# *Annex I*

# *Associated Projects for Supporting Regional Socio-Economic Activities*

# Annex I ASSOCIATED PROJECTS FOR SUPPORTING REGIONAL SOCIO-ECONOMIC ACTIVITIES

## Table of Contents

## List of Tables



## List of Figures

# Annex I ASSOCIATED PROJECTS FOR SUPPORTING REGIONAL SOCIO-ECONOMIC ACTIVITIES

## I1 Introduction

The implementation of water resources development will bring about some extent of inconveniences to people in the project area, such as the relocation of settlements, change in the river environments, disconnection of local communities due to reservoir impoundment, etc. For compensation to those inconveniences, it is worthy of considering the implementation of projects aiming at improvement of people's livelihood and enhancement of regional economic activities. The description hereafter gives the outline of the projects proposed in this respect.

## I.2 Flood Control and Drainage Improvement in Lower Agos

### I2.1 General

The municipalities of Infanta and General Nakar of Quezon Province are the major municipalities within the Agos River basin, and the Agos River delineates these municipalities. The town proper areas of these municipalities are located in the flood plain areas of the lower reach of the Agos River basin (the lower Agos) where Infanta on the right bank of the river and General Nakar on the other. To date, these areas have suffered from seasonable floods, which severely damaged public works, irrigation, agriculture, and personal property. The floods also cause bank erosion and scouring which lead to the change of its river course and width. The inundation are caused due to the storm surge by typhoons, overbank flow of the Agos River, and insufficient drainage capacity and drainage system of the municipality areas.

### I2.2 Major Typhoon Records

According to the records of PAGASA on the major typhoons in the Philippines, there were 28 typhoons that hit Infanta and General Nakar in the past 27 years. The typhoon with recorded maximum 24-hr rainfall is Typhoon Kading in 1978.

The record of major typhoons is listed in Table 3.7 of Volume II.

### I2.3 Present Condition

#### I2.3.1 Land Use

The land use of the lower Agos River basin was confirmed from the satellite image map, aerial photographs, data from municipality offices, and through the field reconnaissance. The rice paddy, coconut field, and built-up areas are identified as major land uses in the low-flat land of Infant and General Nakar as shown in Figure I2.1.

#### I2.3.2 River Morphology

The Infanta Peninsula lies in the lower Agos where the town propers of Infanta and General Nakar municipalities are located. Based on the topographical and geological data, it is assumed that the Infanta Peninsula is an alluvial fan which was formed with the sediment deposite from the Agos River Basin. Usually, a river runs in the alluvial fan changes its stream course from time to time and has unstable river bank.

To examine the changes of the river course and width, the aerial photographs taken in 1951, 1966, 1995, and 2002 were compared as illustrated in Figure I2.2. The orange shades in the Figure indicate the land which has been eroded. Based on the comparison, the following observations were made:

- The shape of the Agos River mouth has been drastically changed.
- Due to the change of flow direction, a right river bank in Barangay Ilog, Infanta, has been eroded and left bank has been extended; in contrast, the lower area of left bank near the town proper area of General Nakar has been eroded.
- The natural levee (mound) is created along the right bank of Agos River in Barangay Ilog, Infanta.
- Presently, the river has a tendency to become meander which results in heavy bank erosion.

I2.3.3 Flood Damage Survey

The flood damage survey for the lower Agos was conducted in June 2001 and August 2002 covering municipalities of Infanta and General Nakar. The collected flood damage records of Infanta and General Nakar municipalities are shown in Table 3.8 of Volume II.

(1) Municipality of Infanta

There are seven (7) Barangays suffering from inundation due mainly to the storm rainfall coupled with high tide, namely Barangay Ilog, Barangay Bantilan, Barangay Katambungan, Barangay Pinaglapatan, Barangay Boboain, Barangay Poblacion 38, and Barangay Poblacion 39. The result of survey is shown in Table 3.9 of Volume II. These Barangays usually experience 60-90 centimeter high inundation due to flooding every year. On the other hand, Barangay Banugao was reported as a flood free area. During the floods, Barangay halls, church, schools, and neighbors are used for evacuation centers. The most serious inundation was experienced in October 1989 (Typhoon Rosing). Due to the Typhoon Rosing, the inundation was approximately 1.2 meter high. Based on the hearing, the duration of inundation is estimated at approximately 4 to 8 hours, depending on the location of the Barangays. When the tidal level lowered, the inundation subsided. There is also a possibility that the flood water from the Agos River may intrude from the irrigation intake in Barangay Banugao or spilled out to the irrigation canal. Most likely, the inundation is composed of flood from the Agos River coupled with high tide. Some part of the municipality has constructed and maintained the drainage channels which are connected to the Bantilan River to improve the drainage condition. Several Barangay captains emphasized the necessity of measures for bank erosion of the Agos River. Due to the erosion, the river stream courses change every five years. Recently, the river shape has changed from narrow to wide.

The calamity fund (approximately PHP 12,000), relief goods, and medicine are given to each Barangay.

The following requested were learned during the survey:

a) Dredging of the riverbed of the Agos River to increase the flow capacity;

b) Construction of drainage canals from town proper to the sea;

c) Completion of the retaining wall along the Agos River.

(2) Municipality of General Nakar

The Poblacion area and Barangay Banglos in General Nakar have been suffering from inundation occasionally. The erosion of the river bank near the town proper area is the imminent problem as well. Previously, the municipal office (town proper) is very far from the river bank, but due to the massive erosion, the town proper becomes just 200 meters from the river bank and the river width is widened. The Barangay captains were requesting to implement the bank protection works to prevent further bank erosions and loss of lands.

I2.3.4 Existing Flood Control and Drainage Facilities

(1) Municipality of Infanta

The grout riprapping are constructed along the Agos River in Barangay Ilog as well as along the Bantilan River in Barangay Bobain, Poblacion 38, and Barangay Bantilan. The municipality of Infanta has proposed the DPWH to provide the concrete retaining wall starting from the downstream site of the bridge construction in Barangay Banugao to the river mouth. While, the municipality has already completed a part of the retaining wall in Barangay Ilog where bank erosion is severe. The municipality is now looking for funds to complete the whole part. The municipality office strongly hopes to formulate the flood control plan on a comprehensive basis and to design the flood control works based on the flood control plan.

(2) Municipality of General Nakar

The construction of retaining wall is going on to prevent the further river bank erosion in the Poblacion area of General Nakar. The length of retaining wall is approximately 100 meters as of August 2002. The drain ditch is also provided in the Poblacion area.

## I2.4 Hydraulic Analysis

I2.4.1 Carrying Flow Capacity of the Lower Agos

The carrying flow capacity of the Agos River is examined by non-uniform flow analysis with the river cross sections surveyed in June 2002 as well as the tidal level of EL. 1.99 m which is the highest tidal level recorded in Real, Quezon, the nearest tidal level recording station. The result shows that the lower Agos is capable to sustain 2-3 year probable flood.

