1. FEASIBILITY STUDY OF GACO SMALL RESERVOIR IRRIGATION PROJECT

1.1. Background

Cognizant of the pressure due to population growth, increasing food demand, and other development issues and needs in the area, an agricultural project that could fully address identified constraints has to be urgently implemented. Project identification, formulation and planning necessitate absolutely essential and best available means to ensure efficient use of capital funds, and to ensure successful implementation on schedule.

The development of irrigation infrastructure is essential in order to support the rice sufficiency program of the national government. One of the identified, promising water resources may be obtained from the proposed Gaco River Small Reservoir Irrigation Project.

The Gaco River Small Reservoir Irrigation Project is a development project of the National Irrigation Administration. The proposed project is located at Gaco River in the municipality of Cabugao province of Ilocos Sur with coordinates 17 degrees, 45 minutes, 6.42 seconds north latitude and 120 degrees, 31 minutes, 3.72 seconds east longitude. Presently access is by Four-wheel drive vehicle.

The project involves the construction of a high storage dam and appurtenant structures across the Gaco River and the construction of corresponding irrigation and drainage canals and structures within the coverage area in the municipality of Cabugao in the province of Ilocos Sur. The volume of water that will be stored shall be studied and evaluated if economically feasible for efficient utilization, by way of a) provision of year-round irrigation to 600 hectares of agricultural land in the municipality of Cabugao, province of Ilocos Sur and; b) provision of hydro-power generation, flood control, fishery, water supply and recreation.

1.2. Project Description

1.1.1. Project Location and Area

The project area is located in the Province of Ilocos Sur, one of the four provinces comprising Region 1 (Ilocos Region). The Province of Ilocos Sur is located along the western coast of Northern Luzon. It is bounded by Ilocos Norte in the north, Abra in the northeast, Mountain Province in the east, Benguet in the Southeast,0 La Union in the south, and West Philippine Sea in the west. It has a total land area of 2,579.6 square km. The province is politically subdivided into 32 municipalities and 2 cities.

Vigan City is the seat of the Provincial Government and is about 407 km north-northwest of Manila, 82 km away from Laoag City and 138 km north of San Fernando, La Union, the regional capital The province has a total land area of 2,579.60 sq. km or 20.1% of the total area of Region I. Ilocos Sur province is the 3rd largest in size in Ilocos Region and consists of two (2) congressional districts comprising thirty two (32) municipalities and two (2) component cities. (Figure 9.1- Ilocos Sur's Location and its and Municipalities).

The development of irrigation infrastructure is essential in order to support the rice sufficiency program of the national government. One of the identified, promising water resources may be obtained from the proposed Gaco River Small Reservoir Irrigation Project.

The Gaco River Small Reservoir Irrigation Project is a development project of the National Irrigation Administration. The proposed project is located at Gaco River in the municipality of Cabugao province of

Ilocos Sur with coordinates 17 degrees, 45 minutes, 6.42 seconds north latitude and 120 degrees, 31 minutes, 3.72 seconds east longitude. Presently access is by Four-wheel drive vehicle.

The project involves the construction of a 51.9 m high rockfill embankment dam and appurtenant structures across the Gaco River and the construction of corresponding irrigation and drainage canals and structures within the coverage area in the municipality of Cabugao in the province of Ilocos Sur. The volume of water that will be stored is 10, 520 x 10^3 cubic meter shall be studied and evaluated if economically feasible for efficient utilization, by way of a) provision of year-round irrigation to 560 hectares of agricultural land in the municipality of Cabugao, province of Ilocos Sur.

The left and right abutment consist hills both rising at about 45 degrees from the ground. Rock outcrops can be seen at both abutments and at the river bed indicating that firm foundation can be had at a shallow depth. The spillway can be located at the right abutment by excavating into the hill. The outlet work can be located under the dam embankment. The location of both spillway and outlet work shall be studied thoroughly to come up with the best scheme technically and economically.

