for maintaining lateral-level infrastructures as well.

The proposed plants and equipment for maintenance work is shown in Table G.4 in Annex G. Those plants and equipment deployed to the projects would be operated and maintained in the mechanical workshop of each project. The existing KIS workshop would be used as it is and a new workshop would be developed for NDIS.

Chapter 5

Initial Environmental Examination (IEE)

Chapter 5 Initial Environmental Examination (IEE)

5.1 Comparative Examination of Alternatives

(1) Proposed Project

The outline of the proposed project is as follows at this stage:

- About 2,500 farmers (small holder, emerging farmer) and the private sector (Agri-business) will be working on the plains after the completion of the project.
- Planned irrigation area is about 11,000 ha in total;
  - KIS (Kpong Irrigation Scheme): 4,100 ha,
  - No. 1 Area (Norboyita area):2,700 ha,
  - No. 2 Area (1st Priority area + Prairie area):4,200 ha.
- Construction of New Irrigation Water Intake (Outlet from the Kpong Dam Reservoir).
- Construction of New Irrigation Canal (about 70 km) including partial siphon.
- Drainage.

(2) Alternatives to the project, including the option of not adopting the project

The alternatives to the project are summarized below:

Table 5.1.1 Summary of Alternatives

Alternatives	Description
Adopting the project 【Case 1】 New development area (NDIS) only, excluding existing KIS.	- Meteorology: No adverse impact is expected. - Hydrological Situation: Water loss from canal is expected because the existing canal of KIS has so many places to be rehabilitated. - Eco-System: The project area does not include the wetland ecosystem (lake and pond). However, wetland conditions are likely to change if runoff from farmland comes into the lake and pond in the wetland area. - Livelihood: Animal husbandry is one of main sources of the local economy. Irrigation canals are likely to block cattle grazing unless cattle crossing points are provided. - Involuntary resettlement: No involuntary resettlement is expected at the present stage, because irrigation canals don't pass through or near the existing communities.
Adopting the project 【Case 2】 NDIS and improvement of KIS by concrete lining of the main canals.	- Meteorology: No adverse impact is expected. - Hydrological Situation: Water loss will be minimized by constructing concrete lining. - Eco-System: The project area does not include the wetland ecosystem (lake and pond). However, wetland conditions are likely to change if runoff from farmland comes into the lake and pond in the wetland area. - Livelihood: Animal husbandry is one of main sources of the local economy. Irrigation canals are likely to block cattle grazing unless cattle crossing points are provided. - Involuntary resettlement: No involuntary resettlement is expected at the present stage, because irrigation canals don't pass through or near the existing communities. - Proposed gravity irrigation area covers a total of about 11,000 ha of the Accra Plains. This alternative may be one of the methods to enhance food security and the development of agro-based industries. However, since the target area of this alternative consists of vast plains, and there is some possibility of adverse impacts, it is necessary to take account of environmental and social

	considerations, and to minimize and mitigate adverse impacts.
Adopting the project 【Case 3】 Combined plan of NDIS and KIS as one new main canal. Existing KIS intake and canal are abolished.	- Meteorology: No adverse impact is expected. - Hydrological Situation: Water loss will be minimized by constructing concrete lining. However, existing KIS facilities, such as the water intake and main canal need to be abolished. In this case, construction waste will be generated. Therefore, it can be said that Case 3 has a greater negative impact than Case 2. - Eco-System: The project area does not include the wetland ecosystem. However, wetland conditions are likely to change if runoff from farmland comes into the lake and pond in the wetland area. - Livelihood: Animal husbandry is one of main sources of the local economy. Irrigation canals are likely to block cattle grazing unless cattle crossing points are provided. - Involuntary Resettlement: No involuntary resettlement is expected at the present stage, because irrigation canals don't pass through or near the existing communities.
Not adopting the project	- No action will be taken. Under this scenario, only 3,354 ha of the Accra Plains will be under irrigation. Vast sections of the plains will be under various uses, including small-scale farming. Therefore, the impact of these activities on major eco-systems will be insignificant. However, it may not be in line with Ghana's agriculture policy on food security or the millennium development goal for the reduction of hunger.

5.2 Possible Adverse Environmental and Social Impacts

No extensive involuntary resettlement is expected. The route of the main canal and road has been selected to pass though the high elevated area along the hilly area in order to increase the gravitational irrigable area as much as possible. Normally, residential areas and villages are located in the flat area along the Volta River, but there are very few houses located in the hilly and high elevated area, where the new main canal and road are planned to locate. Therefore, in general, large-scale involuntary resettlement will not be necessary in this project implementation, although a few houses might need to be shifted or replaced in cases where the layout of the new canals and roads might cross some residential area.

The new irrigation water intake might not affect the intrusion of salt water into the Volta River. The peak irrigation water intake from the Kpong Dam is estimated to be 11.4m3/sec for NDIS, 7.2m3/sec for KIS, or a total of 18.6m3/sec. The amount of the peak intake corresponds to 1.55% compared with the water release from the hydro-power generation capacity of 1,200 m3/sec. However, the duration of the peak intake period will be limited to within a few days. The daily average water intake from the Kpong Dam is estimated to be 7.6 m3/sec, which is 0.63 % of the water for hydro-power generation.

Such a small percentage of water intake upstream of the Kpong Dam will have almost no effect on the intrusion of salt water downstream of the Volta River. However, occasionally there will be a water release shortage from the Kpong Dam to downstream of the Volta River caused by time lag and power demand of water release for hydro-power generation between the Akosombo Dam and Kpong Dam. The problem of the salt water intrusion downstream of the Volta River should be considered by and be the responsibility of VRA. Fortunately, VRA is a member of Water Resources Commission (WRC), which regulates and manages the utilization of water resources in Ghana. VRA utilizes water

resources based on the strategy for Integrated Water Resources Management (IWRM) for the sustainable utilization of the nation's water resources. Therefore, it is likely that VRA is considering reducing salt water intrusion downstream of the Volta River.

The adverse impact that may be caused by the implementation of the project is shown in Table F.1 in Annex F. The extent of possible adverse impacts at each phase of the project is shown in Table 5.2.1.

Table 5.2.1 Extent of Possible Adverse Impacts at each Phase of the Project

	No	Items	Overall Rating	Planning	Construction Phase				Operation Phase			
				Land acquisition	Intake (Outlet from Kpong Dam Reservoir)	Irrigation canal (siphon)	Drainage	Operation of Construction Equipment and Vehicles	Land Clearing and Levelling	Usage of Irrigation Water (Water Sharing)	Substantial Change in Farming System	Increase influx of settlers
Social Environment	1	Involuntary Resettlement	B	B								
	2	Local economy such as employment and livelihood, etc.	B+	B	B	B	C		B		C	B+
	3	Land use and utilization of local resources	B+			B	C	C	B		C	B+
	4	Social institutions such as social infrastructure and local decision-making institutions	B+	B		B			B		C	B+
	5	Existing social infrastructures and services	B+	B		B	B	C				B+
	6	The poor, indigenous and ethnic people	B	B		B			B			B
	7	Misdistribution of benefit and damage	B	B		B			B	B	C	B
	8	Cultural heritage	B	B		B	B		B			B
	9	Local conflict of interests	B	B		B	B		B		C	B
	10	Water Usage or Water Rights and Rights of Common	B	B		B	C		C	B		B
	11	Sanitation	B			B	B					B
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B+		B+	B+	B+		C			B+
Natural Environment	13	Topography and Geographical features	B+		B	B			B+			
	14	Soil Erosion	B+		B	B+	B		B+			B
	15	Groundwater	B			C	C		C		B	
	16	Hydrological Situation	B			B	C		B	B		
	17	Coastal Zone	C							C		
	18	Flora, Fauna and Biodiversity	B		B	B		C	B	B	C	B
	19	Meteorology										
	20	Landscape （ Aesthetic value）	B						B			
	21	Global Warming										
Pollution	22	Air Pollution	B					B	C		C	
	23	Water Pollution	B+		B	B			B		B+	B
	24	Soil Contamination	B+					C			B+	
	25	Waste	B		B	B	B					B
	26	Noise and Vibration	B					B				B
	27	Ground Subsidence										
	28	Offensive Odour	B					B				
	29	Bottom sediment										
	30	Accidents	B					B				B

Rating: A: Serious impact is expected.
B+: Adverse impact is expected to be smaller than A, but some impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)
No mark: No impact is expected. IEE/EIA is not necessary.

5.3 Mitigation and Monitoring for Key Impacts

The assumed mitigation measures for the adverse impacts are shown in Table F.2 in Annex F.

5.4 Proposed Additional Study for EIA during F/S

(1) To hold Public Consultations

At the time of an Environmental Impact Assessment Study (5,000 ha as a 1st Priority Area), public consultations took place from 29th July to 12th August, 2009, and the key stakeholders of the North Tongu District participated (including the District Assembly, District Agriculture Directorate, Health Experts, councillors of communities, traditional rulers of communities, farmers and residents, others concerned).

The project area of APGIP covers not only the North Tongu District, but also Dangme East District and Dangme West District. Therefore, public consultation meetings need to be held in these two Districts as well.

(2) To undertake an Environmental Impact Assessment Study, including a study on wetland

An Environmental Impact Assessment Study (5,000 ha as a 1st Priority Area) was carried out at the time of the Feasibility Study of the Accra Plains Irrigation Project (Detailed Feasibility Study for the 5,000 ha). As a result of the Study, negative impacts were identified, and mitigation measures were established to prevent or minimize negative impacts. However, this study does not cover other areas, such as the No. 1 Area (Norboyita area) or KIS (Kpong Irrigation Scheme area). Therefore, an additional Environmental Impact Assessment Study needs to be carried out covering the whole project area of the Accra Plains Gravity Irrigation Project (APGIP). The scope of the Study needs to be in line with the requirements of the Environmental Protection Agency (EPA), Ghana.

The project area is not located in the National Parks or Protected Area, but a wetland consisting of lakes and ponds extends near the No.1 Area (Norboyita area). The wetland is likely used not only as a fishing point for the communities, but also as habitats for wildlife. However, since an environmental study or research has not been conducted yet in this area, the value or importance of this wetland is not clear. Therefore, an Environmental Study on the wetland near the No. 1 Area (Norboyita area) may be necessary.

(3) To respect traditional religious objects

There are seven culturally sensitive areas within the project area which may be affected by the development of the irrigation fields. Out of the seven, six are sacred groves covering an area of about one acre each while the remaining one is a sacred rock. In order to respect the traditional religious objects, the land around the culturally sensitive areas should not be acquired. The irrigation canals need to make a detour around those culturally sensitive areas. New settlers need to be informed of the presence of culturally sensitive areas, so that they can understand and respect traditional culture.

(4) To consider the existing water distributing pipe network being laid underground

All the communities in the project area have access to pipe-borne water through community standpipes provided under the Three District Water and Supply Scheme. The project is being implemented by the Community Water and Sanitation Agency in the Dangme West District, Dangme East districts and North Tongu District. There are two water intakes near Aveyime town in the Volta River. New irrigation canals are thought to cross those water distributing pipes laid underground. Therefore, it is necessary to collect information on the existing water distributing pipe network.

(5) To provide Cattle Crossing Bridges

Animal husbandry is one of the main sources of the local economy. Irrigation canals area likely to block cattle grazing unless cattle crossing points are provided. Therefore, when designing irrigation canals, cattle crossing points need to be provided at the planning phase and temporary cattle crossing points need to be provided at the construction phase.

(6) To study an effective and feasible Monitoring Plan

Irrigation development promotes farm production during the dry season. It signifies a possible increase in usage of chemical fertilizers, pesticides, and herbicides. As a result, overuse of those chemicals may cause water pollution and soil contamination. Therefore, it is necessary to study an effective and feasible monitoring plan.

Chapter 6

Possible Options of Organization and Management

Chapter 6 Possible Options of Organization and Management

6.1 Introduction

The term “Public-Private Partnership” (PPP) describes a range of possible relationships among public and private entities in the context of infrastructure and other services. The idea of involving private investors and managers in the irrigation sector was debated in the hope that private partners would bring efficient management skills, fresh funds, and relief of government responsibility.

PPP allocates the tasks, obligations, and risks among public and private partners in an optimal way. In order to make PPP effective, each partner should have certain advantages, relative to the other, in performing specific tasks. At the same time, the structure of the partnership should be designed to allocate risks to the partners who are best able to manage those risks. Because the possible relationships between public and private partners vary greatly and there are no fixed paths, it is necessary to have careful discussion among the stakeholders during the process of designing the PPP mechanism in the project.

Regarding the management of the irrigation system in APGIP, the PPP approach can be applied to any field of the project, in theory, such as development, operation and maintenance of the irrigation system and related infrastructure, development of the agricultural field, management of farming and marketing, and providing irrigation service and agricultural support to farmers. To discuss and design the PPP mechanism for the project, it is necessary to understand the possible private partners and to have careful and deep discussion with them to identify their intentions toward investment as well as their business idea; however, this is outside the scope of the study, and to be left to the succeeding market test and detailed PPP study for APGIP, which are expected to be held by WB. Considering the above situation, possible options of organization and management of APGIP were examined in this study in order to provide some materials for starting the discussion.

The aspects to be discussed on the irrigation system management are:

- Land ownership
- Irrigation users
- Development of land and irrigation infrastructure
- Management of irrigation system
- Agricultural support service
- Irrigation service charge and other fees

6.2 Land Ownership

KIS

Land of the existing KIP area is owned by GIDA/GOG. (it was acquired by GIDA/GOG when development started and allocated to farmers under lease contracts (Land Allocation Agreements between KIP and farmers).

NDIS

Development land for NDIS can be:

a. Owned by GIDA/GOG and rented to users.
   This is the conventional method, and is the same as the procedure applied in KIP.
b. Land owners maintain ownership during the project period. GIDA will acquire long-term land leaseholds with exclusive attorneyship by premium payments of one-third of the land value to land owners. After development of land, land users pay the land rent fee to the land owners through GIDA annually, based on the contracts between the land users and GIDA. In the 2nd Area, GIDA has started *sensitization* and negotiations with land owners under this condition.

6.3 Irrigation Users

KIS

Irrigation users and Land Allocation Agreements of KIP are to remain as they are. All small-scale farmers in KIS are organized into the Osudoku Farmers Cooperative. A low recovery ratio of ISC from small-scale farmers shall be solved to improve KIP's performance. In addition, it is necessary to discuss that ISC payment of the banana estate (Golden Exotic Ltd) shall be connected to KIP's Internal Generated Fund (IGF) in order to strengthen and stabilize the financial situation of KIP.

NDIS

The irrigation users invited to NDIS will be categorized into three farmer types, i.e., small-scale, medium-scale and large-scale farmers.

Table 6.3.1 Farmer Types of Irrigation Users

Object	Self consumption and commercial	Commercial	
Farmer Type	Small-scale	Medium-scale	Large-scale
Farming Type	Self consumption/ Local market or functioning as out-grower of agribusiness	Domestic market	Domestic/ Export Agribusiness
Size	1–2 ha Represented by 1.5 ha	10–30 ha Represented by 20 ha	One unit: 50–100 ha
Support Services	Necessary for support service fully or partially		Not necessary/ individual

6.4 Development of Land and Irrigation Infrastructure

The issue in the construction of irrigation infrastructure is how to demarcate the investment between the public and private sector. As the situation is different between the rehabilitation of existing infrastructure and new development of the irrigation scheme, KIS and NDIS shall be discussed separately.

KIS

Considering the history of the development of KIS, it is reasonable that the public sector is to cover the investment for rehabilitation, except for the area of the banana estate. As for the banana estate, only the main and secondary canal up to the pump station are to be rehabilitated by the project,

whereas the pumps and canal network after the pump shall be maintained by the farm.

Table 6.4.1 Options for Demarcation of Rehabilitation of KIS

Options	Stakeholders	Main canal	Secondary canal	Lateral canal network	Land development
Rehabilitation	Public (GIDA)	●	●	●	
	Small-scale farm			▲ Partially (Labour contribution)	▲ If necessary
	Banana Estate (Large-scale farm)		● After pump station	●	● Expansion area

NDIS

(1) Concept of Land Development

GIDA is preparing the new policy of land allocation in the large-scale irrigation development, which will be reflected to the amendment on the Regulation of GIDA (L.I.1350). According to the new policy, at least 30% of the developed land shall be allocated to local (and recruited) small holders when a private investor develops the land utilizing public irrigation water, for the purpose of securing the livelihood of local small holders. When the government develops the land, 30% of the developed land is recommended to be allocated for commercial farms, in consideration of the promotion of commercial farming.

In consideration of GIDA's new policy, a *Private Development Block* and *Public Development Block* are proposed to be introduced in NDIS. The land of NDIS will be divided into a number of secondary blocks, the size of which is expected to be 100–300 ha depending on the geographical and irrigation network conditions. Those secondary blocks are considered hydraulically independent under the main irrigation system. Thus they are able to be managed independently. Some of the small blocks less than 100 ha would be combined into one block from the aspect of management size. Each secondary block would be categorized as *Private Development Block* and *Public Development Block*, depending on the type of development.

Private Development Block is to be developed by the initiative and investment of the private sector, such as agribusiness enterprise (Large-scale farm). Within the block, the large-scale farms occupy 70% of land for their own farming and the remaining 30% will be allocated to small-scale farms, which are expected to perform as out-grower farming or contract farming under the large-scale farms. Large-scale farms are expected to take care of the farming of small-scale farms and to provide agricultural support services, such as technical extension, input supply, mechanical service, post harvest and marketing under a contract.

In consideration of the target crops, the expected investors of the private development blocks are large-scale rice farm companies operating in and around the project area who intend to expand

business; rice processing and trading companies who intend to go into production; and investors who intend to go into rice cultivation. Those farms are expected to supply a value chain to the project area by equipping large-scale rice processing and storage plants on site or other places. In most cases, it is expected that such kind of companies intend to gather up rice produced around their farm for their commodity as well as to produce rice themselves.

Small-scale farmers in the *Private Development Block* are expected to sell their products to large-scale farms under an out-growing scheme or contract farming. The large-scale farms provide agricultural services to the small-scale farms, such as extension, input supply and mechanical service. In any case, depending on the policy and plan, large-scale farms are expected to contribute to the project area by supplying agricultural service and/or a value chain, and a farm which does not have such plan would be required to compensate by alternative means, such as additional payments for development and so on.

Potential investors need to be identified in the further study so that a deep and detailed discussion on the possible mechanism or relationship between large-scale farms and small-scale farms in the block will be started.

The Public Development Block is to be developed by the government (GIDA), and 70% of the land will be allocated to small-scale farmers and 30% will be allocated to medium-scale farmers. The project will provide agricultural support services, such as technical extension, mechanical service, post harvest, and marketing, to both small and medium-scale farmers through SMC. Medium-scale farmers are expected to lead farmer's organizations in the block as well, especially in the marketing activity. A farmer's organization formulated by all small and medium farmers in the project area is expected to play the role of marketing production. Some of the production is expected to be gathered up by the large-scale farms in the project area as well.

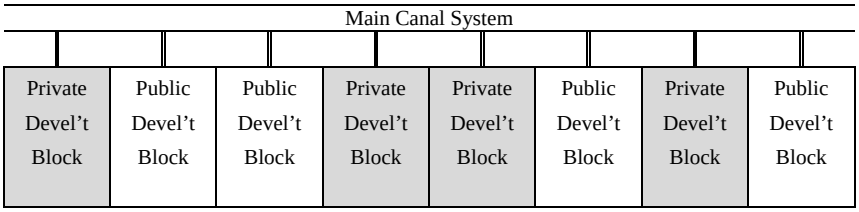
Most small-scale farmers recruited in the project are expected not to have any experience of irrigated agriculture. Thus, careful technical extension is vital, as well as providing mechanical service and other support.

It is expected that many farmers who have experience of irrigated agriculture or medium-scale farming, regardless of crop types, will come to the project as medium-scale farmers. Because of their experience and management skills, they are expected to act as anchor farmers in the block who will lead the introduction of appropriate farming technology and farm business. Medium-scale farmers are expected to possess agricultural machinery, at least tractors. Those who have extra machinery will provide machinery service to other farmers.

(2) Scenarios for Land and Block Distribution

The overall land distribution to each farmer type will be decided by the allocation of public and private blocks, which shall be decided in consideration of marketability and business plans of invited

large-scale farms, as well as the governmental policy. In the study, it is possible to set two scenarios of land and block distribution as shown below:



Scnario-1: Allocate Private Development Block 50% and Public Development Block 50%

Private Development Blocks	Public Development Blocks
Large-scale farms: 70%	Medium-scale farmers: 30%
Small-scale farmers: 30%	Small-scale farmers: 70%

← 50 % → ← 50 % →

In this scenario, small-scale farms will occupy 50% of the developed land, medium-scale farms occupy 15% and large-scale farms will occupy 35% in total (in other words, small holders: 50%; commercial farms, including medium-scale farms: 50%).

Scenario-2: Allocate Private Development Block 100%

Private Development Blocks
Large-scale farms: 70%
Small-scale farmers: 30%

← 100 % →

In this scenario, small-scale farms will occupy 30% of the developed land and large-scale farms will occupy 70% in total (in other words, small holders: 30%; commercial farms: 70%).

(3) Demarcation of Investment by Public and Private Sector

The construction of irrigation infrastructure of NDIS consists of main, secondary and lateral canal/drainage and land development. It is to be discussed how to demarcate the necessary investment between the public and private sector. The possible demarcations of public and private investment are shown in the table below.

In the case of rice development, the cost for land development becomes huge and it might be difficult for private investors (large-scale farm) to cover the land development cost for small-scale farms. Thus, there may be an option of burdening the public sector with the land development for small-scale farms in the private development block. (Option a-2)

Table 6.4.2 Options for Demarcation of Construction of NDIS

Options	Stakeholders	Main canal	Secondary canal	Lateral canal network	Land development
a-1. Private Development Block	Public	●	●		
	Small-scale farm				
	Large-scale farm		●After the boundary of block	●	●
a-2. Private Development Block	Public	●	●		● For small-scale farms
	Small-scale farm				
	Large-scale farm		●After the boundary of block	●	● For own farms
b-1. Public Development Block	Public	●	●	●	●
	Small-scale farm				
	Medium-scale farm				
b-2. Public Development Block	Public	●	●	●	●
	Small-scale farm				
	Medium-scale farm			●	●

6.5 Irrigation System Management

(1) Management organization

As for the structure of the management organization, it is theoretically possible to consider both types, i.e., introducing a unified management unit for KIS and NDIS under single organization and appointing management units individually. However, the unified management is not recommended in consideration of the history of KIS, the scale of irrigation schemes, and differences between users and their farming styles in KIS and NDIS.

The possible options for irrigation system management are to:

a. Appoint management units individually in KIS and NDIS

Individual management units in KIS and NDIS will have the advantage of making service contents and an irrigation service charge suitable for the conditions of each scheme, especially considering the differences between users and their farming styles. In this case, KIP will be appointed to the management unit of KIS. However, it should be noted that KIP needs to strengthen its management, so as to improve water management practice, and increase its effectiveness and efficiency. For NDIS, there are two options, i.e., i) establishing a GIDA project office (public management unit), and ii) hiring a private scheme management company.

b. Combine unified and individual management

Even though establishing individual management units has an advantage in the flexibility of services, it is worth considering to set-up an umbrella structure to improve the effectiveness and

efficiency of scheme management. There is an option that the appointed private Scheme Management Company of NDIS supervises the management of KIP so that the know-how or experience of private business will be transferred to KIP. This is the combination of unified management and individual management.

In this case, it is necessary to consider a contract for supervision between KIP/GIDA and the scheme management company.

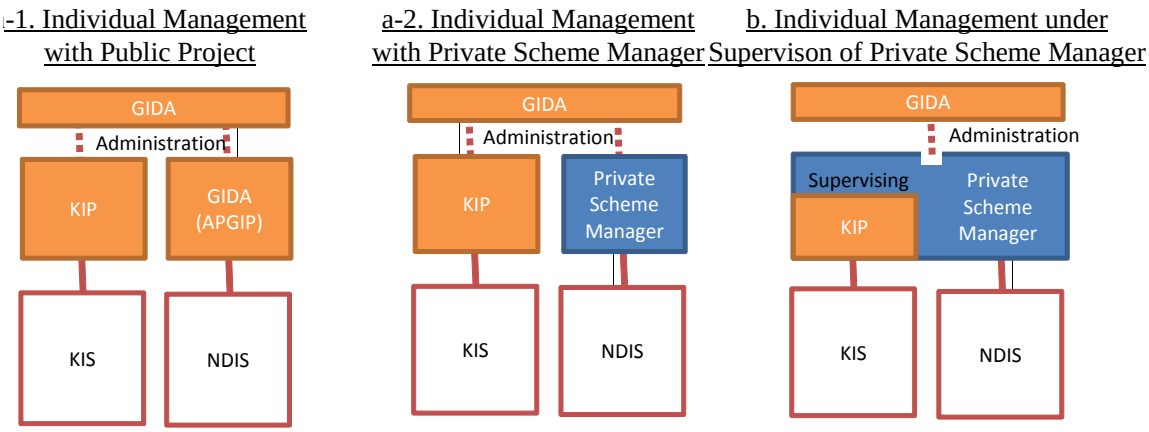


Fig. 6.5.1 Irrigation Management Organization

(2) Demarcation of Responsibility for Operation and Maintenance

Small-scale farms are responsible for the operation and maintenance of the lateral canal network, while the scheme management company and/or KIP are responsible for the canal system from the intake to the off-takes in the lateral canals. In case of medium and large farms, the scheme management company is responsible for the canal system from the intake to off-takes in the main canal or to the beginning of their farm territories, and the remaining parts are managed by small farms.

Table 6.5.1 Options for Demarcation of Operation and Maintenance

Scheme	Stakeholders	Main canal	Secondary canal	Lateral canal network	On-farm irrigation
KIS	KIP	●	●		
	Small holders / Association			●	●
	Private (Banana estate)		● After pump station	●	●
NDIS Private Development Block	Scheme Management Company	●	●		
	Small-scale farm			●	●
	Large-scale farm		● After the block boundary	●	●
NDIS Public Development	Scheme Management Company	●	●		
	Small-scale farm			●	●

Block	Medium-scale farm		● After the boundary of farm	●	●

(3) Water Management and Farmer's Organization

KIS

Osudoku Cooperative was formulated to cover all small holders in KIS, which has the function of a WUA as well as a Farmer-based organization (FBO) in KIS. Osudoku Cooperative is required to enhance its activity to cope with the increasing of its responsibility once the irrigation system enters full operation after rehabilitation. It can do so by enhancing the Lateral Group as well as the Branch/Block Group to manage minute water distribution and maintenance work.