I2.4.2 Drainage System of Infanta

The result of above hydraulic analysis explains that the municipality of Infanta is less likely to be innundated by overbanking of flood water; however, the inundation was reported in the flood damage survey. During the field reconnaissance, the Bantilan River, catchment area of approximately 10 $km^2$, was identified as an only drainage which also covers the catchment area of Infanta town proper area. The major drainage system of Infanta is shown in Figure I2.3. Considering that Infanta has 5-years return period rainfall of 244.3 mm and 10-years return period rainfall of 279.6 mm, the flow capacity of the Bantilan River and its tributaries are not enough to drain the rainfall in the area, and as a result, inundation occurs every year. The overflow from the Bantilan River is assuemd to be one of the causes which results in the inundation of the town proper area as well as its neibor Barangays. There are two irrigation canals which flow toward the town proper area and join with the Bantilan River. It seems that these irrigation drainage canal also worsen the inundation. The overall drainage system of Infanta needs to be reviewed in accordance with its catchment area and drainage capacity.

I2.4.3 Characteristics of Flood in Lower Agos River Basin

Based on the review of existing data and site reconnaissance, the characteristics of flood in low-flat area of Infanta and General Nakar municipalities are explained as follows:

- Overbank flow of the Agos River during the high tide, particularly in General Nakar
- Insufficient capacity of drainage canals especially the Bantilan River
- Inefficient drainage capacity and system (irrigation drains / supply canals)
- Location of the town proper area with ground elevation of 4.5 to 6.0 m in General Nakar and 7.5 to 11.0 m in Infanta

## I2.5 Proposed Flood Control and Drainage Improvement Works

The proposed projects in the lower Agos are categorized in three components: (1) river bank protection works, (2) flood control works, and (3) drainage improvement works. The proposed structure measures in the lower Agos are described in Figure I2.4.

I2.5.1 River Bank Protection Works

The bank erosion in Barangay Ilog, Infanta, and Poblacion, General Nakar, is serious issue to be considered, especially for those areas in General Nakar. The urgent project implementation in General Nakar is strongly recommended since the town proper area is close to the current river bank. The municipality of General Nakar has already begun the construction of retaining wall to protect from further erosion in some areas, so the wall should be extended to the downstream site. In addition to the retaining wall, the gabion spur dikes are recommended to be constructed to reduce the bank erosion and stabilize the river stream course. A

pilot project should be programmed for certain period to examine the effectiveness of the spur dikes. Additional spur dikes will then be installed after the confirmation of their effectiveness. The typical plan and section of the proposed structures are shown in Figure I2.5. The construction of spur dike will sometime lead to the erosion on the opposite river bank; therefore, the river banks should be monitored and surveyed until such time that the river course is stabilized. The retaining wall in Barangay Ilog is also proposed to prevent from the bank erosion.

Proposed Structure Measures

The proposed structure measures for bank protection and stream course stabilization are as follow:

**Proposed Bank Protection Works**

| Place | Proposed Work | Length |
|---|---|---|
| Town Proper of General Nakar | Boulder masonry revetment work with gabion spur dykes | 900 m |
| Barangay Ilog, Infanta | Boulder masonry revetment work | 900 m |

## I2.5.2 Flood Control Works

A 10-year probable flood is adopted for the formulation of the flood damage mitigation plan in the lower Agos with reference to the flood protection levels applied to other flood control projects in the Philippines. The discharge of 10-year probable flood for the lower Agos is estimated at 3,530 $m^3$/sec through the hydrological analysis. With above conditions, the water level of lower Agos is computed. The longitudinal river profile is illustrated in Figure I2.6. As a result of the analysis, the flood prone area due to overbank flow of the Agos River is estimated as shown in Figure I2.7. The result indicates that the municipality of General Nakar is likely to suffer from the floods of the Agos River. On the contrary, the municipality of Infanta experiences floods in the limited area since most of the area is protected by natural levee.

Therefore, the flood protection dike is proposed on the General Nakar side of the Agos River. To reduce the relocation houses and land acquisition cost, a total length of dike is minimized. The proposed alignment of earth dike is shown in Figure I2.4. Based on the non-uniform flow analysis, the height of the earth dike is estimated to be approximately 2 meters. The new Barangay road is also proposed for the evacuation purpose during the flood period.

Proposed Structure Measures

The proposed flood control structures are as follow:

**Proposed Flood Damage Mitigation Work**

| Place | Proposed Work | Length |
|---|---|---|
| General Nakar | Flood Protection Dike<br>New Barangay Road | 1,300 m<br>400 m |

### I2.5.3 Drainage Improvement Works

The town proper area of Infanta experiences the inundation from time to time due to insufficient flow capacity of drainage canals and appropriate drainage system. Presently, the flow capacity of the Bantilan River is computed as 10 to 45 $m^3$/sec. On the other hand, the actual flow discharge of the Bantilan River is estimated to be 50 to 70 $m^3$/sec. Therefore, the drainage improvement work of Bantilan River and its tributaries is strongly recommended. In addition, the new drainage channel is proposed in the southern part of Infanta to accelerate the inundation subsidence and to drain the rainfall to the southern area and not to the town proper area.

Proposed Structure Measures

The proposed structures for drainage improvement are as follow:

**Proposed Infanta Drainage Improvement Works**

| Place | Proposed Work | Quantity |
|---|---|---|
| Infanta | Improvement of the Bantilan River (Open Canal with wet masonry revetment, 15-30m x 1.5m) | 2,500 m |
| | Improvement of Town Drainage Facilities (15 ha) | 15 ha |
| | Improvement of a Southern Drainage Canal (Earth-excavated Channel, 3m x 1m) | 1,000 m |

### I2.5.4 Flood Peak Reduction by Agos Dam

The construction of Agos Dam will not improve the flood condition in the lower Agos since the dam is not constructed for the flood control purpose. The outflow discharge from the dam may decrease from 2,582$m^3$/sec to 2,236$m^3$/sec for 5-year probable flood and 3,438$m^3$/sec to 3,408$m^3$/sec for 10-year probable flood. There will be only slight effectiveness in terms of flood control.

### I2.5.5 Other Proposal

Periodic Monitoring

To maintain the sustainable flood control plan of the lower Agos, the municipality offices should be responsible for the following arrangements:

- Collection and organization of the flood damage data, and
- Periodic monitoring of river stream course and river bank erosion.

Dredging of the riverbed

During the field investigation work, some local residents were requesting to dredge the Agos River to increase its river flow capacity. The dredging will increase the flow area and will improve the flow capacity of the river. The dredging seems attractive measure for flood control; however, considering that the lower Agos River has a steep riverbed, the dredging may not be suitable for a long-lasting measure of flood control. In the next detailed design stage, the further examination must be undertaken to confirm its effectiveness.

## I2.6 Project Cost Estimate and Project Evaluation

### I2.6.1 Project Cost Estimate

The project costs for river bank protection, flood control, and drainage improvement are estimated at US$ 420,000, US$ 330,300, and US$ 2,420,000, respectively. The project costs are summarized in the following table:

**Summary of Project Costs**

(Unit: US$)

| Project Name | Project Cost |
|---|---|
| River Bank Protection | |
| Infanta | 150,000 |
| General Nakar | 270,000 |
| Flood Control | |
| General Nakar | 330,000 |
| Drainage Improvement | |
| Infanta (Bantilan River) | 670,000 |
| Infnata (Town Proper Area) | 1,600,000 |
| Infanta (Southern Infanta) | 150,000 |

### I2.6.2 Project Benefit

The project benefit for bank protection works are tentatively estimated based on the present selling/buying land value. The result is shown below:

**Annual Benefit for Bank Protection Works**

| | Total Eroded Area in 1996-2002 ($m^2$) | Annual Eroded Area ($m^2$/year) | Unit Price of Land (PHP/$m^2$) | Annual Benefit Total (PHP) |
|---|---|---|---|---|
| Infanta | 193,966 | 5,242 | 26.9 (1) | 298,288 |
| General Nakar | 972,208 | 26,276 | 86.5 (2) | 3,061,141 |

Notes: (1) Assuming that the land use of Infanta is 50% agriculture land, 10% residential area, and 40% grassland.
(2) Assuming that the land use of General Nakar is 40% agricultural land, 20% residential area, 10% commercial area, and 30% grassland.