The river bed is blanketed in boulders, sand and gravel with quantity arranged in that order. For this reason it should be appropriate to construct a rock-filled dam. A rockfill dam is a dam that relies on rock, either dumped in lifts or compacted in layers, as a major structural element. An impervious membrane is used as the water barrier and can be placed either within the embankment (internal membrane) or on the upstream slope (external membrane). Various materials have been used for this membrane including earth materials, concrete, steel and asphaltic concrete. The rockfill dam is the more stable dam because it has no pore water pressure which tends to destabilize the dam. The source for boulders for the rockfill dam and pervious shell material for the zone-type earthdam can be the Gaco River itself while impervious material for the core embankment can be sourced at the vicinity. A thorough study shall be conducted to evaluate which type of dam is appropriate.

Figure 1.1. Project Location Map - Ilocos Sur's Location and its Municipalities

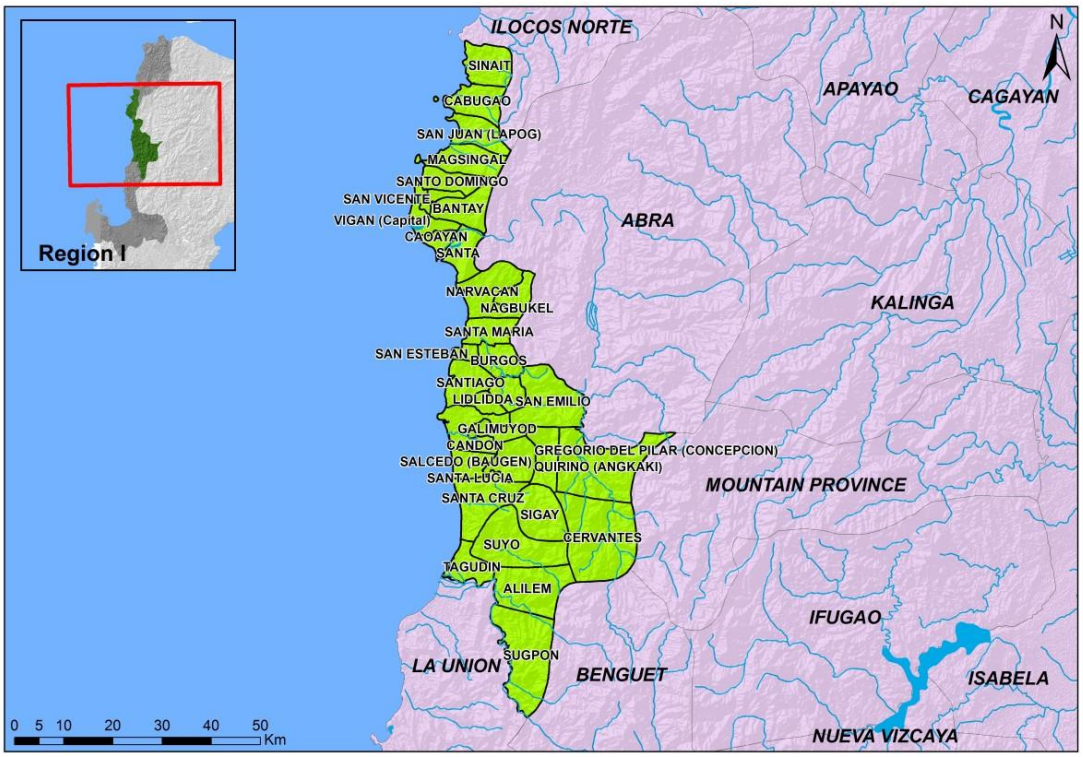


Figure 1.2. Project Location Map

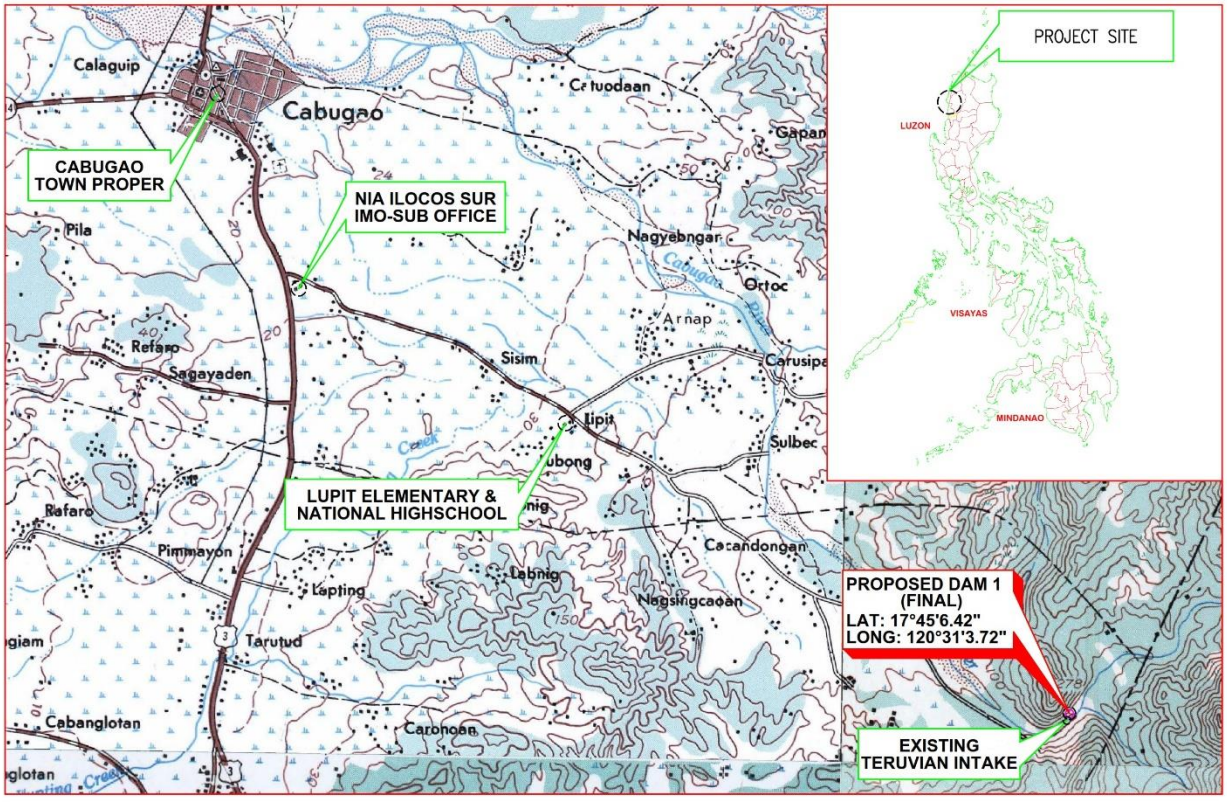
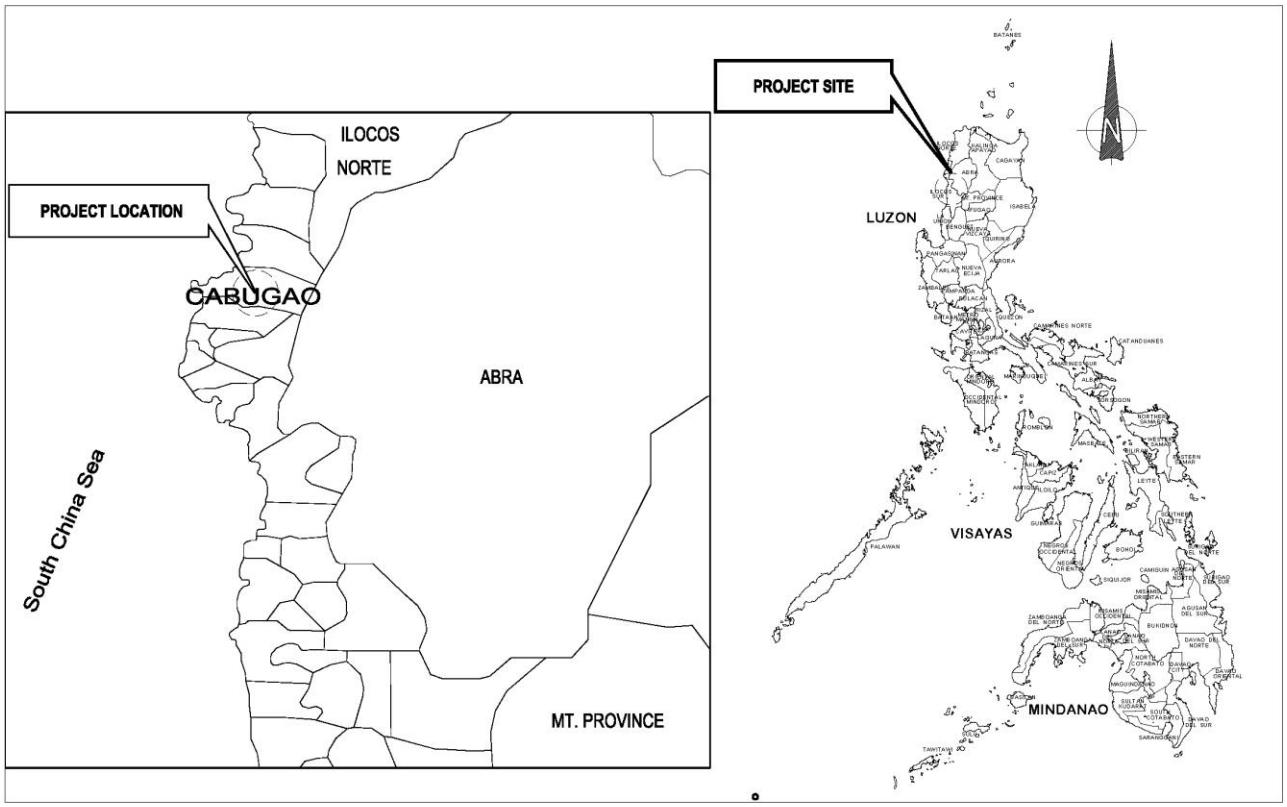


