ANNEX VI :
FLOOD CONTROL

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

Volume VI-1 SUPPORTING REPORT

ANNEX VI FLOOD CONTROL

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CHAPTER 1 PRESENT RIVER CONDITION

1.1 Present River Condition

In this section, the present river conditions as individual characteristics of the Cagayan River are described, based on the site reconnaissance, related data collected, and river cross-section survey result conducted by the Study Team in 2000, etc. Major contents of this section are river system, general features of the present river channel, and river morphology including river geomorphology, meandering and variations of the river channel.

1.1.1 River System

(1) General

The total basin area and river length of the Cagayan River are 27,281 km^2 and 520 km, respectively. The major tributaries of the Cagayan River are the Chico (basin area: 4,550 km^2), Siffu-Mallig (2,015 km^2), Magat (5,110 km^2) in the left side, and Pared (970 km^2), Tuguegarao (660 km^2), Tumauini (960 km^2) and Ilagan (3,130 km^2) in the right side.

Figures 1.1.1 to 1.1.4 show the general basin map, schematic river system, catchment areas at key points and general longitudinal river profiles of the Cagayan River.

(2) River System

The main Cagayan originates in the Caraballo mountain range. Passing through the mountainous areas towards north-northeast, it joins the largest tributary, the Magat at the left bank and the right tributary, the Ilagan, in succession. According to site reconnaissance, denuded areas exist in various places in the upper Magat river watershed, especially along the Santa Cruz River, while vegetation in the mountainous areas extending over the right side of the Cagayan River is relatively rich. The total basin area of the Cagayan at the confluence with the Ilagan is around 15,100 km^2.

Magat dam is located in the gorge of the upper Magat, having two functions of irrigation water supply and hydroelectric power generation. The dam is operated by the National Irrigation Administration (NIA). The dam has basically no flood control space in its reservoir, although it can be said that the dam is substantially contributing to flood peak reduction.

Just downstream from the confluence with the Ilagan River, it changes its direction towards north-northwest, and flows down in the alluvial plain confined by natural levees, terraces, etc., and reaches Alcala. The Cagayan river channel in this reach especially from the Buntun bridge to Alcala meanders violently. The major tributaries in this reach are the Siffu-Mallig in the left bank and Tumauini, Tuguegarao and Pared in the right bank. The total basin area at Alcala is around 21,400 km^2.

From Alcala to Magapit, it runs further towards north-northwest passing through the valley area in around 30 km long called as the Magapit Narrows. Particularly, there exist three bottlenecks at Tupang, Nassiping and Magapit. The Magapit irrigation pump station operated by NIA is located at the right bank upstream of the Magapit bridge. The pump station covers a total service area of 11,500 ha extending over the right bank.

In the reach of the Magapit Narrows, the Cagayan river joins the second largest tributary, the Chico at the left bank, and minor tributaries, the Zinundungan at the left bank and the Dummon at the right bank. The total basin area of the Cagayan at Magapit is around 27,100 km^2.

After passing through the Magapit Narrows, the Cagayan flows down in the flat area changing its direction to north, and finally discharges into the Babuyan channel at Aparri having the total basin area of 27,281 km^2.

1.1.2 General Features of Present River Channel

Figures 1.1.5 to 1.1.7 show longitudinal profiles, river widths, channel depths and estimated channel carrying capacities of the Cagayan, Chico and Tuguegarao Rivers based on the river cross-sections newly surveyed in the year 2000.

Such general features of the main Cagayan River are as follows.

Average Riverbed Slope

- River mouth to Magapit Bridge: 1/21,000
- Magapit Bridge to Alcala: 1/10,000
- Alcala to Confluence with the Tuguegarao River: 1/9,000
- Tuguegarao River to Cabagan: 1/7,000

Low Water Channel Width

- River mouth to Magapit Bridge: 400 to 2,000 m
- Magapit Bridge to Alcala: 300 to 1,400 m
- Alcala to Tuguegarao: 300 to 1,100 m
- Upstream of Tuguegarao: 300 to 1,000 m

Mean Depth of Low Water Channel

- River mouth to Magapit Bridge: 3 to 12 m
- Magapit Bridge to Alcala: 5 to 20 m
- Alcala to Cabagan: 3 to 15 m

Bankful Carrying Capacity of Low Water Channel

- River mouth to Magapit Bridge: 9,000 to 25,000 m^3/s
- Magapit Bridge to Alcala: 4,000 to 20,000 m^3/s
- Alcala to Cabagan: 2,000 to 9,000 m^3/s

The carrying capacities below the riverbank elevation of both the rivers Chico and Tuguegarao are summarized below.

Bankful Carrying Capacity of Low Water Channel in Chico River

- Confluence to 10 km upstream: 1,000 to 11,000 m^3/s
- 10 km to 14 km upstream: 1,000 to 5,500 m^3/s

Bankful Carrying Capacity of Low Water Channel in Tuguegarao River

- Confluence to 3 km upstream: 1,000 to 15,000 m^3/s
- 3 km to 9 km upstream: 1,500 to 14,000 m^3/s
- 9 km to 14 km upstream: 1,000 to 2,500 m^3/s

1.1.3 River Morphology

(1) Alluvial Plain formed by Cagayan River

1) General

A river geomorphologic study was made based on the observation of satellite image, aerial photographs, topographic maps, and site reconnaissance. A river has the individual characteristics based on its unique natural condition. Also the Cagayan River has peculiar characteristics resulted from prehistoric background through repeated upheaval and lowering ground movement.

The main Cagayan flows down generally in a northerly direction. Notable geomorphologic features of the Cagayan River are the existence of bottlenecks (constricted sections) in the narrows named as Magapit Narrows stretching for 30 km long and river meander forming in the upstream reaches especially from Alcala to around Tuguegarao. According to the study results made so far, the following can be said.

Compound actions of repeated upheaval and lowering ground movements in the prehistoric time formed a Cagayan Valley with bottlenecks of Magapit Narrows. Afterwards, alluvial plain in the Cagayan River was gradually developed in combination with the repeated actions of sedimentation by rivers and fluctuation of seawater level resulted from climatic changes.

The present alluvial plain extending over the upstream at Alcala was thus formed largely by backwater phenomena due to the bottlenecks in the Magapit Narrows. Similarly, river meandering naturally and violently proceeded in the alluvial plain because of gentle slope gradient. Such historical process of the Cagayan River formed the present river channel.

2) Characteristics of Alluvial Plain formed by Cagayan River

Geomorphologic survey map of the Cagayan River showing classification of flood prone area is presented in Figure 1.1.8. Figure 1.1.9 presents typical cross-section of the alluvial plain. The geomorphologic classification of the Cagayan River is as follows.

Mountain, hill and terrace
Alluvial plain formed by the Cagayan River

- Higher alluvial plain
  Natural levee (large-scale with high ground elevation)
- Lower alluvial plain
  Valley plain
  Natural levee (small-scale with low ground elevation)
  Back swamp
  Former river course

Valley plain formed by tributaries
Steep slope, cliff
Water surface

The alluvial plain formed by the Cagayan River is classified into two categories of a higher and a lower as mentioned above. The higher alluvial plain is defined in this study as a large-scale natural levee with sufficiently high ground elevation and the lower alluvial plain, other alluvial plain except the higher alluvial one, respectively. Such natural levees in the alluvial plain were historically and repeatedly formed by deposition of sediment discharges transported by overflowing from the low water channel of the Cagayan River.

The lower alluvial plain consists of natural levees, back swamps, former river courses, valley plain, etc. The floodwater is principally discharged through the low water channel and the floodplain is limited by such natural levees. Further, inundation area due to floodwaters overflowing from the Cagayan River is confined within the limit of the valley plain in the lower alluvial plain. As lowering of the water level in the Cagayan River subsides, the overflowed water naturally flows back into the channel of the Cagayan River without spilling out into the other river basins.

The ground elevations of the natural levees are higher than those in the valley plain. On some natural levees with far higher ground elevations, residential areas have been created. Small and low natural levees are occasionally submerged. Likewise the valley plain itself is subject to frequent inundations by the main Cagayan River. Accordingly, no cultivation on the valley plain has been made in the rainy season and only in the dry season, the valley plain has been utilized mainly for cornfields. In case of historical big floods, the former river courses are easily subject to change into a path of floodwater. Therefore, the lower alluvial plain has been suffering from frequent inundations, river course shifting resulting in meander, bank erosion, etc. On the other hand, groundwater is abundant in and along the former river courses.

Ground elevations of the higher alluvial plain are sufficiently higher than flood water levels overflowed from the main Cagayan river channel. Therefore, lands on the higher alluvial plain have been developed as village areas, and irrigated and rain-fed paddy fields.