The economic internal rate of return (EIRR) of the project is estimated at 4.4% for Infanta and 17.6% for General Nakar.

## I3 Projects Proposed for Supporting Regional Socio-Economic Activities

### I3.1 Provision of River Water Use Facility

Once the Agos Dam is completed, the riverine environment of the reaches downstream from the Agos Dam will change significantly. Particularly, change in water level condition gives direct impacts on the people's use of the river. The following changes in flow conditions are projected:

(a) Agos Power Plant will release 25.6 $m^3$/sec of water in terms of daily average (at the stage of water abstraction of 3,000 MLD for supply to Metro Manila). This flow rate roughly corresponds to 95 % discharge under current natural condition. However, the release from the power plant varies from 15.7 $m^3$/sec to 55.4 $m^3$/sec depending on the operation of the power plant. This causes the daily fluctuation of river water levels, which is roughly estimated to be 1 m. Although the extent of fluctuation is not so large, it may give inconveniences in river water use by local people along the river.

(b) Agos Dam traps most of sediment yields from the upstream basins. This may cause the degradation of riverbed levels over a long term and accordingly the lowering of river water levels.

For removing the people's inconvenience caused by such change of river water levels, it is proposed to provide a river bank structure for facilitating the people's use of the river, such as navigation, bathing and washing, at the place where people use the river. The proposed structure is a stairway type of riverbank revetment work, which would be usable at any river water levels for boat landing, bathing and washing.

The facility will be provided at 21 places located along the river stretch of 20 km between Agos Dam and Infanta-General Nakar. Figure I3.1 shows the location of the proposed works with a typical section of the riverbank structure.

### I3.2 Provision of Access Roads/Footpaths for the Communities

The proposed Agos Reservoir, once impounded, will disconnect the existing traffic paths presently used by people in the area. To compensate this, the project will provide several compensation measures. The proposed facilities are shown in Figure I3.2 and described below.

#### I3.2.1 Access Road to Resettlement Sites

Resettlement scheme for the Agos Dam contemplates the relocation of affected settlements to two (2) new resettlement sites as shown in Figure I3.2. The project will provide access to those new resettlement sites by extending a road from the access roads built for the construction works. Access to the Resettlement Site No.2 is via a non-vehicle road on the left bank. The road is a macadam-paved one-lane road. The length is tentatively estimated at 14 km.

I3.2.2 Footpaths

In addition to access facilities to the settlement sites, a trunk footpath connecting Agos Dam, Kaliwa Low Dam and Barangay Daraitan will be built. A footpath will also be provided along the Kanan River. These footpaths will facilitate the people's access to shops, schools, medical facilities and other public facilities located at Barangay Daraitan and Barangay Magsaysay. Total length of the footpaths is estimated at some 30 km.

I3.2.3 Reservoir Crossing Facility

At the locations where local people have to cross the reservoir, a boat landing facility will be provided at 6 locations, including the one near the Agos Dam site to facilitate the people's traffic from and to the upstream area. The proposed locations are shown in Figure I3.2.

The boat landing facility is a sloped masonry concrete structure similar to the riverbank structure shown in Figure I3.1. It extends from the MOL up to the FSL in elevation and the width is 2 m.

I3.2.4 Access to Barangay Daraitan

The upstream end of the Agos Reservoir reaches close to the Barangay Daraitan villave proper. When the reservoir water level is lower than the Full Supply Level (FSL at EL.159 m), the river condition is unchanged from the present. However, the reservoir raises the river water level by about 2 m when the reservoir is at its FSL. This makes the access by vehicle a little difficult, where presently vehicles can cross the shallow part of river in the dry season.

To provide a permanent access measure to the village, construction of an access road (2 km) with two bridges (70m+80m) is planned at this study stage. The proposed alignment of access road and bridges is shown in Figure I3.3.

## I3.3 Flood Protection Bund for Barangay Daraitan

It is foreseen that flood water levels at the Barangay Daraitan would become slightly higher than the present levels due to backwater effect when the reservoir water level is at FSL. This suggests the provision of a flood protection bund along the perimeter of the village on the left bank.

Under the present condition, the low-lying area of village appears to be a habitual flooding area being subject to inundation during high flow period. The flood protection bund will contribute to alleviate the habitual flooding in the low-lying area. Drainage of the inner land will be by gravity through drainage sluices. Figure I3.3 shows a preliminary layout plan of the flood protection bund.

## I3.4 Establishment of a Manpower Training Center

Some of the project affected families (PAFs) will have to change their occupation due mainly to resettlement outside the present livelihood area, though the relocation is within the same Barangay. As a program of supporting the sustainable livelihood

of those affected people, a manpower training center will be established at a place where the people prefers (e.g. Barangay Daraitan, Agos Damsite or a new resettlement site). The center will be operated by the project during the construction period and later transferred to the municipalities concerned after the construction works.

The subjects of manpower training would depend on what skills the local people would like to acquire for earning their living. It is supposed that the skills for woodworking, inland fishery, citrus farming, woodcrafts and rattan crafts may be the vocational subjects fitting the economy around the area. Local people expressed at the public consultation that they are interested in acquiring the construction-related skills so that they could be employed in the project construction works.

## I3.5 Establishment of a Health Center

Barangay Daraitan is a core village in the project-affected area. In Barangay Daraitan, there are at present two health centers staffed by a nurse and a midwife, the latter coming once a week. The center is less than the quality level required for a medical facility for the area having about 4,000 populations covering the surrounding area. The proposed work is to build a new health center with the minimum required equipment and being staffed by a physician, a nurse and a mid-wife. The new center will be located either at Barangay Daraitan or a new resettlement site.

The health center will be operated by the project during the construction period and later transferred to the municipality concerned.

## I3.6 Cost Estimate

Table I3.1 shows a preliminary estimate of costs required for the above proposed works. Total cost is estimated roughly to be US$ 5.0 million equivalent or Peso 260 million equivalent. The quantities assumed in the estimate should be further refined during the detailed design.

## I4 River Maintenance Discharge

One of the concerns raised by the people at the public consultation and workshop was whether the Agos Dam would release an appropriate quantity of river maintenance discharge to the downstream. In this respect, the Study preliminarily looked into the rate of minimum flow to be secured in the downstream reaches. The concepts given herein will have to be explained to the local people concerned accordingly in the subsequent public consultations.

### I4.1 Minimum Flow Assumed in Hydrological Study

In assessing the water resources development potential at various sites, hydrological study placed a criterion that the minimum flow to be released downstream should be not less than 10 % of the '80% discharge'. This criterion originally comes from an earlier study made by an engineer of NWRB and has been adopted in previous studies. According to a hydrological static book available at NWRB, the '80% discharge' almost equals to the average flow of the rivers in the Philippines.

Note: '80% Discharge' means the lowest flow rate that would be assured for 80% period of the total duration.