NDIS

A new farmers association (Farmers Cooperative) is required to be formulated by all the farmers of NDIS.

In the Public Development Block, a Secondary Group would be formulated as a key sub-structure for managing the irrigation system in the Secondary Block under the Farmers Cooperative. The Secondary Group is expected to function as a WUA and take responsibility for the operation and maintenance of the irrigation system at the lateral level. ISC would be collected by the person in charge of the Secondary Group and paid all together to the scheme management company.

In the Private Development Block, large-scale farms would be the key entities for management of the irrigation system within the block. Large-scale farms and small-scale farms would formulate WUA through the Secondary Block. WUA takes responsibility for coordinating the distribution schedule, and for the operation and maintenance of the system. Small-scale farms would formulate a Lateral Group and carry out operation and maintenance at the lateral level.

(4) Collection of Irrigation Service Charge

The Irrigation Service Charge (ISC) is to be collected separately by the project management body, i.e., KIP, for KIS and by a private scheme manager for NDIS. The ISC price shall be set to cover the necessary cost for operation and maintenance of the irrigation system, including human expenses and administration cost, in principal. If it is difficult for new small-scale farmers to pay the full price of ISC from the beginning of their farming, it will be necessary to consider a governmental subsidy, but such subsidy shall be limited to the launching period of their farming.

6.6 Agricultural Support Service

The items to be examined in the agricultural support service are:

- Which kind of agricultural support service is to be provided by the project?
- Will a new private service provider be established/hired, or will the scheme management company cover agricultural support service?
- How can commercial farms in and around the irrigation schemes contribute to the provision

of agricultural support service?

Currently, most of the GIDA irrigation project, including KIP, provides the agricultural support service as shown below. In general, farming machinery, post harvest and marketing services are provided by a combination of the project, farmer's organization, and private sector. Due to the limitation of the capacity of public service, private actors, such as private millers, farmers who own extra tractors, intermediaries, and traders, complement the needs of farmers.

Service contents

1) Technical extension
2) Farming machinery service (Land preparation, harvesting, carting)
3) Input supply service (fertilizer, chemicals, seeds, etc.)
4) Post harvest service (drying, rice husking and milling, storage)
5) Marketing service (storage, packing and sales)
6) Farming credit (facilitation for accessing to ADB credit)

KIS

a. KIP provides agricultural support service as it is. The capacity of KIP shall be increased in order to meet farmer's needs.
b. KIP provides agricultural support service as it is. The scheme management company or a private service provider for the NDIS will contribute to compensate for any deficit of the capacity of KIP or local private entities.

NDIS

a. The scheme management company will cover agricultural support service as its activity.
   Advantage: Easy to secure ICS recovery.
   Disadvantage: The scheme management company will have a complicated business. Large investment is required for the scheme management company.
b. Hiring Private Service Provider
   Advantage: The scheme management company can concentrate on water management.
   Disadvantage: The scheme management company possibly faces difficulty in ISC collection.

Existing and newly-entering private millers and traders are also expected to contribute to meeting farmers needs. Large-scale commercial farms with extra capacity for post harvesting and marketing capacity, such as Prairie Volta Ltd., can be expected to contribute to the value chain of other farms.

Possible Demarcation for Kpong Irrigation Scheme

Small Holders

Kpong-Small

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance							
Ownership / concession		Public					
Investment &financing							
OMM			Farmers / Farmers Association				

Banana Estate

Kpong-Banana

	Main & secondary	Pump station	Canals in the farm	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance	Public						
Ownership / concession							
Investment &financing				Private (Banana Estate)			
OMM							

Possible Demarcation for Accra Plain Gravity Irrigation Scheme

Private Development Block

Small Scale Farm

Private-Small-1

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance	Public						
Ownership / concession		Private					
Investment &financing		(Large Scale Farm)					
OMM			Farmers / Farmers Association				

Private-Small-2

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance	Public						
Ownership / concession		Private					
Investment &financing		(Large Scale Farm)					
OMM	Private		Farmers / Farmers Association				

Large Scale Farm

Private Large-1

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance	Public						
Ownership / concession							
Investment &financing			Private (Large Scale Farm)				
OMM							

Private Large-2

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance	Public						
Ownership / concession							
Investment &financing			Private (Large Scale Farm)				
OMM	Private						

Public Development Block

Small Scale Farm

Public-Small-1

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance							
Ownership / concession		Public					
Investment &financing							
OMM			Farmers / Farmers Association				

Public-Small-2

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance							
Ownership / concession		Public					
Investment &financing							Private
OMM	Private		Farmers / Farmers Association				

Medium Scale Farm

Public-Med-1

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance							
Ownership / concession		Public					
Investment &financing							
OMM			Farmers				

Public-Med-2

	Main canal	Secondary canal	Tertiary canal	Land development	On-farm irrigation	Farm operation	Agricultural support
Governance							
Ownership / concession		Public					
Investment &financing							Private
OMM	Private		Farmers				

Fig. 6.6.1 Conceptual Diagram of Public and Private Demarcation of Irrigation System Management

Chapter 7

Cost Estimation

Chapter 7 Cost Estimation

7.1 Project Facility Plan

7.1.1 General

The construction site is composed of the NDIS and KIS area. The construction work is broadly classified into the construction of the intake, canal construction and land development in NDIS, and concrete lining work in KIS. In addition, both projects include drainage improvement work. The construction of the project office, workshop, garage for OM machinery and equipment, rice dryers and rice storage facilities is categorized as architectural work. Procurement of OM and agricultural machinery and equipment is also included in the project.

Local materials are available for all the work except the work for the gate hoist devices, which shall be imported from South Africa, for example, to ensure reliable quality for longer service life. The large-scale civil work, including that for the main and secondary canals, drainage canal excavation, maintenance, and farm roads, will be carried out mainly by the heavy construction machinery. The work for minor rehabilitation and small structures will be done by manpower with minor construction equipment.

7.1.2 Prominent Features of the Project

Tables 7.1.1 and 7.1.2 indicate the prominent features of the project.

Table 7.1.1 Prominent Features of the Project (NDIS)

	Items	Description	Length / sites
	NDIP		
1.	Main irrigation canal	Concrete lining (t=0.1m – 0.07m)	69.1 km
2.	Secondary irrigation canal	Concrete lining (t=0.07m)	115.5 km
		Conduits (dia. 600 – 800mm)	9.6 km
3.	Intake	2.0m × 2.0m × 3 lanes	3 sluice gate
4.	Siphon	2.5m × 2.5m	7 sites
5.	Drainage culverts	2.0m × 2.0m × 1 or 2 culverts	32 sites
6.	Road culvert	2.5m × 4.0m (double culvert) − 2.0m × 1.0m (single culvert)	266 sites
7.	Drainage work	Widening of drainage channel	33.5 km
8.	Spillway and outlet		11 sites
9.	Land development	Land levelling, canal construction	6,450 ha
10.	Agricultural facilities		
10.1	Dry floor	400 m^2/ site with partial roof	40 sites
10.2	Rice storage	100 m^2/ site	40 sites
10.3	Large rice storage	600 m^2/ site	1 site
11.	Project office, etc.		
11.1	Project office	420 m^2	1 site
11.2	Dormitory	400 m^2 (Project staff)	1 site
11.3	Workshop	600 m^2 (OM machinery repair)	1 site
11.4	Garage	600 m^2 (OM machinery and equipment)	1 site
11.5	Generator room		1 site
11.6	Toilet, fence, others		l.s.
12.	OM machinery and equipment		l.s.
13.	Agricultural equipment		l.s.

Table 7.1.2 Prominent Features of the Project (KIS)

	Items	Description	Length / sites
	NDIP		
1.	Main irrigation canal	Concrete lining (t=0.1m – 0.07m)	43.3 km
1.1	Akuse main canal		16.2 km
1.2	South Lower Level Canal		5.3 km
1.3	North Lower Level Canal		5.1 km
1.4	Distributary Z		8.1 km
1.5	Distributary Y		3.0 km
1.6	High Level Canal		5.6 km
2.	Road culverts	2.0m × 2.5m × 2	5 sites
3.	Drainage work	Widening of drainage channel	8.2 km
4.	Agricultural facilities		
4.1	Dry floor	400 m^2/ site with partial roof	43 sites
4.2	Rice storage	100 m^2/ site	43 sites
4.3	Large rice storage	600 m^2/ site	1 site
5.	OM machinery and equipment		l.s.
6.	Agricultural equipment		l.s.

7.2 Implementation Plan and Schedule

(1) Implementation plan

The original contracts are divided into several packages, including the package for building work, OM, and agricultural machinery/equipment procurement. Considering the urgent needs to rehabilitate the existing KIS irrigation systems, the package is recommended to be carried out in parallel with the main canal construction of NDIS in the extent of the Akuse main canal and the south low level canal. The north low level canal, distributaries Y and Z, and the high level canal are rehabilitated during the non-cultivated period in two rice cropping periods. As to the canal construction work, including the secondary canal of NDIS, there is no obstructive factor for the construction. The contracts of three to four packages are recommended considering the management capacity of the local contractors. It will be a significant achievement to secure quality control of the embankment of the main canal from 15 km to 30 km, where the canal is constructed on the relatively large embankment. Land-development work is composed of land levelling, lateral irrigation, drainage canal excavation, and farm road construction. Land development works are scheduled corresponding to the progress of the main and secondary canal construction for realizing earlier benefits.

(2) Implementation schedule

The number of monthly workable days for regular work, such as concrete work, and earthwork for the irrigation facilities, is estimated based on the rainfall data from 1990 to 2010. The estimate indicates that 25 days per month and 300 days per annum can be deemed as work days for the construction work.

Considering an appropriate construction capacity of the heavy machinery for the earthwork—mainly compaction of the embankment—and the concrete production capacity of the mixing plant, it is necessary to include periods for mobilization and demarcation of three years and two years,

respectively, in order to complete the NDIS and KIS rehabilitation work. It is preferable to complete the construction of the project offices, dry floor, and rice storage facilities at an early stage. Bidding for the procurement of OM, and for agricultural machinery and equipment shall be announced early to ensure a period for machinery assembly and shipping of at least eight months.

7.3 Project Cost Estimate

7.3.1 Assumptions

The following are assumptions of the cost estimates for both KIS rehabilitation work and NDIS:

1) Material costs were based on data in "Quantity Surveyor Issue 2, 2009, the Ghana Institution of Surveyors in 2090."
2) The exchange rate used in the estimates is US$1.00=GHC1.49
3) Construction cost is calculated on the basis of contracts with local contractors.
4) The physical contingency of 5 % of the total cost of the construction, equipment procurement, administration, and engineering services is included in the project cost.
5) Price contingency is also taken into account at an annual price escalation rate of 2.0 percent.

7.3.2 Project Cost

Project cost is comprised of following items:

1) Construction costs
   Construction costs are composed of direct cost, temporary and preparatory work, contractors' expenses, overheads, profit, etc. Direct temporary costs, such as mobilization/demobilization of the construction machinery and equipment, and concrete plant installation is inclusive in the direct cost.
2) Temporary costs
   Temporary costs are composed of the cost for temporary roads, a stockpile yard, dewatering, etc.
3) Site expenses
   Site expenses are the costs for the site office, material storage, warehouse, workshop, accommodation facilities, material test, topographic survey, salary for the contractor's employees, medical expenses, and other expenses necessary to accommodate the construction work.
4) Administration costs
   Detailed design and construction work is undertaken by GIDA with assistance and advice from a consultant. Administration cost is estimated at 1 % or 2 % percent of the construction cost of each project, taking required the technical level into account.
5) Engineering service costs
   Engineering service costs are estimated for the detailed design and construction supervisory work undertaken by consultants. The consultants technically assist and advise the GIDA staff during the detailed design and construction supervision period. Engineering cost is equivalent

to 5 percent of the construction work.

6) Physical contingency

   The physical contingency of 5 % of the total cost of 1), 2) and 3) above is taken into account.

7) Price contingency

   The price contingency of 2 percent per annum is taken into account.

7.3.3 Cost Estimates

The construction cost is composed of the direct construction cost, indirect cost, OM facility and equipment, agricultural equipment, land acquisition and compensation, administration, engineering services, physical contingency, and price contingency, as well as the tax. Project cost is summarized in Table 7.3.1 and 7.3.2 for NDIS and KIS, respectively.

Table 7.3.1 Project Cost (NDIS)

	Description	Amount (GHC'000)		Remarks
I.	Construction Cost			
	1. Main irrigation canal construction			
	1.1 Earthwork	11,009.6		
	1.2 Concrete lining work	13,386.1		
	1.3 Intake construction	760.4		
	1.4 Siphon construction	3,494.9		
	1.5 Drainage culvert construction	1,472.1		
	1.6 Road culvert construction	604.4		
	1.7 Gate installation	512.8		
	1.8 Spillway, outlet works	267.1		
	Subtotal 1	31,507.4		
	2. Secondary canal construction			
	2.1 Earthwork	2,337.2		
	2.2 Concrete lining work	6,286.6		
	2.3 Siphon construction	408.1		
	2.4 Road culvert construction	931.2		
	2.5 Gate installation	2,124.0		
	2.6 Pipe line work	7,685.7		
	Subtotal 2	19,772.8		
	3. Drainage works			
	3.1 Earthwork	361.8		
	Subtotal 3	361.8		
	4. Land development			
	4.1	19,223.2		
	Subtotal 4	19,223.2		
	5. Warehouse, building works			
	5.1 Dryer, rice storage	1,316.8		
	5.2 Project office, workshop, etc.	1,150.3		
	Subtotal 5	2,467.1		
	Total (1+2+3+4+5)	73,332.3		
	6. Temporary cost	1,466.6	2	% of (1+2+3+4+5)
	7. Site expense	7,479.9	10	% of (1+2+3+4+5+6)
	8. Overhead and profit	6,852.3	8	% of (1+2+3+4+5+6+7)
	Total I.	88,861.1		
II.	Procurement cost for OM equipment	4,976.0		
	Total (I+II)	93,837.1		
III.	Administration cost	938.4	1	% of (I+II)
IV.	Engineering services	4,691.9	5	% of (I+II)
	Total (I+II+III+IV)	99,467.4		
V.	Physical contingency	4,973.4	5	% of (I+II+III+IV)
VI.	Price contingency	10,428.7	2	% per year of (I+II+III+IV)
	Total project cost	114,869.5		

Note: Cost for agricultural machinery/equipment (GHC3,542,700). Land acquisition cost is excluded from the table.

Table 7.3.2 Project Cost (KIS)

	Description	Amount (GHC × 1000)		Remarks
I.	Construction Cost			
1.	Akuse main canal	6,035.2		
2.	South lower level canal work (by pump station)	658.6		
3.	South lower level canal work (downstream of pump station)	649.8		
4.	North lower level canal work	525.1		
5.	Distributary Y canal work	251.9		
6.	Distributary Z canal work	762.6		
7.	High-level canal work	1,373.7		
8.	Gate installation including concrete works	581.6		
9.	Drainage works	977.1		
10.	Dryer, rice storage work	1,313.7		
	Total (1–10)	13,129.3		
11.	Temporary cost	262.6	2	% of (1-10)
12.	Site expense	1,339.2	10	% of (1-11)
13.	Overhead and profit	1,178.5	8	% of (1-12)
	Total I.	15,909.6		
II.	Procurement cost for equipment			
1.	Procurement cost for OM equipment	2,326.7		
2.	Procurement cost for agricultural machinery	2,339.0		
	Total II.	4,665.7		
	Total (I+II)	20,575.3		
III.	Administration cost	364.7	2	% of (I+II)
IV.	Engineering services	911.8	5	% of (I+II)
	Total (I+II+III+IV)	21,851.8		
V.	Physical contingency	975.6	5	% of (I+II+III+IV)
VI.	Price contingency	1,747.5	2%	of (I+II+III+IV)
	Total project cost	24,574.9		

Note: Land acquisition cost is excluded from the table.

7.4 Annual Operation, and Maintenance Cost and Replacement Cost

7.4.1 Annual Operation and Maintenance Cost

The costs for annual operation and maintenance at the full development stage are estimated to be about GHC 1.40 million (direct cost) for NDIS and GHC 0.71 million (direct cost) for KIS. The depreciation cost of machinery and equipment is excluded from OM cost. OM cost is comprised of the costs for salaries, wages of project staff, and running and maintenance costs, such as for fuel and lubricant for the irrigation facilities. OM cost for the irrigation facilities consists of rehabilitation of the concrete lining, gravel pavement repair, weeding, etc.

Annual OM costs above are equivalent to about 1.6% and 4.5% of the construction cost of each project. Since the OM cost for KIS includes road maintenance, and salaries and wages of project staff, the amount is relatively high compared to that of NDIS. Table 7.4.1 indicates OM cost of both irrigation systems:

Table 7.4.1 Annual Operation and Maintenance Cost

(NDIS)

	Item of OM	Quantity	Cost (GHC × 1000)	Remarks
1.	Concrete lining	5% of lining concrete per year	847	Replace with concrete
2.	Road pavement	30% of road pavement per year	147	Including drainage ditch excavation
3.	Repair of embankment	Embankment of canal, road	156	Weeding, gully protection
4.	Project staff salary		250	
	Total		1,400	

Note: OM cost is composed of fuel, lubricant, maintenance and operators' costs, thus, machinery cost (depreciation cost) is excluded from the OM cost.

(KIS)

	Item of OM	Quantity	Cost (GHC '000)	Remarks
1.	Concrete lining	5% of lining concrete per year	351	Replace with concrete
2.	Road pavement	30% of road pavement per year	54	Including drainage ditch excavation
3.	Repair of embankment	Embankment of canal, road	52	Weeding, gully protection
4.	Project staff salary		250	
	Total		707	

Note: OM cost is composed of fuel, lubricant, maintenance and operators' costs, thus, machinery cost (depreciation cost) is excluded from the OM cost.

7.4.2 Replacement Cost

The intake and division gates require replacement within the project's useful lifetime because the facilities have a shorter useful life than civil works. The replacement cost is estimated to be about GHC 1.23 million for 10 year replacement for the small gates, and GHC 0.36 million for the large gates of NDIP. Similarly, GHC 0.27 million for 10 year replacement for the small gates and GHC 0.04 million for large gates are estimated for KIS. OM, and agricultural machinery and equipment would also be replaced after ten consecutive years of use.

7.5 Disbursement Schedule

The disbursement schedule is shown on Tables 7.5.1 and 7.5.2.

Table 7.5.1 Cost Schedule (NDIS)

Amount (GHC × 1000)

		Year	2011	2012	2013	2014	2015	2016	Total
			1	2	3	4	5	6	
I.	Construction work								
	1.	Main irrigation canal construction	0.0	0.0	0.0	9,452.2	12,603.0	9,452.2	31,507.4
	2.	Secondary canal construction	0.0	0.0	0.0	3,626.1	4,834.9	3,626.1	12,087.1
	3.	Drainage works	0.0	0.0	0.0	0.0	361.8	0.0	361.8
	4.	Land development	0.0	0.0	0.0	5,767.0	7,689.2	5,767.0	19,223.2
	5.	Warehouse, building works	0.0	0.0	0.0	2,467.1	0.0	0.0	2,467.1
	6.	Temporary work	0.0	0.0	0.0	426.2	509.8	376.9	1,312.9
	7.	Site expense	0.0	0.0	0.0	2,173.9	2,599.9	1,922.2	6,696.0
	8.	Overhead and profit	0.0	0.0	0.0	1,913.0	2,287.8	1,691.6	5,892.4
II.	Procurement cost for OM equipment		0.0	0.0	0.0	0.0	4,976.0	0.0	4,976.0
III.	Administration		84.5	84.5	169.0	169.1	169.1	169.0	845.2
IV.	Engineering services service		845.2	1,267.9	845.2	422.6	422.7	422.6	4,226.2
V.	Physical contingency		46.5	67.6	50.7	1,320.9	1,822.7	1,171.4	4,479.8
VI.	Price contingency		19.5	56.8	63.9	2,219.0	3,827.7	3,197.9	9,384.8
			995.7	1,476.8	1,128.8	29,957.1	42,104.6	27,796.9	103,459.9

Note: The cost for agricultural machinery/equipment (GHC 3,542,700) is excluded from the table.

Table 7.5.2 Cost Schedule (KIS)

Amount (GHC ×1000)

	Year	2011 1	2012 2	2013 3	2014 4	2015 5	Total
I.	Construction work						
	1. Akuse main canal	0.0	0.0	0.0	3,017.6	3,017.6	6,035.2
	2. South lower level Canal work (by pump station)	0.0	0.0	0.0	329.3	329.3	658.6
	3. South lower level canal work (downstream of Pump station)	0.0	0.0	0.0	324.9	324.9	649.8
	4. North lower level canal work	0.0	0.0	0.0	262.6	262.5	525.1
	5. Distributary Y canal work	0.0	0.0	0.0	126.0	125.9	251.9
	6. Distributary Z canal work	0.0	0.0	0.0	381.3	381.3	762.6
	7. High-level canal work	0.0	0.0	0.0	686.9	686.8	1,373.7
	8. Gate installation	0.0	0.0	0.0	290.8	290.8	581.6
	9. Drainage work	0.0	0.0	0.0	977.1	0.0	977.1
	10. Dryer, rice-storage work	0.0	0.0	0.0	1,313.7	0.0	1,313.7
	11. Temporary work	0.0	0.0	0.0	154.2	108.4	262.6
	12. Site expense	0.0	0.0	0.0	786.4	552.8	1,339.2
	13. Overhead and profit	0.0	0.0	0.0	692.1	486.4	1,178.5
II.	Procurement cost for OM equipment	0.0	0.0	0.0	2,326.7	0.0	2,326.7
III.	Administration	36.5	36.5	109.4	109.4	72.9	364.7
IV.	Engineering services	182.4	273.5	182.4	182.4	91.1	911.8
V.	Physical contingency	10.9	15.5	14.6	598.1	336.5	975.6
VI.	Price contingency	4.6	13.0	18.4	1,004.8	706.7	1,747.5
	Total	234.4	338.5	324.8	13,564.3	7,773.9	22,235.9

Note: The cost for agricultural machinery equipment (GHC 2,339,000) is excluded from the table.

7.6 Preliminary Estimation of Irrigation Service Charge

(1) Conditions of estimation

Irrigation Service Charge (ISC) comprises three components, namely the land rent fee, water fee, and development fee. The administration fee, which is included in the ISC of KIS, is considered as included in the water fee in this study.

Land Rent Fee: The land rent fee is not considered in the study because the price of the land lease is not yet decided.

Water Fee: The water fee is to be set to cover the necessary cost for operation and maintenance of the infrastructure managed by the project. The administration cost required for the management of the project office is considered as included in the operation cost and labour cost (human expense of the project office) as mentioned above. The replacement cost of hydraulic structures, as well as construction machinery, is allocated to the annual maintenance cost equitably by dividing the purchase cost by the life period. KIP and SMC shall allocate the replacement cost into the special account in preparation for replacement.

Development Fee: The development fee is to be set to cover the construction cost of 1) main irrigation canal, 2) secondary irrigation canal and 3) drainage work, which are burdened by the government cost. Those costs are divided by the project life (50 years) and disbursed to the annual development fee equitably. 6) Temporary cost, 7) site expense, 8) overhead and profit, 9) administration cost, 10) engineering cost, and 11) physical contingency are included in the construction cost for calculating the development fee.

Demarcation of construction cost of secondary canal in the private block: The secondary canal of NDIS is constructed using government funds up to the boundary of the block (distance of delivery canal), and the length after the boundary (distance of on-farm canal) is to be paid for by the private sector—the large-scale farms in principal. However, the length of the pipeline in the hilly area is to be constructed by the governmental cost.

The billing structure of ISC by farm type is assumed as shown below:

Table7.6.1 Billing Structure of ISC by Farm Type

Farm Type	Irrigation Service Charge		
	Land Rent Fee*	Development Fee	Water Fee
Large-scale farms	●	●	●
Medium-scale farmers	●		●
Small-scale farmers	●		●

Note *: The land rent fee is not considered in this study.

(2) Preliminary estimation of ISC prices

The ISC prices of KIS and NDIS are estimated as shown below:

Table7.6.2(1) Preliminary Estimation of ISC Price of KIS

Farm Type	Irrigation Service Charge (GHC/ha-year)		
	Development Fee	Water Fee	Total ISC
Large-scale farms	78	243	322
Small-scale farms		243	243

Note: ISC price is estimated based on the reference price of 2011.

Table 7.6.2(2) Preliminary Estimation of ISC Price of NDIS

Farm Type	Irrigation Service Charge (GHC/ha-year)		
	Development Fee	Water Fee	Total ISC
Large-scale farms	178	276	431
Medium-scale farmers		276	276
Small-scale farmers		276	276

Note: ISC price is estimated based on the reference price of 2011.

(3) ISC in Farm Budget

ISC prices were assessed based on each farm type's share of the financial crop budget. The ratio of ISC to production cost and net return are as shown below:

Table 7.6.3 Ratio of ISC to Production Cost in Financial Crop Budget per ha of Rice with Project

Irrigation Scheme	Farmer Type	ISC (GHC)	Total Production Cost (GHC)			Ratio of ISC to Production Cost
			Major Season	Minor Season	Annual	
KIS	Large-scale	322				
	Small-scale	243	1,074	1,074	2,148	11.3%
NDIS	Large-scale	431	866	866	1,732	24.9%
	Medium-scale	276	1,079	1,079	2,158	12.8%
	Small-scale	276	1,204	1,204	2,408	11.4%

Table 7.6.4 Ratio of ISC to Net Return in Financial Crop Budget per ha of Rice with Project

Irrigation Scheme	Farmer Type	ISC (GHC)	Net Return (GHC)			Ratio of ISC to Net Return
			Major Season	Minor Season	Annual	
KIS	Large-scale	322				
	Small-scale	243	2,281	2,611	4,892	5.0%
NDIS	Large-scale	431	2,794	3,154	5,948	7.2%
	Medium-scale	276	2,276	2,606	4,882	5.6%
	Small-scale	276	1,846	2,146	3,992	6.9%

(4) Farmer's Responsibility other than ISC

Farms are to pay for the maintenance of on-farm level infrastructure. The on-farm OM cost is estimated to be 160 GHC/ha. In the case of large-scale farms of NDIS, the maintenance cost of the secondary canal within a block (on-farm secondary canal), which is estimated to be 23 GHC/ha, is to be added to the above cost.