From the above, the alluvial plain upstream of Alcala has been suffering for centuries from various flood damage such as frequent inundations, river course shifting accompanying by meander, bank erosions, etc. Specific social problems caused by river course shifting are casualties and damages to assets, change of administrative boundaries (usually delineated by the center line of river channel) between municipalities, dispersion of agricultural lands, etc.

3) Relationship with River Planning

As seen in Figure 1.1.8, the Cagayan River has formed various natural levees especially in the reach from Alcala to Tuguegarao. Such natural levees were historically and repeatedly formed by sediment deposited by overflowing from the low water channel of the Cagayan River. Distributions of natural levees imply flow direction and flow width of floodwater during large historical floods. In another word, such flow width (river width) confined by natural levees is minimum and necessary width to discharge historical big floods safely.

In planning of dike construction in the said flood plain, it is important to keep the necessary width or to align dike along natural levees from a stability viewpoint of river channel and dike. In case a dike is constructed across the former river courses located in the floodplain, it should be considered to provide sufficient protection works against flow attack or piping phenomena. At the turning point with a right angle, the Cagayan River downstream of

Amulung pump station, the present riverbed elevation is so deep whereas the river width of low water channel is narrow. This means the right riverbank at this section is considerably solid and covered by clayey sand.

As shown in Figure 1.1.8 and Figure 1.1.15, the river course of the Cagayan was historically forced to shift towards the right riverbank of the Cagayan. For the whole stretch of the Cagayan, it can be said that the present right riverbank foundation is considerably solid. Therefore, a national highway was constructed on the right riverbank in early time and that there exist countless villages and towns since old times. From the above viewpoints, a cut-off channel scheme at Gabut and San Isidro to shift river course intentionally towards right bank side is a reasonable one in the reach from Alcala to the Buntun bridge.

(2) Variations of River Channel

River channel variations are basically brought about by a natural cause and an artificial cause. The natural causes are upheaval and lowering ground movement, fluctuation of seawater level, sediment discharge volume to be transported, flood, earthquake, etc., as basic factors. The artificial causes are actions such as excavation and reclamation, etc. In the case of the Cagayan River, it says that the artificial causes cannot be observed so far.

Variations of river channel are studied from the plan geometric, and longitudinal and cross-sectional viewpoints based on the topographic maps, aerial photographs, and surveyed cross-sections viewpoints as follows.

1) River Course Shifting

Figure 1.1.10 shows the historical river course shifting of the Cagayan River, by using the 4 river courses reproduced from 2 topographic maps prepared in 1947 to 1953 and 1979, and 2 aerial photographs taken in 1996 and 2000. Based on the above data, the following can be said.

River course shifting especially in the reach from Alcala to upstream of Tuguegarao is so significant. Active shifting resulting in river meander is caused by fairly gentle water surface slope due to backwater from the bottlenecks in the Magapit Narrows. Up and downstream at Iguig, the extent of shifting reached 5 km in distance only over the past 50 years. Such shifting is generally caused not gradually through years but suddenly or accidentally in the flood time. Except the above reaches, there is no significant shifting.

As already explained in the above Characteristics of Alluvial Plain, such river course shifting resulting in meander causes serious flood control problems of damage and casualty to assets, riverbank erosion, separation of agricultural lands, revision of administrative boundaries among municipalities, etc.

2) Variations of Longitudinal and Cross-Sectional Profiles

Figures 1.1.11 and 1.1.12 show longitudinal and cross-sectional variations of the main Cagayan River channel. There are only 2 series of data available surveyed in 1986 and 2000. Variations was studied based on the above two limited data.

According to the Figure 1.1.11, the general tendency of the longitudinal riverbed elevations is as follows.

a) River mouth to Magapit Bridge: no significant change
b) Magapit Bridge to Alcala: slightly raised
c) Alcala to Confluence with the Tuguegarao River: slightly raised
d) Confluence with the Tuguegarao River to Cabagan: no significant change

On the other hand, riverbed fluctuation in the future of 5, 10, 25 and 50 years under the present (natural) river condition was simulated as described in ANNEX IV. According to the above simulation, average riverbed fluctuation in each part (lower, lower middle, upper middle and upper) is stable enough, although slight aggradations of riverbed are recognized in the lower middle and upper parts.

From the above, it can be said that the longitudinal riverbed variation is, as a whole, in equilibrium condition.

3) Variations of Sandbars near River Mouth

Figure 1.1.13 presents variation of sandbars in the lower reach of Cagayan near river mouth. This comparison was made based on 1 topographic map (1979) and two (2) aerial photographs (1996 and 2000).

According to the figure, it can be said that there is no serious increase of the sandbars in the river channel, although the local shifting has been observed. However, some local people say that shifted sandbars are obstacle to navigation in the fishing port near the river mouth. The river channel conditions at the river mouth will be explained in Section 1.2.1 Bank Erosion and Sedimentation.

(3) River Meander

Streams or river channel tend to meander through level or mild slope reaches due to compound actions of river waters, sediment discharges, covering materials of riverbank, etc. To meander is to move aimlessly and idly without fixed direction. Therefore, it is so difficult to control river meander. It is a challenging matter in the flood control as well as civil engineering.

Figure 1.1.14 shows an image of erosion and sedimentation process brought about by river meander.

1) Meandering Rate

In this study, a meandering rate that indicates sinuosity (S) applied by Kouichi Yamamoto, 1988: Kado Tokuseiron, Public Works Hydraulic Research Paper Vol.2662, was used as an index classifying the degree of river meander.

For the said reach from Alcala to Upstream of Tuguegarao of the Cagayan River, the meandering rate (S) of sinuosity was checked for four (4) stages from the year 1950 to 2000 as shown in Figure 1.1.15. The meandering rate (S) is defined as:

(S)= Actual channel length (km)/ Straight-line length (km).

High value (S) above 1 means meander and (S)= 1, straight river channel without meander, respectively.

According to the above figure, (S) has been gradually decreased from 2.12 calculated on the maps prepared in 1950 to 1.81 on the aerial photographs newly taken in 2000. The tendency observed in the recent 50 years indicates that river meandering is being changing towards a straighter river course.

2) Other Studies on River Meandering

Some studies on the river meandering have been made so far. According to such study results, it can be said that a straighter river channel is caused by an increase of the surface water slope in the meandering reach. The surface water slope is increased by constructions of floodway or cut-off channel and by widening of low water channel. Among those are explained below.

Yamamoto investigated and studied river meandering for the various rivers in natural condition without river improvement works, in Indonesia, India and others. Figures 1.1.16 to 1.1.17 show the relationships between meandering rate (S) and hydraulic factors.

According to his study results, development process of river meander is as shown in Figure 1.1.16 (A), referring to basic data prepared by Kondrat'yev, N.Y. Generally, formation of river channel shape or river course has a close relation to development of sand dunes and their locations in the riverbed that is largely governed by a ratio: B (river width of low water channel)/H (water depth).

Yamamoto further shows relationships between the meandering rate (S) and (B/R) or (B/Hmax) for various rivers in view of climatic, topographic and soil conditions. Each abbreviation is defined below.

B: low water channel width (m)

R: average water depth (m) of low water channel

Hmax; maximum water depth of low water channel (m)

Figure 1.1.16 (B) presents a relationship between meandering rate (S) and (B/Hmax), referring to basic data provided by Schumm S.A. The extent of meandering is largely governed by a factor of (B/Hmax). Based on this relationship, the following can be said.

(B/Hmax) is above 70~80: river course is a straight

(B/Hmax) is below around 30: river course meanders

In case of the river course from Alcala to Tuguegarao of the Cagayan River, the estimated (S) and (B/Hmax) are 1.81 and 70, respectively, as plotted in the above Figure.

Figure 1.1.17 (A) presents a relationship between meandering rate (S) and (B/R) taking notice of riverbed slope for various rivers in Indonesia. According to this figure, it indicates that river meandering is affected by not only a factor of (B/R) but also a factor of riverbed slope. Anyhow, it says that river with more steeper riverbed slope is not apt to meander. The value of the Cagayan River is plotted as shown in Figure 1.1.17 (A).

Figure 1.1.17 (B) shows a relationship taking notice of mean grain size of riverbed materials for various rivers in India and Pakistan, referring to basic data provided by Chitales, S.V. 1970, River channel patterns, ASCE.Vol.96, pp.201-221. As seen in the said figures, it concludes that river course is not subject to meander, according as grain size of riverbed materials becomes large. The value of the Cagayan River is plotted as shown in Figure 1.1.17 (B).