Figure 1.3. Vicinity Map



The size of the watershed or catchment basin is the most important parameter affecting the determination of the total runoff. It is generally defined by the limits of the topographic divide which is the line that separates water flow between basins.

The drainage areas or the points of interest in the study were determined from the 1:50,000 topographic maps of the National Mapping and Resource Information Authority (NAMRIA) of the Department of Environment and Natural Resources (DENR). The catchment area and other hydrologic parameters were determined using AUTOCAD software and estimated as shown in Table 9.1. The delineated waterway is shown in Figure 9.4.

Table 1.1. Catchment Parameters

Watershed	Drainage Area (sq. km)	Waterway length, L (km)	Slope (m/m)
Gaco SRIP	13.31	5.45	0.11832

The use of land and the type of surface the rainfall falls upon have an obvious impact on the flow of water. The mountainous areas are characterized by moderate to steep slopes with secondary forest growth.

The topography is a natural factor dictating the velocity of runoff and the rate at which the discharge flows through the catchment. The flatter the slopes, the longer the time lag for water movement. Topography also influences depression storage areas which help reduce peak flows during flooding by storing some of the runoff.

Figure 1.4. Gaco Dam Site Watersheds

1.1.2. Direct and Indirect Impact Areas

Projects affect a specific area but this area can vary among resource types and by phase of development. The area of influence for a project is the combination of all of these. By determining the area of influence (often called the region of influence [ROI] or affected environment) is the next step in performing an impact assessment. The area of influence is often, if not always, variable and dependent on the impacting factor (both direct and indirect) and the affected resource. Some examples for different resources include: soils and geology, water resources, air quality, ecological resources, land use and socioeconomics.

The direct and indirect impact areas are important to determine the potential effect of the project especially to the local community directly affected by the dam construction as well as the adjacent communities that may be affected.

The direct impact area is the impounding dam infrastructures, submerged area, irrigation canals, and excavation areas for rock fills, and road networks.

The indirect areas would be the areas outside the defined boundaries of the dam area that maybe affected during the operations stage of the project.