On a basis of applying this criterion, the minimum release from the Agos Dam is calculated as 4.35 $m^3$/sec. Under this condition, the flow at Banugao is roughly estimated at 4.8 $m^3$/sec by applying the ratio of catchment areas between Agos Damsite (858 $km^2$) and Banugao (940 $km^2$). This corresponds roughly to a specific discharge rate of 0.5 $m^3$/sec per 100 $km^2$ of catchment area.

Flow duration curve at the Agos Damsite is shown in Figure C3.1 in Annex-C. The Figure indicates that the 50% discharge is 85.27 $m^3$/sec, 80% discharge 43.45 $m^3$/sec, 90% discharge 30.24 $m^3$/sec, 95% discharge 23.64 $m^3$/sec, respectively. The average flow is 113.3 $m^3$/sec.

### I4.2 Discharge Released from the Proposed Agos Dam

At the final stage of water supply project around year 2025, Agos Reservoir will deliver the water to Metro Manila at the rate of 3,000 MLD or 34.7 $m^3$/sec. The total volume corresponds to 30 % of the total runoff yield.

The release to downstream reach is through a power plant of 51.5 MW in installed capacity. The daily average release is 25.6 $m^3$/sec, but the actual release varies in a range from 15.7 $m^3$/sec to 55.4 $m^3$/sec depending on power generation mode. This indicates the average discharge in the downstream reach almost equals to the present 95% discharge and the minimum flow is more than the rate assumed in Section I4.1 above.

### I4.3 River Conditions in the Agos Lower Reach

The minimum flow rate assumed in Section I4.1 is based on a general criterion commonly applicable to various rivers. The condition is, however, different in each

river. In a strict term, the minimum flow should be assessed for each specific river. In this respect, the conditions of the Agos downstream reach were looked into from the following viewpoints:

(1) People's River Use

Reduced flow in the dry seasons would cause the lowering of river water level. Figure I4.1 shows the profile of riverbed and water levels in the reach between the river mouth and Agos Damsite. The Figure indicates that the lowering of water level is not so significant in a range of low flows of less than 50 $m^3$/sec.

Nevertheless, the change of river flow regime will give a varying nature of impacts to the daily river use by the people. Hence, a countermeasure described in Section I3.1 has been proposed (provision of riverbank revetment structure). This would solve most of the inconveniences related to the people's river water use.

In the case a specific need of raising the water level should arise at particular sites, a possible countermeasure would be to construct a groundsill across the riverbed. The groundsill is not a costly work.

Hence, this aspect would not be a decisive factor of determining the minimum flow rate.

(2) Lowering of Riverbed Levels

Agos downstream reach has a relatively steep gradient of 1/500. However, the riverbed is generally hard, being surfaced by boulders and coarse gravel. It is presumed that the degradation of the riverbed would not take place at a fast rate.

Nevertheless, in the case of occurrence of the degradation at particular locations (e.g. irrigation intake sites), the construction of a groundsill proposed in (1) above would be an effective measure. The reduced flow condition can be overcome by this measure.

(3) Navigation

Owing mainly to steep gradient of the water surface with many rapids, in general, there is no active navigation along the river. Hence, the reduced dry season flow would give only a minimal impact to this river use.

According to the EIA, some people stated the difficulty of navigation during the low flow period. This is presumed to be a condition at particular sites and could be overcome by providing a countermeasure by groundsill.

Transportation of wood logs on the water surfaces would become almost impossible due to shallow water depths at increased number of rapids. It should be substituted by the transportation on land. Since most of logs currently transported seem to come from illegal logging, there is no reason for augmenting the minimum flow from this viewpoint.

(4) Riverine Fishery

There is no active fishery activities of notable commercial value in the Agos downstream reach. Nevertheless, EIA found that about 38 % of households are engaged in fishery activity for family consumption purpose. Although the actual impact of reduced dry season flow on this fishery production is difficult to predict at the present, it is supposed to be of a minimal extent since the Agos Dam releases 25.6 $m^3$/sec under the normal condition. This flow, equivalent to 95% discharge under the present natural condition, would maintain the minimum flow regime not different so much from the present condition.

A practical approach to this issue would be to monitor the actual impacts arising in the future stage. Should any adverse effect arise, a possible measure will be the artificial conservation of fishing places at selected locations by providing a measure for increasing the river water depths adequate for living of fishes (e.g. by provision of groundsill or submerged weir).

(5) Riverine Scenery and Ecology

In the Agos downstream reach, there seem no particular scenic places requiring the increase of river water flow.

Reduction of the dry season flow will give a certain extent of impacts on fauna and flora in and along the river course. EIA identified, however, no specific species to be protected by increasing the flow.

(6) Downstream Water Demand

Irrigation is the major water user in the Agos downstream reach. Groundwater is the source for domestic water and its potential is estimated to be more than enough to meet the future demand increase. Notable industrial water demand is not foreseen at present.

Infanta Irrigation Project under management of NIA envisages irrigating 1,400 ha, of which some 1,200 ha has already been developed. NIA holds the water right of 2.25 $m^3$/sec for the project. In General Nakar, there are some 300 ha of paddy land, of which only a partial area is irrigated by pump-up of groundwater. Besides these areas, a very rough estimate on 1:5,000 maps indicates that there is an additional 1,000 ha of potential irrigable area in the Infanta plain. Also, there is about 100 ha of the existing agricultural land along the river valley between Agos Damsite and Infanta plain. Hence, the gross potential area for irrigation is roughly estimated as 2,800 ha (1,400+300+1,000+100).

Diversion requirement for this 2,800 ha is estimated as 4.5 $m^3$/sec, including 2.25 $m^3$/sec for the existing Infanta Irrigation Project. This 4.5 $m^3$/sec is regarded as the maximum potential water demand in the Agos downstream areas in the future. Agos Dam should assure to release water enough for meeting this potential water demand.

(7) Salt Water Intrusion

The length of salt tongue is supposed to be 2 to 3 km from the river mouth under the present condition. Even under the reduced discharge condition, it would not reach the 4-km point, judging from the existence of rapids just upstream of General Nakar town proper. Release of 25.6 $m^3$/sec from the Agos Dam would maintain this present condition. These should be confirmed by in-situ investigation at the stage of the next detailed design.

Under an extreme condition of no discharge from the upstream and highest spring tide level, salt tongue could theoretically reach the 5.5-km point near to the newly constructed highway bridge site at Banugao (See Figure I4.1). However, this would not cause serious problems since there is no notable water abstraction in this reach. The existing irrigation intake, situated at a further 1-km upstream point, would not be affected even under the extreme condition.

The above infers that there is no serious factor of requiring extra discharge for prevention of saltwater intrusion.

## I4.4 Factors for Determining the River Maintenance Discharge

Assessing overall the factors described in Section I4.3 above, this Study proposes to adopt the following concepts for determining the minimum flow to be released from the Agos Reservoir:

(a) A basic requirement in the lower Agos area is to secure the discharge enough to meet the future potential water demand, which is estimated at 4.5 $m^3$/sec. In this case, the minimum release from the Agos Dam is 4.35 $m^3$/sec as assessed in Section I4.1. River flow available at Banugao is 4.8 $m^3$/sec, which is more than the required discharge of 4.5 $m^3$/sec.