In conclusion, according to the above study and research results, the following 3 measures are applicable to overcome against river course shifting due to river meander.

a) Increase of surface water slope by means of construction of diversion channel or floodway,
b) Widening of low water channel by means of river channel improvement, and
c) Replacement of riverbed materials.

The above 2 measures of a) and b) are more practicable in the ordinary flood control projects, however, c) is artificially difficult.

[Reference]

This is a reference data on required river width (low water channel width) of the Cagayan River in the reach from Alcala to upstream of Tuguegarao.

Judging from an estimated curve drawn on the Figure 1.1.17 (A), B/R at S=1.1 (that means a straighter river course) will be around 170. Required low water channel width will be, in this case, around 1,200 m against a water depth of 7 m that is an average water depth of the present low water channel. In other words, the Cagayan River course will be changed to a straighter one under a condition of low water channel width of 1,200 m. The present low water channel width is around 500 m in this reach. Widening towards the above 1,200 m requires huge amount of construction cost and actually it is impossible to implement.

3) Example of Decrease of Meandering by Flood Control Works

The following are the reference data on that meander river channels that were changed to straighter river channels by artificial actions. According to the said data, it can be said that construction of a floodway or a cut-off channel and widening of the low water channel (surface water slope becomes a more steeper) can improve a meander river channel into a straighter one. The details are as follows.

A: Case of the Agano River by Construction of a Floodway

The following is a case of the Agano River in Japan, as shown in Figure 1.1.18. The Agano River flowing in Niigata Prefecture discharges into the Japan Sea. The river meander of the Agano River was originally so significant or heavier. The construction of a floodway decreased the then meandering rate, that is, to a straighter channel.

Figure 1.1.18 shows both the river courses in around 1713 and in around 1762. These river courses were in a reproduction by Ohya and Kato in 1984, based on the old maps and aerial photographs. The river course in 1713 meanders remarkably. In 1730, the lowermost 10 km reach was improved by the construction of the floodway with a total length of 4 km. The excavated channel width was originally 50 to 130 m and subsequently in 1731, the width was incidentally widened to 270 m on an average by accompanying big floods. In the period from 1734 to 1740, also the diversion channel in the middle reach was constructed. Such actions made the slope gradient of water level steeper drastically in the lower reaches and influenced variation of river channel in the upper reaches.

Resulted from such drastic artificial actions, the meander rate of river channel in 1713 was gradually decreased towards a straighter river channel as observed in 1762. Afterwards in 19^{th} and 20^{th} centuries, the river improvement works repeatedly carried out in the middle reaches and consequently, the present river course was completely confined by continuous dike.

B: Case of the Mogami River by Channel Improvement with a Confined Dike

Figure 1.1.19 presents historical river course shifting of the Mogami River in Japan. The Mogami River discharges into Japan Sea. In this case, comprehensive and continuous river improvement works with confined dikes, changed the then meandering river channel to a straighter one.

C: Other Cases by Construction of Cut-off Channels

A construction of the cut-off channel in the meandering rivers makes its original slope gradient steeper. Generally, it lowers riverbed elevation in the upstream of the cut-off channel on the contrary it raises riverbed elevation and widens river width in the downstream so as to adjust imbalance of dynamic energy of the flow before and after construction of cut-off channel.

According to K.Yamamoto, 1997: Chuuseki Kasengaku, pp.317, several cases that were brought about by construction of cut-off channels, are presented below under the condition that both the riverbed materials between the new and the old river channels are nearly equal.

Widening of River Width by Construction of Cut-Off Channel

River/Location	Grain Size: dm (mm)	Old River Width (m)	Present River Width (m)	Old River Course	Present River Course	Present River Slope
Kusiro river /38~45 km	5~10	30~40	50~60	meander	straight	1/1200
Yuibetu river/ 2~10 km	2~3	50~70	90~120	meander	straight	1/1400
Omono river/ 81~88 km	20	100~120	250	meander	straight	1/900
Agano river/ 15~30 km	20~25	200~300	600~750	meander	meander	1/800
Agano river/ 4~11 km	0.6~0.8	200~250	650	meander	straight	1/1300
Ishikari river/92~105 km	10~20	195	230	meander	straight	1/1300
Ishikari river/ 108~110 km	10~20	159	180	meander	straight	1/1300

Source; K. Yamamoto, 1989: Chuuseki Kasengaku

(4) Consideration of Decreased Meandering Rate

As already explained, river meander is caused by imbalance between flow energy and channel capacity to keep up with the flow energy. Basic factor of meander will be influenced by the individual site conditions such as topography and geology, river slope, sediment discharge, channel width and water depth, etc. Generally, a river is subject to easily meander under a condition of considerably gentle slopes. Especially in the upstream of Alcala in the Cagayan, the bottlenecks in the Magapit narrows aggravate the prime factor of river meandering.

Reasons of the decreased meandering rate or changing towards straighter river course are considered as follows.

Topography and geology

Dr. R. Saito, made a Comparative Study on Development Process of Alluvial Plain in the Tropical Zone in 1994. In this study, Dr. Saito reports that velocity of upheaval of ground movement (0.9 mm/year) in the Cordillera Central Mountains in the left side of the Cagayan River is larger than that (0.60 mm/year) of Sierra Madre Mountains in the right side. Also relative relief energy (900 m) in the left side is higher than that (740 m) of the right. In 1990, Baguio (Luzon) earthquake occurred and landslides was brought about in various places in the watersheds in the left side. Displacement by the said earthquake is recorded at 6 m in maximum. From such facts, it can be said that landslide is apt to occur in the mountainous areas especially in the left side.

Meantime, denuded areas exist in various places in the left side, while vegetation in the mountainous areas in the right side is relatively rich. Tributaries in the left side of the Cagayan are larger than those of the right side. According to general river profiles as shown in Figure 1.2.4, a knick point can be observed in the left tributaries resulting in upheaval of ground

movement. From such viewpoints, sediment discharge yields from the left tributaries are bigger than that of the right side and assumed to increase in the future.

The above geologic facts imply in the geologic time span that an overall topographic slope in the left side is gradually being inclined or changed steeper towards right riverbank with solid foundation.

From such background, the river course of the Cagayan was historically forced to shift towards the right riverbank of the Cagayan. As shown in Figure 2.5.15, it is natural that the river courses in the past 50 years have been concentrating towards the right riverbank of the Cagayan River.

River slope

It can be said that the river slope becomes steeper judging from the above-mentioned facts. As shown in Figure 1.1.17 (A) and explained in the later section, it indicates that river meandering is strongly affected by a factor of riverbed slope. From this fact, it can be said that river having more steeper riverbed slope is not apt to meander.

Riverbed material

According to site inspection, average grain size of riverbed material in the Cagayan River is so fine varying from 0.6 to 0.3 mm. In the meantime, sediment discharge with large grain sizes from the left tributaries will be increased and the riverbed of the main Cagayan River is subject to cover by far coarse material. Such tendency is assumed to be accelerated in combination with armored phenomenon as recognized in rivers in Japan and river slope changing into steeper year by year as described above. As shown in Figure 1.1.17 (B), it is concluded that the river course is not subject to meander, as the grain size of riverbed materials becomes large.

Channel width and water depth

As meandering river course becomes straighter, the ratio of river width and hydraulic mean depth (B/R) becomes larger according to a research data as shown in the above Figure 1.1.17.

Alluvial fans have been developed in the upper tributaries in the left side. In view of the geomorphologic aspect, an alluvial fan is temporary topography in the formation process of the topography and finally becomes extinct in connection with changing into equilibrium river slope. As a step in the transitional state, braided river actually as seen in the main upstream channel

of the Cabagan and the lower Magat River, will be expanded towards downstream of the Cagayan River. The braided river flows in an interconnected network of channels. Further, the riverbed elevation of the main Cagayan will be raised by increasing sediment discharge with coarse grain size coming from the tributaries in the left side. Hence, total river width inevitably becomes wider although those of individual channels become small or narrow.

On the other hand, there exist some sections with deep riverbed elevations according to survey result of river cross-sections especially in the Magapit narrows reach. However, it can be said that such deep river sections are special case. Accordingly, channel depth or (R) is supposed to become shallow or decrease in connection with changing into the braided river. From the above, a value of (B/R) will become larger by combination of wider river width and shallow water depth, and consequently meandering rate is decreased.

With due the considerations in the above, meandering river course in the Cagayan has been changed to a straighter river based on combined factors and actions for the time being although it is based on a short period of recent 50 years. Anyhow, it might be said that an upheaval of the features of the Central Mountains is one of major reasons of the decreased meandering rate and such tendency continues for the future. Eventually, the river course in this reach is assumed to move and concentrate towards the present right riverbank line in the whole reach of the Cagayan River especially at significant meandering sections of Gabut and San Isidro.