Furthermore, the identification and delineation of the direct and indirect impact areas is necessary to determine the potential risks that the project may bring about to the local communities living within and adjacent to the project site. The direct impact areas are places where project structures and facilities are to be established such as areas affected by the impounding dam infrastructures, submerged area, irrigation canals, and excavation areas for earth fills, and road networks. Indirect

areas, meanwhile, are areas outside the defined boundaries of the service area but may be potentially affected during the establishment and operations of the project.

1.1.3. Land

The present land use of the proposed project area is a combination of forest zone and public lands. The proposed service area is crossed by the Gaco River, which is also the water source of the municipality of Cabugao.

Large portion of the proposed service area of the Gaco River is planted with rice. These areas will be developed as irrigable rice fields when the project becomes operational. Based on the spatial analysis conducted, the proposed impounding dam will have a capacity for holding 3,959,000 cubic meters of water. There are also other encroachments in the upper portions of the watershed adjacent to the impounding dam presently cultivated for varied varieties of crops.

1.1.4. Water

The Cabugao River is the only big river that cuts across the town. Two big tributaries come from the eastern portion of the Municipality. Sitio Caset in Maradodon and Gaco in Barangay Cacadiran. The barangays that lie along the Cabugao River are flood prone areas during the rainy season. The uncontrollable surges of water erode the properties that line the Cabugao River endangering life and limb. The creek that runs through the Poblacion easily clogs up in rain causing portions near it to be inundated.

Physio-chemical analysis such as pH, total suspended solids (TSS), total dissolved solids (TDS), hardness and total alkalinity; chemical compound such as chloride, phosphate, nitrite and calcium; heavy metals such as cadmium, chromium and magnesium were measured for the Cabugao River.

The average rainfall in the basin is heavily influenced by monsoon and terrain. Rainfall distribution is uneven by time and space. The watershed rainfall at the dam site is reckoned from the nearest rainfall station. The Sinait rainfall station would likely influence the rainfall pattern and behavior in the Gaco SRIP.

Where the identified river source is ungauged and only rainfall data is available, the discharge of the river is estimated using the analytical technique of area-rainfall method. Water enters the model as precipitation and leaves as either evapotranspiration losses or as streamflow at the outlet. Precipitation that lands on the ground surface is routed to the surface and subsurface storages based on the amount of water occupying the soil water content storages (distributed uniformly); water leaks out of the bottom of the soil water content storages and into subsurface storage, while water that exceeds the capacity of the soil water content storages become overland that eventually enters the surface storage. The combined outflow from each of the storages becomes the total outflow at the watershed outlet.

1.1.5. People

The scope of work for the people module for the EIS includes the following activities: socio-economic profiles of barangays and specifically identified direct impact areas; review of available secondary data, reports, relevant studies and other information; conduct of a reconnaissance survey of the project areas to be affected by the proposed project, gathering and review of relevant primary data critical to the study.

1.2. Project Rationale

The Philippines is basically an agricultural country, where the agriculture sector plays a vital role in sustaining the socio-economic development of the country. The country can never be self-sufficient, lest its resources are harnessed to its optimal level. However, there are repercussions to be taken into consideration, such as environmental impacts. The need to avoid adverse impacts and to ensure long term benefits led to the concept of sustainability. This has become accepted as an essential feature of development if the aim of increased well-being and greater equity in fulfilling basic needs is to be met for this and future generations. Irrigated agriculture is crucial to the economy, health and welfare of a very large part of the developing world. Irrigation has contributed significantly to poverty alleviation, food security, and improving the quality of life for rural populations. However, irrigated agriculture often radically changes land use and is a major consumer of freshwater. Irrigation development thus has a major impact on the environment. All new irrigation and drainage development as the case of Gaco earth dam would result in some form of degradation. It is necessary to determine the acceptable level and to compensate for the degradation. This degradation may extend both upstream and downstream of the irrigated area. The impacts may be both to the natural, physical environment and to the human environment.

With the operation of the project would provide year-round irrigation to 600 hectares of agricultural land in the municipality of Cabugao, Province of Ilocos Sur, thereby increasing crop yield, eventually alleviating poverty, it is expected that the agricultural productivity in the region will improve by turning idle lands into well-cultivated ones and thereby augmenting the socio-economic status of the people in the region.