(b) Water to the downstream reach is released through the Agos power plant, which is equipped with two (2) units of turbines. A basic requirement for the power plant is the assurance of release of minimum flow on a 24-hour basis. On one hand, the minimum turbinable flow through a turbine is 40 % of the turbine design discharge. The latter being 11.1 $m^3$/sec per turbine, the minimum release from the power plant is 15.7 $m^3$/sec, which is more than the minimum flow required in (a) above.

(c) The case (b) above is an exceptional case, which would not occur under normal conditions. The power plant is normally operated with discharges ranging from 15.7 $m^3$/sec (base load operation) to 55.4 $m^3$/sec (peak load operation) by 2 units. Hence, normal minimum release is 15.7 $m^3$/sec. Average daily discharge is 25.6 $m^3$/sec.

Note: This represents the condition at the ultimate stage of water supply project (supply of 3,000 MLD to Metro Manila) in Year 2025 onward. Before 2025, more water is available for power generation and hence the minimum release from the plant is more than the above.

(d) In the case of shutdown of the power plant in emergency cases (such as trouble on transmission system), the minimum flow of 4.35 $m^3$/sec would be released from the river outlet work. Alternatively, the need of provision of a bypass valve for this specific purpose would be examined at the time of detailed design of the powerhouse, if so required by the people.

## I4.5 Proposed River Maintenance Discharge

The results of assessment stated above are summarized below:

(a) Agos Dam will release the minimum discharge of 4.35 $m^3$/sec under any extreme conditions. This will suffice the long-term water demand in the downstream area.

(b) Actually, the release from the Agos Dam will be in the range of 15.7 $m^3$/sec and 55.4 $m^3$/sec, where daily average flow is 25.6 $m^3$/sec during the dry season.

(c) Flow regime during the flood season will remain unchanged from the present.

(d) In quantitative term, the allocated use of water resources is 70 % for the Agos River basin and 30 % for water supply to Metro Manila, respectively.

The above shall be explained to the LGUs and people in the Agos Lower Reach accordingly.

# *Tables*

## Table I3.1 Projects for Regional Development - Cost Estimate (1/2)

(Unit: US$ equiv.)

| Work Item | Unit | Quantity | Unit Price | Amount | Remarks |
|---|---|---|---|---|---|
| **R-1: Provision of River Bank Facilities for Facilitationg Use of River** | | | | **221,760** | At 14 Sitios |
| a Construction | | | | 221,760 | |
| - Detailed Design (by local consultants) | LS | | | 20,000 | |
| - Excavation | m3 | 1,600 | 3 | 4,800 | 0.5m x 15m x 10m x 21 |
| - Stone Masonry Work | m3 | 3,200 | 50 | 160,000 | 1.0m x 15m x 10m x 21 |
| - Miscellaneous Compensation 20% | LS | | | 36,960 | |
| b Land Acquision | | | | 0 | |
| - Acquisition of Land | ha | 0 | | 0 | River area |
| - Miscellaneous Compensation 20% | LS | | | 0 | |
| **R-2: Construction of Access Roads/Foot Paths/Flood Bund for Enhancement of Community Economic Activities** | | | | | |
| 1 **Access Road and Bridges at Daraitan** | | | | **685,200** | |
| a Construction | | | | 670,800 | |
| - Detailed Design (by local consultants) | LS | | | 100,000 | |
| - Acess Road | km | 1.5 | 200,000 | 300,000 | W=4.5m |
| - Bridge No.1 (Bailey Type) | m2 | 250 | 300 | 75,000 | W=4.5m, L=70 m |
| - Bridge No.2 (Bailey Type) | m2 | 280 | 300 | 84,000 | W=4.5m, L=80 m |
| - Miscellaneous Compensation 20% | LS | | | 111,800 | |
| b Land Acquision | | | | 14,400 | |
| - Acquisition of Land | ha | 3 | 4,000 | 12,000 | 20mx1500m, Peso 20/$m^2$ |
| - Miscellaneous Compensation 20% | LS | | | 2,400 | |
| 2 **Flood Protection Bund for Daraitan L=1,400m** | | | | **469,740** | |
| a Construction Works | | | | 457,740 | |
| - Detailed Design (by local consultants) | LS | | | 30,000 | |
| - Top Soil Grabbing | m3 | 5,500 | 1 | 2,750 | 13mx0.3mx1400m |
| - Eearth Embankment | m3 | 42,000 | 5 | 210,000 | (4m+13m)/2x3.5x1400 |
| - Stone Masonry Facing | m3 | 2,300 | 50 | 115,000 | 5.4mx0.3mx1400m |
| - Sod Facing | m2 | 7,600 | 2 | 15,200 | 5.4mx1400m |
| - Gravel Pavement | m3 | 1,700 | 5 | 8,500 | 4mx0.3mx1400m |
| - Miscellaneous works 20% | LS | | | 76,290 | |
| b Land Acquision | | | | 12,000 | |
| - Acquisition of Land | ha | 3 | 4,000 | 10,000 | 18mx1400m, Peso 20/$m^2$ |
| - Miscellaneous Compensation 20% | LS | | | 2,000 | |
| 3 **Acess Roads and Fottpaths around Reservoir Area** | | | | **3,288,000** | |
| a Construction Works | | | | 3,144,000 | |
| - Detailed Design (by local consultants) | LS | | | 50,000 | |
| - New Roads to Resettlement Site No.1 | km | 7 | 200,000 | 1,400,000 | W=4.5m |
| - New Roads to Resettlement Site No.2 | km | 7 | 150,000 | 1,050,000 | W=3m |
| - Foot Paths | km | 30 | 4,000 | 120,000 | |
| - Miscellaneous works 20% | LS | | | 524,000 | |
| b Land Acquision | | | | 144,000 | |
| - Acquisition of Land for Roads | ha | 30 | 4,000 | 120,000 | 20mx15km, Peso 20/$m^2$ |
| - Miscellaneous Compensation 20% | LS | | | 24,000 | |