In connection with a river planning, a cut-off channel scheme at Gabut and San Isidro is reasonable and applicable countermeasures in this reach from such geomorphologic viewpoint.

1.2 Flood Damages

In this section, flood damages and flood control projects are described. Firstly, bank erosion, sedimentation, flood inundation, flood damages, etc., are explained. Subsequently, ongoing and proposed flood control or disaster prevention projects are presented in view of structural, non-structural and supporting measures.

1.2.1 Bank Erosion and Sedimentation

(1) Bank Erosion

Bank erosion was observed in various places of the main Cagayan and its tributaries, and is one of the serious flood control problems involved in the Cagayan River basin. A lot of bank protection works have continuously provided at various places. Bank protection works consisting of spur dike and revetment, and their combination type are major existing measures in the Cgayan River.

Several sites are being exposed to destructive damage. Based on inventory surveys conducted by each district office and the study team, 73 candidate sites were selected as listed in Table 1.2.1 and Figure 1.2.1. Figure 1.2.2 shows the process of the bank erosion through the past 5 decades at Enrile and Tuguegarao areas. The bank erosion upstream at Alcala is far more serious than that of downstream.

Average annual bank erosion rate in the downstream of Magapit Narrows, reaches 10 m as estimated from 5 serious bank erosion sites as marked sections in Figure 1.1.10. Similarly, that of the upstream at Alcala reaches 24 m that estimated at 4 sites. The annual erosion rates at sites vary from 28 m to 6 m.

(2) Sedimentation

According to site reconnaissance, it proves that vegetation in the mountainous areas extending over the left side (Cordillera Central Mountains) of the main Cagayan is poor whereas that of the right side (Sierra Madre Mountains), is relatively rich. In addition, violent landslides caused by a historical earthquake in 1990 are widely observed especially in the upper watersheds of the Magat.

1) Upper Cagayan River (Magat Dam Reservoir)

Resulting from such natural situation devastated, sediment discharges from the upper watersheds have abruptly being increased especially from those of the left tributaries of the Cagayan. Particularly, a rapid sedimentation in the reservoir of the Magat dam is a challenging matter that cannot be overlooked any longer from the viewpoint of effective water supply for irrigation use. Figure 1.2.3 presents the progress of sedimentation in the reservoir.

The Magat dam having a basin area of 4,140 km^2 was completed in 1982 (by NIA). The live storage capacity and dead storage capacity of the reservoir were originally 1.2 billion m^3 and 300 million m^3, respectively. The dam has been in operation for 19 years since its completion. Due to increased sediment discharges from the upper basin especially from the Santa Cruz

River, Santa Fe, etc., the sedimentation space of the reservoir has been significantly reduced to 112 million m^3 from the original space of 300 million m^3.

Calculated annual sediment rate for the past 18 years (1981 to 1999) is 10.4 million m^3 (2,600 m^3/km^2/year) against the projected rate of 5.5 million m^3 (1,330 m^3/km^2/year), as shown below.

Sedimentation in the Reservoir of the Magat Dam

Unit: Million m^3

Surveyed Year	Accumulated Sediment Volume	Annual Sediment Rate	Remarks
Design value	-	5.5	
1982	7.4	-	Completion of dam
1984	22.0	7.3	
1988-1989	49.0	6.7	Earthquake occurred in 1990
1995	179.0	12.8	
1998	181.0	10.6	
1999	188.0	10.4	

Source: NIA, Region 2 Office

To decrease sediment inflow from the upper watersheds is inevitable matter and an urgent issue from the viewpoint of effective utilization of the live storage capacity of the reservoir.

2) Middle and Lower Cagayan River

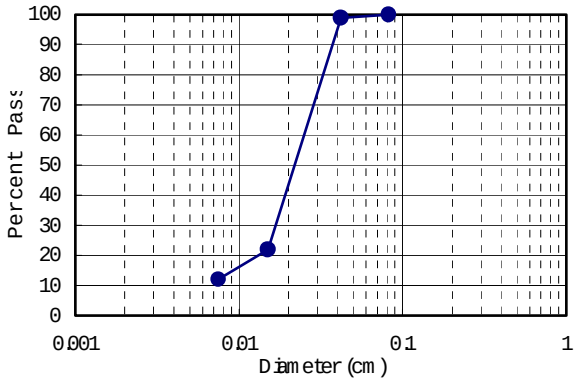
As already explained in Figures 1.1.11 (variation of average riverbed elevation) and 1.1.13 (variation of sandbars near river mouth) in Section 1.1.3, it can be said that the extent of sedimentation in the middle and lower Cagayan River is not so serious in view of actual variation and/or variation of sandbars located near the river mouth. In other words, the sediment transport capacity in the middle and lower Cagayan River is at an equilibrium condition although the riverbed elevation in the reach of the Magapit narrows has a slight tendency of rising and sedimentation can be observed locally at the inlet of the Amulung pumping station and the river mouth of the Appagonan River at Aparri.

3) River Mouth Clogging (block up)

According to the survey results made so far, it can be said that there is no problem on river mouth clogging.

As seen in Figure 1.1.12 in Section 1.1.3 showing river cross-sections surveyed in the end of the dry season from April to May, cross-sections near the river mouth have sufficient flow area, respectively.

The following shows grain size distribution obtained from material sampling at 1.6 km from the river mouth by the study team. An average grain sizes at 50 % in size and weighted mean grain size are 0.036 cm and 0.022 cm, respectively.



In this viewpoint, critical shear velocities (velocity to move riverbed materials) for the above specific grain sizes and shear velocities for the several discharges in the lower reach near the river mouth were estimated by using the following formulae.

Shear velocity: $\sqrt{gRIe}$ (cm/s)

Critical shear velocity: $8.41d^{11/32}$ for d more than and/or equal to d= 0.0065 cm and less than 0.0565 cm

where; g : acceleration of gravity (980 cm/s^2)

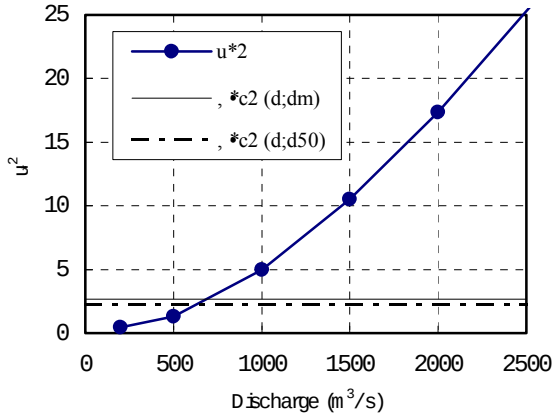
R : hydraulic mean depth (cm)

Ie : energy gradient

d : grain size (cm)

It should be noted that R and Ie was estimated as average values for 10 km reach from river mouth, respectively.

The result is as follows.



According to the above figure, it can be said that sediment loads deposit on the riverbed where the river discharges are less than 500 to 600 m^3/ s, whereas those against river discharges more than 500 to 600 m^3/s are flushed away the sediment loads to the sea without deposition. The sediment loads transported by river discharges less than 500 to 600 m^3/s in the dry season are not so much in volume and such sediment loads are easily flushed away by floods due to typhoons in the rainy season. Suspension and wash loads prevail in sediment loads transported in the lower Cagayan River. Also according to study on sediment condition in the lower Cagayan descried in ANNEX IV, the ratio of suspension and wash loads to the total sediment load is high value with about 75 % in the lower Cagayan.

From these results, it is concluded that the river mouth of the Cagayan is not closed by sedimentation.

On the other hand, there exists one spur dike on the right bank of the river mouth to block drift sands flowing towards the river mouth. The original spur dike was extended by 120 m in length in 1994. According to site observations, the dike has been functioning in good condition accompanying with newly created beach in front of the original beach. It can be said that the related agencies efforts in this matter have resulted in success.

1.2.2 Flood Inundation

The Cagayan river basin has about 1,860 km^2 flood prone areas which are presently used as production areas of rice, corn, legumes, and vegetables, according to the data: Integrated Regional Disaster Management, RDCC Region II. The flood prone areas of 1,860 km^2 were estimated as inundation areas brought by the 1973 flood, the biggest in the past. Fifty-two municipalities extend over the above areas. Afterwards, a big flood occurred in 1980 and the inundation areas by the 1980 flood reached about 1,740 km^2. Figures 1.2.4 and 1.2.5 show inundation

areas by both the above floods, respectively. The destructive and historical floods caused such extensive inundation areas over the higher alluvial plain that is explained later.