Table 7.6.5 Ratio of On-farm OM Cost to Net return in Financial Crop Budget per ha of Rice with Project

Irrigation Scheme	Farmer Type	On-farm OM Cost (GHC)	Total Production Cost (GHC)	Ratio to Production Cost	Net Return (GHC)	Ratio to Net Return
KIS	Large-scale					
	Small-scale	160	2,148	7.4%	4,892	3.3%
NDIS	Large-scale	183	1,732	10.6%	5,948	3.1%
	Medium-scale	160	2,158	7.4%	4,882	3.3%
	Small-scale	160	2,408	6.6%	3,992	4.0%

Apart from the on-farm OM cost, large-scale farms in NDIS are required to bear the land development cost as an initial investment. The land development cost, including the cost of 30% of land for small-scale farmers, is estimated to be 7,055 GHC/ha, which is equivalent to the depreciation cost of 706 GHC/ha-year for 10 years.

On the condition that large-scale farms would be exempt from the land development cost of small-scale farms, the land development cost of large-scale farms would be 4,939 GHC/ha, which is equivalent to the depreciation cost of 494 GHC/ha-year for 10 years. The cost of ISC, on-farm OM, and land development for large-scale farms is estimated to be 1,108 GHC/ha, which is equivalent to a net-return of 18.6% in the financial crop budget in the case of adopting the project.

Table 7.6.6 ISC, On-farm OM and Land Development Cost, and Ratio to Net Return

Irrigation Scheme	Farmer type	ISC (GHC/ha-year)	On-farm OM Cost (GHC/ha-year)	Depreciation of land development (GHC/ha-year)	Total cost (GHC/ha-year)	Ratio to net return
KIS	Large-scale	322				
	Small-scale	243	160		403	8.2%
NDIS	Large-scale	431	183	706	1,319	22.2%
		431	183	494	1,108	18.6%
	Medium-scale	276	160		436	8.9%
	Small-scale	276	160		436	10.9%

(5) Recommendation on Cost Burden of ISC

Small-scale farmers in KIS: The estimated ISC price is 243 GHC/ha, which is equivalent to almost double the current price (120 GHC/ha). The deficit of ISC revenue is covered by the budget allocation for human expense by GIDA at the moment. According to the Willingness to Pay (WTP) survey in KIS, most farmers would accept an increase of the ISC price if the irrigation service would be improved after rehabilitation. However, the average price that farmers are willing to pay after rehabilitation is 134 GHC/ha, meaning that there is still a big difference from the estimated price. In consideration of the current situation of ISC recovery, it seems that such a big increase of ISC would be difficult, so it is advisable to raise the price after a few years of showing the results of service increase.

Large-scale farms in KIS: It is recommended to start discussing the post-rehabilitation increase of the ISC price based on the above estimation upon the renewal of contracts, scheduled for 2012. It is also necessary to start the procedure for transferring the ISC of the banana estate, which is now allocated in the revenue of GIDA HQ, to the IGF of KIP.

Small-scale farmers in NDIS: The estimated price of ISC for small-scale farmers, 276 GHC/ha, in NDIS is considered expensive in comparison with prices in other GIDA projects, including the current KIP price. Considering that most small farmers of NDIS are expected to be new to irrigation agriculture or rice cultivation, it is recommended to provide a governmental subsidy to their ISC for a few years until their farm management would be stabilized.

Large-scale farms in NDIS: The annual burden of ISC, on-farm OM cost, and land development cost of large-scale farms in NDIS occupy over 20% of the expected net return of the crop budget. It might be difficult to bear in some cases. According to the results of the future market test, it might be necessary to consider governmental support for land development for small-scale farms, which is to be borne by large-scale farms in the private development block.

Annex G.5 Preliminary Estimation of ISC and Share in Farm Economy

Chapter 8

Project Evaluation

Chapter 8 Project Evaluation

8.1 Objectives

The objectives of the project evaluation are:

- To examine the economic viability of the proposed project,
- To examine the financial impact of investment of the proposed project on beneficiary farmers capacity to pay in each irrigation scheme, and
- To examine the indirect benefits, intangible benefits, and socio-economic impact of the proposed project.

The results of the examinations are to be employed as factors in judging the economic viability, financial soundness, and social acceptance of the project.

8.2 Proposed Project for Evaluation

The present project evaluation is made on the two irrigation schemes (KIS & NDIS) and the overall Accra Plains Gravity Irrigation Project (APGIP) as follows:

Table 8.2.1 List of Evaluated Irrigation Schemes & Project

Project/Irrigation Block	Project Area (ha)*	(%)
Kpong Irrigation Scheme (KIS)	4,100 ha	37
New Developed Irrigation Scheme (NDIS)	6,900 ha	63
Accra Plains Gravity Irrigation Project (APGIP)	11,000 ha	100

*: Net area

8.3 Economic Evaluation

8.3.1 Economic Evaluation Procedures

Both the project benefits and costs are estimated based on the following conditions or assumptions:

- All the prices are expressed in constant prices as of the beginning of 2011, and the foreign currency exchange rate is fixed at US$ 1.00 = GHC 1.49,
- The project life is assumed to be 50 years, starting from 2014, which is the proposed year for the commencement of project implementation,
- Farm-gate prices of internationally traded agricultural inputs and outputs are calculated in the form of export or import parity prices, as shown in Annex H-1.
- A standard conversion factor (SCF) of 0.90 was applied.[8] Annex H-2 summarized the prices applied for the estimation of economic crop budgets. Transfer payments, such as taxes, duties, and subsidy interest, were excluded in estimating the economic benefits and costs. Financial construction costs were converted into economic costs using the conversion factor of 0.765 {financial cost − (VAT/NHIL 15%) × SCF},

[8] SCF applied in World Bank project, “Ghana Social Opportunity Project,” effective from November, 2010

- Basically, it was assumed that the case of not adopting the project is actually the same as the present condition, and that, in Prairie Volta Farm, the expansion of rice fields to 561 ha is carried out as scheduled by the farm from 2011 to 2022
- Sunk costs were not taken into consideration in the economic evaluation.
- Because of rather limited accessibility to economic data on the agri-business farms operating in the project area, the following approaches were taken in the project evaluation.

Agri-business Farms	Approaches in Economic Evaluation
Golden Exotics Farm	Only the planned extension area of 600 ha is taken into consideration for economic evaluation. No changes between the cases of adopting the project and not adopting it are assumed in the existing farm.
Cassi Farm	Excluded from economic evaluation because no direct effects on their farm operation will be brought in the case of adopting the project. No changes in NPV (net production value) between the cases of adopting the project and not adopting it are assumed.
Prairie Volta Farm	

- To avoid complexity in project evaluation, the Aveyime Scheme, located within the NDIS Area, was included in the evaluation of the NDIS as the planned areal extent of the former is only 75 ha or accounts only for 1% of the NDIS Area.

8.3.2 Economic Benefits

(1) Irrigation and Drainage Benefit (Crop Production Increase)

The project irrigation and drainage benefit will accrue from land use conversion from upland fields/grassland to irrigated fields, and from the increase in cropping areas and productivity of the target crop, irrigated rice. The economic benefit was estimated as the increment net production value in the future between the cases of adopting the project and not adopting it. The economic crop budgets of subject crops were prepared for both of such cases by applying prices (Annex H-3 to H-5). The project benefits (increment of net production value) of KIS, NDIS and the project (APGIP) are estimated as shown in Annex H-6 to H-8 and are summarized in the following table.

Table 8.3.1 Economic Irrigation and Drainage Benefit

Project/Scheme	Net Production Value (GHC'000)			
	Project Area	Adopting the project	Not adopting the project	Increment
Kpong Irrigation Scheme (KIS)	4,100 ha	23,429	12,865	10,564
New Developed Irrigation Scheme (NDIS)	6,900 ha	29,220	5,477	23,743
Accra Plains Gravity Irrigation Project (APGIP)	11,000 ha	52,649	18,342	34,307

The annual economic benefit flow was estimated based on the progress of the area to be developed. The project benefit is assumed to be realized from 2016 in all the KIS, NDIS and APGIP. The attainment of the target yields and the full development stage assumed for the project evaluation are as follows:

Table 8.3.2 Assumptions on Full Development Stage and Build-up Period Assumed

Project/Scheme	Project Area (ha)	Target Yield Attained/ Full Development (major season)	Build-up Period (years)
Kpong Irrigation Scheme (KIS)	4,100	2020	5
New Developed Irrigation Scheme (NDIS)	6,900	2022	7
Accra Plains Gravity Irrigation Project (APGIP)	11,000	2022	7

Based on these assumptions, the build-up of project irrigation & drainage benefits of individual irrigation schemes and the project are estimated as shown in the following table. The full project benefit is realized from 2022 onward, the 9th year after the commencement of the project implementation.

Table 8.3.3 Build-up of Irrigation & Drainage Benefits in Proportion

Irrigation	Year						
Scheme/Project	2016	2017	2018	2019	2020	2021	2022
KIS	50	75	85	90	100	100	100
NDIS	11	47	59	72	82	92	100
- No. 1 Area	25	50	65	75	85	95	100
- No. 2 Area	-	45	55	70	80	90	100
APGIP	23	56	67	78	88	95	100

The details of economic benefit flows are presented in Annex H-9.

(2) Other Anticipated Project Benefits

Reducing OMM costs by lining the main canal in the KIS, and reducing the pumping cost in the Prairie Volta Farm (in NDIS) by introducing gravity irrigation under the project are expected as shown in the following table.

Table 8.3.4 Other Project Benefits

Irrigation Block	With-project 1/	With-out Project 1/	Saving/Year
KIS	Main canal OMM cost/year: Financial:GHC 63,200	Main canal OMM cost/year: Financial:GHC 108,400	Financial: GHC 45,200; economic: GHC 36,100
Prairie V. Farm	Gravity irrigation water supply	Annual pumping cost: Financial: GHC 626,400; economic: GHC458,000	Financial: GHC 626,400; economic: GHC458,000

1/: Source – JICA Study Team (KIS) & Prairie Volta Farm

(3) Project Benefits

The full project benefit is realized from 2020 onward in the KIS and 2022 in NDIS and APGIP. The estimated economic project benefit streams are presented in Annex H-9 and summarized as follows:

Table 8.3.5 Annual Increases in Project Benefits

Items	Unit	Year							
		2016	2017	2018	2019	2020	2021	2022	2023
Cropped Area 1/	ha	9,100	20,200	20,200	20,200	20,200	20,200	20,200	20,200
- KIS	ha	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400
- NDIS	ha	2,700	13,800	13,800	13,800	13,800	13,800	13,800	13,800
Incremental Benefit 2/									
- KIS	GHC 000	5,171	7,812	8,868	9,396	10,453	10,453	10,453	10,453
- NDIS	GHC 000	2,651	11673	14,577	17,609	19,983	22,357	24,202	24,202
- APGIP	GHC 000	7,822	19,485	23,445	27,005	30,436	32,810	34,655	34,655

1/: Cropped area under irrigation; banana cropped area 1,800ha/year 2/: Total project benefit

8.3.3 Negative Benefit

The agricultural production foregone in farmland located outside the project area acquired for the construction of irrigation & drainage and other physical facilities, and the loss of generated power due to the use of water from the Kpong dam for irrigation purposes are the tangible negative benefits of the project. Under the project, a limited portion of farmland in the project area is acquired for the construction of physical facilities. Changes to "right of way" areas have been taken into account in the future in the land-use plan for the case of adopting the project, therefore, production foregone in such areas is not considered as a negative benefit in estimating the annual economic benefit. The tangible negative benefits under the project are estimated as follows:

Table 8.3.6 Estimation of Annual Tangible Negative Benefits under Project

Farm Land Acquired for Right-of ways	Area	NPV/year	Financial	Economic
(Outside project area)	200 ha	GHC 1,133,000	GHC 1,133,000	GHC 56,200
Loss of generated power	Water Use/Year	Loss of Power/Year	Financial	Economic
- KIS	79.7 million m^3	1.88 million kWh	GHC 164,000	GHC 148,000
- NDIS	158.6 million m^3	3.73 million kWh	GHC 729,000	GHC 656,000
Annual Negative Benefits	-	-	GHC 2,026,000	GHC 860,000

8.3.4 Economic Cost

The economic project investment costs include the following cost items:

- Preparatory works,
- Direct construction cost, including intake facilities, main and secondary systems, drainage works, rehabilitation works of physical facilities, on-farm development, miscellaneous works, and contractor's expenses,
- OMM equipment and farm machinery,
- Annual OMM cost, major repairing cost and replacement cost,
- Administration cost, consulting service cost, and
- Physical contingencies

The economic project investment cost was estimated by applying conversion factors as indicated in Annex H-10. The annual OMM cost, major repairing cost, and replacement cost were converted to economic values from financial cost by multiplying SCF.

The annual disbursement of the estimated project economic cost scheduled according to the construction schedule is presented in Annex H-11 and summarized below.

Table 8.3.7 Disbursement Schedule of Project Investment Cost

Unit: GHC 000

Items	Year					
	2013	2014	2015	2016	2017 & on	Total
Initial Investment Cost	1,138.9	38,869.4	50,065.0	26,545.8		116,619
Annual OMM Cost				524.3	1,420.0	-
Total	1,138.9	38,869.4	50,065.0	27,070.1	1,420.0	-
Major Repairing/Replacement Cost	from 2024 every 10 years: 3,821.8; from 2025 every 20 years: 10,052.4 from 2035 every 20 years: 10,125.2					

8.3.5 Economic Evaluation and Sensitivity Analysis

The economic cost and benefit streams for 51 years (project life of 50 years plus preparatory work over 1 year), comprising the preparatory work, project investment cost, annual OMM cost, repairing & replacement cost for the stream and irrigation & drainage benefit, other benefits, and negative benefits are presented in Annex H-9 & H-11. The results of economic evaluations are expressed by the economic internal rate of return (EIRR) and Net Present Value (B-C) and benefit-cost ratio (B/C) at a discount rate of 12% are presented in Annex H-12 and summarized below.

Table 8.3.8 Results of Economic Evaluation

Project/Scheme	EIRR (%)	Present Value (at 12% discount rate) (GHC × 1000)			
		Benefit	Cost	B - C	B/C Ratio
KIS	20.8	56,050	31,733	24,317	1.8
NDIS	19.3	110,768	64,374	46,394	1.7
APGIP	19.8	166,818	96,107	70,711	1.7

As shown in the table, it can be said that the two irrigation schemes and the project are economically viable under the conditions set up as described earlier.

A sensitivity analysis was made for the following five cases.

- Case 1 Construction cost: up 10 %,
- Case 2 Irrigation & drainage benefit (crop production benefit): down 10 %,
- Case 3 Irrigation water supply (construction works): 1 year delay,
- Case 4 Target yields of paddies: down about 10% (about 14% less than irrigation/drainage benefit) as follows.

Case	KIS (t/ha)	Small-scale Farm (t/ha)	Medium-scale Farm (t/ha)	Large-scale Farm (t/ha)
Normal	5.5	5.0	5.5	6.0
Case 4	5.0	4.5	5.0	5.5

- Case 5 Case 1 combined with Case 2.

The results of sensitivity analyses are expressed similarly by the economic internal rate of return (EIRR), net present value (B−C), and benefit-cost ratio (B/C) at the discount rate of 12% are presented in Annex H-13 to H-17 and summarized in the following table.

Table 8.3.9 Results of Sensitivity Analysis of the Project

Schemes/Project	Indicator	Case 1	Case 2	Case 3	Case 4	Case 5	Normal
KIS	EIRR (%)	20.1	18.9	20.3	18.3	18.2	20.8
	B/C Ratio	1.7	1.6	1.7	1.5	1.5	1.8
NDIS	EIRR (%)	17.9	17.7	18.1	17.0	16.4	19.3
	B/C Ratio	1.6	1.6	1.6	1.5	1.4	1.7
APGIP	EIRR (%)	18.6	18.1	18.8	17.4	17.0	19.8
	B/C Ratio	1.6	1.6	1.7	1.5	1.5	1.7

As shown, the project economic viability will not be seriously affected by the changes in the conditions examined in the present sensitivity analysis. However, as the decreases of target yields will affect the project economic viability most (Case 4), the strengthening of extension and agricultural

support services is considered essential for the attainment of target yield levels at the earliest stage possible.

8.3.6 Comparison with the Previous FS Study

The comparison of the economic evaluation results between the present Pre-F/S and the F/S on 5,000ha (1st Priority Area) is as follows:

Table 8.3.10 Comparison of Economic Evaluation Results

Subject Study	EIRR (%)	B/C Ratio
Present Pre-F/S (NDIS)	19.3	1.7 (at 12% discount rate)
F/S on 5,000ha by Studi International*	20.4	2.2 (at 10% discount rate)

*: Mixed scenario-agribusiness, large-scale & small-scale farmers Source - Studi Report 5,000ha

8.4 Financial Evaluation

(1) Capacity-to-pay

The financial evaluation of the project was carried out from a farm-economics view point. However, because of the limited accessibility to information on farm economic conditions in the project area, the evaluation was made by examining the incremental capacity-to-pay of small-scale farms in KIS and NDIS. The assumptions set for the evaluation are as follows:

Table 8.4.1 Assumptions for Financial Analysis on Small-scale Farms (Typical Farm)

Items	KIS	NDIS
Typical farm size	1.0ha/farm	1.5ha/farm
Cropping pattern	Double cropping of rice	Double cropping of rice
Proportion of family labour to total	40%	30%
Crop budgets applied	No project: Table D-1, with: Table D-4	No project: Table D-1, with: Table D-4

The results of the evaluation based on the assumptions are as follows:

Table 8.4.2 Results of Financial Analysis on Small-scale Farms (Incremental Net Return) 1/

Unit: GHC

Adopting/Not adopting the project*	KIS (1.0 ha/farm)			NDIS (1.5 ha/farm)		
	Major Season	Minor Season	Annual	Major Season	Minor Season	Annual
Present/Adopting project						
- Gross Return	2,867	2,680	5,547	1,769	324	2,093
- Net Return	1,772	1,573	3,345	1,086	179	1,265
With-Project						
- Gross Return	3,355	3,685	7,040	4,575	5,025	9,600
- Net Return	2,281	2,611	4,892	2,769	3,219	5,988
Increment	509	1,038	1,547	1,683	3,040	4,723

*: Refer to Tables D-1 & D-4 in the Annex

The incremental net return in the case of adopting the project is GHC 1,547 in KIS and GHC 4,723 in NDIS. On the basis of the estimated irrigation service charges under the project and the assumption on interests due for farm credit, the capacity-to-pay of the small-scale farms is examined as follows:

Table 8.4.3 Examination of Capacity-to-Pay in Case of Adopting Project[1]

Item	KIS: 1.0ha/farm (GHC)		NDIS: 1.5ha/farm (GHC)	
Net Return per Farm	4,892	100 %	5,988	100 %
Irrigation Service Charges (ISC)[2]	243	5.0 %	414	6.9 %
Credit Interest[3]	139	2.8 %	294	4.9 %
Net Surplus	4,510	92.2 %	5,280	88.2 %

[1]: At full development stage onward

[2]: ISC (including water fee) estimated in the Section 7.6

[3] Assuming: (Farm machinery hiring cost + farm inputs cost) × 24 % × 6/12 × 2 seasons

As shown, the net surpluses of GHC 4,510 (92% of net return) in KIS and of GHC 5,280 (88% of net return) in NDIS are expected under the project. This reveals that beneficiary farmers can fully shoulder the annual irrigation service charges (OMM cost & others) and interests levied on farm credit services.

(2) FIRR (Financial Internal Rate of Return)

The FIRRs of the project were calculated by applying financial costs and benefits as shown in Annex H-18 and as summarized in the following table.

Table 8.4.4 FIRR (Financial Internal Rate of Return) of the Project

Project/Scheme	FIRR (%)	Present Value (at 12% discount rate) (GHC × 1000)			
		Benefit	Cost	B−C	B/C Ratio
KIS	21.6	71,675	38,500	33,085	1.9
NDIS	14.7	113,153	90,123	23,030	1.3
APGIP	16.8	184,828	128,714	56,115	1.4

8.5 Socio-economic Impact, Indirect Benefits and Intangible Benefits

8.5.1 Socio-economic Impact

(1) Creation of Employment Opportunities

In addition to the huge impact on the national economy of the incremental production of paddies (i.e. 75,300 tons) or rice (i.e. 48,900 tons) and the impact of reducing foreign exchange costs by some US$25.6 million at the full development stage and onward, the most important anticipated socio-economic impact of the project on the society and people in and around the project area is the creation of employment opportunities. The incremental employment opportunities under the project in comparison with the case of not adopting the project are estimated as follows:

Table 8.5.1 Increased Employment Opportunities under the With-project

Scheme/Land Use	With-project			Without-project						Incremental Labour Requirements	
	Area (ha)	Cropped Area (ha)	Annual Labour Requirements (mandays)	Area (ha)	Major Season		Minor Season		Annual Labour Requirements (mandays)	(mandays)	(%)
					Cropped Area (ha)	Labour Requirements (mandays)	Cropped Area (ha)	Labour Requirements (mandays)			
KIS											
-Irrigated Rice Field	2,300	4,600	570,400	1,852	1,274	175,812	1,440	174,240	350,052	220,348	
-Banana Farm1/	1,800	1,800	450,000	1,200	1,200	300,000			300,000	150,000	
-Upland Field				600	600	69,000	180	21,600	90,600	-90,600	
-Others	210			658	658						
Sub-total	4,310	6,400	1,020,400	4,310	3,732	544,812		195,840	740,652	279,748	138
NDIS											
-Irrigated Rice Field	5,687	11,374	613,110							613,110	
-Upland Field				3,309	3,309	380,535	993	119,160	499,695	-499,695	
-Others	297			2,675							
Sub-total	5,984	11,374	613,110	5,984	3,309	380,535		119,160	499,695	113,415	123
Total (APGIP)	**10,294**	**17,774**	**1,633,510**	**10,294**	**7,041**	**925,347**		**315,000**	**1,240,347**	**393,163**	**132**

Note: Prairie Volta Farm&Cassi Farm not included since no chanes in labour requirements between with & without project assumed
1/: Assumed 1 permanent staff/ha; souce: Golden Exotics Farm

As shown in the table, the creation of employment opportunities of about 393,000 man-days or some 1,600 fulltime workers (farmers) is anticipated under the project. The future employment opportunities under the project are roughly about 130% of the same under present conditions. Further, in addition to the creation of employment opportunities in farming, increased job opportunities in the fields of processing, transportation, and marketing of products are expected.

(2) Activation of District/Regional Economy

Marketing of farm inputs and outputs would expand drastically under the project and farmers' purchasing power capacity would increase substantially along with the improvement of farm incomes. These would contribute to the activation of district/regional economy.

8.5.2 Indirect Benefits

The livestock sub-sector is another important economic activity in and around the project area. Under the project, the incremental production of rice straw of approximately 75,000 tons (when assuming straw/grain rate = 1) is expected. The volume is roughly estimated to be the monthly roughage requirements of approximately 75,000 cattle (assuming roughage requirement/head/month = 1.0 ton) and will greatly contribute to the roughage supply in a dry season when cattle in and around the area suffer from a shortage of roughage/grasses. In addition to straw, by-products of rice bran and broken rice (about 10% of paddies) could be used for quality animal feeds when rice milling is done in the large-scale rice mill of Prairie Volta Farm or mills in and around the project area.

8.5.3 Intangible Benefits

Ancillary business chances created in the course of processing, transporting and transacting of rice/paddies, and attributed to the project implementation could be regarded as typical intangible benefits that will contribute to rural and individual farm economies through an increase in inputs to be purchased and transported, as well as the value addition of outputs.

Chapter 9

Conclusion and Recommendations

Chapter 9 Conclusion and Recommendations

9.1 Conclusion

The proposed gravitational irrigation system of the Accra Plains Gravity Irrigation Project taking water from the Kpong Dam has strong potential for development and is deemed to be technically and economically feasible at the pre-feasibility level of the study. The unit costs per hectare of the APGIP for the construction cost and operation & maintenance cost derived from the study show that these costs are almost half those of the pump irrigation system of the APIP studied in 2010. The investment cost as well as OM cost for the gravity irrigation system of the APGIP has proven to have very high advantages compared with a pump irrigation system.

It is concluded that the implementation of the proposed project contributes greatly to the national economy on the basis of commercial agriculture as well as poverty eradication through stabilization and improvement of commercial oriented smallholders' paddy rice production. It also greatly contributes to increasing the rice production by a gravitational irrigation system with less operation and maintenance cost, thus resulting in the reduction of importing rice from other countries and reducing the expenditure of foreign currency.

9.2 Recommendations

The Accra Plains development for irrigated agriculture will be the flagship project in the GOG, as mentioned in important policies. A Full Feasibility Study is recommended to be performed as soon as possible.

It is recommended to MoFA/GIDA to take the initiative as the leading ministry for implementing the project in close coordination and collaboration with the concerned authorities and agencies. However, it is necessary to tackle the following hurdles as early as possible:

1) Investigating potential commercial enterprises and conducting a study for financial analysis for evaluation and management of the project.

2) In preparing a necessary procedure to proceed to the next step of full feasibility study, it will be necessary to take action to collaborate with related authorities and donors.

Further Study Items Needed to undertake the Full-Scale Feasibility Study

1. Necessary Information

(1) In the pre-feasibility study, the irrigation and drainage planning was formulated based on the 5 m contour line map of DTM (Digital Terrain Model). Although the DTM with a 1 m contour line was also provided at the end of the study, the 1 m counter line of the DTM was not clear, so it was not used for the facility planning or the land development plan. It is necessary to obtain a clear contour line map or digital mesh elevation data to prepare a detailed topographic map in order to review the route of the main and secondary canals as well as the boundary of the land development area.

(2) Topographic and Geological Survey

The topographic survey covered only the specified route of the main canal of the intake, siphon, and the large embankment areas. However, it is necessary to conduct a topographic survey all along the line of the main canal and secondary canals, including a plain survey at the intake, siphon and diversion points at several locations.

In addition, it is also necessary to conduct a geological survey to examine the bearing stress and profile of the foundation of the intake, siphon, and the large embankment portion. A soil test is also to be conducted to examine the stability of the embankment.