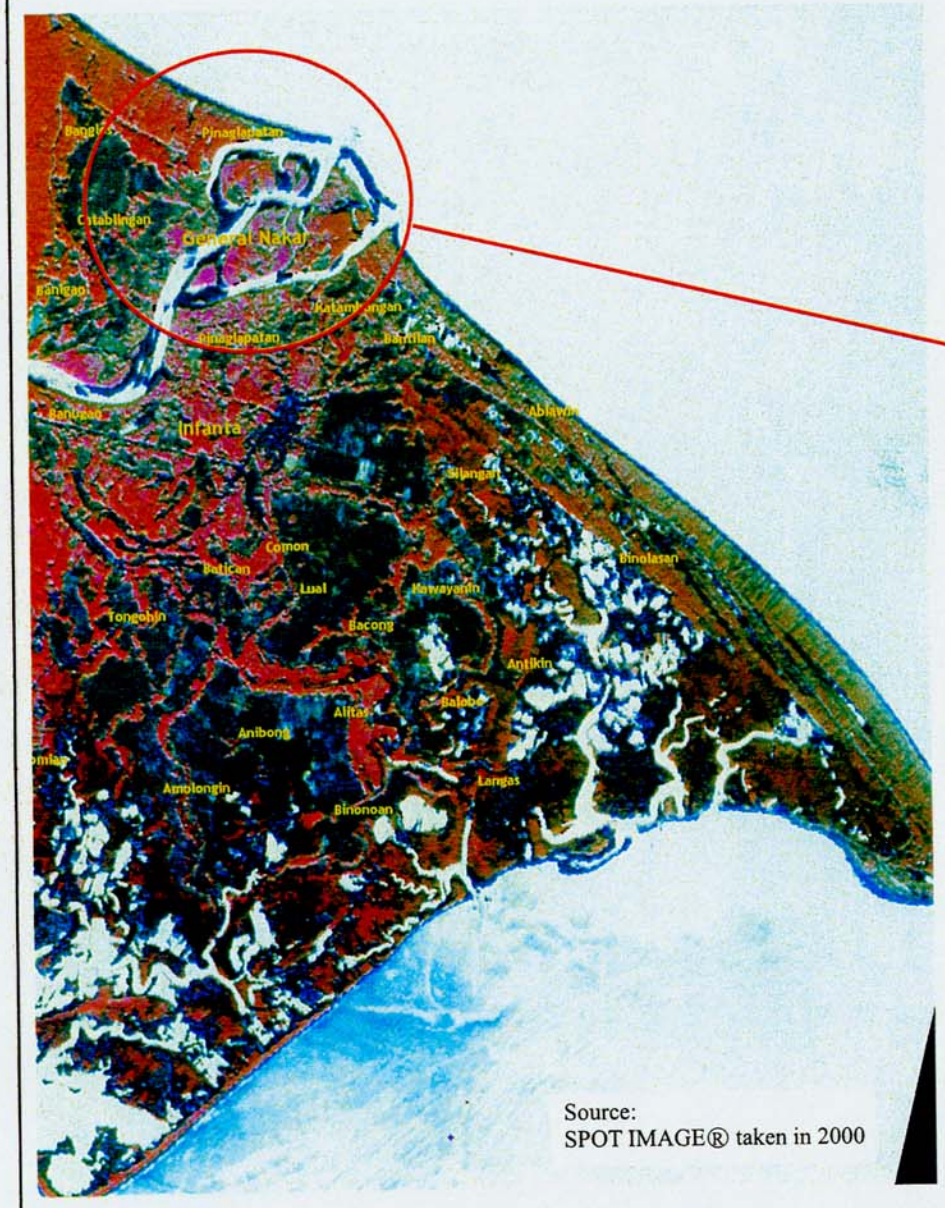
## Table I3.1 Projects for Regional Development - Cost Estimate (2/2)

(Unit: US$ equiv.)

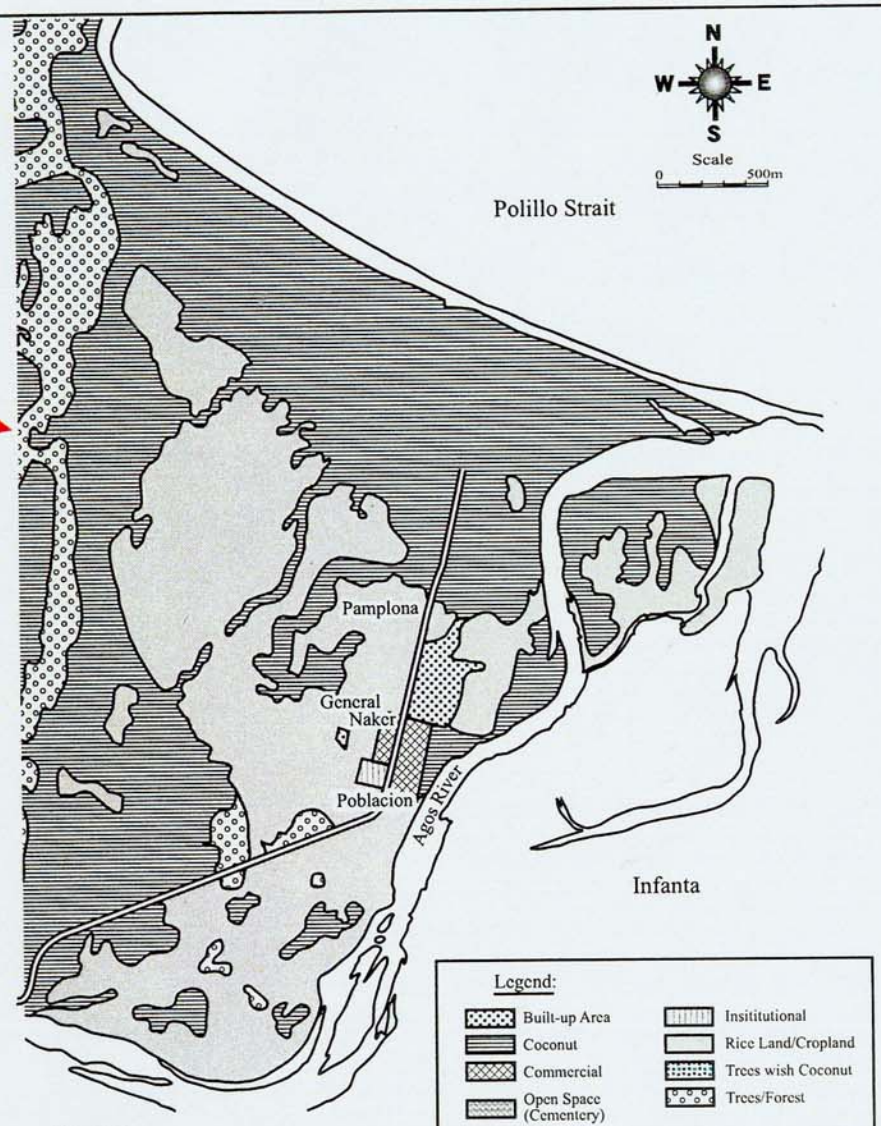
| Work Item | Unit | Quantity | Unit Price | Amount | Remarks |
|---|---|---|---|---|---|
| **4 Construction of Boat Landing Places in Reservoir Area** | | | | **131,840** | 10 places incl.2 at Damsite |
| a Construction Works | | | | 129,840 | |
| - Detailed Design (by local consultants) | LS | | | 20,000 | |
| - Excavation | m3 | 2,100 | 2 | 4,200 | 0.5m x 70m x 3m x 10 x 2 |
| - Stone Masonry Platform | m3 | 2,100 | 40 | 84,000 | 0.5m x 70m x 3m x 10 x 2 |
| - Miscellaneous Compensation 20% | LS | | | 21,640 | |
| b Land Acquision | | | | 0 | |
| - Acquisition of Land for Roads | ha | 0 | | 0 | Acquired for Reservoir |
| - Miscellaneous Compensation 20% | LS | | | 0 | |
| c Supply of Boats | | | | 2,000 | |
| - Supply of Boats | No. | 10 | 200 | 2,000 | Peso 10,000/boat |
| **R-3: Establishment of a Manpower Training Center** | | | | **117,280** | |
| a Construction | | | | 103,680 | |
| - Detailed Design (by local consultants) | LS | | | 30,000 | |
| - Area grading | m2 | 5,000 | 1 | 5,000 | 50mx100m |
| - Building | m2 | 300 | 140 | 42,000 | Peso 7,000/$m^2$ |
| - Outdoor Facilities | LS | | | 9,400 | 20% |
| - Miscellaneous Works 20% | LS | | | 17,280 | |
| b Land Acquision | | | | 3,600 | |
| - Acquisition of Land | ha | 1 | 6,000 | 3,000 | Peso 30/$m^2$ |
| - Miscellaneous Compensation 20% | LS | | | 600 | |
| c Supply of Equipment | | | | 10,000 | |
| - Supply of Equipment | LS | | | 10,000 | |
| **R-4: Establishment of a Health Center** | | | | **72,392** | |
| a Construction | | | | 66,528 | |
| - Detailed Design (by local consultants) | LS | | | 30,000 | |
| - Area grading | m2 | 1,200 | 1 | 1,200 | 30mx40m |
| - Building | m2 | 100 | 200 | 20,000 | Peso 10,000/$m^2$ |
| - Outdoor Facilities | LS | | | 4,240 | 20% |
| - Miscellaneous Works 20% | LS | | | 11,088 | |
| b Land Acquision | | | | 864 | |
| - Acquisition of Land | ha | 0 | 6,000 | 720 | Peso 30/$m^2$ |
| - Miscellaneous Compensation 20% | LS | | | 144 | |
| c Supply of Equipment | | | | 5,000 | |
| - Supply of Equipment | LS | | | 5,000 | |
| Grand Total | | | | 4,986,212 | |