On the other hand, delineation of the inundation areas by the 1998 flood is as shown in Figure 1.2.6, based on the data obtained from the Office of Civil Defense (OCD) Region II and interview surveys. The inundation areas were within the limited areas of lower alluvial plain, except for some natural levees with far higher elevations.

1.2.3 Flood Damages

(1) Flood Damages Recorded by NDCC

National Disaster Coordinating Council (NDCC) compiles the flood damage data sent by Regional Disaster Coordinating Councils (RDCCs). Tables 1.2.2 to 1.2.4 show recorded disasters including flood damages in the country and Region 2/ CAR.

(2) Flood Damages Recorded by OCD Region 2

The disaster damage report issued by the Office of Civil Defense (OCD) Region 2, which is the secretariat of the RDCC gives the data on the following damages in Region 2 due to recent typhoons and flooding:

	Typhoon ILIANG October 1998	Typhoon LOLENG October 1998	Typhoon PEPANG October 1999
Affected barangays (No.)	1,367	648	702
Affected persons (No.)	925,524	417,748	186,104
Destroyed houses (No.)	74,290	1,214	11,696
Casualties: dead (person)	36	8	8
Casualties: injured (person)	398	8	14
Casualties: missing (person)	22	4	5
Agricultural damage (peso)	1,587,935,930	291,539,737	273,461,400
Infrastructure damage (peso)	220,500,000	198,703,000	65,843,000

(3) Problems on Damage Records

The following problems are seen in the existing damage records:

1) The damage values in the records show only the damages to properties and products and do not include opportunity losses such as losses in producing and business activities during suspension period, and,
2) Past flood damage reports prepared by the DCCs of LGUs have not been kept properly by them, except for a few Municipalities in Region 2.

(4) Flood Damage Survey

The flood Damage Survey was conducted in April to June 2000 to investigate past flood inundation area, depth, duration and damages in the Cagayan River basin and present status of disaster management. The survey results are compiled in Data Book.

1.3 Existing Flood Control Projects (Structural Measures)

(1) Existing Flood Control Projects by DPWH

Tables 1.3.1 and 1.3.2 show the ongoing (61 projects with a total budget of Pesos 33.1 million) and proposed (49 projects tentatively, with Pesos 93.5 million) flood control projects in DPWH Region 2 office as of February 2001.

The regional office has a medium-term infrastructure program for the period from 1999 to 2004. The program consists of infrastructure development categories for national highways and bridges, and flood control. Total projected budget is around Pesos 12.46 billion at the 1999 price level, whereas the allocated budget to the flood control category is only 10 % of the total projected budget.

On the other hand, there is no ongoing flood control project being assisted by foreign funds in the regional office, as of February 2001.

(2) Existing Flood Control Projects by LGUs

Due to financial constraints, flood control projects by LGUs are limited to a few and small-scale riverbank protection works. Aside from the financial constraint, the LGUs also report a lack and/or insufficiency of technical staff capable in project formulation and preparation of feasibility studies on flood control.

Under such circumstances, Table 1.3.3 shows ongoing and proposed flood control projects by the provincial governments of Cagayan, Isabela and Nueva Vizcaya, and the municipal governments of Tuguegarao and Ilagan as of February 2001.

Among such proposed projects, it is worthy to note that Tuguegarao City has a plan to implement flood control projects with a total budget of Pesos 111.5 million to be assisted by a foreign loan.

(3) Existing Flood Control Plan by DPWH

The 1987 flood control master plan was formulated by JICA, as one of the components of the Water Resources Development Master Plan. In order to integrate the flood control plan into the water resources development master plan,

the flood control plan consists of four stage wise schemes of the framework plan, long-term plan, master plan and short-term plan.

The framework plan is a basin wide flood control plan with a design discharge of a 100-year flood, which embodies the ideal flood control system in the Cagayan River basin, while the long-term plan is a basin wide flood control plan with a reduced discharge of a 25-year flood within the scheme of the framework plan.

The master plan was formulated with several schemes encompassed in the above long-term plan aiming at the target year of 2005. Within the formulated flood control master plan, a few schemes were selected to form the short-term plan as an urgent implementation by 1995.

However, due to budget limitations, the short-term plan as an urgent project has not yet been implemented so far.

1.4 Flood Disaster Prevention System (Non-structural Measures)

1.4.1 Existing Disaster Management Plans and Activities

(1) Organization

Presidential Decree 1566 was issued in June 1978. The primal idea of the decree is to strengthen the disaster preparedness and response of the government from the national down to the barangays, thereby promoting local management assistance among the various local governments. Following the Presidential Decree 1566, the disaster coordinating councils were organized at national, regional, provincial, city/municipal and barangay levels. Figure 1.4.1 shows the communication flow among the disaster coordinating councils.

(2) National Disaster Management

The establishment of NDCC is embodied in Section 2 of the Presidential Decree 1566. The NDCC serves as the President's advisor on disaster preparedness programs, disaster operations and rehabilitation efforts. It functions as the top coordinator of all disaster management efforts and serves as the highest policy-making body. In the discharge of its functions, the NDCC utilizes the facilities and services of the OCD. The Calamities and Disaster Preparedness Plan was formulated by NDCC in 1988.

(3) Regional Disaster Management

RDCC is established in each Region and the Regional Director of the Philippine National Police chairs RDCC. Its functions are coordination of disaster operations activities, implementation of the NDCC guidelines, etc.

Disaster action plans and management systems have been established and operated in the Regions, Provinces, City/Municipalities and Barangays. In Region 2, RDCC2 prepared the general plan for typhoons/floods "OPLAN BAGYO/LAYOS" in May 1998. Cordillera RDCC also prepared Cordillera Regional Disaster Management Plan in 1994, which is in the process of revision. The purposes of the disaster action plans are to implement effective disaster preparedness, mitigation and prevention activities to minimize damage to property and human suffering.

The OPLAN of Region 2 embraces all kinds of emergency operations to mitigate the damage resulting from typhoons and floods by optimizing response and utilization of resources and capabilities of all RDCC2 member agencies. Eight committees have been created under the OPLAN as presented in Figure 1.4.2. The Committees are responsible for communication and warning services, health and medical services, transportation services, welfare and rehabilitation services, price stabilization and security services, relief service, rescue and recovery services, and training service, respectively. Each committee has a committee plan based on the implementing plan prepared by each member agency. The present committee plans are under updating and simplifying by the RDCC2.

PRO2 LOI LA NINA (IMPLAN) and LOI KALIGTASAN are to support the OPLAN.

In the Cagayan River basin, some joint operation on the disaster management is conducted between the RDCC2 and Cordillera RDCC. When any assistance of the RDCC2 on the emergency operation is required in the Chico River or other river basins in CAR, the Cordillera RDCC asks the RDCC2 for urgent response against disasters.

(4) Provincial, City, Municipal and Barangay Disaster Management

Provincial Disaster Coordinating Council (PDCC) is organized in each province and chaired by the governor. City Disaster Coordinating Council (CDCC)/ Municipal Disaster Coordinating Council (MDCC) is organized in each city/ municipality. Barangay Disaster Coordinating Council (BDCC) is organized at barangay level and chaired by the barangay captain.

According to questionnaire surveys conducted during the Study, the following issues are seen as activities of the DCCs:

1) Almost all the municipalities among the 13 municipalities in the lower Cagayan River basin have their disaster preparedness plans, while less than half of the barangays among 26 sample barangays have their plans,
2) Training of the staff in disaster management and drill for local people are insufficient, and,
3) Facilities in the existing evacuation centers are insufficient.

Detail of the questionnaire survey results is presented in Data Book.

1.4.2 Existing Flood Forecasting and Warning System

(1) General

There are 2 existing flood forecasting and warning systems in the Cagayan River basin. One is the Cagayan Flood Forecasting and Warning System operated by PAGASA. The another one is the Magat Dam Flood Forecasting and Warning System managed by NIA. Location of facilities of the systems is given in Figure 1.4.3.

(2) Cagayan Flood Forecasting and Warning System

In the communication and warning services of the OPLAN in Region 2, the Cagayan Flood Forecasting and Warning System is operated by PAGASA. The system consists of Tuguegarao subcenter, 5 rainfall/water level gauging stations and a repeater station as seen in Figure 1.4.3. According to the PAGASA subcenter in Tuguegarao, the present status of their operation is as follows:

1) The Tuguegarao subcenter, Ilagan repeater station and all the rain gauges are in normal operation,
2) Among 5 water level gauges, 3 gauges are not in normal operation due to siltation, no spare parts, etc., and,
3) Simple flood forecasting is made by the Tuguegarao subcentre based on the rainfall and water level data and staff's experience, which includes rainfall intensity and possible flooding area. The Central Office does not execute the flood forecasting due to old hardware.