Specifically, the project will provide the following benefits:

- increase rice production, thereby answering the need for a sufficient supply of rice, not just in the locality;
- increase farmers income;
- alleviate the problem of literacy in the country by helping the farmers send their children to school to receive formal education;
- increase employment by hiring workers throughout the stages of the project;
- encourage entrepreneurship as small scale businesses would be established nearby;
- improve national food sufficiency;
- improve dollar reserves by reducing the importation of rice;
- better political condition with an improved food supply; and
- encourage local tourism activities by the view of countryside and the technology.

Conceivable notions about constructing a dam in an area range from misconceptions to "close to the truth" perspectives. There are speculations that dam projects would lead to flooding; however, in this case, the proposed project may even help reduce the potential for flooding. The function of dams and reservoirs in flood control is to reduce the peak flows entering a flood prone area. Rather than maintaining high water levels for increased head or sustained water supply for irrigation, flood control operation requires that water levels be kept drawn down deliberately prior to and during the flood season in order to maintain the capacity to store any incoming floodwater. However, flood plains may be productive environments because flooding makes them so. Flooding recharges soil moisture and replenishes the rich alluvial soils with flood deposits of silt. In arid areas, flooding may be the only source of natural irrigation and soil enrichment. Reduction or elimination of flooding has the potential for impoverishing flood recession cropping, groundwater recharge, natural vegetation, wildlife and livestock population in the flood plain which are adapted to the natural flood cycles. Specifically, the project aims to:

- provide irrigation to approximately 600 hectares of land;
- increase rice production, thereby answering the need for a sufficient supply of rice, not just in the locality;
- increase farmer's income;
- create an upsurge of agricultural activity;
- alleviate the problem of literacy in the country by helping the farmers send their children to school to receive formal education;
- increase employment by hiring workers throughout the stages of the project;
- encourage entrepreneurship as small scale businesses will eventually be established nearby;
- improve national food sufficiency;
- improve dollar reserves by reducing the importation of rice;
- alleviate poverty by the chain of economic activities resulting from the increased purchasing power of farmers due to better earnings;
- better political condition with an improved food supply;
- encourage local tourism activities by the view of countryside and the irrigation technology;
- promote and enhance socio-cultural and economic participation of the farmers' beneficiaries for the country's food security program;
- increase agricultural production with the provision of irrigation and drainage;
- promote rural employment;
- keep in phase with the agricultural modernization efforts of the national government; and
- Strengthen the farmers organization though meaningful participation in project implementation.

To sustain the government's efforts in providing a better quality of life to the Filipino people, the eradication of poverty remains a top national concern and a big challenge to the present administration in the Philippines.

1.3. Project Alternatives

Focusing only on the more defensive aspect of reducing adverse impacts of a project to the environment would mean restriction on the side of the authorities to fully exercise their power in decision-making and mobilization. This ultimately defeats the purpose of making do with the available resources to achieve development as it somehow delimits proper utilization and management of the available resources. It is neither wise nor proactive to just leave things idle and unproductive despite the obvious potential and capability of the management, manpower, and resources.

A systematic study of the alternatives for the proposed project and the technology involved is carried out considering the preparation of initial investigation and feasible study. These previous studies help the proponent to foresee environmental impacts, capital and recurrent costs, suitability in the local conditions, institutional, training, and monitoring requirements. The benefits are quantified to the extent possible to have a clearer picture on the economic values the project has. If the Proponent would opt to the "no go" alternative, which means that the proposed irrigation project would not be pushed through in the area, it definitely will not become advantageous to the community as a whole, particularly, the farmers who are dependent on their agriculture-based livelihood. Farmlands would remain rain-fed, and idle lands would not become lucrative. Without the project, the agricultural capacity of the area will not be harnessed to its optimum level, and might gradually decline in the future.