Note: The above estimete is preliminary, subject to refinement in the detailed design stage.

# *Figures*

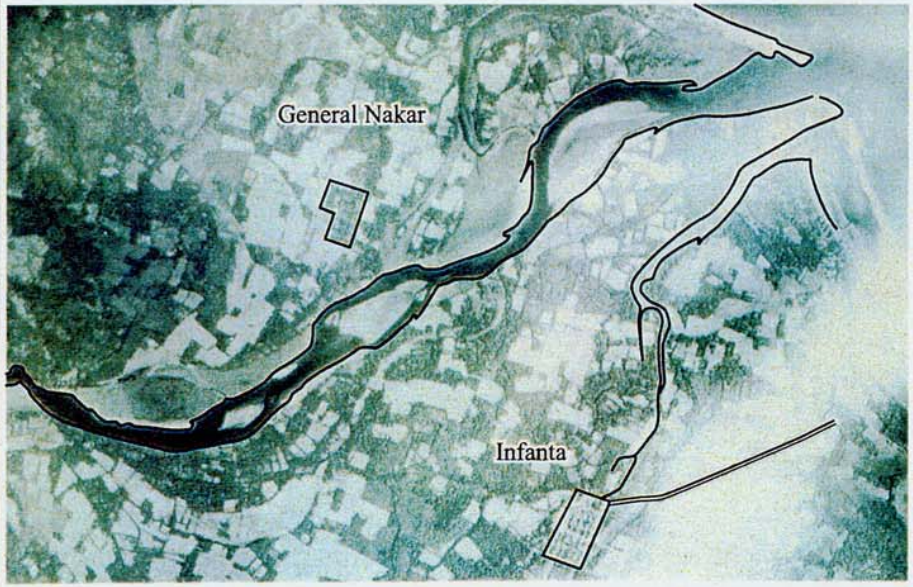



Source:
SPOT IMAGE® taken in 2000

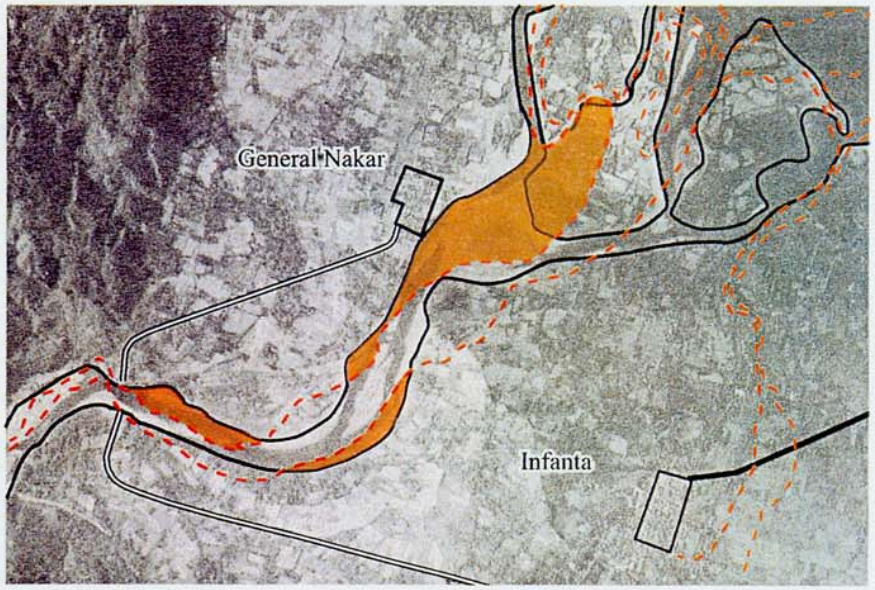



Source:
Comprehensive Land Use Plan,
1999-2029

Figure I2.1 Satellite Image of the Lower Agos and Present Land Use of General Naker