Beside the above problems on the facilities, the Tuguegarao subcentre needs strengthening of the computer system for local flood forecasting as well as communication system.

(3) Magat Dam Flood Forecasting and Warning System

The Magat Dam Flood Forecasting and Warning System functions under NIA. The system consists of FFWS center facilities, 5 raingauges, 2 water level

recorders, 2 repeater stations, 15 new warning stations and 7 old warning stations as shown in Figure 1.4.3. According to the NIA MRIIS Office, the present status of their operation is as follows:

1) One new warning station is not operational because it has no battery. The others are functioning.
2) The flood warning is given to RDCC, LGUs and public. The warning area is limited to the lower Magat River area between the Magat Dam and Gamu as shown in Figure 1.4.4. The warning contains information on grade of river stage and instruction for evacuation.

The present needs for the FFWS center are upgrading of hardware and software for flood forecasting and warning.

1.4.3 Existing Evacuation Center

(1) Designated Evacuation Center

RDCC Region 2 through DSWD and in coordination with the DECS, DOH, LGUs and the religious sectors had identified and designated public elementary and secondary schools, district hospitals, rural health units and churches/chapels in municipalities and barangays adjacent to or near the disaster/flood prone areas as immediate evacuation centers for disaster victims which double as relief distribution centers. The number of the identified evacuation centers is 174 in Cagayan Province, 36 in NuevaVizcaya Province, 56 Quirino Province and 198 Isabela Province according to Integrated Regional Disaster Management, RDCC Region 2.

(2) Issues on Evacuation Center

The survey on present status of the existing evacuation centers was carried out during the Study, of which the results are shown in Table 1.4.1.

According to the above survey results as well as information given by OCD Region 2, the existing problems at the evacuation center are insufficient supply of water and food, and lack of cooking facilities and comfort rooms. The questionnaire survey on flood damages, of which the result is presented in Data Book, revealed that the respondents shun away from designated evacuation centers due to lack of these basic facilities. They would rather stay with relatives living at high ground while others prefer to stay home for fear of being looted.

1.5 Existing Flood Control Facilities and River Related Structures

1.5.1 Flood Control Facilities

(1) Structural Measures

Table 1.5.1 presents the existing structural measures of flood control in the Cagayan River basin by the direct control of the respective Districts Offices in Region 2. The major structures are the jetty on the right bank at the river mouth, concrete parapet walls on the right bank near the river mouth, cut-off channel in the lower Tuguegarao River, bank protection works in basin wide, etc.

There exists 1 jetty on the right bank near the river mouth of the Cagayan to block drift sands that will be transported dominantly from right side. The total length is around 520 m including newly extended portion of a 120 m. Also the concrete parapet walls were constructed for about 1.5 km along the right bank in the lower reach of the Cagayan.

At Tuguegarao, there exists 1 cut-off channel in the lower Tuguegarao River (river mouth) to regulate flow direction of the Tuguegarao River. The total channel length and width of the cut-off channel are 900 m and 100 m, respectively. At present, this cut-off channel is working as a main channel of the lower Tuguegarao River.

The typical flood control facilities in the Cagayan River are bank protection works. The bank protection works consist of gabion, concrete revetment, dry masonry, wet masonry, spur dike and those combined types.

1.5.2 River Related Structures

The major related structures are Magat dam, intake weirs for irrigation use named as diversion dam, irrigation pump station, bridge, etc. Those outlines are as follows.

(1) Dam and Intake Weir

In the Cagayan River basin, the Magat dam exists in the Magat River having two purposes of irrigation water supply and hydroelectric power generation. The following are the principal features of the Magat dam and the details are summarized in Table 1.5.2.

Magat Dam

Dam

Height: 114m

Crest length: 4,160 m

Crest elevation: EL 200m

Discharge capacity of spillway: 30,600m^3/sec

Reservoir

Full supply level (FSL): EL I93 m

Maximum flood level (MFL): EL I97.6m

Storage capacity at FSL: 1.08 billion m^3 (as of May l999)

Storage capacity at MFL: 1.26 billion m^3 (as of May l999)

Basin area at dam axis: 4,140km^2

Source□NIA□Region II Office□

Diversion Weir/Intake Weir

There are 2 major intake weirs for irrigation use consisting of scouring gate and sluiceway gate named as "Maris diversion weir" in the Magat River and "Chico diversion weir" in the Chico River. Table 1.5.2 shows the detailed dimensions of the diversion weirs.

Casecnan Diversion Dams (ongoing)

A Casecnan multipurpose irrigation and power Project (CMIPP) located in the upper basin of the Cagayan River is presently being implemented under a BOT agreement with the California Energy Corporation as the proponent. The objective of the project is to divert water for multipurpose use into the reservoir of Pantabangan dam located in the Pampanga river basin by means of two diversion dams with 25 m high and 200 m long each at Denip and Casecnan rivers, and a 26 km long tunnel into the Pantabangan reservoir with a diameter of 6.5m.

(2) Irrigation Facilities

Reservoir and Storage Dam

Small-scaled reservoirs are constructed on the upper reach of the small streams, though only 4 and 9 numbers are listed in lsabela and Quirino provinces, respectively.

Intake

Uncontrolled natural flow intake facility is usually on tributaries, for example on the Pinacanauan Tuguegarao River in Penablanca. Intake type diversion is taken in 7 NISs, namely Baggao, Dummon, Zinundungan, Penablanca, San Pablo-Cabagan, Tumauini and Bagabag systems.

Irrigation Pump Station

Pump stations of Mgapit, Amulung, Iguig and Solana exist along the main Cagayan River under the direct administration of NIA. Table 1.5.3 outlines the existing facilities. A CIS pump station is at Santa Maria.

(3) Bridges

There are a lot of road bridges across over the main Cagayan and its major tributaries. Table 1.5.4 summarizes the existing bridges based on the inventory survey.

Among the above bridges, the detailed dimensions of the Magapit bridge at the lower end of the Magapit narrows were surveyed in connection with widening scheme of the bottlenecks in the narrows. Figure 1.4.1 shows the outline of the Magapit bridge and the major dimensions are summarized as fo1lows.

Class of road

Main highway□national highway□

Completion year of construction

1972

Dimension of bridge

Bridge width: 10m (carriage way: 7.32m and pavement:1.34m×2)

Bridge length: 329.8m (256.6×l main span□36.6×2 spans)

Bridge type: suspension (main span) and steel truss girder (both side spans)

Foundation type of main tower and abutment: steel pipe pile foundation for left bank and direct foundation for right bank

CHAPTER 2 LONG TERM FLOOD CONTROL PLAN

2.1 Basic Concept of Flood Control

To cope with flood control problems involved in the basin, a flood control long-term plan proposed in the 1987 Master Plan is examined and reviewed in this chapter. Study items in this chapter are basic concept of flood control, alternative study on flood control in the lower Cagayan and selection of an optimum plan, and finally formulation of reviewed flood control long-term plan. Firstly, the basic concept of flood control will be described below.

2.1.1 Target Area

The target area to be protected under the flood control long-term plan is the whole Cagayan River basin including watersheds in the upper basin and major tributaries.

2.1.2 Basic Concept

Flood damage or disaster may be conceptually given by the following equation.

Flood damage = Hazard ×Vulnerability

Hazard is a risk of natural disaster and may be reduced by structural measures of flood control. Vulnerability is a social weakness for coping with hazard. If there is no people in the hazardous area and no property therein, no damage may occur. The vulnerability may be reduced by means of relocation of affected people and/or evacuation at risk of emergency hazard. Evacuation and resettlement are called here as non-structural measures.

The target of the flood control project is to prevent casualties and damages to assets from disasters resulting in inundation, river course shifting with river meander, riverbank erosion, etc., likewise to increase agricultural products for improvement of the regional economy in the Cagayan River and poverty incidence that is considerably high as 40 to 60 %.

Figure 7.1.1 presents a concept of flood damage mitigation measures to be applied in the study and those basic concepts are outlined below.

a) Flood damage mitigation measures consist of structural measures, non-structural measures and supporting measures as described in the following.

- The structural measures mainly aim to alleviate the causes of flood damage or to mitigate hazard by constructing dikes, cut-off channels,

flood control dams, retarding basins, etc.

- The non-structure measures mainly aim to reduce damageable objects or properties in the flood prone areas or lower vulnerability areas against disasters by means of floodplain management, flood forecasting and warning system, evacuation system, etc., supported by legislation and establishment of consensus among the people and the authorities concerned.
- The supporting measures aim to support and sustain both the above measures by improving organizational and institutional aspects, and funding system for the project implementation.

b) The following basic lines of flood control are adopted.