(3) Census in 2010

The population, and the number of the farm households in the project area were estimated based on previous census data, and the data obtained through the hearing survey from the District offices. In the Feasibility Study, it is necessary to update these demographic data by using Census 2010 data.

2. Project Cost

After the revision of canal alignment, the project cost shall be reviewed with an accurate quantity survey of the concrete lining and earth movement volume of the canal. The unit cost of labour, materials and operation cost of the construction machinery shall also be reviewed by doing a latest cost survey.

3. Farming Plan

In the pre-feasibility study, the irrigated rice is envisioned in the irrigation schemes on the basis that the rice cultivation needs a larger water requirement and that the market price of rice is relatively stable. It is necessary to examine the profitability and marketability of other target crops to encourage the entry of large-scale farmers in the project.

4. Project Benefit

Allocation of farmland

The decision process of the farmland allotment between the small farmers and the commercial farmers shall be clarified in line with the policy of the government as described in the draft of LI-1350. The introduction of PPP may impose a tremendous burden on large-scale farmers due to certain unfavourable conditions of PPP operation. Therefore, the allocation of the project investment cost between the large and the small holders, and the agricultural support policy for the small holders shall be discussed and clarified first. Since the land-sharing balance of the various farmers groups have a crucial impact on the economical evaluation as well as the financial evaluation of the project, it is necessary to propose an effective technique on the land sharing between the commercial, small, and medium-scale farmers in accordance with the survey result of the market test proposed by the World Bank. In addition, the roles of the Ghana Irrigation Development Authority (GIDA) shall be discussed when a private

company is employed for the operation and maintenance of the entire irrigation system.

The Government policy of land sharing between the small holders and the large-scale farmers is unclear in the government development project. It is necessary to review the land sharing ratio of 7:3 of large and small holders, which is described in LI-1350.

5. Economical Evaluation (EIRR)

In the economic analysis, it is important to clarify that, from the viewpoint of the national economy, the profits of a private company may be deducted from a benefit, especially when a private company gains the benefit through the export of produce.

6. Basic Policy of PPP

Regarding PPP policy, there are two types of organizations within the private sector—the users of the irrigation system, and the private organizations that are to operate and manage the irrigation facilities. The commercial farmers, as users, manage the irrigation farming in their farmland. On the contrary, the private organizations, such as the scheme management companies (SMCs), have to cover a wider area of irrigation facility operation, farming services, etc., with the sufficient knowledge and financial back-up of the government.

The potential on management and investment plan of the large commercial farming shall be studied. The potential of SMCs shall be also studied from the viewpoints of willingness to participate in the project, management skills, fund management, human resources, etc.

7. Financial Analysis

The tangible financial analysis of commercial farming, including the investment plan and cash flow analysis (income and expenditure balance), is necessary in the project formulation under the PPP policy. The financial analysis becomes practicable when the evaluation conditions, such as target crops, marketability of the produce, price trends, and balance of production cost and depreciation cost, are accurately estimated. The financial analysis of SMC is conducted from the business viewpoint. The payable cost of commercial farmers for operation and maintenance of the irrigation facilities, and financial support by the Government to reduce management risk shall be estimated accurately from the analysis.

8. Consultation with VRA

There are several factors to be considered in preparing the irrigation plan. For example, the irrigation water requirement is dependent on the crop selection of the commercial farmers, and the irrigation method shall be the pressurized method, drip irrigation, etc. In addition, the commercial farmers can plan to select a farm area including an elevated upland area to mitigate flood damage. When the commercial farmers select a higher elevation area located at an upper area of the main canal, some irrigation blocks may be left unused in the proposed gravity irrigation area. The intake capacity is also subject to change due to the extension of the irrigation area outside the proposed gravity irrigation area. Since such modifications need to be consulted with VRA in each case, it is proposed to deliberate several issues related to

intake discharge and the location of the irrigation area, in advance. In any case, the irrigation plan shall be modified and updated in consultation with VRA and GIDA.

9. Scope of Work for Full Feasibility Study is outlined as follow:

(1) Collection of Basic Data (through local consultants under sub-contract)

1) Topographic data through supplemental survey
2) Geological data through geological investigation and tests
3) Soil survey by observation of pit and tests
4) Identification of the potential beneficiaries through interviews with small holders and private entrepreneurs on their possible intentions and conditions for participation in the proposed project.
5) Identification of the development constraints and possible countermeasures for the ongoing projects which are operated by PPP in and around the project site.

(2) Review, update and prepare preliminary designs for the agriculture development facilities and cost estimates

1) Main and principal canals and major facilities
2) Secondary canal system
3) Tertiary canal systems for 3 pilot areas in a total of 300 ha.
4) Related facilities, including flood protection, market facilities and workshops, if needed
5) Review, update and prepare project costs (financial and economic costs) for the project facilities, agricultural input, and OMM cost, including replacement cost.

(3) Identification of the proposed beneficiaries, benefit and allocation of participation

1) Preparation of profitable cropping plan and acreages.
2) The government policy, process and participation allocation of private entrepreneurs and small holders
3) Preparation of proposal for introducing private entrepreneurs and small holders after a study and market test
4) Preparation of a proposal on the future role and implication of GIDA in the project after a study

(4) Investigation for potential investors and companies to be introduced for large-scale farming and scheme management, and operation for the proposed irrigation scheme on the basis of introducing Public Private Partnership (PPP) for the irrigation scheme.

1) Investigation of potential private entrepreneurs for large-scale farming
2) Investigation of potential private entrepreneurs for the scheme management company for water management and operation of all facilities and agricultural services for the irrigation scheme.
3) Study for irrigation system operation, maintenance and management system under PPP.

(5) Economic and financial analysis

1) Preparation of investment plan, estimation of financial cost and benefit, cash flow, etc. for the project operation system selected from the above investigations.
2) Estimation of economic cost and benefit for the selected operation system
3) Estimation of FIRR and EIRR with sensitivity analysis.

(6) Environmental and social safeguard

EIA with environmental monitoring and management, including a mitigation plan, will be prepared by the GIDA in accordance with the guidelines for environmental and social considerations of the Government and JICA, and the environmental and social safeguard policies of the World Bank.

(7) Project implementation schedule for Full Feasibility Study

A two-year study period will be required because it takes one-and-a-half years to prepare topographical maps and study PPP, and another six months for coping with comments on Environmental and Social Considerations submitted by the JICA Advisory Committee on Environmental and Social Considerations, World Bank and Government of Ghana, such as EPA (Environmental Protection Agency).

The overall work schedule can be depicted as follows:

Work Category	1st fiscal year												2nd fiscal year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Data collection, survey, investigation and preparation of feasibility study																								
Assistance to GIDA to carry out EIA for environmetal and social safeguard																								

(8) Assignment schedule

According to JICA Guidelines for Environmental and Social Considerations, the project is classified as “Category A” because it falls into the agriculture sector and involves large-scale irrigation under the Guidelines. The full scale F/S is scheduled to be implemented for a period of two years, including the study period for assisting GIDA to carry out EIA. Based on the results of the pre-F/S, JICA reviews the scoping draft and supports consulting with local stakeholders. JICA conducts environmental and social surveys at the EIA level in accordance with TOR.

The following nine expatriate specialists within two years will be required.

1) Team leader/irrigation development, 2) Irrigation and drainage facilities plan and design, 3) Construction plan and cost estimate, 4) Agronomy and pedology, 5) Irrigation system operation and management, 6) Agro-economist, 7) Environmental safeguard, 8) Social safeguard, 9) Coordinator/Marketing

(9) Undertaking by the Government of Ghana

1) Assignment of full time counterpart for each expatriate specialist

2) Exemption of taxes for the expatriate specialists and their families
3) Working room with desks, chairs, electricity, telephone and air conditioner

(10) The following work is planned to be carried out by the local consultants in Ghana who are employed and supervised by the JICA study team:

1) Profile survey for the main canal with a distance of 70 km, a cross section survey with intervals of 500 m to 1 km, and a topographic survey for major proposed facilities.
2) Geological investigation and laboratory test at the intake site and major hydraulic structures.
3) Farm economy survey of small holders and medium-scale farmers.
4) Interview with potential entrepreneurs, large-scale farming for asset management plan for introducing PPP for irrigation schemes.
5) Investigation of potential private companies for scheme management of the irrigation scheme.
6) Financial analysis of potential investors to be introduced for the NIDS.
7) Environmental impact assessment, including soil, water quality, fauna and flora, monitoring and management.

ANNEXES

Annex A

Hydro-Meteorological Information

Table A.1 Monthly Maximum Temperature

Akuse Station (Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	33.7	35.6	36.5	34.4	33.1	32.3	29.8	31.0	31.6	32.7	34.1	32.5
1991	33.8	34.8	35.3	33.7	32.6	32.0	30.3	29.9	31.8	31.7	32.9	32.7
1992	34.2	36.5	35.3	34.8	33.1	31.4	29.8	30.4	31.4	32.7	32.5	33.2
1993	33.9	35.7	35.1	34.3	33.8	31.9	30.0	30.4	31.6	32.2	33.6	32.7
1994	33.6	35.3	35.1	34.6	33.5	31.2	30.4	30.9	31.2	32.2	33.5	33.8
1995	35.0	36.6	34.8	35.0	33.6	31.9	30.8	30.7	31.9	32.7	33.6	33.5
1996	34.5	35.1	34.6	34.3	32.8	31.5	30.5	29.5	31.2	32.9	33.7	33.9
1997	35.0	36.0	34.7	33.3	32.8	31.3	30.1	31.0	33.0	33.6	33.8	33.8
1998	34.5	37.3	37.4	37.3	34.1	33.1	31.5	31.4	33.0	33.0	34.3	34.0
1999	34.4	35.3	36.2	35.6	33.8	33.5	32.1	31.4	32.4	32.9	34.2	33.9
2000	33.9	34.5	34.6	35.1	33.4	33.8	32.7	31.9	32.6	33.1	33.8	33.7
2001	34.3	34.6	35.1	35.4	33.9	31.5	30.3	30.1	31.6	33.9	33.8	34.8
2002	34.2	36.5	36.3	35.0	34.1	31.9	30.9	30.7	32.4	33.0	33.9	34.1
2003	34.8	36.5	36.7	34.4	34.4	31.6	31.3	31.0	32.0	33.7	34.2	34.5
2004	35.3	36.4	35.7	35.1	33.4	31.4	31.0	31.0	32.5	33.1	33.8	34.3
2005	34.4	36.8	35.6	35.9	33.7	31.3	30.8	30.8	33.0	33.0	34.1	33.7
2006	35.2	36.4	35.5	35.1	33.3	32.5	31.3	30.9	31.9	33.1	34.8	34.6
2007	35.0	36.6	35.9	34.8	34.3	31.3	30.8	30.6	31.9	32.4	33.8	34.2
2008	34.3	36.3	35.2	33.9	33.1	31.6	31.3	31.1	31.9	33.8	34.6	34.3
2009	34.9	36.2	36.3	34.9	34.6	32.1	30.7	30.5	32.6	33.9	34.4	35.3
2010	35.3	36.5	35.6	35.8	34.0	32.0	31.1	31.5	31.7	33.2	34.3	35.4
Average	34.5	36.0	35.6	34.9	33.6	32.0	30.8	30.8	32.1	33.0	33.9	33.9

Source: Ghana Meteorological Service Department

Table A.2 Monthly Minimum Temperature

Akuse Station (Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	22.7	23.2	25.1	24.5	23.8	23.4	22.5	22.3	22.6	22.7	22.7	22.1
1991	22.6	24.4	24.7	23.6	23.9	23.8	22.7	22.6	22.5	21.7	22.3	21.7
1992	20.5	24.1	25.4	24.8	23.9	23.1	22.5	21.8	22.1	22.6	22.2	22.7
1993	20.6	23.8	23.6	24.0	24.1	23.0	22.7	22.2	22.3	22.6	22.8	22.6
1994	21.7	24.1	24.5	24.5	23.6	23.1	22.6	22.5	23.2	22.6	22.5	20.8
1995	21.6	24.7	24.3	25.0	24.9	24.0	23.7	22.6	23.1	22.4	22.3	21.1
1996	22.3	23.1	24.1	24.4	23.8	24.3	23.5	22.7	22.7	22.9	23.3	23.1
1997	23.9	23.9	24.6	24.3	23.8	23.5	22.5	22.6	23.4	23.6	23.4	23.3
1998	22.0	25.3	26.4	26.8	25.2	24.0	23.4	22.9	23.6	23.5	23.9	23.3
1999	23.7	23.3	24.5	24.4	24.0	23.5	23.1	22.2	22.4	22.6	22.7	22.3
2000	23.1	22.3	25.2	24.7	24.3	23.4	22.0	22.5	22.9	22.7	23.1	23.0
2001	22.9	23.9	24.9	24.7	24.4	23.6	22.8	22.9	22.4	22.8	22.8	23.2
2002	22.3	23.6	24.9	24.7	24.3	23.3	23.2	22.3	22.8	23.0	23.2	21.5
2003	23.1	24.5	25.0	24.4	24.3	23.7	22.7	23.0	23.1	23.5	23.3	22.8
2004	24.0	24.5	25.1	24.8	24.3	23.1	22.7	22.9	22.9	23.2	23.4	23.7
2005	20.9	25.5	24.9	25.4	24.3	23.9	23.1	22.2	23.5	23.2	23.5	23.0
2006	23.8	24.9	24.3	24.8	23.9	23.3	23.2	22.6	23.1	23.3	23.2	23.0
2007	20.3	24.4	25.1	24.9	24.5	23.5	22.9	22.9	23.0	22.8	23.1	23.1
2008	20.0	24.5	24.8	24.5	24.0	23.3	22.9	22.8	23.1	23.2	23.4	23.2
2009	22.9	24.4	24.7	24.2	24.1	24.0	23.2	23.3	23.1	22.9	23.1	23.7
2010	23.9	24.8	25.3	25.2	24.6	24.1	22.7	23.2	23.4	23.5	23.4	23.2
Average	22.3	24.2	24.8	24.7	24.2	23.6	22.9	22.6	22.9	22.9	23.0	22.7

Source: Ghana Meteorological Service Department

Table A.3 Monthly Maximum Temperature

Aveyime Station (Unit: °C)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1990	35.3	36.2	37.2	34.3	33.2	31.1	27.3	31.1	31.3	32.8	34.2	33.5
1991	34.4	35.5	36.0	33.8	32.5	31.9	30.2	30.1	32.1	32.3	33.7	33.7
1992	34.8	36.4	35.0	34.2								
1993												
1994												
1995												
1996										32.3	34.1	33.2
1997	34.4											
1998												
1999												
2000												34.6
2001	34.5	36.4	35.0	34.3	34.3	31.9	30.7	30.1	31.0	33.4	33.2	34.2
2002	34.3	35.9	35.7	35.5	33.5	31.8	30.5	30.7	32.1	33.4	34.1	34.7
2003	34.6	36.2	35.4	33.7	33.4	31.6	31.6	30.6	31.5	33.1	33.6	33.9
2004	35.0	35.9	35.7	34.3	32.9	31.1	31.0	30.6	31.9	32.8	35.1	35.2
2005	35.2	36.4	35.2	35.5	33.6	30.6	30.4	30.6	32.5	33.1	34.4	34.4
2006	35.5	36.5	35.0	34.9	32.9	32.3	31.0	29.9	30.9	32.3	34.2	35.1
2007	35.3	36.3	36.2	34.9	34.7	30.8	29.9	30.2	31.5	32.7	33.5	34.4
2008		36.2	35.9	34.6	33.3	31.2	30.9	31.0	31.9	33.9	35.0	34.6
2009	35.2	36.0	36.2	35.0	34.6	32.0	30.1	30.4	32.4	33.6	34.8	35.5
2010	35.3	35.9	36.0	36.7	34.9	31.9	31.3	31.5	32.0	33.0	34.0	35.2
Average	34.9	36.1	35.7	34.7	33.7	31.5	30.4	30.6	31.8	33.0	34.1	34.4

Source: Ghana Meteorological Service Department

Table A.4 Monthly Minimum Temperature

Aveyime Station (Unit: °C)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1990	23.3	23.7	25.7	24.4	23.8	23.6	22.3	22.0	22.5	22.9	23.2	22.5
1991	23.1	24.2	24.8	23.3	23.6	23.1	22.8	22.7	22.8	22.6	23.5	22.9
1992	21.7	25.0	25.8	25.3								
1993												
1994												
1995												
1996										22.9	23.6	24.0
1997	24.1											
1998												
1999												
2000												23.7
2001	23.7	24.7	25.0	25.1	24.8	23.5	23.3	23.0	22.8	23.6	23.8	24.3
2002	24.1	24.8	25.6	25.4	24.5	23.5	23.5	22.6	23.1	23.4	24.0	22.9
2003	24.3	25.4	25.7	24.8	24.9	23.9	23.1	23.1	23.6	24.0	24.0	23.5
2004	24.4	24.9	24.9	25.2	24.5	23.4	23.0	23.0	23.1	23.9	24.1	24.7
2005	22.6	26.2	25.2	26.4	25.0	24.0	23.2	22.4	23.7	23.7	24.4	23.9
2006	24.8	25.6	25.0	25.5	24.2	23.5	23.3	22.8	23.1	23.6	23.9	23.6
2007	21.9	25.8	26.2	25.5	24.8	23.7	23.2	23.1	23.3	23.3	23.7	23.7
2008		25.0	25.7	24.7	24.1	23.6	23.2	22.9	23.2	23.7	24.4	24.2
2009	23.8	25.6	25.8	25.1	24.9	24.4	23.7	23.1	23.5	24.1	24.3	24.8
2010	25.2	26.0	26.6	26.4	25.6	24.7	23.7	23.9	24.0	24.0	24.1	24.1
Average	23.6	25.1	25.5	25.2	24.6	23.7	23.2	22.9	23.2	23.5	23.9	23.8

Source: Ghana Meteorological Service Department

Table A.5 Monthly Rainfall

Akuse Station (unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	15.0	58.2	71.9	116.6	118.2	140.8	51.7	1.3	100.0	93.7	59.1	85.2	911.7
1991	28.2	2.1	86.4	190.2	283.0	156.1	110.1	44.6	57.2	151.9	47.6	14.2	1171.6
1992	0.0	0.0	56.7	56.5	251.9	46.7	82.9	4.9	36.9	147.8	96.3	3.1	783.7
1993	0.0	59.9	40.7	146.8	55.2	216.5	34.7	94.0	168.0	81.2	78.9	33.8	1009.7
1994	1.5	46.2	118.4	113.7	177.9	157.2	36.1	15.8	122.9	136.2	120.1	0.0	1046.0
1995	0.0	7.6	108.9	179.0	58.7	295.6	195.9	149.3	113.2	158.7	59.2	80.0	1406.1
1996	1.3	55.5	144.3	161.2	338.2	121.2	217.6	86.6	50.8	205.1	24.4	2.1	1408.3
1997	5.6	1.5	139.5	147.0	214.0	360.4	128.5	9.5	22.2	108.3	93.9	38.2	1268.6
1998	10.0	8.8	33.7	21.3	301.9	221.6	31.1	12.8	68.3	314.7	71.6	15.8	1111.6
1999	7.9	43.2	97.2	89.9	56.5	302.6	191.3	144.0	85.3	75.2	94.6	6.7	1194.4
2000	28.8	25.8	16.6	142.0	183.0	152.6	127.1	49.7	199.2	114.5	38.5	25.2	1103.0
2001	0.0	2.7	44.8	58.9	144.6	140.9	48.7	1.6	127.3	106.2	89.8	2.8	768.3
2002	78.3	15.4	25.0	176.9	80.5	212.9	68.6	20.7	46.2	121.9	43.3	3.2	892.9
2003	54.9	26.6	62.0	140.3	185.4	150.7	142.6	5.4	58.1	92.2	40.0	14.7	972.9
2004	3.0	70.2	92.2	36.8	161.8	170.8	62.8	40.9	151.2	28.8	98.8	68.8	986.1
2005	0.8	10.5	121.8	53.1	81.1	93.7	76.7	21.8	70.7	173.7	121.2	53.9	879.0
2006	2.4	31.5	96.1	71.2	245.6	91.1	6.6	10.2	136.9	104.0	33.7	27.6	856.9
2007	0.0	42.9	116.3	142.4	113.6	117.4	172.2	25.3	184.1	125.7	59.0	0.5	1099.4
2008	26.5	9.1	79.8	172.6	147.5	136.6	154.5	15.2	90.6	77.5	62.9	45.6	1018.4
2009	15.2	21.8	113.3	159.8	130.3	143.5	46.4	77.0	50.7	88.1	n.a.	n.a.	846.1
2010	68.9	42.7	144.4	109.5	116.3	73.5	40.2	34.2	172.8	160.1	118.5	n.a.	1081.1
Average	16.6	27.7	86.2	118.4	164.1	166.8	96.5	41.2	100.6	126.9	72.6	27.4	1044.9

Source: Ghana Meteorological Service Department

Table A.6 Monthly Rainfall

Aveyime Station (unit: mm)

Year	Jan	Fem	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	0.0	11.5	84.8	128.3	118.4	176.8	131.1	9.2	92.6	73.3	41.0	76.1	943.1
1991	17.0	14.2	26.7	206.5	171.9	82.1	154.6	5.2	35.2	167.1	24.1	0.5	905.1
1992	0.0	0.0	62.7	66.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	20.8	70.6	105.1	51.0	38.1	
1994	0.0	53.8	36.1	43.3	157.3	72.2	26.9	24.7	116.3	124.7	148.3	0.0	803.6
1995	0.0	0.3	75.6	309.6	88.9	310.4	118.5	45.2	85.4	159.8	46.3	14.5	1254.5
1996	26.3	118.6	107.3	211.3	152.9	94.2	158.7	97.7	6.3	47.5	12.4	59.6	1092.8
1997	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	27.4	
2001	0.0	4.4	91.4	93.7	120.3	296.3	4.0	5.2	102.7	126.2	39.7	39.3	923.2
2002	70.1	3.8	49.4	151.1	157.0	170.0	42.1	3.7	48.0	99.7	150.9	0.0	945.8
2003	15.6	6.2	127.2	291.7	135.4	81.7	29.6	31.6	78.3	124.0	96.8	15.5	1033.6
2004	19.5	37.5	87.7	69.9	192.4	47.1	18.3	50.7	116.0	37.1	14.3	0.2	690.7
2005	0.0	23.4	129.3	15.3	139.8	93.7	42.0	6.2	54.3	170.3	68.1	42.7	785.1
2006	6.0	17.5	61.5	93.4	288.6	104.1	36.5	38.8	194.8	73.5	113.3	0.0	1028.0
2007	0.0	2.3	71.6	101.0	95.3	172.8	111.3	29.5	87.0	120.3	96.6	4.3	892.0
2008	n.a.	18.0	22.8	148.9	186.8	97.0	33.7	57.7	44.2	92.9	32.3	23.9	
2009	0.6	7.5	28.9	125.6	53.6	177.5	9.9	38.7	18.4	81.1	24.3	8.4	574.5
2010	91.0	28.4	68.3	34.4	72.0	89.9	47.5	33.2	43.2	154.2	80.6	n.a.	
Average	15.4	21.7	70.7	130.7	142.0	137.7	64.3	31.1	74.6	109.8	65.0	21.9	885.0

Source: Ghana Meteorological Service Department

Table A.7 Monthly Evaporation

Akuse Station (unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	138.9	191.8	189.0	145.7	140.1	110.8	84.4	103.5	105.8	119.8	134.4	119.8	1584.0
1991	146.3	155.3	159.2	131.6	106.3	100.1	85.5	84.9	108.0	112.5	122.1	131.6	1443.4
1992	197.4	200.8	164.8	150.8	132.8	99.6	79.3	101.3	104.1	115.9	116.4	119.3	1582.5
1993	176.6	176.1	161.4	136.7	120.4	99.6	82.7	87.8	99.6	100.7	122.6	112.5	1476.7
1994	147.4	162.0	154.1	138.9	122.1	88.3	87.2	98.4	93.4	104.6	122.6	159.2	1478.2
1995	187.9	194.1	146.8	140.6	117.0	95.6	84.9	84.4	102.9	111.4	123.8	131.1	1520.5
1996	141.8	153.6	138.9	127.7	104.6	90.6	83.8	74.3	94.5	113.6	128.8	131.6	1383.8
1997	157.5	189.6	153.0	118.1	105.8	83.8	81.6	95.1	118.7	123.2	124.3	125.4	1476.1
1998	171.6	203.1	192.4	187.3	124.3	113.6	100.7	108.0	126.0	114.2	127.1	132.8	1701.1
1999	141.8	172.7											
2000													
2001	141.8	153.6	138.9	127.7	124.9	91.1	81.6	87.2	102.4	128.8	118.1	134.4	1430.5
2002	150.8	180.0	168.8	144.0	122.6	96.2	83.8	88.9	112.5	114.8	119.8	142.3	1524.5
2003	147.3	176.1	176.1	132.8	129.4	87.8	92.8	90.0	102.9	119.3	129.9	142.9	1527.3
2004	163.1	187.9	167.1	146.3	118.1	92.3	90.6	95.1	110.3	116.4	123.2	129.9	1540.3
2005	170.4	178.3	153.6	156.5	124.3	89.4	91.7	99.0	122.1	113.6	124.3	118.7	1541.9
2006	148.5	176.1	159.8	142.9	118.1	105.2	100.1	96.8	98.4	113.1	147.4	150.8	1557.2
2007	207.0	183.9	168.8	135.6	133.3	85.5	86.6	87.2	87.2	105.2	120.9	139.5	1540.7
2008	194.6	189.0	154.1	122.1	111.4	91.7	92.8	94.5	101.3	127.7	141.8	135.0	1556.0
2009	174.9	171.6	169.9	144.0	138.4	99.0	85.5	84.9	111.4	132.2	137.3	154.1	1603.2
2010	154.7	172.1	151.3	151.9	120.4	90.6	92.3	100.1	97.9	113.6	124.3		
Average	163.0	178.4	161.5	141.1	121.8	95.3	87.8	92.7	105.2	115.8	126.8	133.9	1526.0

Source: Ghana Meteorological Service Department

Table A.8 Monthly Evaporation

Aveyime Station (unit: mm)