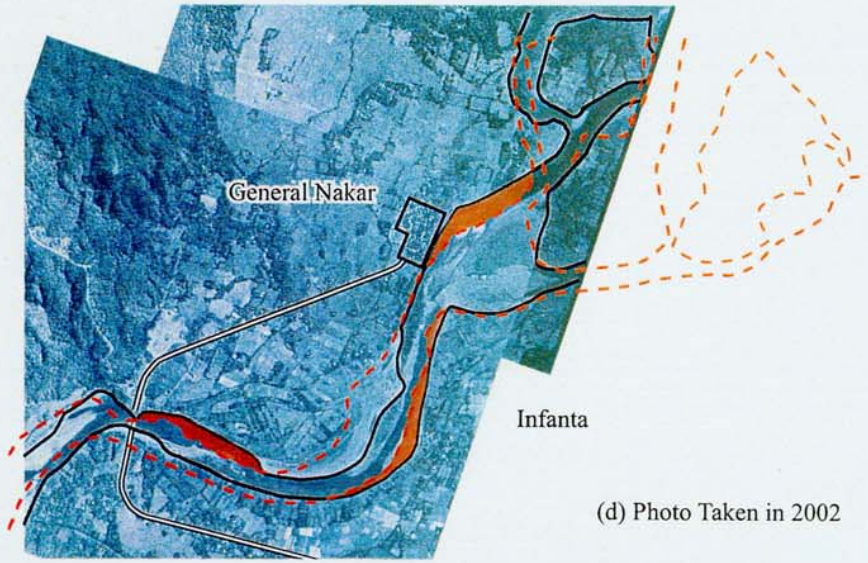



(a) Photo Taken in 1951




(c) Photo Taken in 1995

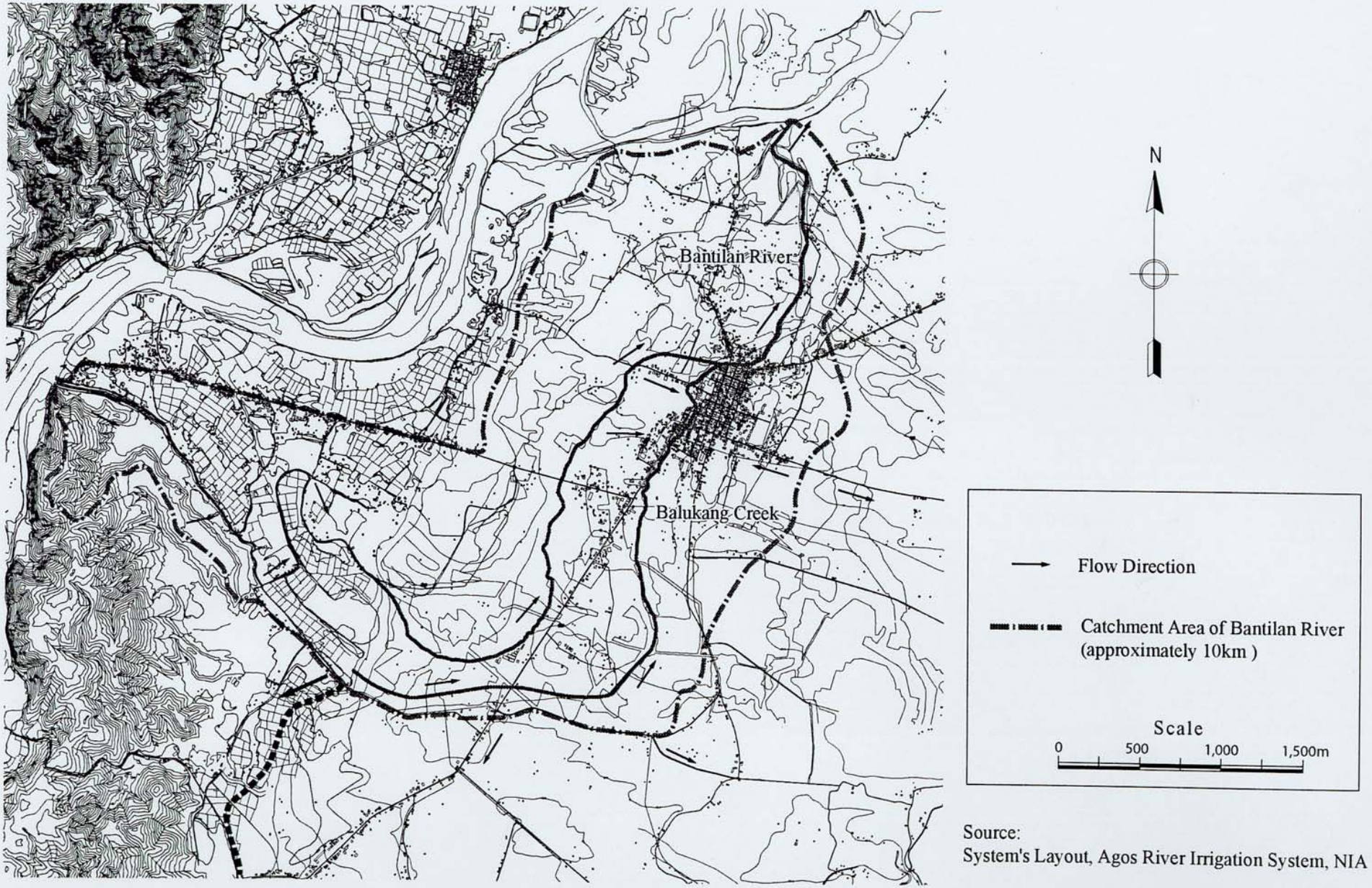

(b) Photo Taken in 1966




(d) Photo Taken in 2002


Bank Erosion

Figure I2.2 River Course Changes of Lower Agos




Source:
System's Layout, Agos River Irrigation System, NIA

Figure I2.3 Major Drainage Canals in Municipality of Infanta

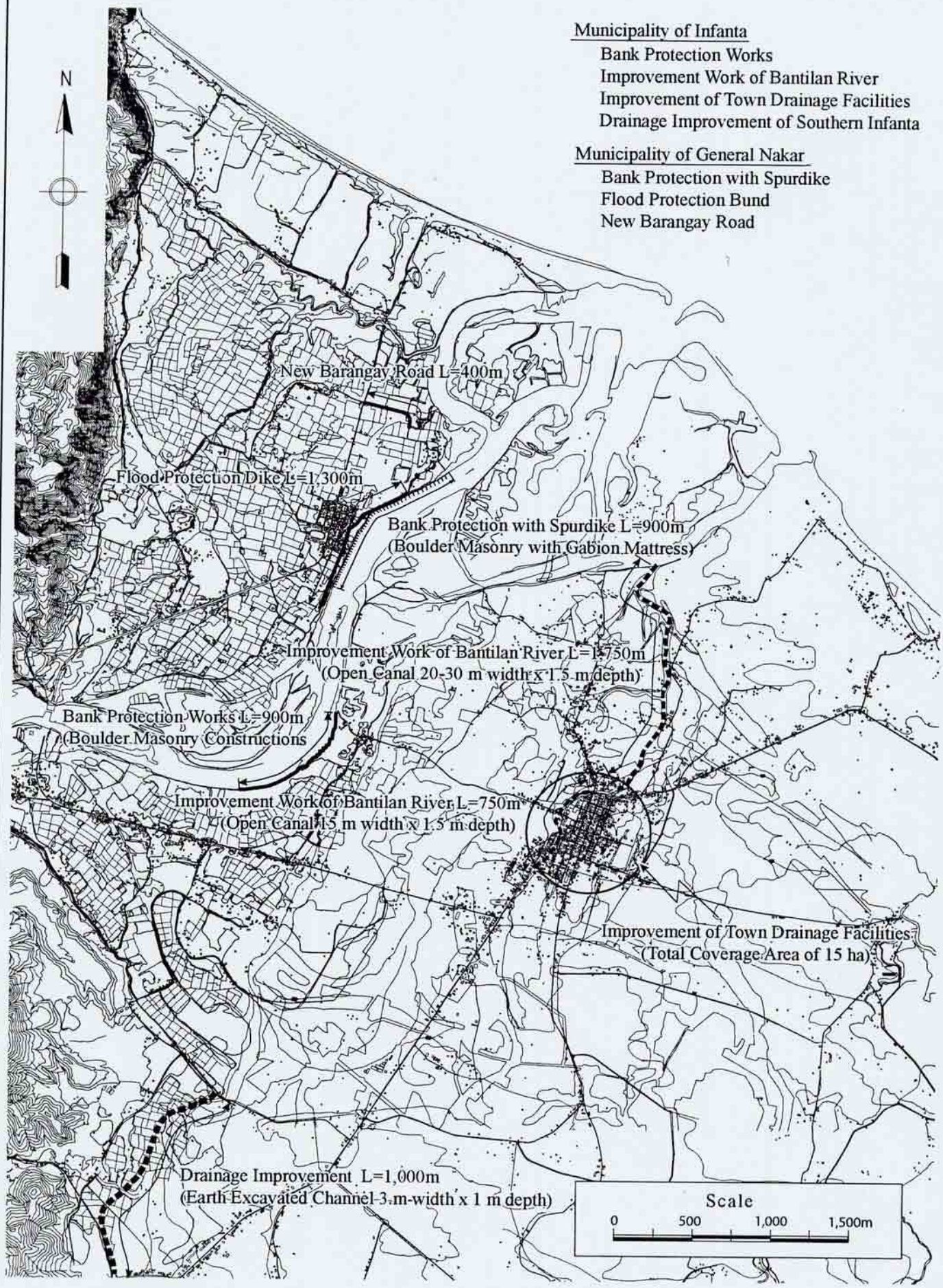



Figure I2.4 Proposed Structure Measure in the Lower Agos