- In the upper Cagayan: to store floodwaters and decrease flood peaks towards downstream reaches as much as possible,
- In the middle Cagayan: to retain a part of floodwaters in case appropriate and suitable land is available and if not, to discharge floodwaters promptly by dike system, and
- In the lower Cagayan: to discharge floodwaters promptly by dike system including river channel improvement.

c) Flood control projects are implemented with a stage wise (phase-by-phase) aiming at the target year of 2020 from the technical aspect of flood control and financial aspect of funding constraint.

2.1.3 Conditions for Formulating Flood Control Plan

The following are the planning conditions for a plan formulation.

1) A design flood with 1/25 return period is adopted based on the current criteria being applied in the ongoing flood control plans and projects under the direct control of the DPWH (same as 1987 Master Plan).
2) Five multipurpose dams (Mallig No.2, Siffu No.1, Magat, Alimit No.1 as subrogation to Magat, and Matuno No.1) in the upper Cagayan including tributaries are incorporated as a given condition and already reviewed in CHAPTER 6.

   Allocated flood control spaces are 112 million m^3 for Mallig, 115 million m^3 for Siffu and 139 million m^3 for Magat, respectively.
3) For the middle reach of the Cagayan, a dike system as proposed in 1987 Master Plan is incorporated for smooth and swift drainage of floodwaters.
4) For the lower reach of the Cagayan, a dike system is provided including river channel improvement to accelerate smooth and swift drainage of floodwaters.

5) In the major tributaries of Ilagan, lower Magat and lower most of the Siffu-Mallig in the middle Cagayan, dike systems proposed in 1987 Master Plan are incorporated as they are. On the other hand, in the Chico and middle Siffu-Mallig Rivers, special countermeasures are not taken up under the condition that the existing retarding functions of the respective channels are remained as they are.
6) The bank protection works at 73 sites are taken up, as they are in the long-term plan. Two types of a slope protection and a spur dike are applied in the bank protection works. The slope protection principally consists of a riprap foot protection and a slope protection of gabion or dry masonry.
7) The river width between continuous dike scheme and its alignment shall be the same as proposed in the long-term plan in 1987. In the 1987 Master Plan, the river width was estimated to be more than $10\sqrt{A}$, where A is basin area in km^2. According to this criterion, the river width in the lower Cagayan will be approximately from 2 km near river mouth to 1.5 km in the upstream of Alcala. This relationship is developed in the design of rivers in Japan under comparable conditions.
8) The standard dike section is a trapezoidal section with riverbank tree zone as shown in Figure 2.1.2. The riverbank tree zone is planned with around 30 m in wide along the dike alignment on the riverside.
9) The design high water level is planned based on the water level calculation by non-uniform flow method.
10) The following design discharge distribution proposed in the 1987 Master Plan as shown in Figure 2.1.3 is adopted as it is.
    - River mouth to confluence with Chico River: 17,900 m^3/s
    - Confluence with Chico to confluence with Siffu River: 17,700 m^3/s
    - Confluence with Siffu to confluence with Ilagan River: 16,900 m^3/s
    - Confluence with Ilagan to confluence with Magat River: 15,600 m^3/s
11) Manning's roughness coefficients are 0.04 for low water channel, 0.10 for floodplain and 0.06 for flood plain with a confined dike, as applied in the 1987 Master Plan.
12) Widening of bottlenecks in the Magapit narrows is planned as follows.
    The riverbanks at the bottlenecks are widened up to the low water channel width of 500 m with an average bank slope of 1 to 2 and the excavation level is planned at design riverbed elevation considering the present mean riverbed elevations in the lower reaches.
13) Cut-off channel upstream of Alcala is planned as follows.
    The width of cut-off channel (low water channel with compound section) is

planned at 500 m estimated as an average low water channel width in the up and downstream reaches of the proposed cut-off channel.

The riverbed elevation of the channel is planned at design riverbed elevation considering the present mean riverbed elevations in the up and downstream reaches (Figure 2.2.3).

14) Topographic maps prepared in 1979 are used as the basic maps in the planning. The river cross-sections surveyed by the study team in 2000 are used for hydraulic study in river planning.

2.1.4 Upper Cagayan

The remarkable flood control problems in the watershed of the upper Cagayan especially in the upper Magat River are deforestation, voluminous sediment yields caused by landslides and sedimentation in the existing river channel. Further, other flood control problems in this reach of the Cagayan including those of Mallig, Siffu and Ilagan Rivers which are local inundations in the low-lying areas limited to the riverside areas and local riverbank erosions.

The most important role of this reach in the flood control aspect is, as much as possible, to store floodwaters not only for reduction of peak discharges towards the downstream reaches but also for irrigation developments.

To cope with such problems in the upper Cagayan, the following measures are taken up in the flood control plan.

- Reforestation (watershed management) in the mountainous areas
- Reduction of flood peaks by dams
- Riverbank protection

The watershed management programs would consist of the reforestation and Sabo works. The details are explained in ANNEX VII Watershed Management.

A construction of 4 multipurpose dams (Siffu No.1 dam, Mallig No.2, Alimit No.1 dam and Matuno dam) and a modification of the present operation rules of Magat dam as already reviewed in CHAPTER 6 MULTIPURPOSE DAMS in the Main Report is incorporated in the long-term plan. Especially at the Magat dam, a flood control space of 135 million m^3 is to be attained in the present reservoir. For other dams, a flood control space will be 115 million m^3 at the Siffu No.1 dam and 112 million m^3, at the Mallig No.2 dam, respectively. Such attained flood control spaces contribute drastically to mitigation of flooding in the downstream reaches.

As another problem, voluminous gravels and sands deposited especially in the upper Magat River upstream of the Magat dam is a further challenging matter for

effective utilization of dam reservoir aiming at extension of the lifetime of the present Magat dam reservoir. Accordingly, an excavation of such deposited gravels and sands are inevitable and an important issue for the future.

2.1.5 Middle Cagayan

The remarkable flood control problems in the middle reach of the Cagayan River upstream of Cabagan are inundations in the low-lying areas along the river courses and local riverbank erosions.

In order to alleviate such problems, in this reach, it is ideally to retain a part of flood in view of reduction of flood peaks towards the downstream reaches with the same idea for flood control dam. Regrettably, this flood retention basin scheme is not taken in the plan because of non-availability of appropriate and suitable land. However, the retaining or storage functions available in the existing river channels of the lower Cagayan and middle Siffu-Mallig Rivers are kept as they are. In this reach, reduction of flood peaks is expected in the future owing to the reforestation in the watersheds and constructions of multipurpose dams.

Accordingly, the following measures are taken up in the middle Cagayan.

- Riverbank protection
- Dike systems including Ilagan, lower Magat and lower most of the Siffu-Mallig as proposed in the 1987 long-term plan

As mentioned above, in order to ultimately alleviate inundations involved, a construction of continuous dike systems as proposed in the 1987 long-term plan is incorporated in this review, as they are in the middle Cagayan River upstream of Cabagan including Siffu-Mallig, Magat and Ilagan.

2.1.6 Lower Cagayan

(1) Preliminary Review of Proposed Schemes of the Master Plan in 1987

Firstly, a preliminary review on the selected structural schemes in the lower reach proposed by the Master Plan in 1987 will be made for the 6 components categorized as a river channel improvement aiming at selection of conceived schemes for the further review. As already reviewed in CHAPTER 6 Multipurpose Dams of the Main Report, three multipurpose dam schemes (with flood control space) are incorporated in the long-term plan to be reviewed as a given condition.

The review was made for the above 6 components on the basis of economic viability (EIRR). Applying price deflators derived from CPI and WPI for the

cost, and CPI and growth of GRDP per capita for the benefit, respectively, recalculated EIRR for each candidate project, thereby reevaluating their priority ranks. The further information is descried in section 10.8 in CHAPTER 10 of the Main Report.

The result is as follows.

No	Component	EIRR(%) under present condition	EIRR (%) under future condition	Priority order
1	Tuguegarao dike	17.1	25.5	1
2	Narrow improvement (NLL)	12.7	20.2	2
3	Bank protection works	6.9	12.9	4
4	Cabagan dike	7.6	13.8	3
5	Narrow improvement (NLR)	6.4	12.3	5
6	Narrow improvement (NUP)	-	-	6

As shown in the table, the components that EIRR is more than 15 % under future conditions are 2 only among 6 components. Thus, the above 2 components of Tuguegarao dike and narrow improvement are considered as advantageous ones from the economic viewpoint.