Year	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990													
1991													
1992													
1993													
1994													
1995													
1996								122.1	102.9	115.3	137.8	122.1	
1997	139.5												
1998													
1999													
2000												144.0	
2001	147.9	193.5	142.3	123.8	127.1	95.1	88.9	87.8	95.6	119.8	111.4	125.4	1458.6
2002	137.8	169.3	158.1	149.6	110.3	93.9	80.4	95.1	111.9	123.8	126.6	162.6	1519.4
2003	146.8	172.1	151.3	116.4	112.5	92.3	103.5	83.3	88.9	108.0	111.4	132.8	1419.3
2004	146.3	173.3	177.8	126.0	102.9	68.1	87.2	89.4	97.9	98.4	147.4	147.4	1462.1
2005	186.8	153.6	134.4	143.4	110.8	72.6	87.2	90.6	113.1	108.6	125.4	130.5	1457.0
2006	153.0	171.0	144.0	136.7	104.6	99.0	91.7	82.7	84.4	97.3	123.2	155.3	1442.9
2007	207.0	172.7	166.5	144.0	133.9	74.3	72.0	81.6	93.9	108.0	115.9	137.8	1507.6
2008		182.8	162.6	136.1	112.5	82.1	86.1	96.8	101.8	127.7	144.0	141.8	
2009	182.3	164.8	145.7	149.1	133.9	76.5	96.2	86.6	112.5	127.1	143.4	143.4	1561.5
2010	147.9	135.0	155.8	164.3	135.6								
Average	159.5	168.8	153.9	138.9	118.4	83.8	88.1	91.6	100.3	113.4	128.7	140.3	1478.6

Source: Ghana Meteorological Service Department

Table A.9 Monthly Sunshine Duration

Akuse Station (unit:hr/day)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	6.7	6.2	7.1	6.2	7.3	6.2	3.3	3.9	4.5	7.2	7.8	6.9
1991	5.2	6.7	6.4	7.0	5.7	5.2	3.9	3.0	5.1	5.7	6.9	4.8
1992	3.0	7.3	4.6	6.0	7.1	4.6	2.4	3.7	4.3	6.7		6.6
1993	5.1	7.4	6.3	6.2	6.5	5.5	3.3	3.8	4.9	7.2	7.1	5.1
1994	4.7	4.7	7.1	6.6	6.5							
1995												
1996				7.1	6.2	5.0	4.9	3.1	4.9	6.9	7.8	7.2
1997	7.4		5.1	6.7	7.2	4.9	4.8		5.8	7.1	7.7	7.7
1998	5.1	7.2	6.2	7.3	7.1	5.6						
1999		7.4							5.1	6.6	7.1	5.4
2000	6.2	6.7	6.5	8.0	7.0	5.1	5.7	4.6	4.7	7.6	8.4	6.8
2001	7.5	7.0	6.4	6.7	6.6	5.6	5.5	3.0	4.7	7.2	7.6	7.5
2002	3.9	5.5	5.8	6.5	6.9	6.0	4.3	4.2	5.1	6.7	7.3	7.5
2003	6.0	6.7	6.3	6.5	7.0	4.3	5.3	4.0	4.1	7.9	7.4	6.7
2004	4.5	5.0	4.7	6.4	5.3	4.6	4.4	3.5	5.9	6.4	6.2	6.6
2005	3.9	6.2	6.2	5.5	6.3	4.8	3.9	3.5	5.3	7.5	7.8	7.5
2006	6.6	7.2	6.1	6.2	6.4	6.9	4.4	3.7	4.8	7.2	7.6	6.5
2007	1.1	6.2	6.2	7.1	5.9	4.6	3.6	3.8	5.6	6.0	7.3	6.3
2008	6.0	5.7	5.6	5.9	6.1	4.8	4.3	4.7	7.0	7.2	7.0	6.5
2009	5.7	7.0	5.9	7.5	7.1	4.7	3.9	2.8	4.7	6.4	7.1	7.2
2010	6.8	7.3	4.1	6.6	6.3	2.8	4.3	3.7	3.9	6.2	7.2	8.0
Average	5.3	6.5	5.9	6.6	6.6	5.1	4.2	3.7	5.0	6.9	7.4	6.7

Source: Ghana Meteorological Service Department

Table A.10 Monthly Sunshine Duration

Aveyime Station (unit:hr/day)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990								5.4	5.1	7.5	8.4	7.5	
1991	6.3	7.2	7.2	8.0	6.2	5.2	3.7	3.8	5.9		7.7	7.1	6.3
1992	6.0	8.0	5.4	7.2									6.0
1993									7.4				
1994													
1995													
1996													
1997													
1998													
1999													
2000													
2001													
2002													
2003								3.7		8.2	7.7	6.9	
2004	5.3		5.9			5.2	4.8	4.2	5.7	7.2	7.2	7.0	5.3
2005	5.1		6.5	7.0	7.4	5.3	4.6	4.5		7.4	8.0		5.1
2006			6.5	7.3	6.9	7.5	5.1	4.5	4.5	7.3	8.3	7.3	
2007	2.4	7.0	6.7	7.6	6.5	5.0	4.9	4.5	5.8	6.6	7.8	7.0	2.4
2008		5.1	6.6	6.2	6.4	5.4	4.6	4.6	4.8	7.4			
2009	6.5	7.7	6.0	7.8	7.5	5.1	4.5	3.9	5.3	7.6	7.9	7.5	6.5
2010	7.7	8.5	5.0	6.9	6.6	4.5	5.2	4.7	4.4	6.2	7.2	7.7	7.7
Average	5.6	7.3	6.2	7.3	6.8	5.4	4.7	4.4	5.4	7.3	7.8	7.3	5.6

Source: Ghana Meteorological Service Department

Table A.11 Average Monthly Relative Humidity

Akuse Station (%)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	67.5	62.5	64.5	72.5	77.5	79.0	81.5	77.0	78.5	79.0	79.5	75.0
1991	71.0	72.0	71.5	75.5	82.0	83.0	82.0	81.5	79.5	78.0	78.0	71.5
1992	56.5	63.0	70.0	73.5	78.5	81.0	82.5	77.5	79.5	82.0	79.5	77.0
1993	62.0	69.0	71.0	76.0	78.5	83.0	81.0	81.5	83.0	81.5	82.5	78.0
1994	70.5	71.0	71.5	76.0	78.5	84.0	80.5	78.0	83.0	81.5	79.0	67.0
1995	62.5	65.5	73.0	75.0	79.5	84.0	82.0	82.5	83.0	82.0	77.0	75.5
1996	74.5	73.0	75.0	78.0	82.5	82.0	83.5	84.0	80.5	82.0	77.0	75.5
1997	72.0	64.0	71.0	78.0	83.0	86.0	81.5	80.5	81.0	80.5	80.0	77.0
1998	63.5	65.5	68.5	68.0	80.0	80.0	78.5	76.0	76.5	80.0	82.0	76.0
1999	74.0	67.0	73.5	75.5	79.5	84.0	85.0	81.5	82.0	83.5	84.0	75.5
2000	73.5	63.0	69.0	75.0	80.5	84.5	82.0	81.5	81.5	81.5	78.5	73.0
2001	71.0	66.5	72.0	74.5	79.0	85.0	83.0	79.5	80.5	83.0	84.5	78.5
2002	73.5	72.0	74.0	76.0	80.0	83.0	86.0	82.0	79.5	84.5	85.0	75.0
2003	76.0	72.5	73.0	80.5	80.0	85.5	83.0	81.5	82.5	82.0	79.5	74.5
2004	71.5	68.5	71.0	76.0	82.0	83.5	84.0	81.5	84.0	81.5	82.5	79.0
2005	68.0	72.0	74.0	75.5	79.0	83.0	80.0	78.5	78.5	82.5	81.0	79.0
2006	75.5	72.0	73.5	77.0	81.5	82.0	79.5	80.0	82.5	83.5	76.5	73.0
2007	57.0	69.0	71.0	77.0	78.5	84.0	84.0	82.0	82.5	85.0	81.0	75.0
2008	60.0	66.5	73.0	80.5	81.5	83.0	81.5	80.0	81.0	81.0	79.5	76.5
2009	65.0	73.0	75.0	76.5	77.0	82.5	82.5	81.5	79.5	80.5	79.5	74.0
2010	73.5	72.5	76.0	77.5	82.0	84.5	82.5	80.5	83.0	84.0	83.0	77.0
Average	68.5	68.6	72.0	75.9	80.0	83.2	82.2	80.4	81.0	81.9	80.4	75.4

Source: Ghana Meteorological Service Department

Table A.12 Average Monthly Relative Humidity

Aveyime Station (%)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990												
1991												
1992												
1993												
1994												
1995												
1996										80.5	79.0	78.5
1997	77.0											
1998												
1999												
2000												74.5
2001	73.0	67.0	76.0	79.0	79.5	84.0	80.5	77.5	79.5	80.0	81.5	78.0
2002	75.0	72.0	74.5	76.5	82.0	82.5	84.0	77.0	78.5		79.0	69.5
2003	73.0	73.0	74.5	80.5	80.5	83.0	81.0	83.5	85.0	82.0	83.0	75.5
2004	76.5	72.0	69.5	79.0	83.0	86.0	83.5	81.5	83.5	84.5	77.5	75.5
2005	65.5	74.0	79.0	76.5	82.0	86.0	82.0	82.5		83.0	80.0	79.0
2006	76.0	72.5	76.5	78.5	83.5	82.0	82.5	82.5	83.0	84.5	81.5	73.0
2007	57.0	72.0	73.0	78.0	78.5	86.5	85.5	83.5	83.0	83.5	80.5	76.5
2008		70.0	75.0	79.0	79.0	84.0	82.5	82.0	81.5	80.0	77.0	
2009	64.5	73.5	74.0	74.5	79.0	81.0	85.0	84.5	79.0	80.0	78.0	78.5
2010	77.0	74.5	75.5	75.5	78.0	85.0	82.0	93.0	81.0	84.0	81.0	75.5
Average	71.5	72.1	74.8	77.7	80.5	84.0	82.9	82.8	81.6	82.2	79.8	75.8

Source: Ghana Meteorological Service Department

Table A.13 Average Daily Wind Speed

Akuse Station (%)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	0.9	1.5	1.7	1.7	1.3	1.9	1.9	1.9	1.6	1.2	1.1	1.0
1991	1.0	1.7	1.7	1.5	1.1	1.2	1.4	2.0	1.4	1.3	0.9	0.8
1992	1.2	1.6	2.1	1.8	1.3	1.9	2.0	2.2	1.9	1.3	0.8	1.1
1993	1.4	2.0	1.9	1.8	1.7	1.3	2.3	1.9	1.5	1.2	1.1	0.8
1994	1.2	2.0	2.3	2.0	1.4	1.3	2.0	2.2	1.4	1.0	0.7	0.8
1995	1.5	1.8	1.6	1.6	1.2	1.1	1.6	1.3	1.0	0.8	0.6	0.9
1996	1.1	1.5	1.4	1.3	1.1	1.3	1.3	1.6	1.8	1.5	1.0	1.5
1997	1.7	1.8	2.2	1.9	1.1	1.1	1.7	1.6	1.6	1.3	1.1	1.0
1998	1.2	1.6	1.8	2.5	1.4	1.4	2.1	2.2	2.0	1.4	0.9	1.0
1999	1.4	1.9	1.9	1.6	1.5	1.2	1.6	1.7	1.5	1.3	1.1	1.1
2000	1.2	1.4	1.9	2.0	1.2	1.1	1.5	1.7	1.5	1.1	1.0	1.2
2001	1.3	1.6	2.2	2.4	2.1	1.7	2.1	2.5	2.0	1.2	0.9	0.9
2002	1.1	1.7	2.2	1.9	1.7	1.5	1.6	1.6	1.6	1.3	1.0	1.0
2003	1.2	1.5	1.3	1.2	1.4	1.2	1.3	1.5	1.3	1.1	1.0	0.8
2004	0.9	1.0	1.0	1.2	1.0	1.0	1.1	1.3	1.0	0.9	0.7	0.7
2005	0.8	1.3	1.2	1.3	1.1	1.2	1.1	1.3	1.1	0.7	0.6	0.5
2006	0.9	1.1	1.0	0.9	0.7	0.7	1.1	1.2	0.9	0.7	0.6	0.5
2007	0.7	1.0	1.0	0.9	0.7	0.8	0.8	2.1	0.8	0.6	0.5	0.5
2008	0.7	0.8	1.0	1.9	0.7	0.6	0.8	0.8	0.8	0.6	0.6	0.5
2009	0.8	1.0	0.9	0.8	0.8	0.7	0.9	1.1	0.8	0.8	0.5	0.7
2010	0.7	0.9	0.8	0.9	0.7	0.7	1.0	0.9	0.8	0.6	0.5	0.6
Average	1.1	1.5	1.6	1.6	1.2	1.2	1.5	1.6	1.3	1.0	0.8	0.9

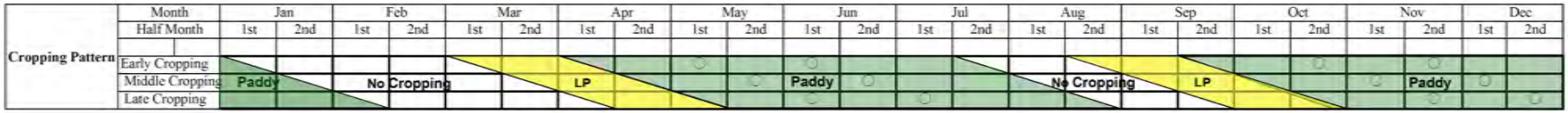
Source: Ghana Meteorological Service Department

Annex B

Irrigation and Drainage Development

Table B.1 Water Requirement Analysys for Accra Plain Gravity Irrigation Project

Calculation of Net Field Water Requirement for Paddy



Irrigation Efficiency for New Development Area 68.85%

Gross Unit Water Requirement (lit/sec/ha) **Paddy Field**

(Unit: lit/sec/ha)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	(m3/ha)	(mm)	(mm)	(mm)	Year
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Max. of Unit WR	Water per ha	Gross	Net Water Requirement	Effectiv e	
1990	0.729	0.378	0.060	0.000	0.350	0.301	1.342	0.757	0.565	1.405	0.740	0.422	0.000	0.674	0.276	0.374	0.499	1.113	1.411	1.044	1.283	1.294	1.115	0.749	1.411	22,306	2,231	1,536	673	1990
1991	0.729	0.226	0.060	0.000	0.149	1.007	0.502	0.925	0.800	0.749	1.278	0.792	0.000	0.674	0.361	0.374	0.634	1.432	0.721	0.893	1.253	1.445	1.283	1.220	1.445	23,109	2,311	1,591	618	1991
1992	0.729	0.378	0.060	0.000	0.350	0.520	1.275	1.413	1.036	0.000	1.329	1.027	0.713	0.439	0.361	0.374	0.920	1.264	0.385	1.515	0.830	1.294	1.283	1.220	1.515	24,636	2,464	1,696	513	1992
1993	0.729	0.378	0.060	0.000	0.199	0.906	1.074	0.942	1.271	1.253	0.675	0.287	1.066	0.506	0.260	0.273	0.667	1.096	1.360	0.826	1.183	1.227	0.963	1.220	1.360	24,335	2,434	1,676	533	1993
1994	0.729	0.378	0.000	0.000	0.149	0.923	1.309	1.547	1.036	0.581	1.060	1.128	1.150	0.473	0.361	0.113	0.667	0.676	1.108	1.095	0.409	1.261	1.283	1.220	1.547	24,588	2,459	1,693	516	1994
1995	0.729	0.378	0.060	0.000	0.165	0.553	1.174	0.000	0.935	1.270	0.000	0.422	0.192	0.624	0.361	0.000	0.499	1.180	1.319	0.439	0.981	1.530	1.182	1.220	1.530	20,090	2,009	1,383	826	1995
1996	0.729	0.378	0.000	0.000	0.000	0.385	1.074	0.841	0.000	0.363	1.295	0.456	0.000	0.372	0.361	0.000	0.499	1.432	0.688	0.792	1.199	1.530	1.283	1.220	1.530	19,607	1,961	1,350	859	1996
1997	0.729	0.327	0.060	0.000	0.065	0.183	0.973	1.043	0.683	0.665	0.000	0.000	0.192	0.674	0.361	0.374	0.869	1.382	1.428	0.943	1.351	0.823	0.963	1.220	1.428	20,217	2,022	1,392	817	1997
1998	0.729	0.293	0.000	0.000	0.266	0.856	1.561	1.497	0.000	0.598	1.362	0.000	0.965	0.624	0.310	0.273	0.869	0.945	0.335	0.237	1.149	1.227	1.182	1.220	1.561	21,737	2,174	1,497	712	1998
1999	0.678	0.378	0.009	0.000	0.000	0.671	1.292	1.194	1.321	1.237	0.000	0.405	0.444	0.000	0.041	0.000	0.920	0.844	1.327	1.246	0.947	1.227	1.283	1.220	1.327	22,033	2,203	1,517	692	1999
2000	0.527	0.378	0.060	0.000	0.350	0.906	0.720	1.346	1.069	0.497	0.993	0.556	0.444	0.405	0.361	0.000	0.264	0.457	1.159	1.111	1.132	1.429	1.283	0.985	1.429	21,666	2,167	1,492	717	2000
2001	0.729	0.378	0.060	0.000	0.000	0.906	1.174	1.278	1.288	0.732	1.463	0.000	1.150	0.674	0.361	0.374	0.550	0.928	1.428	0.573	1.149	1.479	0.930	1.220	1.479	24,816	2,482	1,709	500	2001
2002	0.107	0.378	0.060	0.000	0.000	1.007	0.720	1.194	0.784	0.850	0.841	0.422	0.999	0.475	0.361	0.374	0.667	1.281	1.411	0.910	0.039	1.530	1.283	1.220	1.530	22,365	2,237	1,540	669	2002
2003	0.729	0.277	0.060	0.000	0.000	0.654	0.000	1.245	1.338	0.447	1.144	0.926	1.150	0.439	0.108	0.374	0.482	1.180	0.906	1.162	0.964	1.109	1.148	1.220	1.338	22,509	2,251	1,550	659	2003
2004	0.577	0.378	0.000	0.000	0.132	0.486	1.006	**1.665**	0.817	0.463	1.110	1.246	1.083	0.674	0.361	0.046	0.583	0.810	1.377	1.431	1.351	1.412	1.283	1.220	**1.665**	25,692	2,569	1,769	440	2004
2005	0.729	0.378	0.000	0.000	0.000	0.671	1.494	1.598	1.305	0.497	0.656	1.246	1.150	0.338	0.361	0.273	0.667	1.247	0.772	0.910	0.914	1.445	0.930	1.220	1.598	24,755	2,474	1,703	506	2005
2006	0.678	0.378	0.000	0.000	0.182	0.721	1.090	1.346	0.000	0.631	0.690	1.128	1.150	0.388	0.041	0.374	0.000	1.012	1.243	1.330	0.409	1.530	1.283	1.220	1.530	22,240	2,224	1,531	678	2006
2007	0.729	0.378	0.060	0.000	0.283	0.503	0.653	**1.665**	1.490	0.716	0.673	0.607	1.150	0.000	0.361	0.180	0.869	0.894	1.226	0.876	0.661	1.462	1.283	1.220	**1.665**	23,581	2,358	1,623	586	2007
2008	0.729	0.176	0.000	0.000	0.182	1.007	0.939	1.009	0.700	0.749	0.942	1.078	1.150	0.506	0.361	0.000	0.920	1.147	1.041	1.212	1.132	1.530	1.215	1.119	1.530	24,832	2,483	1,710	500	2008
2009	0.729	0.378	0.060	0.000	0.132	1.007	1.090	1.026	1.338	1.203	0.993	0.237	1.150	0.674	0.361	0.012	0.852	1.348	1.007	1.380	1.233	1.462	1.283	1.220	1.462	26,654	2,665	**1,835**	374	2009
2010	0.628	0.000	0.000	0.000	0.048	0.758	1.561	1.430	1.473	0.917	0.724	1.246	0.797	0.674	0.361	0.096	0.869	1.281	0.654	1.095	1.199	1.042	1.283	1.220	1.561	25,467	2,547	1,754	455	2010
Ave.	0.673	0.332	0.035	0.000	0.143	0.710	1.049	1.189	0.917	0.753	0.856	0.649	0.766	0.491	0.307	0.203	0.656	1.093	1.062	1.001	0.988	1.347	1.191	1.181	1.497	23,201	2,320	1,597	612	Ave.
Max	0.729	0.378	0.060	0.000	0.350	1.007	1.561	**1.665**	1.490	1.405	1.463	1.246	1.150	0.674	0.361	0.374	0.920	1.432	1.428	1.515	1.351	1.530	1.283	1.220	**1.665**	26,654	2,665	**1,835**	859	Max

Table B.1 (1) Kpong Irrigation Scheme (KIS)

KIS Area(ha)	KIS Area(ha)					Golden Exotics(ha)			Total
	Paddy	Expansion	Upland	Fish pond	Sub Total	Banana	Expansion	Sub total	(ha)
	1852	407	41	20	2320	1200	600	1800	4120

Total KIS Area (ha)			
Paddy	Upland	Banana	Total
2259	61	1800	4120

20ha of fish pond is included in the Upland.
Banana is irrigated under drip irrigation with 12 hours irrigation.

Kpong Irrigation Scheme (KIS)

Gross Water Requirement (m3/sec)

(Unit: lit/sec/ha)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	Average	Year
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(m3/sec)	(m3/sec)	Year
1990	3.130	1.622	0.257	0.000	1.505	1.294	5.767	3.253	2.427	6.034	3.181	1.813	0.000	2.896	1.188	1.608	2.145	4.781	6.060	4.485	5.513	5.559	4.787	3.218	6.060	3.022	1990
1991	3.130	0.972	0.257	0.000	0.638	4.326	2.156	3.975	3.438	3.218	5.491	3.401	0.000	2.896	1.549	1.608	2.722	6.153	3.099	3.835	5.296	6.209	5.509	5.240	6.209	3.130	1991
1992	3.130	1.622	0.257	0.000	1.505	2.232	5.478	6.069	4.449	0.000	5.708	4.412	3.063	1.885	1.549	1.608	3.950	5.431	1.655	6.507	3.563	5.559	5.509	5.240	6.507	3.349	1992
1993	3.130	1.622	0.257	0.000	0.855	3.893	4.611	4.047	5.460	5.384	2.892	1.235	4.579	2.174	1.115	1.174	2.867	4.709	5.843	3.546	5.080	5.270	4.137	5.240	5.843	3.297	1993
1994	3.130	1.622	0.000	0.000	0.638	3.965	5.622	6.647	4.449	2.496	4.553	4.845	4.940	2.030	1.549	0.484	2.867	2.903	4.760	4.702	1.758	5.415	5.509	5.240	6.647	3.339	1994
1995	3.130	1.622	0.257	0.000	0.711	2.377	5.045	0.000	4.016	5.457	0.000	1.813	0.824	2.680	1.549	0.000	2.145	5.070	5.626	1.885	4.213	6.570	5.076	5.240	6.570	2.721	1995
1996	3.130	1.622	0.000	0.000	0.000	1.655	4.611	3.614	0.000	1.557	5.564	1.957	0.000	1.597	1.549	0.000	2.145	6.153	2.955	3.402	5.152	6.570	5.509	5.240	6.570	2.666	1996
1997	3.130	1.405	0.257	0.000	0.277	0.788	4.178	4.480	2.933	2.857	0.000	0.000	0.824	2.896	1.549	1.608	3.733	5.936	6.132	4.052	5.802	3.537	4.137	5.240	6.132	2.740	1997
1998	3.130	1.261	0.000	0.000	1.144	3.676	6.705	6.430	0.000	2.568	5.852	0.000	4.146	2.680	1.332	1.174	3.733	4.059	1.438	1.019	4.935	5.270	5.076	5.240	6.705	2.953	1998
1999	2.914	1.622	0.040	0.000	0.000	2.882	5.550	5.130	5.677	5.312	0.000	1.740	1.907	0.000	0.177	0.000	3.950	3.625	5.699	5.352	4.069	5.270	5.509	5.240	5.699	2.986	1999
2000	2.264	1.622	0.257	0.000	1.505	3.893	3.095	5.780	4.593	2.135	4.264	2.390	1.907	1.741	1.549	0.000	1.134	1.965	4.977	4.774	4.863	6.137	5.509	4.229	6.137	2.941	2000
2001	3.130	1.622	0.257	0.000	0.000	3.893	5.045	5.491	5.532	3.146	6.286	0.000	4.940	2.896	1.549	1.608	2.361	3.986	6.132	2.463	4.935	6.353	3.993	5.240	6.353	3.369	2001
2002	0.458	1.622	0.257	0.000	0.000	4.326	3.095	5.130	3.366	3.651	3.614	1.813	4.290	2.030	1.549	1.608	2.867	5.503	6.060	3.907	0.170	6.570	5.509	5.240	6.570	3.026	2002
2003	3.130	1.188	0.257	0.000	0.000	2.810	0.000	5.347	5.749	1.918	4.914	3.979	4.940	1.885	0.466	1.608	2.073	5.070	3.893	4.990	4.141	4.765	4.932	5.240	5.749	3.054	2003
2004	2.480	1.622	0.000	0.000	0.566	2.088	4.322	**7.152**	3.510	1.990	4.769	5.351	4.651	2.896	1.549	0.195	2.506	3.481	5.915	6.146	5.802	6.065	5.509	5.240	7.152	3.492	2004
2005	3.130	1.622	0.000	0.000	0.000	2.882	6.417	6.863	5.604	2.135	2.820	5.351	4.940	1.452	1.549	1.174	2.867	5.358	3.316	3.907	3.924	6.209	3.993	5.240	6.863	3.365	2005
2006	2.914	1.622	0.000	0.000	0.783	3.099	4.684	5.780	0.000	2.713	2.964	4.845	4.940	1.669	0.177	1.608	0.000	4.347	5.338	5.713	1.758	6.570	5.509	5.240	6.570	3.011	2006
2007	3.130	1.622	0.257	0.000	1.216	2.160	2.806	**7.152**	6.399	3.074	2.892	2.607	4.940	0.000	1.549	0.773	3.733	3.842	5.265	3.763	2.841	6.281	5.509	5.240	7.152	3.210	2007
2008	3.130	0.755	0.000	0.000	0.783	4.326	4.034	4.336	3.005	3.218	4.047	4.629	4.940	2.174	1.549	0.000	3.950	4.925	4.471	5.207	4.863	6.570	5.221	4.807	6.570	3.373	2008
2009	3.130	1.622	0.257	0.000	0.566	4.326	4.684	4.408	5.749	5.168	4.264	1.018	4.940	2.896	1.549	0.051	3.661	5.792	4.327	5.929	5.296	6.281	5.509	5.240	6.281	**3.611**	2009
2010	2.697	0.000	0.000	0.000	0.205	3.171	6.705	6.141	6.326	3.940	3.108	5.351	3.424	2.896	1.549	0.412	3.733	5.503	2.810	4.702	5.152	4.476	5.509	5.240	6.705	3.461	2010
Max	3.130	1.622	0.257	0.000	1.505	4.326	6.705	7.152	6.399	6.034	6.286	5.351	4.940	2.896	1.549	1.608	3.950	6.153	6.132	6.507	5.802	6.570	5.509	5.240	7.152	3.611	Max
Average	2.890	1.424	0.149	0.000	0.614	3.051	4.505	5.106	3.937	3.237	3.675	2.788	3.292	2.108	1.318	0.871	2.816	4.695	4.561	4.299	4.244	5.786	5.117	5.075	6.431	3.148	Average