Project alternatives may comprise alternative sites, alternative processes or alternative implementation schedules. The EIA process contributes to generation of a number of project alternatives. Seeking project alternatives for Gaco Small Reservoir Irrigation Project focused on investigating a number of sites along

the Cabugao River. These investigations were spear- headed by the Proponent, EH Sison and Design Consultant. Due consideration was given:

Distance to beneficiary areas	the shorter the conveyance the more economical
Accessibility of the site	easy accessibility of the site the cheaper it is to construct
Topographical characteristics	narrowest section of the valley is preferred
Catchment area of the dam	the wider the catchment area of the dam the higher discharge available

The geology and soil type are the other critical factors that were taken into account In view of the above, a variety of project alternatives presented themselves from the design and management of dam project. As such, three options were considered namely:

- Avoid construction of any earth dam and continue to depend on rains with the view of increasing productivity without irrigation;
- Raise the dam wall for Gaco earth dam to make it a single large dam; and
- With the existing teruvian intake (downstream), construction of the proposed earth dam at the upstream of the river to complement water storage requirement for the irrigable area.

The first option which is a do nothing option is retrogressive for an existing enterprise whose vision is to create world-class farming operations and integrated businesses across the agricultural value chain, and to leave a legacy of responsible commercial agricultural practices in the region. Choosing this option would entail perpetual losses on the part of the government resulting in low productivity as witnessed in recent years by other farmers. This would further undermine the championing of agriculture as an engine for economic growth in the country. Further no additional employment opportunities are envisaged under this option.

The second option appears to be the most attractive and a onetime investment whose returns can be considerable. This option would certainly be a solution to the projected water demand for National Irrigation Administration and Department of Agriculture's current and future undertakings. However, considering the fact that large dam have far reaching environmental effects most of which are irreversible, and the area to be inundated would be large basically consuming the entire submerged and downstream area of the dam, choosing this option would be in variance with the NIA's environmental policy. This would embrace the principle of sustainable development that ensures that any development meets the needs of the present generation without compromising those of future generations. Therefore, this option was found to be inappropriate and environmentally challenging.

The third option not only provides a technical solution but also in many ways environmentally sound. Choosing this option cumulatively guarantees availability of adequate water throughout to meet current and future water demand for NIA for meaningful irrigation. This option would mean creating a number of small earth dams with minimum flooded areas, in which case the environmental effects will be localized to a small geographical area thus minimizing the extent of impacts within the project area. Besides, the environmental effects resulting from small dam can easily be minimized and managed. However, cumulatively the benefits will be huge. Employment for the local people would be guaranteed due to increased agricultural productivity. As such, NIA settled for the third option as the best option under the circumstance.

1.4. Project Components

The Gaco Small Reservoir Irrigation Project has two major components, namely:

- The construction of an impounding dam and appurtenant structures that shall elevate the water level to be diverted to the irrigation canals; and
- The construction of irrigation and drainage ditches to supply irrigation water to the 560 hectare proposed service area.

1.5. Project Development Plan

Irrigation has historically been a major factor for increasing crop productivity. Irrigation raises the productivity of land directly by providing sufficient water supply to raise the yield per hectare per crop and by allowing a second crop to be grown during the dry season when yields are potentially higher. But the development of irrigation facility in itself (consequently the productivity and profitability) depends on several factors, which should be understood clearly and which are essential for the successful operation of an irrigation system.

APPENDIX III: GOOGLE MAP OF THE GACO RIVER WATERSHED

Map 1: Shows the sampling areas for biodiversity survey.

NOTE: Yellow icon are the area where 20 m x 20 m plots are located and also served as point counts for bird survey. The white square was the proposed construction site for Small water impounding. Point 0 to point 21 is exactly 2 km and plots are established every point which is 100 meters in between points.

APPENDIX IV: PICTURES

Picture 1: Overviewing the proposed construction site for the Small Water Impounding
In between the two walls (gold dotted line, facing western side)

Picture 2: Existing diversion canal which is also the same site for the construction of Small Water Impounding (facing eastern side).

Picture 3: The team measuring a bird, Balicassiao during the morning rounds.

Picture 4: Camp site with the survey crew, 8 from our group and 4 from barangay Cacadiran.

Picture 5: Biological Survey Team, 8 from our group and four from barangay Cacadiran