Kpong Irrigation Scheme (KIS)

Gross Water Requirement Volume (m3)

(Unit: lit/sec/ha)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	Annual Total	Year
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(1,000 m3)	(1,000 m3)	Year
1990	3245.926	1793.750	266.239	0.000	1560.454	1430.747	5979.777	3373.065	2516.773	6674.316	3298.156	1879.562	0.000	3203.613	1231.581	1778.143	2224.002	4957.397	6283.687	4960.785	5716.808	5764.511	4964.297	3559.721	6674.316	#########	1990
1991	3245.926	1074.913	266.239	0.000	661.907	4785.321	2235.833	4121.854	3565.077	3559.354	5694.281	3526.898	0.000	3203.613	1605.976	1778.143	2823.033	6380.095	3213.653	4241.948	5492.171	6438.421	5713.086	5796.103	6438.421	#########	1991
1992	3245.926	1793.750	266.239	0.000	1560.454	2469.068	5680.262	6293.342	4613.382	0.000	5918.918	4575.202	3175.957	2085.422	1605.976	1778.143	4095.974	5631.307	1716.075	7197.168	3695.078	5764.511	5713.086	5796.103	7197.168	#########	1992
1993	3245.926	1793.750	266.239	0.000	886.544	4306.096	4781.715	4196.733	5661.686	5955.479	2998.641	1280.531	4748.413	2404.905	1156.702	1298.918	2972.791	4882.518	6059.051	3922.465	5267.535	5464.996	4290.387	5796.103	6059.051	#########	1993
1994	3245.926	1793.750	0.000	0.000	661.907	4385.967	5830.019	6892.373	4613.382	2760.646	4720.855	5024.476	5122.808	2245.164	1605.976	535.705	2972.791	3010.545	4935.867	5200.398	1823.106	5614.754	5713.086	5796.103	6892.373	#########	1994
1995	3245.926	1793.750	266.239	0.000	736.786	2628.809	5230.988	0.000	4164.108	6035.350	0.000	1879.562	854.711	2964.001	1605.976	0.000	2224.002	5256.912	5834.414	2085.436	4368.988	6812.816	5263.813	5796.103	6812.816	#########	1995
1996	3245.926	1793.750	0.000	0.000	0.000	1830.101	4781.715	3747.459	0.000	1722.326	5769.160	2029.320	0.000	1765.939	1605.976	0.000	2224.002	6380.095	3063.895	3762.723	5342.413	6812.816	5713.086	5796.103	6812.816	#########	1996
1997	3245.926	1554.137	266.239	0.000	287.513	871.651	4332.442	4646.006	3040.925	3160.000	0.000	0.000	854.711	3203.613	1605.976	1778.143	3871.338	6155.459	6358.566	4481.560	6016.323	3667.903	4290.387	5796.103	6358.566	#########	1997
1998	3245.926	1394.396	0.000	0.000	1186.059	4066.484	6953.203	6667.736	0.000	2840.517	6068.675	0.000	4299.140	2964.001	1381.339	1298.918	3871.338	4208.608	1491.438	1126.986	5117.777	5464.996	5263.813	5796.103	6953.203	#########	1998
1999	3021.290	1793.750	41.603	0.000	0.000	3187.905	5755.140	5319.916	5886.323	5875.608	0.000	1804.684	1977.894	0.000	183.277	0.000	4095.974	3759.334	5909.293	5919.235	4219.230	5464.996	5713.086	5796.103	5919.235	#########	1999
2000	2347.380	1793.750	266.239	0.000	1560.454	4306.096	3209.258	5993.826	4763.140	2361.292	4421.340	2478.594	1977.894	1925.680	1605.976	0.000	1175.698	2037.120	5160.504	5280.268	5042.898	6363.543	5713.086	4677.912	6363.543	#########	2000
2001	3245.926	1793.750	266.239	0.000	0.000	4306.096	5230.988	5694.311	5736.565	3479.483	6517.949	0.000	5122.808	3203.613	1605.976	1778.143	2448.639	4133.729	6358.566	2724.402	5117.777	6588.179	4140.629	5796.103	6588.179	#########	2001
2002	475.407	1793.750	266.239	0.000	0.000	4785.321	3209.258	5319.916	3490.198	4038.579	3747.430	1879.562	4448.898	2245.164	1605.976	1778.143	2972.791	5706.185	6283.687	4321.819	175.770	6812.816	5713.086	5796.103	6812.816	#########	2002
2003	3245.926	1314.525	266.239	0.000	0.000	3108.034	0.000	5544.553	5961.202	2121.680	5095.250	4125.929	5122.808	2085.422	482.792	1778.143	2149.123	5256.912	4037.321	5519.881	4294.109	4940.844	5114.055	5796.103	5961.202	#########	2003
2004	2572.016	1793.750	0.000	0.000	587.028	2309.326	4482.199	7416.525	3639.956	2201.550	4945.492	5548.628	4823.292	3203.613	1605.976	216.222	2598.397	3609.577	6133.929	6797.814	6016.323	6288.664	5713.086	5796.103	7416.525	#########	2004
2005	3245.926	1793.750	0.000	0.000	0.000	3187.905	6653.687	7117.009	5811.444	2361.292	2923.762	5548.628	5122.808	1606.197	1605.976	1298.918	2972.791	5556.428	3438.289	4321.819	4069.472	6438.421	4140.629	5796.103	7117.009	#########	2005
2006	3021.290	1793.750	0.000	0.000	811.665	3427.517	4856.594	5993.826	0.000	3000.259	3073.520	5024.476	5122.808	1845.809	183.277	1778.143	0.000	4508.123	5534.898	6318.589	1823.106	6812.816	5713.086	5796.103	6812.816	#########	2006
2007	3245.926	1793.750	266.239	0.000	1260.938	2389.197	2909.743	7416.525	6635.112	3399.613	2998.641	2703.230	5122.808	0.000	1605.976	855.188	3871.338	3983.971	5460.019	4162.077	2946.289	6513.300	5713.086	5796.103	7416.525	#########	2007
2008	3245.926	835.300	0.000	0.000	811.665	4785.321	4182.684	4496.248	3115.804	3559.354	4196.703	4799.839	5122.808	2404.905	1605.976	0.000	4095.974	5107.154	4636.352	5759.493	5042.898	6812.816	5413.570	5316.878	6812.816	#########	2008
2009	3245.926	1793.750	266.239	0.000	587.028	4785.321	4856.594	4571.127	5961.202	5715.866	4421.340	1055.895	5122.808	3203.613	1605.976	56.480	3796.459	6005.701	4486.594	6558.201	5492.171	6513.300	5713.086	5796.103	6558.201	#########	2009
2010	2796.653	0.000	0.000	0.000	212.634	3507.388	6953.203	6368.221	6560.233	4358.062	3223.278	5548.628	3550.351	3203.613	1605.976	455.834	3871.338	5706.185	2914.137	5200.398	5342.413	4641.328	5713.086	5796.103	6953.203	#########	2010
Max	3245.926	1793.750	266.239	0.000	1560.454	4785.321	6953.203	7416.525	6635.112	6674.316	6517.949	5548.628	5122.808	3203.613	1605.976	1778.143	4095.974	6380.095	6358.566	7197.168	6016.323	6812.816	5713.086	5796.103	7416.525	91610.781	Max
Average	2996.330	1575.215	154.118	0.000	636.811	3374.270	4671.681	5294.789	4082.691	3580.030	3811.114	2891.126	3413.987	2331.805	1367.076	963.873	2920.371	4868.255	4729.059	4755.403	4401.079	5999.845	5306.600	5613.542	6710.990	#########	Average

Note: Banana Farm is irrigated under drip irrigation with 12 hours irrigation in a day, so that the volume of water for Banana Farm is estimated half of one day gross water requiement of m3/sec

Table B.1 (2) New Development Irrigation Scheme (NDIS)

New Development Area	No.1 Area (ha)		
	Paddy	Cassi(Upland)	Sub Total
	2538	162	2700

No.2 Area (ha)		
Paddy	Sub total	Total
4200	4200	6900

Total New Area (No.1 + No.2) (ha)		
Paddy	Upland	Total
6738	162	6900

New Development Irrigation Scheme (No.1 and No.2 Area)

Gross Water Requirement (m3/sec)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	Average	Year
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(m3/sec)	(m3/sec)	Year
1990	4.982	2.581	0.409	0.000	2.395	2.059	9.177	5.177	3.863	9.603	5.062	2.885	0.000	4.609	1.890	2.558	3.413	7.608	9.644	7.138	8.774	8.847	7.619	5.122	9.644	4.809	1990
1991	4.982	1.547	0.409	0.000	1.016	6.885	3.431	6.326	5.471	5.121	8.739	5.413	0.000	4.609	2.465	2.558	4.333	9.792	4.932	6.103	8.429	9.881	8.768	8.340	9.881	4.981	1991
1992	4.982	2.581	0.409	0.000	2.395	3.553	8.718	9.659	7.080	0.000	9.084	7.022	4.874	3.001	2.465	2.558	6.286	8.643	2.634	10.355	5.671	8.847	8.768	8.340	10.355	5.330	1992
1993	4.982	2.581	0.409	0.000	1.361	6.196	7.339	6.441	8.689	8.569	4.602	1.965	7.288	3.460	1.775	1.869	4.562	7.493	9.299	5.644	8.084	8.387	6.585	8.340	9.299	5.247	1993
1994	4.982	2.581	0.000	0.000	1.016	6.311	8.948	10.578	7.080	3.972	7.245	7.711	7.862	3.230	2.465	0.771	4.562	4.620	7.575	7.482	2.798	8.617	8.768	8.340	10.578	5.313	1994
1995	4.982	2.581	0.409	0.000	1.131	3.782	8.028	0.000	6.391	8.684	0.000	2.885	1.312	4.265	2.465	0.000	3.413	8.068	8.954	3.001	6.705	10.456	8.079	8.340	10.456	4.330	1995
1996	4.982	2.581	0.000	0.000	0.000	2.633	7.339	5.751	0.000	2.478	8.854	3.114	0.000	2.541	2.465	0.000	3.413	9.792	4.702	5.414	8.199	10.456	8.768	8.340	10.456	4.243	1996
1997	4.982	2.236	0.409	0.000	0.441	1.254	6.649	7.130	4.667	4.547	0.000	0.000	1.312	4.609	2.465	2.558	5.942	9.447	9.759	6.448	9.234	5.629	6.585	8.340	9.759	4.360	1997
1998	4.982	2.006	0.000	0.000	1.820	5.851	10.671	10.233	0.000	4.087	9.314	0.000	6.598	4.265	2.120	1.869	5.942	6.459	2.289	1.622	7.854	8.387	8.079	8.340	10.671	4.699	1998
1999	4.637	2.581	0.064	0.000	0.000	4.587	8.833	8.165	9.034	8.454	0.000	2.770	3.036	0.000	0.281	0.000	6.286	5.770	9.069	8.517	6.475	8.387	8.768	8.340	9.069	4.752	1999
2000	3.603	2.581	0.409	0.000	2.395	6.196	4.925	9.199	7.310	3.397	6.786	3.804	3.036	2.771	2.465	0.000	1.804	3.126	7.920	7.597	7.740	9.766	8.768	6.731	9.766	4.680	2000
2001	4.982	2.581	0.409	0.000	0.000	6.196	8.028	8.739	8.804	5.006	10.003	0.000	7.862	4.609	2.465	2.558	3.758	6.344	9.759	3.920	7.854	10.111	6.355	8.340	10.111	5.362	2001
2002	0.730	2.581	0.409	0.000	0.000	6.885	4.925	8.165	5.357	5.811	5.751	2.885	6.828	3.230	2.465	2.558	4.562	8.758	9.644	6.218	0.270	10.456	8.768	8.340	10.456	4.816	2002
2003	4.982	1.891	0.409	0.000	0.000	4.472	0.000	8.509	9.149	3.053	7.820	6.332	7.862	3.001	0.741	2.558	3.298	8.068	6.196	7.942	6.590	7.583	7.849	8.340	9.149	4.860	2003
2004	3.947	2.581	0.000	0.000	0.901	3.323	6.879	11.382	5.586	3.168	7.590	8.516	7.403	4.609	2.465	0.311	3.988	5.540	9.414	9.781	9.234	9.651	8.768	8.340	11.382	5.557	2004
2005	4.982	2.581	0.000	0.000	0.000	4.587	10.212	10.923	8.919	3.397	4.487	8.516	7.862	2.311	2.465	1.869	4.562	8.528	5.277	6.218	6.246	9.881	6.355	8.340	10.923	5.355	2005
2006	4.637	2.581	0.000	0.000	1.246	4.932	7.454	9.199	0.000	4.317	4.717	7.711	7.862	2.656	0.281	2.558	0.000	6.919	8.495	9.091	2.798	10.456	8.768	8.340	10.456	4.792	2006
2007	4.982	2.581	0.409	0.000	1.935	3.438	4.466	11.382	10.183	4.891	4.602	4.149	7.862	0.000	2.465	1.230	5.942	6.114	8.380	5.988	4.522	9.996	8.768	8.340	11.382	5.109	2007
2008	4.982	1.202	0.000	0.000	1.246	6.885	6.419	6.901	4.782	5.121	6.441	7.367	7.862	3.460	2.465	0.000	6.286	7.838	7.116	8.287	7.740	10.456	8.308	7.650	10.456	5.367	2008
2009	4.982	2.581	0.409	0.000	0.901	6.885	7.454	7.016	9.149	8.224	6.786	1.621	7.862	4.609	2.465	0.081	5.827	9.217	6.886	9.436	8.429	9.996	8.768	8.340	9.996	5.747	2009
2010	4.292	0.000	0.000	0.000	0.326	5.047	10.671	9.774	10.068	6.270	4.947	8.516	5.449	4.609	2.465	0.656	5.942	8.758	4.472	7.482	8.199	7.123	8.768	8.340	10.671	5.507	2010
Max	4.982	2.581	0.409	0.000	2.395	6.885	10.671	11.382	10.183	9.603	10.003	8.516	7.862	4.609	2.465	2.558	6.286	9.792	9.759	10.355	9.234	10.456	8.768	8.340	11.382	5.747	Max
Average	4.599	2.266	0.237	0.000	0.977	4.855	7.170	8.126	6.266	5.151	5.849	4.437	5.240	3.355	2.098	1.387	4.482	7.472	7.258	6.842	6.755	9.208	8.144	8.077	8.077	5.010	Average

New Development Irrigation Scheme (No.1 and No.2 Area)

Gross Water Requirement Volume (m3)

(m3)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	Annual Total	Year
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(1,000 m3)	(1,000 m3)	Year
1990	6456.238	3567.819	529.558	0.000	3103.786	2845.796	11893.944	6709.121	5005.932	13275.402	6560.126	3738.502	0.000	6372.077	2449.649	3536.777	4423.603	9860.401	12498.430	9867.141	11370.891	11465.775	9874.126	7080.384	13275.402	152485.477	1990
1991	6456.238	2138.031	529.558	0.000	1316.552	9518.138	4447.134	8198.483	7091.039	7079.655	11326.084	7015.099	0.000	6372.077	3194.330	3536.777	5615.092	12690.189	6392.045	8437.353	10924.082	12806.201	11363.488	11528.612	12806.201	157976.258	1991
1992	6456.238	3567.819	529.558	0.000	3103.786	4911.045	11298.199	12517.633	9176.146	0.000	11772.893	9100.206	6317.067	4147.963	3194.330	3536.777	8147.008	11200.827	3413.321	14315.369	7349.613	11465.775	11363.488	11528.612	14315.369	168413.672	1992
1993	6456.238	3567.819	529.558	0.000	1763.360	8564.947	9510.965	8347.419	11261.253	11845.614	5964.381	2547.013	9444.727	4783.424	2300.713	2583.585	5912.965	9711.465	12051.621	7801.892	10477.274	10870.030	8533.700	11528.612	12051.621	166358.574	1993
1994	6456.238	3567.819	0.000	0.000	1316.552	8723.812	11596.072	13709.123	9176.146	5491.003	9389.913	9993.823	10189.408	4465.693	3194.330	1065.532	5912.965	5988.059	9817.578	10343.737	3626.208	11167.903	11363.488	11528.612	13709.123	168084.014	1994
1995	6456.238	3567.819	529.558	0.000	1465.488	5228.775	10404.582	0.000	8282.528	12004.479	0.000	3738.502	1700.044	5895.481	3194.330	0.000	4423.603	10456.146	11604.813	4147.990	8690.039	13550.882	10469.871	11528.612	13550.882	137339.781	1995
1996	6456.238	3567.819	0.000	0.000	0.000	3640.123	9510.965	7453.802	0.000	3425.754	11475.020	4036.375	0.000	3512.501	3194.330	0.000	4423.603	12690.189	6094.173	7484.161	10626.210	13550.882	11363.488	11528.612	13550.882	134034.245	1996
1997	6456.238	3091.223	529.558	0.000	571.871	1733.739	8617.348	9241.037	6048.485	6285.329	0.000	0.000	1700.044	6372.077	3194.330	3536.777	7700.199	12243.380	12647.366	8913.949	11966.636	7295.561	8533.700	11528.612	12647.366	138207.459	1997
1998	6456.238	2773.492	0.000	0.000	2359.105	8088.351	13830.115	13262.314	0.000	5649.868	12070.765	0.000	8551.110	5895.481	2747.522	2583.585	7700.199	8371.039	2966.513	2241.607	10179.401	10870.030	10469.871	11528.612	13830.115	148595.218	1998
1999	6009.430	3567.819	82.749	0.000	0.000	6340.832	11447.136	10581.462	11708.061	11686.749	0.000	3589.566	3934.087	0.000	364.542	0.000	8147.008	7477.421	11753.749	11773.524	8392.167	10870.030	11363.488	11528.612	11773.524	150618.433	1999
2000	4669.004	3567.819	529.558	0.000	3103.786	8564.947	6383.305	11921.888	9474.018	4696.676	8794.169	4929.992	3934.087	3830.232	3194.330	0.000	2338.496	4051.889	10264.387	10502.602	10030.465	12657.265	11363.488	9304.498	12657.265	148106.899	2000
2001	6456.238	3567.819	529.558	0.000	0.000	8564.947	10404.582	11326.143	11410.189	6920.790	12964.383	0.000	10189.408	6372.077	3194.330	3536.777	4870.411	8222.102	12647.366	5418.913	10179.401	13104.073	8235.827	11528.612	13104.073	169643.947	2001
2002	945.599	3567.819	529.558	0.000	0.000	9518.138	6383.305	10581.462	6942.103	8032.847	7453.743	3738.502	8848.982	4465.693	3194.330	3536.777	5912.965	11349.763	12498.430	8596.218	349.612	13550.882	11363.488	11528.612	13550.882	152888.827	2002
2003	6456.238	2614.627	529.558	0.000	0.000	6181.967	0.000	11028.271	11856.997	4220.080	10134.595	8206.589	10189.408	4147.963	960.287	3536.777	4274.667	10456.146	8030.344	10979.198	8541.103	9827.477	10171.998	11528.612	11856.997	153872.901	2003
2004	5115.813	3567.819	0.000	0.000	1167.616	4593.314	8915.220	14751.676	7239.975	4378.946	9836.722	11036.377	9593.663	6372.077	3194.330	430.071	5168.284	7179.549	12200.558	13521.042	11966.636	12508.328	11363.488	11528.612	14751.676	175630.115	2004
2005	6456.238	3567.819	0.000	0.000	0.000	6340.832	13234.370	14155.931	11559.125	4696.676	5815.444	11036.377	10189.408	3194.771	3194.330	2583.585	5912.965	11051.890	6838.854	8596.218	8094.294	12806.201	8235.827	11528.612	14155.931	169089.771	2005
2006	6009.430	3567.819	0.000	0.000	1614.424	6817.428	9659.901	11921.888	0.000	5967.598	6113.317	9993.823	10189.408	3671.367	364.542	3536.777	0.000	8966.783	11009.068	12567.851	3626.208	13550.882	11363.488	11528.612	13550.882	152040.615	2006
2007	6456.238	3567.819	529.558	0.000	2508.041	4752.180	5787.560	14751.676	13197.423	6761.925	5964.381	5376.801	10189.408	0.000	3194.330	1700.993	7700.199	7924.230	10860.132	8278.488	5860.251	12955.137	11363.488	11528.612	14751.676	161208.870	2007
2008	6456.238	1661.435	0.000	0.000	1614.424	9518.138	8319.475	8943.164	6197.422	7079.655	8347.360	9547.015	10189.408	4783.424	3194.330	0.000	8147.008	10158.273	9221.833	11455.794	10030.465	13550.882	10767.743	10575.420	13550.882	169758.908	2008
2009	6456.238	3567.819	529.558	0.000	1167.616	9518.138	9659.901	9092.100	11856.997	11369.018	8794.169	2100.204	10189.408	6372.077	3194.330	112.340	7551.263	11945.508	8923.961	13044.446	10924.082	12955.137	11363.488	11528.612	13044.446	182216.412	2009
2010	5562.621	0.000	0.000	0.000	422.935	6976.294	13830.115	12666.569	13048.487	8668.308	6411.189	11036.377	7061.748	6372.077	3194.330	906.667	7700.199	11349.763	5796.301	10343.737	10626.210	9231.732	11363.488	11528.612	13830.115	174097.758	2010
Max	6456.238	3567.819	529.558	0.000	3103.786	9518.138	13830.115	14751.676	13197.423	13275.402	12964.383	11036.377	10189.408	6372.077	3194.330	3536.777	8147.008	12690.189	12647.366	14315.369	11966.636	13550.882	11363.488	11528.612	14751.676	182216.412	Max
Average	5959.784	3133.147	306.545	0.000	1266.635	6711.518	9292.104	10531.484	8120.587	7120.780	7580.412	5750.531	6790.515	4638.025	2719.153	1917.170	5808.700	9683.096	9406.231	9458.630	8753.869	11933.860	10554.977	11165.491	11165.491	158603.245	Average

Table B.1 (3) Total Water Requirement of Accra Plain Gravity Irrigation Project (APGIP)

KIS Area (ha)			
Paddy	Upland	Banana	Total
2259	61	1800	4120
	Included 20ha of fish pond		

New Area (No.1 + No.2) (ha)		
Paddy	Upland	Total
6738	162	6900

Total of APGIP (ha)			
Paddy	Upland	Banana	Total
8997	223	1800	11020
	Included 20ha of fish pond		

Total Water Requirement of Accra Plain Gravity Irrigation Project

Gross Water Requirement (m3/sec) (m3/sec)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	nnual Averag	Year
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(m3/sec)	(m3/sec)	Year
1990	8.112	4.203	0.665	0.000	3.900	3.352	14.944	8.430	6.290	15.637	8.242	4.697	0.000	7.506	3.078	4.166	5.558	12.389	15.704	11.623	14.287	14.406	12.406	8.340	15.704	7.831	1990
1991	8.112	2.518	0.665	0.000	1.654	11.212	5.588	10.301	8.910	8.339	14.231	8.814	0.000	7.506	4.014	4.166	7.055	15.945	8.031	9.939	13.726	16.090	14.278	13.580	16.090	8.111	1991
1992	8.112	4.203	0.665	0.000	3.900	5.785	14.196	15.728	11.529	0.000	14.792	11.434	7.937	4.886	4.014	4.166	10.236	14.073	4.289	16.862	9.234	14.406	14.278	13.580	16.862	8.679	1992
1993	8.112	4.203	0.665	0.000	2.216	10.089	11.950	10.488	14.149	13.953	7.494	3.200	11.867	5.634	2.891	3.043	7.429	12.202	15.142	9.190	13.164	13.658	10.722	13.580	15.142	8.543	1993
1994	8.112	4.203	0.000	0.000	1.654	10.276	14.570	17.225	11.529	6.468	11.798	12.557	12.802	5.260	4.014	1.255	7.429	7.524	12.335	12.184	4.556	14.032	14.278	13.580	17.225	8.652	1994
1995	8.112	4.203	0.665	0.000	1.841	6.159	13.073	0.000	10.407	14.140	0.000	4.697	2.136	6.944	4.014	0.000	5.558	13.138	14.581	4.886	10.919	17.026	13.155	13.580	17.026	7.051	1995
1996	8.112	4.203	0.000	0.000	0.000	4.288	11.950	9.365	0.000	4.035	14.418	5.071	0.000	4.137	4.014	0.000	5.558	15.945	7.657	8.816	13.351	17.026	14.278	13.580	17.026	6.908	1996
1997	8.112	3.641	0.665	0.000	0.719	2.042	10.827	11.611	7.600	7.404	0.000	0.000	2.136	7.506	4.014	4.166	9.675	15.383	15.891	10.500	15.035	9.166	10.722	13.580	15.891	7.100	1997
1998	8.112	3.267	0.000	0.000	2.964	9.527	17.377	16.663	0.000	6.655	15.166	0.000	10.744	6.944	3.452	3.043	9.675	10.518	3.727	2.640	12.790	13.658	13.155	13.580	17.377	7.652	1998
1999	7.551	4.203	0.104	0.000	0.000	7.469	14.383	13.295	14.711	13.766	0.000	4.510	4.943	0.000	0.458	0.000	10.236	9.395	14.768	13.868	10.544	13.658	14.278	13.580	14.768	7.738	1999
2000	5.866	4.203	0.665	0.000	3.900	10.089	8.020	14.979	11.904	5.532	11.049	6.194	4.943	4.512	4.014	0.000	2.938	5.091	12.897	12.371	12.603	15.903	14.278	10.960	15.903	7.621	2000
2001	8.112	4.203	0.665	0.000	0.000	10.089	13.073	14.231	14.336	8.152	16.289	0.000	12.802	7.506	4.014	4.166	6.119	10.331	15.891	6.383	12.790	16.465	10.348	13.580	16.465	8.731	2001
2002	1.188	4.203	0.665	0.000	0.000	11.212	8.020	13.295	8.722	9.462	9.365	4.697	11.118	5.260	4.014	4.166	7.429	14.260	15.704	10.126	0.439	17.026	14.278	13.580	17.026	7.843	2002
2003	8.112	3.080	0.665	0.000	0.000	7.282	0.000	13.856	14.898	4.971	12.734	10.311	12.802	4.886	1.207	4.166	5.371	13.138	10.090	12.933	10.731	12.348	12.781	13.580	14.898	7.914	2003
2004	6.428	4.203	0.000	0.000	1.467	5.411	11.201	18.535	9.097	5.158	12.359	13.867	12.054	7.506	4.014	0.507	6.494	9.021	15.329	15.927	15.035	15.716	14.278	13.580	18.535	9.049	2004
2005	8.112	4.203	0.000	0.000	0.000	7.469	16.628	17.786	14.523	5.532	7.307	13.867	12.802	3.763	4.014	3.043	7.429	13.886	8.593	10.126	10.170	16.090	10.348	13.580	17.786	8.720	2005
2006	7.551	4.203	0.000	0.000	2.028	8.030	12.137	14.979	0.000	7.029	7.681	12.557	12.802	4.325	0.458	4.166	0.000	11.266	13.832	14.804	4.556	17.026	14.278	13.580	17.026	7.804	2006
2007	8.112	4.203	0.665	0.000	3.151	5.598	7.272	18.535	16.582	7.965	7.494	6.756	12.802	0.000	4.014	2.004	9.675	9.956	13.645	9.751	7.363	16.277	14.278	13.580	18.535	8.320	2007
2008	8.112	1.957	0.000	0.000	2.028	11.212	10.453	11.237	7.787	8.339	10.488	11.995	12.802	5.634	4.014	0.000	10.236	12.763	11.587	13.494	12.603	17.026	13.529	12.457	17.026	8.740	2008
2009	8.112	4.203	0.665	0.000	1.467	11.212	12.137	11.424	14.898	13.392	11.049	2.639	12.802	7.506	4.014	0.132	9.488	15.009	11.212	15.365	13.726	16.277	14.278	13.580	16.277	9.358	2009
2010	6.989	0.000	0.000	0.000	0.531	8.218	17.377	15.915	16.395	10.211	8.055	13.867	8.873	7.506	4.014	1.068	9.675	14.260	7.283	12.184	13.351	11.599	14.278	13.580	17.377	8.968	2010
Max	8.112	4.203	0.665	0.000	3.900	11.212	17.377	18.535	16.582	15.637	16.289	13.867	12.802	7.506	4.014	4.166	10.236	15.945	15.891	16.862	15.035	17.026	14.278	13.580	18.535	9.358	Max
Averag	7.488	3.691	0.385	0.000	1.591	7.906	11.675	13.232	10.203	8.388	9.524	7.225	8.532	5.463	3.416	2.258	7.298	12.166	11.818	11.141	10.999	14.994	13.262	13.152	13.152	8.159	Average

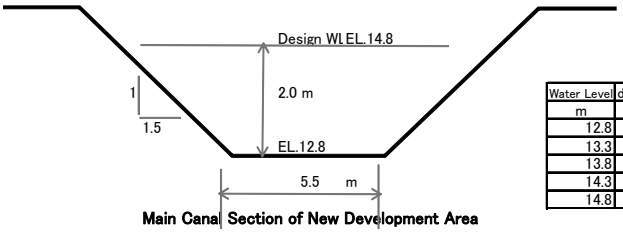
Total Water Requirement of Accra Plain Gravity Irrigation Project

Gross Water Requirement Volume (m3) (m3)

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Max	Annual Total	Year
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(m3)	(1,000 m3)	Year
1990	9702.165	5361.569	795.797	0.000	4664.240	4276.543	17873.721	10082.186	7522.705	19949.718	9858.282	5618.065	0.000	9575.690	3681.230	5314.920	6647.605	14817.797	18782.117	14827.926	17087.699	17230.286	14838.423	10640.105	19949.718	229148.789	1990
1991	9702.165	3212.944	795.797	0.000	1978.459	14303.460	6682.967	12320.337	10656.116	10639.010	17020.365	10541.997	0.000	9575.690	4800.306	5314.920	8438.126	19070.284	9605.698	12679.301	16416.254	19244.622	17076.574	17324.715	19244.622	237400.106	1991
1992	9702.165	5361.569	795.797	0.000	4664.240	7380.113	16978.461	18810.975	13789.528	0.000	17691.810	13675.408	9493.023	6233.384	4800.306	5314.920	12242.982	16832.133	5129.396	21512.537	11044.691	17230.286	17076.574	17324.715	21512.537	253085.014	1992
1993	9702.165	5361.569	795.797	0.000	2649.904	12871.043	14292.680	12544.152	16922.939	17801.093	8963.022	3827.544	14193.140	7188.329	3457.415	3882.504	8885.756	14593.982	18110.672	11724.356	15744.808	16335.026	12824.087	17324.715	18110.672	249996.698	1993
1994	9702.165	5361.569	0.000	0.000	1978.459	13109.779	17426.091	20601.496	13789.528	8251.649	14110.769	15018.299	15312.216	6710.857	4800.306	1601.237	8885.756	8998.605	14753.445	15544.134	5449.314	16782.656	17076.574	17324.715	20601.496	252589.617	1994
1995	9702.165	5361.569	795.797	0.000	2202.274	7857.585	15635.570	0.000	12446.637	18039.829	0.000	5618.065	2554.755	8859.482	4800.306	0.000	6647.605	15713.058	17439.227	6233.426	13059.027	20363.698	15733.683	17324.715	20363.698	206388.472	1995
1996	9702.165	5361.569	0.000	0.000	0.000	5470.224	14292.680	11201.261	0.000	5148.079	17244.180	6065.695	0.000	5278.440	4800.306	0.000	6647.605	19070.284	9158.068	11246.884	15968.623	20363.698	17076.574	17324.715	20363.698	201421.051	1996
1997	9702.165	4645.360	795.797	0.000	859.383	2605.390	12949.789	13887.043	9089.410	9445.329	0.000	0.000	2554.755	9575.690	4800.306	5314.920	11571.537	18398.839	19005.932	13395.509	17982.959	10963.464	12824.087	17324.715	19005.932	207692.381	1997
1998	9702.165	4167.888	0.000	0.000	3545.165	12154.835	20783.318	19930.050	0.000	8490.385	18139.441	0.000	12850.250	8859.482	4128.861	3882.504	11571.537	12579.646	4457.951	3368.593	15297.178	16335.026	15733.683	17324.715	20783.318	223302.671	1998
1999	9030.719	5361.569	124.352	0.000	0.000	9528.737	17202.276	15901.379	17594.384	17562.357	0.000	5394.250	5911.981	0.000	547.819	0.000	12242.982	11236.756	17663.042	17692.759	12611.397	16335.026	17076.574	17324.715	17692.759	226343.074	1999
2000	7016.384	5361.569	795.797	0.000	4664.240	12871.043	9592.563	17915.714	14237.158	7057.968	13215.508	7408.586	5911.981	5755.912	4800.306	0.000	3514.194	6089.008	15424.891	15782.870	15073.363	19020.807	17076.574	13982.410	19020.807	222568.846	2000
2001	9702.165	5361.569	795.797	0.000	0.000	12871.043	15635.570	17020.454	17146.754	10400.274	19482.331	0.000	15312.216	9575.690	4800.306	5314.920	7319.050	12355.831	19005.932	8143.315	15297.178	19692.253	12376.457	17324.715	19692.253	254933.820	2001
2002	1421.006	5361.569	795.797	0.000	0.000	14303.460	9592.563	15901.379	10432.301	12071.426	11201.172	5618.065	13297.880	6710.857	4800.306	5314.920	8885.756	17055.948	18782.117	12918.037	525.382	20363.698	17076.574	17324.715	20363.698	229754.927	2002
2003	9702.165	3929.152	795.797	0.000	0.000	9290.001	0.000	16572.824	17818.199	6341.760	15229.844	12332.518	15312.216	6233.384	1443.079	5314.920	6423.790	15713.058	12067.664	16499.078	12835.212	14768.320	15286.053	17324.715	17818.199	231233.751	2003
2004	7687.829	5361.569	0.000	0.000	1754.644	6902.640	13397.419	22168.201	10879.931	6580.496	14782.214	16585.005	14416.955	9575.690	4800.306	646.293	7766.680	10789.126	18334.487	20318.856	17982.959	18796.992	17076.574	17324.715	22168.201	263929.582	2004
2005	9702.165	5361.569	0.000	0.000	0.000	9528.737	19888.057	21272.941	17370.569	7057.968	8739.206	16585.005	15312.216	4800.968	4800.306	3882.504	8885.756	16608.318	10277.143	12918.037	12163.767	19244.622	12376.457	17324.715	21272.941	254101.026	2005
2006	9030.719	5361.569	0.000	0.000	2426.089	10244.946	14516.495	17915.714	0.000	8967.857	9186.837	15018.299	15312.216	5517.176	547.819	5314.920	0.000	13474.907	16543.966	18886.440	5449.314	20363.698	17076.574	17324.715	20363.698	228480.269	2006
2007	9702.165	5361.569	795.797	0.000	3768.980	7141.376	8697.302	22168.201	19832.535	10161.538	8963.022	8080.031	15312.216	0.000	4800.306	2556.181	11571.537	11908.201	16320.151	12440.565	8806.540	19468.437	17076.574	17324.715	22168.201	242257.939	2007
2008	9702.165	2496.735	0.000	0.000	2426.089	14303.460	12502.159	13439.412	9313.226	10639.010	12544.063	14346.854	15312.216	7188.329	4800.306	0.000	12242.982	15265.428	13858.185	17215.287	15073.363	20363.698	16181.313	15892.299	20363.698	255106.578	2008
2009	9702.165	5361.569	795.797	0.000	1754.644	14303.460	14516.495	13663.228	17818.199	17084.885	13215.508	3156.099	15312.216	9575.690	4800.306	168.820	11347.722	17951.209	13410.555	19602.648	16416.254	19468.437	17076.574	17324.715	19602.648	273827.193	2009
2010	8359.274	0.000	0.000	0.000	635.568	10483.682	20783.318	19034.790	19608.720	13026.371	9634.467	16585.005	10612.099	9575.690	4800.306	1362.501	11571.537	17055.948	8710.438	15544.134	15968.623	13873.060	17076.574	17324.715	20783.318	261626.820	2010
Max	9702.165	5361.569	795.797	0.000	4664.240	14303.460	20783.318	22168.201	19832.535	19949.718	19482.331	16585.005	15312.216	9575.690	4800.306	5314.920	12242.982	19070.284	19005.932	21512.537	17982.959	20363.698	17076.574	17324.715	22168.201	273827.193	Max
Averag	8956.114	4708.362	460.663	0.000	1903.447	10085.788	13963.785	15826.273	12203.278	10700.810	11391.526	8641.657	10204.502	6969.830	4086.229	2881.043	8729.071	14551.351	14135.289	14214.033	13154.948	17933.705	15861.577	16779.033	16779.033	238342.315	Average

Table B.2

Simulation Analysis of Water Availability from Kpong Dam due to Water Level Fluctuation for Neccesary Water Intake through New Irrigation Canal for NDIS



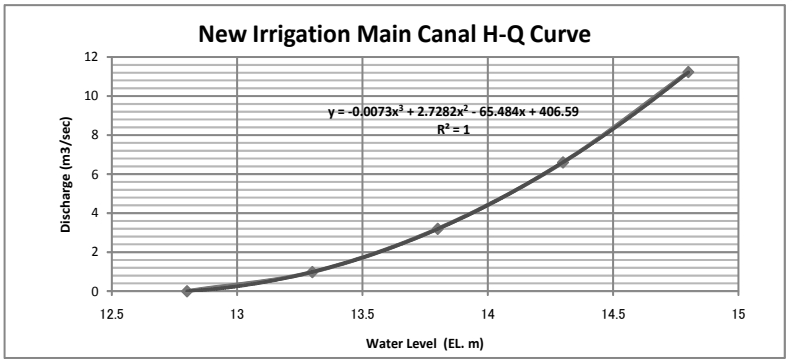
Main Canal Section of New Development Area

i=1/ 15,000
n = 0.015

Water Level	d	A	P	R=A/P	R2/3	V	Q
m	m	m2	m	m		m/sec	m3/sec
12.8	0.00	0.000	0.000	0.000	0.000	0.000	0.000
13.3	0.50	3.125	7.303	0.428	0.568	0.309	0.981
13.8	1.00	7.000	9.106	0.769	0.839	0.457	3.198
14.3	1.50	11.625	10.908	1.066	1.043	0.568	6.603
14.8	2.00	17.000	12.711	1.337	1.214	0.661	11.233

Calculation of Manning Formula

WL (El)	Q	Depth
m	m3/sec	m
12.80	0.000	0.00
13.30	0.981	0.50
13.80	3.198	1.00
14.30	6.603	1.50
14.80	11.233	2.00



Approximation Equation

y	x
Q m3/sec	WL El.m
0.0739	12.8
1.0698	13.3
3.2843	13.8
6.7117	14.3
11.3466	14.8
24.2172	15.8
41.8521	16.8

Approximation Curve Equation

Y= -0.0073X**3 + 2.7282X**2 - 65.484X + 406.59

Y: Water Discharge (m3/sec) X: Water Level at Kpong Dam (EL. m)

Table B.2 (1) Half Monthly Basis Simulation Analysis in the Critical Years

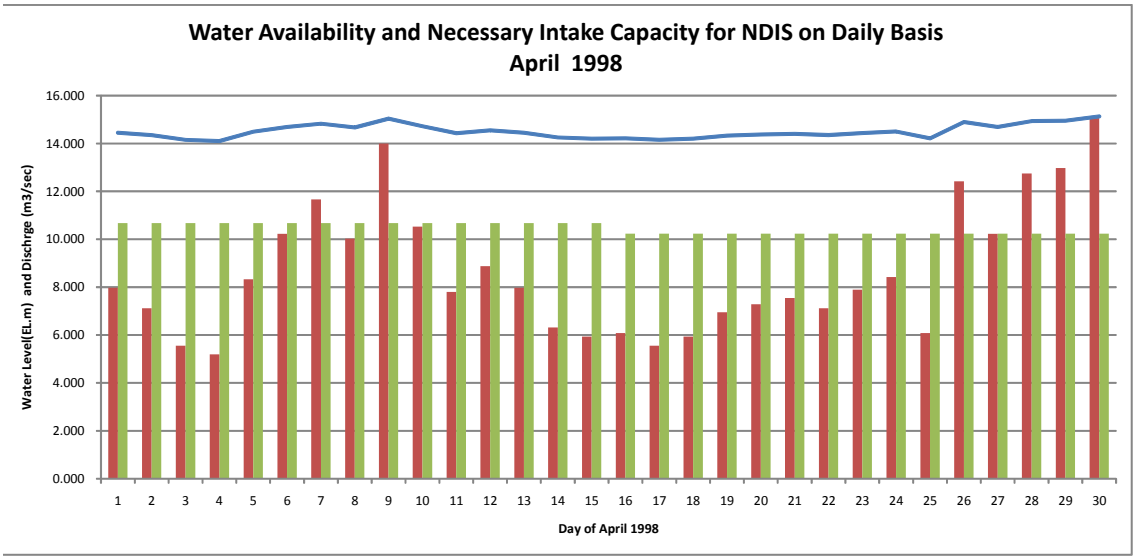
Year	1998				2000				2001				2002			
Month	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance
	EL. Meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec
Jan	15.15	15.363	4.982	10.382	14.859	11.969	3.603	8.367	15.047	14.076	4.982	9.095	15.052	14.139	0.730	13.409
	14.87	12.131	2.006	10.125	15.122	14.967	2.581	12.386	14.898	12.398	2.581	9.817	14.999	13.530	2.581	10.949
Feb	14.40	7.542	0.000	7.542	14.758	10.911	0.409	10.502	14.949	12.964	0.409	12.556	14.982	13.332	0.409	12.924
	14.40	7.555	0.000	7.555	14.898	12.395	0.000	12.395	14.638	9.710	0.000	9.710	15.059	14.223	0.000	14.223
Mar	14.37	7.282	1.820	5.462	14.917	12.609	2.395	10.214	14.759	10.918	0.000	10.918	14.906	12.484	0.000	12.484
	14.43	7.766	5.851	1.915	14.884	12.241	6.196	6.045	14.995	13.480	6.196	7.285	14.962	13.105	6.885	6.220
Apr	14.49	8.343	10.671	−2.328	14.949	12.957	4.925	8.031	14.837	11.741	8.028	3.713	14.996	13.492	4.925	8.566
	14.52	8.590	10.233	−1.643	14.898	12.396	9.199	3.197	14.936	12.816	8.739	4.076	14.885	12.251	8.165	4.086
May	14.95	12.994	0.000	12.994	14.961	13.091	7.310	5.781	14.877	12.171	8.804	3.367	14.875	12.149	5.357	6.793
	14.92	12.624	4.087	8.537	15.032	13.904	3.397	10.507	14.934	12.797	5.006	7.791	14.813	11.478	5.811	5.667
Jun	14.94	12.875	9.314	3.561	15.031	13.898	6.786	7.113	14.974	13.242	10.003	3.238	14.871	12.106	5.751	6.355
	14.93	12.697	0.000	12.697	14.836	11.727	3.804	7.923	14.744	10.768	0.000	10.768	14.885	12.258	2.885	9.373
Jul	14.96	13.069	6.598	6.471	14.899	12.411	3.036	9.375	14.853	11.912	7.862	4.050	14.912	12.550	6.828	5.722
	14.81	11.438	4.265	7.174	14.971	13.211	2.771	10.440	14.673	10.057	4.609	5.447	14.950	12.972	3.230	9.741
Aug	14.87	12.099	2.120	9.979	15.022	13.790	2.465	11.325	14.829	11.649	2.465	9.184	14.995	13.477	2.465	11.012
	14.94	12.811	1.869	10.942	15.041	14.006	0.000	14.006	15.119	14.937	2.558	12.378	14.819	11.550	2.558	8.992
Sep	14.91	12.550	5.942	6.608	14.963	13.121	1.804	11.317	15.015	13.713	3.758	9.955	14.912	12.550	4.562	7.987
	14.93	12.801	6.459	6.342	14.840	11.769	3.126	8.643	14.958	13.061	6.344	6.717	14.865	12.041	8.758	3.284
Oct	14.93	12.697	2.289	10.408	14.667	9.999	7.920	2.079	15.077	14.436	9.759	4.677	14.760	10.932	9.644	1.288
	14.84	11.796	1.622	10.175	14.786	11.197	7.597	3.599	14.937	12.825	3.920	8.905	14.818	11.537	6.218	5.319
Nov	14.98	13.332	7.854	5.478	15.043	14.038	7.740	6.298	15.065	14.295	7.854	6.440	14.889	12.301	0.270	12.032
	14.93	12.712	8.387	4.325	15.121	14.960	9.766	5.194	14.929	12.734	10.111	2.623	14.830	11.663	10.456	1.207
Dec	14.94	12.838	8.079	4.759	14.818	11.536	8.768	2.768	14.897	12.382	6.355	6.027	14.783	11.173	8.768	2.405
	14.99	13.388	8.340	5.048	15.026	13.832	6.731	7.101	15.091	14.593	8.340	6.254	14.759	10.919	8.340	2.579

Year	2007				2008				2009				2010			
Month	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance
	EL.meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec	EL. Meter	m3/sec	m3/sec	m3/sec
Jan	14.80	11.389	5.074	6.315	14.97	13.234	4.982	8.253	15.007	13.621	4.982	8.640	15.011	13.660	4.292	10.719
	14.85	11.863	2.707	9.156	15.04	14.028	1.202	12.826	14.915	12.583	2.581	10.002	15.059	14.218	0.000	15.059
Feb	14.88	12.185	0.566	11.619	15.06	14.201	0.000	14.201	14.926	12.704	0.409	12.296	14.985	13.370	0.000	14.985
	14.91	12.562	0.163	12.398	15.15	15.359	0.000	15.359	15.000	13.538	0.000	13.538	14.995	13.485	0.000	14.995
Mar	14.91	12.513	2.071	10.442	15.16	15.477	1.246	14.232	14.951	12.979	0.901	12.078	14.991	13.431	0.326	14.664
	14.91	12.507	3.552	8.955	15.05	14.123	6.885	7.237	14.961	13.091	6.885	6.206	15.008	13.623	5.047	9.961
Apr	14.72	10.571	4.565	6.006	14.94	12.823	6.419	6.404	14.957	13.054	7.454	5.600	14.999	13.522	10.671	4.327
	14.67	9.993	11.382	−1.390	14.99	13.477	6.901	6.576	14.921	12.653	7.016	5.637	14.986	13.378	9.774	5.212
May	14.51	8.542	10.200	−1.659	14.95	12.964	4.782	8.182	14.983	13.348	9.149	4.199	14.985	13.363	10.068	4.916
	14.39	7.484	4.985	2.499	14.96	13.077	5.121	7.956	14.962	13.105	8.224	4.881	14.991	13.431	6.270	8.720
Jun	14.47	8.135	4.700	3.435	15.04	14.033	6.441	7.592	14.928	12.727	6.786	5.941	15.049	14.107	4.947	10.102
	14.49	8.343	4.253	4.090	14.92	12.587	7.367	5.220	14.962	13.106	1.621	11.486	14.903	12.455	8.516	6.388
Jul	14.50	8.379	7.913	0.466	14.92	12.675	7.862	4.813	14.987	13.385	7.862	5.523	14.964	13.129	5.449	9.515
	14.43	7.839	0.163	7.675	14.93	12.790	3.460	9.330	14.866	12.044	4.609	7.435	14.964	13.133	4.609	10.355
Aug	14.53	8.700	2.593	6.107	15.01	13.637	2.465	11.172	14.953	13.009	2.465	10.544	14.916	12.594	2.465	12.451
	14.37	7.293	1.376	5.917	15.01	13.616	0.000	13.616	14.903	12.445	0.081	12.364	15.063	14.269	0.656	14.407
Sep	14.62	9.571	6.020	3.552	14.88	12.157	6.286	5.870	14.897	12.382	5.827	6.555	15.063	14.263	5.942	9.121
	14.40	7.537	6.190	1.347	14.92	12.616	7.838	4.778	14.835	11.720	9.217	2.503	14.951	12.979	8.758	6.193
Oct	14.67	10.052	8.423	1.629	14.86	11.998	7.116	4.882	14.957	13.054	6.886	6.168	15.020	13.767	4.472	10.548
	14.84	11.756	6.066	5.690	14.77	11.080	8.287	2.793	14.934	12.790	9.436	3.354	15.011	13.666	7.482	7.529
Nov	14.95	12.987	4.620	8.366	14.94	12.823	7.740	5.083	14.973	13.234	8.429	4.805	15.016	13.721	8.199	6.817
	14.83	11.628	10.016	1.612	15.00	13.522	10.456	3.066	14.859	11.977	9.996	1.980	15.035	13.937	7.123	7.911
Dec	14.88	12.178	8.806	3.373	14.89	12.258	8.308	3.949	14.969	13.189	8.768	4.421	14.925	12.697	8.768	6.157
	14.98	13.352	8.383	4.969	14.95	12.979	7.650	5.329	14.948	12.951	8.340	4.611	15.038	13.970	8.340	6.698

Table B.2 (2) Daily Base Simulation Analysis in Critical Months

Year/ Month	2008 October				2007 April				2007 May				2007 June			
	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance
Day	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec
1	14.80	11.347	7.116	4.231	14.80	11.347	4.565	6.782	15.06	14.232	10.200	4.032	14.49	8.331	4.700	3.632
2	15.01	13.652	7.116	6.536	14.87	12.092	4.565	7.527	15.05	14.115	10.200	3.915	14.56	8.972	4.700	4.272
3	15.23	16.294	7.116	9.179	14.74	10.727	4.565	6.162	15.04	13.999	10.200	3.798	14.56	8.972	4.700	4.272
4	14.92	12.638	7.116	5.522	14.36	7.204	4.565	2.639	14.22	6.082	10.200	-4.118	14.50	8.421	4.700	3.722
5	14.78	11.138	7.116	4.023	14.57	9.065	4.565	4.500	14.37	7.288	10.200	-2.912	14.22	6.082	4.700	1.383
6	14.79	11.242	7.116	4.127	14.84	11.769	4.565	7.204	14.28	6.551	10.200	-3.649	14.39	7.457	4.700	2.758
7	15.05	14.115	7.116	7.000	14.77	11.035	4.565	6.470	14.41	7.628	10.200	-2.572	14.55	8.879	4.700	4.179
8	14.80	11.347	7.116	4.231	14.88	12.200	4.565	7.635	14.30	6.712	10.200	-3.489	14.73	10.625	4.700	5.926
9	14.60	9.348	7.116	2.233	14.83	11.663	4.565	7.098	14.45	7.976	10.200	-2.225	14.70	10.323	4.700	5.624
10	14.49	8.331	7.116	1.215	14.63	9.636	4.565	5.071	14.26	6.393	10.200	-3.807	14.50	8.421	4.700	3.722
11	15.04	13.999	7.116	6.883	14.64	9.732	4.565	5.167	14.46	8.064	10.200	-2.137	14.41	7.628	4.700	2.928
12	15.09	14.586	7.116	7.470	14.54	8.786	4.565	4.221	14.54	8.786	10.200	-1.414	14.48	8.241	4.700	3.542
13	14.79	11.242	7.116	4.127	14.71	10.423	4.565	5.858	14.50	8.421	10.200	-1.779	14.27	6.472	4.700	1.772
14	14.84	11.769	7.116	4.654	15.03	13.883	4.565	9.318	14.31	6.793	10.200	-3.408	14.31	6.793	4.700	2.093
15	14.69	10.224	7.116	3.108	14.66	9.927	4.565	5.362	14.45	7.976	10.200	-2.225	14.35	7.121	4.700	2.421
16	14.55	8.879	8.287	0.592	14.46	8.064	11.382	-3.319	14.26	6.393	4.985	1.408	14.46	8.064	4.253	3.811
17	14.64	9.732	8.287	1.446	14.47	8.152	11.382	-3.230	14.39	7.457	4.985	2.472	14.28	6.551	4.253	2.299
18	14.67	10.026	8.287	1.739	14.38	7.372	11.382	-4.010	14.31	6.793	4.985	1.808	14.40	7.542	4.253	3.290
19	14.47	8.152	8.287	-0.135	14.52	8.603	11.382	-2.780	14.32	6.874	4.985	1.889	14.50	8.421	4.253	4.168
20	14.71	10.423	8.287	2.137	14.55	8.879	11.382	-2.504	14.17	5.704	4.985	0.720	14.53	8.694	4.253	4.441
21	14.84	11.769	8.287	3.483	14.53	8.694	11.382	-2.688	14.38	7.372	4.985	2.388	14.67	10.026	4.253	5.773
22	15.18	15.673	8.287	7.387	14.40	7.542	11.382	-3.840	14.51	8.512	4.985	3.527	14.84	11.769	4.253	7.517
23	15.06	14.232	8.287	5.945	14.33	6.956	11.382	-4.427	14.31	6.793	4.985	1.808	14.55	8.879	4.253	4.626
24	14.98	13.310	8.287	5.023	14.77	11.035	11.382	-0.348	14.30	6.712	4.985	1.727	14.28	6.551	4.253	2.299
25	14.84	11.769	8.287	3.483	15.14	15.185	11.382	3.803	14.34	7.038	4.985	2.053	14.31	6.793	4.253	2.540
26	14.57	9.065	8.287	0.778	14.87	12.092	11.382	0.709	14.53	8.694	4.985	3.709	14.42	7.714	4.253	3.462
27	14.78	11.138	8.287	2.851	14.97	13.197	11.382	1.814	14.43	7.801	4.985	2.816	14.46	8.064	4.253	3.811
28	14.57	9.065	8.287	0.778	15.20	15.920	11.382	4.538	14.60	9.348	4.985	4.363	14.44	7.888	4.253	3.635
29	14.79	11.242	8.287	2.955	14.68	10.124	11.382	-1.258	14.62	9.539	4.985	4.555	14.57	9.065	4.253	4.812
30	14.69	10.224	8.287	1.937	14.73	10.625	11.382	-0.757	14.59	9.253	4.985	4.269	14.66	9.927	4.253	5.675
31	15.05	14.115	8.287	5.828					14.23	6.159	4.985	1.174	14.23	6.159	4.253	1.906

Year/ Month	1998 March				1998 April				1998 May				2002 December			
	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance	WL	Q	WR	Balance
Day	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec	EL. M	m3/sec	m3/sec	m3/sec
1	14.43	7.801	1.820	5.981	14.45	7.976	10.671	-2.696	14.62	9.539	0.000	9.539	14.80	11.347	8.768	2.579
2	14.54	8.786	1.820	6.966	14.35	7.121	10.671	-3.550	14.60	9.348	0.000	9.348	14.76	10.932	8.768	2.163
3	14.10	5.196	1.820	3.375	14.15	5.556	10.671	-5.115	14.90	12.418	0.000	12.418	14.76	10.932	8.768	2.163
4	14.20	5.929	1.820	4.109	14.10	5.196	10.671	-5.476	15.14	15.185	0.000	15.185	14.65	9.830	8.768	1.062
5	14.22	6.082	1.820	4.262	14.49	8.331	10.671	-2.340	14.80	11.347	0.000	11.347	14.95	12.972	8.768	4.204
6	14.45	7.976	1.820	6.155	14.69	10.224	10.671	-0.448	14.74	10.727	0.000	10.727	14.75	10.829	8.768	2.061
7	14.44	7.888	1.820	6.068	14.83	11.663	10.671	0.992	14.95	12.972	0.000	12.972	14.46	8.064	8.768	-0.704
8	14.49	8.331	1.820	6.511	14.67	10.026	10.671	-0.646	15.15	15.307	0.000	15.307	14.90	12.418	8.768	3.650
9	14.82	11.557	1.820	9.737	15.04	13.999	10.671	3.327	15.10	14.705	0.000	14.705	14.66	9.927	8.768	1.159
10	14.16	5.630	1.820	3.810	14.72	10.524	10.671	-0.147	15.00	13.538	0.000	13.538	14.70	10.323	8.768	1.555
11	14.15	5.556	1.820	3.736	14.43	7.801	10.671	-2.871	15.05	14.115	0.000	14.115	14.90	12.418	8.768	3.650
12	14.17	5.704	1.820	3.884	14.55	8.879	10.671	-1.793	15.06	14.232	0.000	14.232	14.93	12.749	8.768	3.981
13	14.32	6.874	1.820	5.054	14.45	7.976	10.671	-2.696	14.92	12.638	0.000	12.638	14.94	12.860	8.768	4.092
14	14.51	8.512	1.820	6.691	14.25	6.315	10.671	-4.357	15.20	15.920	0.000	15.920	14.94	12.860	8.768	4.092
15	14.54	8.786	1.820	6.966	14.20	5.929	10.671	-4.742	15.05	14.115	0.000	14.115	14.65	9.830	8.768	1.062
16	14.60	9.348	5.851	3.497	14.22	6.082	10.233	-4.151	14.71	10.423	4.087	6.336	14.75	10.829	8.340	2.489
17	14.24	6.237	5.851	0.386	14.15	5.556	10.233	-4.677	15.34	17.702	4.087	13.615	14.72	10.524	8.340	2.185
18	13.92	3.996	5.851	-1.855	14.20	5.929	10.233	-4.304	15.10	14.705	4.087	10.618	14.56	8.972	8.340	0.632
19	14.62	9.539	5.851	3.688	14.33	6.956	10.233	-3.277	15.02	13.767	4.087	9.680	14.88	12.200	8.340	3.860
20	14.62	9.539	5.851	3.688	14.37	7.288	10.233	-2.945	15.02	13.767	4.087	9.680	14.95	12.972	8.340	4.632
21	14.24	6.237	5.851	0.386	14.40	7.542	10.233	-2.691	14.81	11.452	4.087	7.365	14.70	10.323	8.340	1.984
22	14.43	7.801	5.851	1.950	14.35	7.121	10.233	-3.112	15.22	16.169	4.087	12.082	14.50	8.421	8.340	0.082
23	14.38	7.372	5.851	1.521	14.44	7.888	10.233	-2.345	15.05	14.115	4.087	10.028	14.95	12.972	8.340	4.632
24	14.45	7.976	5.851	2.125	14.50	8.421	10.233	-1.812	14.95	12.972	4.087	8.885	14.94	12.860	8.340	4.521
25	14.10	5.196	5.851	-0.655	14.22	6.082	10.233	-4.151	14.99	13.423	4.087	9.336	14.90	12.418	8.340	4.078
26	14.25	6.315	5.851	0.464	14.90	12.418	10.233	2.185	14.83	11.663	4.087	7.576	14.67	10.026	8.340	1.686
27	14.25	6.315	5.851	0.464	14.69	10.224	10.233	-0.010	14.88	12.200	4.087	8.113	14.98	13.310	8.340	4.970
28	14.40	7.542	5.851	1.691	14.93	12.749	10.233	2.516	14.87	12.092	4.087	8.005	14.70	10.323	8.340	1.984
29	14.70	10.323	5.851	4.472	14.95	12.972	10.233	2.739	14.77	11.035	4.087	6.948	14.50	8.421	8.340	0.082
30	14.95	12.972	5.851	7.121	15.13	15.065	10.233	4.831	14.74	10.727	4.087	6.640	14.70	10.323	8.340	1.984
31	14.86	11.984	5.851	6.133					14.40	7.542	4.087	3.455	14.74	10.727	8.340	2.387



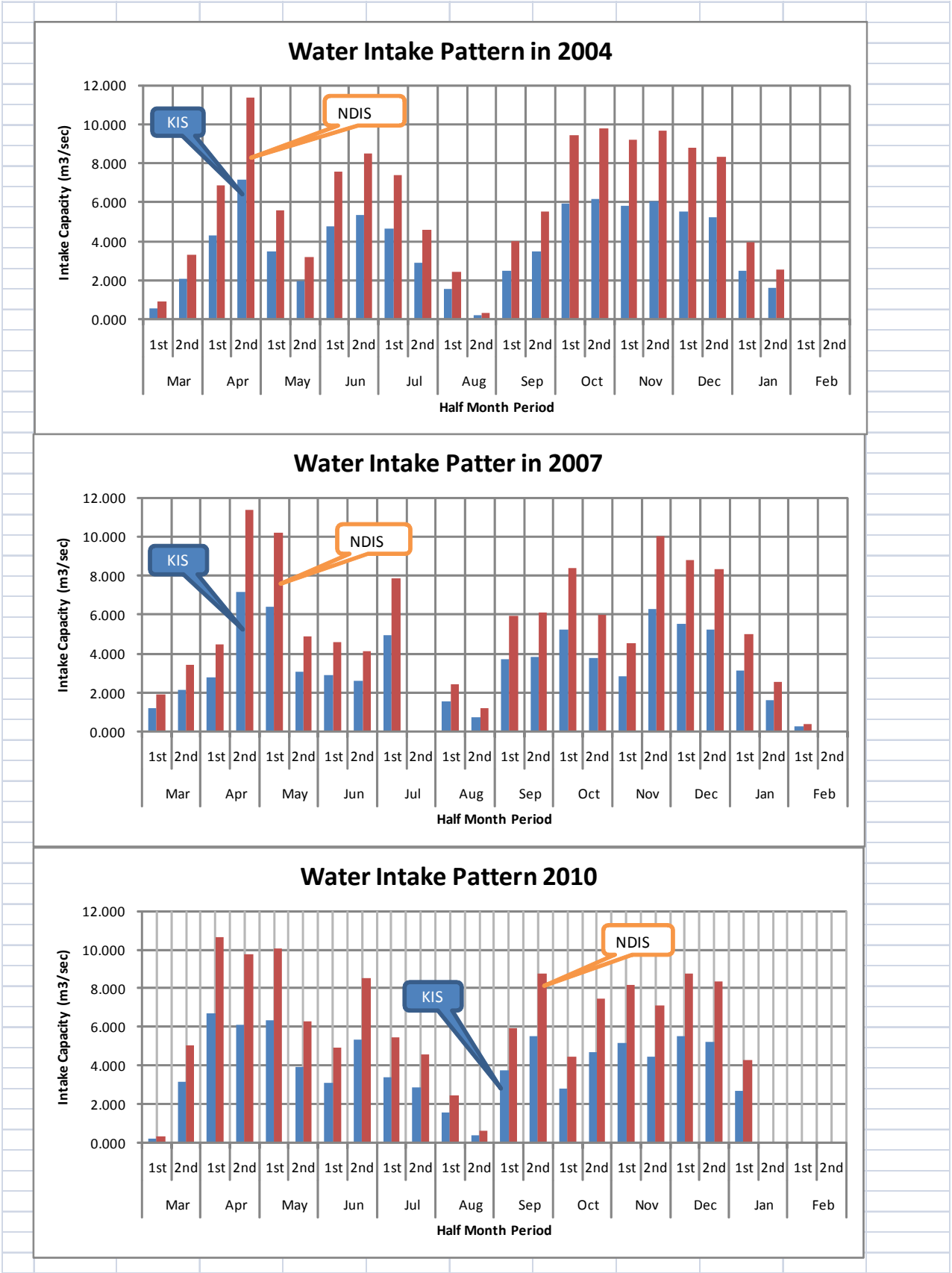
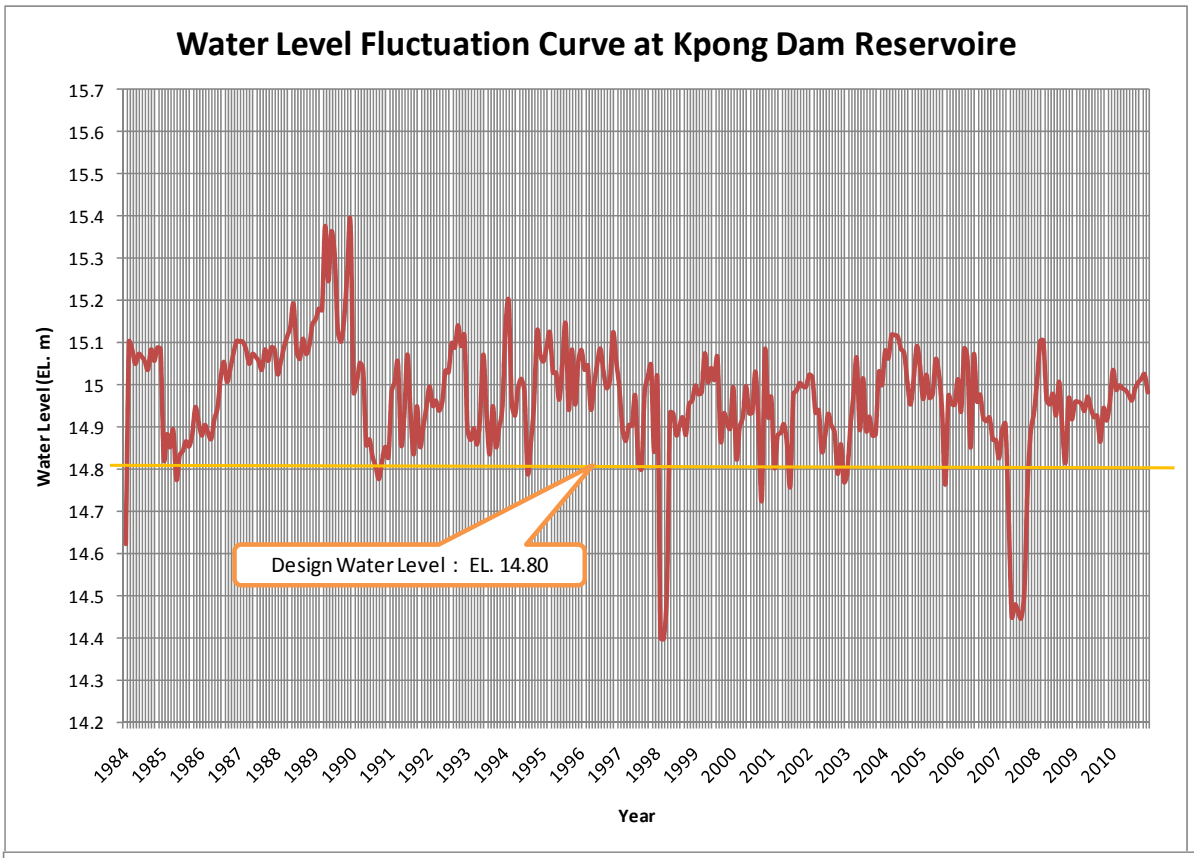


Fig. B.1 Water Intake Pattern for KIS and NDIS



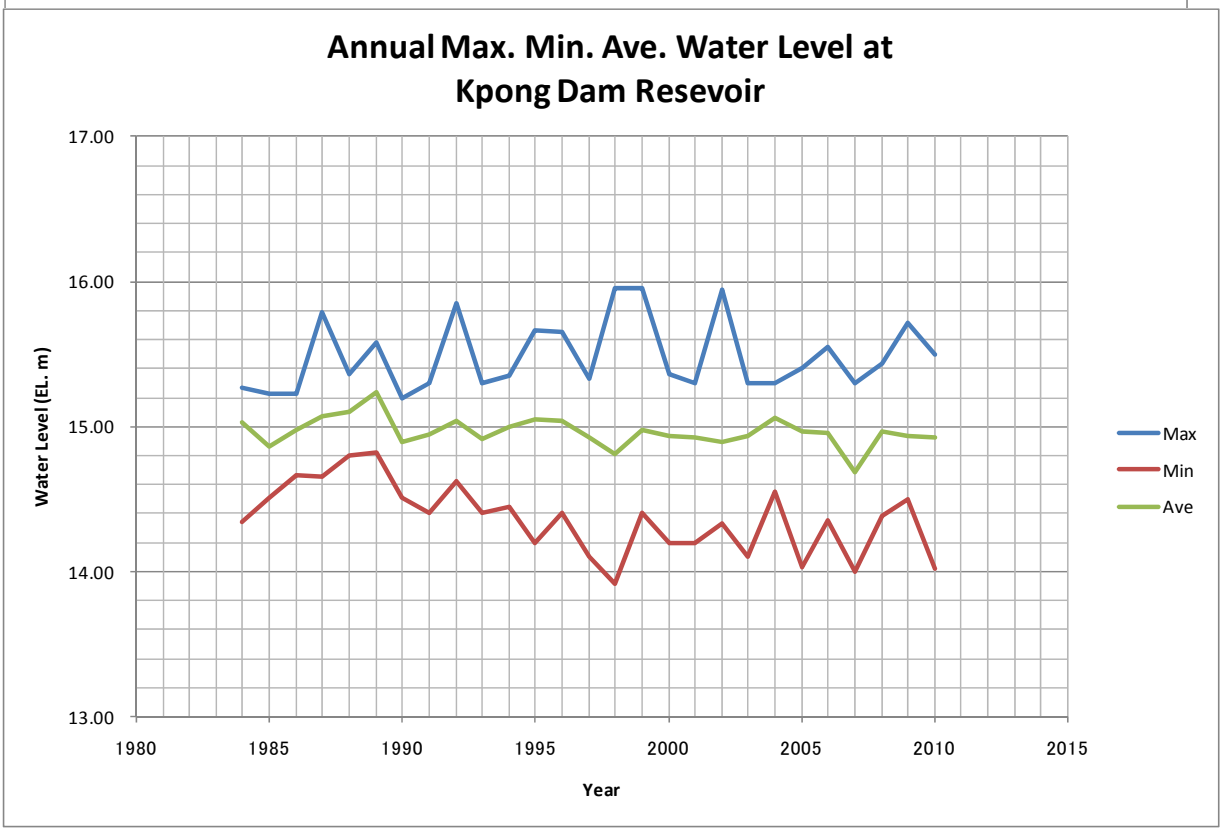


Fig. B.2 Water Level Fluctuation Curve at Kpong Dam Reservoir

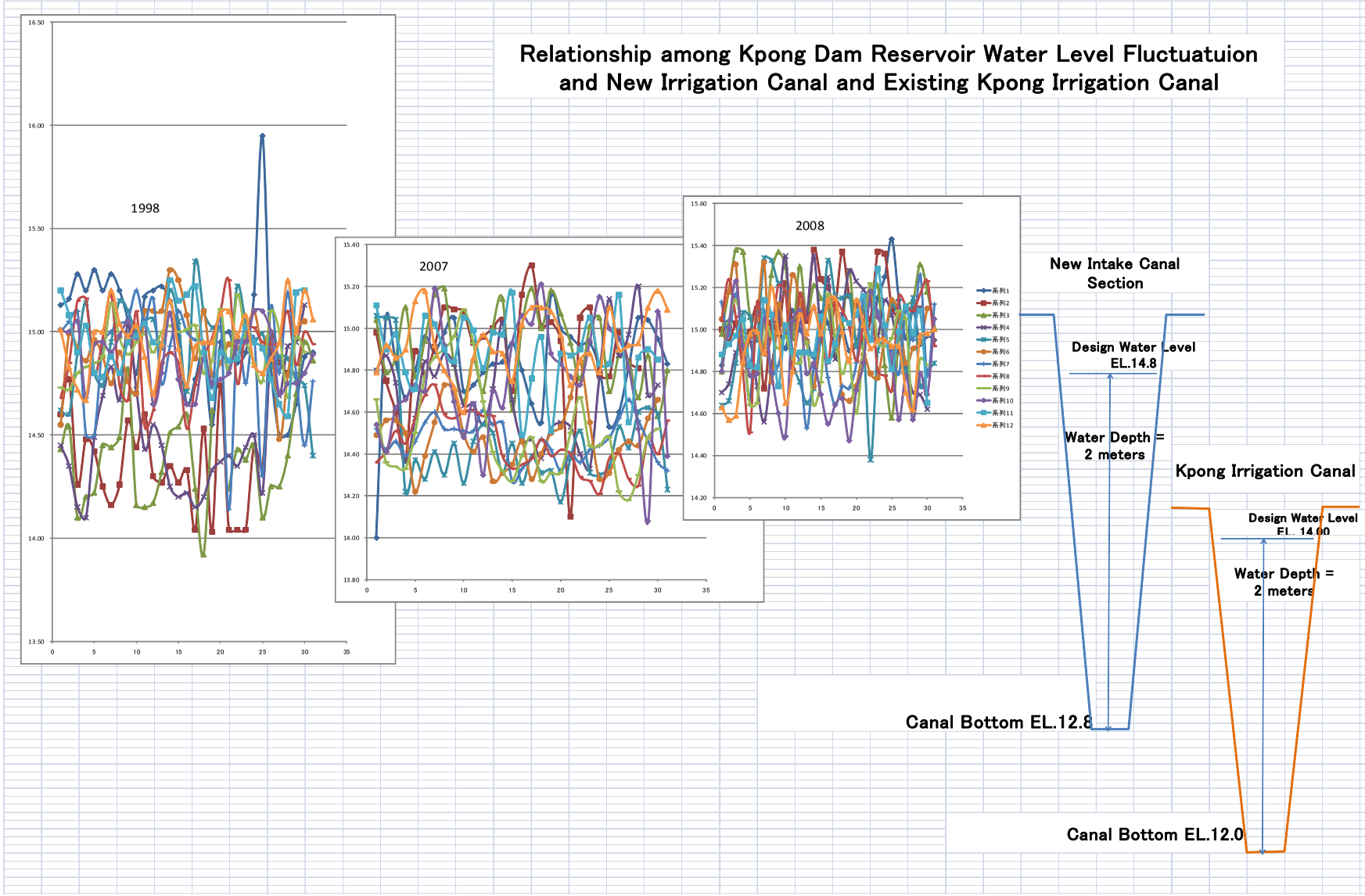


Fig. B.3 Daily Water Level Fluctuation and Elevation of Irrigation Canals

Attachment(1/3)

Minutes of Meeting between Volta River Authority and the Irrigation Development Authority/JICA Study team Held at the Engineering Services Department, Akuse on March 1, 2011

Introduction

The meeting began 11:20am with an introduction of members present. The VRA team was led by Mr. Ada Asomontsi and GIDA/JICA study team was led by Mr. J. K. Antwi. The purpose of the meeting was to continue the discussion on possible water extraction from the Kpong head pond at Akuse for irrigation of the Accra plains by gravity.

Discussions

The leader of the JICA study team for the irrigation feasibility study outlined the background to the Irrigation project. After which he gave three major items that needed to be discussed. The deliberations on the three items are as follows:

Designed intake water level

For the design water level for the proposed irrigation canal, the team suggested El. 14.8m which is the same as the existing canal for the Kpong left bank Irrigation project under MIDA. The team wanted to know whether the intake level 14.8m was acceptable to VRA. VRA indicated that the historic data on water level in the Kpong dam used for analysis was monthly average and that the analysis for the intake level should be based on daily water levels otherwise the water required may not be available if the water level falls below the El. 14.8m. JICA study team requested for drawings of existing intake structure and the daily water levels to aid in detailed study which VRA agreed to provide.

Location of the Intake

The initial impression on the location of the intake was that drilling of the earth dam structure will be required. However, as indicated by the JICA study team, the intake site will be between the end of the dam body and existing airstrip which will not have any adverse effect on the dam structure. VRA noted that the canal will cross their setting out line but JICA study team indicated that a concrete culvert has been proposed for vehicles to cross. VRA had no objection to the location of the intake but however advised GIDA to consult Real estate department since they are in charge of VRA lands.

New water intake capacity

Initially GIDA requested for additional $10m^3/s$ to be extracted from Kpong reservoir. According to the JICA team, the $10m^3/s$ was just an estimated number. Preliminary

study have shown that aside the current 7.2m^3/s being drawn from the Kpong dam, additional flow of about 11.3m^3/s will be required to irrigate an area of 6,900ha. JICA indicated that they intend lining the existing canal to reduce seepage losses and maximize the capacity of 7.2m^3/s. On the issue of opportunity cost VRA stated that the quantity of water to be extracted annually would be required before the opportunity cost could be estimated. VRA concern was on the total quantity of water to be withdrawn per year. JICA study team indicated that they are yet to estimate the actual crop water requirement after which the annual water demand would be known.

The JICA team stated that the project is still in the pre- feasibility study state and will complete in April and they would require more collaboration from VRA. They requested for data on Daily water level in the Kpong reservoir, groundwater seepage and drilling data which VRA agreed to provide after submitting the full list of data needed.

Conclusion

The meeting agreed on the following:

- With regards to the three major items discussed, VRA has no problem with them only that GIDA/JICA should estimate the actual amount of water to be extracted per year to enable VRA estimate the opportunity cost. JICA study team has indicated to prepare the irrigation water requirement and communicate the amount in the next meeting
- JICA requested for information which they would have to submit the full list of data required for VRA to provide
- GIDA would have to consult VRA real estate concerning the proposed canal that will pass their land

Closing

The meeting was closed at 12:13pm

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Ada Asomontsi (Manager, infrastructure)	J. K. Antwi (Dep. Chief Executive-Agro.)
Volta River Authority	Ghana Irrigation Development Authority
Akuse.	Accra.

Attachment(3/3)

Attendants:

Ada Asomontsi (Manager, infrastructure)	VRA
Charles Addo (Manager, System Planning)	,,
Kwame O. M. Darkwah (Senior Civil Engineer)	,,
Alex Nyarko (Dam Studies)	,,
Philip T. Paid (Assist Civil Engineer)	,,
Afua Adwubi (Assist Civil Engineer)	,,
Ama Kesewaa Duah (Assist Civil Engineer)	,,
Busia Dawuni (Senior Irrigation Engineer)	GIDA
J. K. Antwi (Dep. Chief Executive-Agronomy)	,,
Kwabena Boateng (Ag. Dep. Chief Executive-Eng)	GIDA
Hiroyoki Doi (Environ and Social Considerations)	,,
Takashi Shiraki (Agricultural Study)	,,
Takahiro Kato (Facility Planning/Design)	,,
Toshimasa Kobayashi (Irrigation Development)	,,
Takahiro Nakamura (JICA Headquarters)	,,
Mitsuaki Suzuki (JICA Headquarters)	,,
Anthony Quashigah (Maintenance Manager)	KIP
Jacob Aduah (Project Manager)	,,

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