On the other hand, the bank protection works are below the 15 % of the EIRR. However, implementation of bank protection works has been strongly requested through workshops held so far. Accordingly, it is recommendable to take up bank protection works in the long-term plan to be reviewed with due consideration of prevention of damage from casualty and to asset as well as improvement of social welfare and poverty alleviation.

From the above preliminary review results, new components for the review of the long-term plan in the lower reach from Magapit narrows to Tuguegarao would be as follows:

1) A widening scheme of the bottlenecks in the Magapit narrows in order to lower the floodwater levels and its duration in the upstream reach at Alcala,
2) A dike scheme in the upstream at Alcala to protect the residential areas and agricultural lands from its frequent inundations and to enhance land use condition, and
3) A bank protection works scheme to stabilize the low water channel in basin wide.

(2) Basic Approach of Flood Control in the Lower Cagayan

An approach of flood control in the lower reaches downstream of Cabagan is to discharge floodwaters promptly to the sea. Considering the above components

reviewed preliminary, conceived schemes in the lower Cagayan would be as follows.

River Mouth to Magapit Bridge

The Cagayan River in this reach runs in an average river width of 1.5 to 2km. Hilly areas and marsh on the left bank and a national highway on the right bank confine the main channel with a sufficiently high elevation well protected against floodwater levels in the main channel. According to an interview with the inhabitants, it is reported that overflow to the inland from the main channel never happens along this reach. So far, as the study results imply, the Cagayan River channel is fairly stable considering riverbed fluctuation, river course shifting, etc.

In addition, there exists no river mouth clogging although local sedimentation accompanying shifting of sandbars in the lower reach can be observed. It can be said that this reach is presently not facing any urgent and severe flood control problem except for local riverbank erosion. However, channel capacity in this reach is locally less than the design discharge for 25-year probable flood.

From the above, the following measures are taken up in the review.

- Riverbank protection
- Dike system

In this review, a construction of dike system proposed in the long-term plan in 1987 is incorporated to mitigate flood damage.

Magapit Bridge to Upstream of Tuguegarao

The remarkable flood control problems in this reach are frequent inundations over the extensive floodplain in the upstream of Alcala resulted from bottlenecks in the Magapit narrows and river course shifting with local riverbank erosions.

In order to mitigate frequent inundations and stabilize low water channel, the following river channel improvement are examined in this review.

- Widening of bottlenecks in the Magapit narrows
- Dike system with cut-off channel as channel normalization
- Riverbank protection

The detailed examination for the above that is a main item in this review will be conducted in the following section 2.2.

Upstream of Tuguegarao to Cabagan

In this reach, the Cagayan river runs with an average flow width of 1.5 to 2 km including floodplains confined by the higher natural levee on the left bank and a national highway on the right bank with a sufficiently high ground elevation against floodwater levels of the main channel. Also the backwater from the

bottlenecks in the Magapit narrows has not affected this reach. According to interviews with residents at Cabagan town, it is reported that the town area has not been damaged from inundation after completion of the Magat dam in 1990.

There exists no remarkable and urgent flood control problem except for local bank erosion compared with those in the floodplains upstream at Alcala. Further, flood peaks in this reach are so much reduced owing to attained flood control spaces of the multipurpose dams especially by the Magat dam. Further, it is expected that the channel normalization in the downstream lower floodwater level in this reach. However, channel capacity in this reach is as a whole less than the design discharge of 25-year probable flood.

Accordingly, the following measures are taken up in the review.

- *Riverbank protection*
- *Dike system*

As mentioned above, in order to ultimately alleviate inundations involved, a construction of continuous dike systems as proposed in the long-term plan in 1987 is incorporated in this review as they are.

Chico River

The Cagayan River joins a left tributary of the Chico River at Nassiping. The lower Chico River from its river mouth to 10 km upstream runs in an average low water channel width of 400 m. The carrying capacity of the low water channel is estimated at 5,000 to 10,000 m^3/s below the riverbank elevation. Hilly area on the left bank and a provincial road on the right bank confine the river channel including the floodplain, with a sufficiently high elevation well protected against floodwater levels in the Chico and Cagayan Rivers. Therefore, the land in the right bank has been fully developed as paddy fields.

According to interviews with the inhabitants residing near the confluence, it is reported that water overflowing from the Chico and Cagayan has not affected residential areas and paddy fields in this reach, especially during flooding of such magnitude that occurs once in several years.

Consequently, special countermeasures are not taken up in this reach under the condition that the existing retarding function of the Chico River is to remain as it is. Meanwhile, the bank protection works proposed for the middle of the Chico River is taken up as it is in the flood control plan.

2.2 Alternative Study of Flood Control Long Term Plans (from Magapit to Tuguegarao)

2.2.1 Objective Reaches of Alternative Study

Based on the concept and consideration made in the above section 2.1 Basic Concept for Flood Control, a review of the 1987 long-term plan in the reach from Magapit to upstream of Tuguegarao is made in this section. The alternative plans for the above review are examined for the divided reaches considering river characteristics and problems described in Section 1.1.3 River Morphology in CHAPTER 1. Objective reaches will be the 3 reaches as shown below.

- Magapit Narrows (Magapit bridge to Alcala)
- Alcala to Buntun bridge
- Buntun bridge to upstream of Tuguegarao

2.2.2 Flood Control Plan in the Magapit Narrows (Magapit to Alcala)

(1) Flood Control Problem

The flood control problems in this reach are backwater towards upstream reaches due to existence of the bottlenecks in the narrows and riverbank erosions. The main objectives of the study in this reach are to lower floodwater levels and those durations in the upstream reaches. Countermeasures against the above are studied in the following.

(2) Location of Bottlenecks in the Magapit Narrows

Figure 2.2.1 shows the extent of backwater due to the bottlenecks in the Magapit narrows. Rising of flood levels at Alcala (65 km) located at the upper end of the narrow is approximately 2.6 m against the 100-year flood and 2.0 m, for the 25-year flood under the present river condition.

According to the above calculation, the following are the exact locations of the bottlenecks (defined as river reach which has an average low water channel width less than 500 m that is estimated in the upstream reach at Alcala), as shown in Figure 2.2.2.

- Tupang site (upper end of the narrows)
- Nassiping site (upstream of Nassiping bending and upstream of the confluence with the ChicoRiver)
- Magapit bridge site (lower end of the narrows)

(3) Alternative Plans of Widening

Widening of the bottlenecks is planned in the following viewpoints.

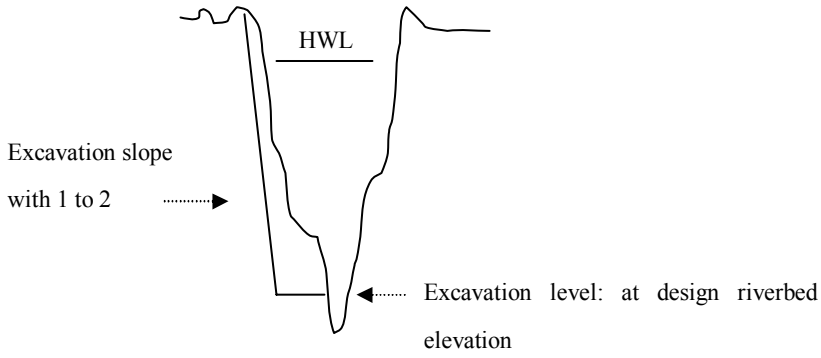
1) To lower floodwater levels and to shorten their durations in the upstream reach at Alcala for mitigation of flood damage due to frequent inundations and enhancement of land use conditions.
2) To stabilize the river course shifting incidentally by increase of surface water slope resulting from widening of the bottlenecks (that is, towards a more straight channel in combination with construction of cut-off channel, riverbank forest zone and bank protection works to be considered in the upstream reach at Alcala).

For the present 3 major bottlenecks in the narrows, the following 5 cases are taken up in the alternatives for widening.

Case 1: Without widening (present condition)
Case 2: Widening of 1 bottleneck at Tupang (channel width: 500 m)
Case 3: Widening of 2 bottlenecks at Tupang and Nassiping (channel width: 500 m)
Case 4: Widening of 3 bottlenecks at Tupang, Nassiping and Magapit (channel width: 500 m)
Case 5: Widening of 3 bottlenecks at Tupang, Nassiping and Magapit (channel width: 700 m)

For the above respective cases, the widening is principally planned in line with the conditions as already discussed in Section 2.1.3 Conditions for Formulating Flood Control Plan. Additional conditions in this reach are as follows.

1) The riverbanks at the bottlenecks will be widened to the low water channel width of 500 m or 700 m with an average bank slope of 1 to 2.
2) The excavation level is planned at a design riverbed elevation considering the present mean riverbed elevations in the lower reaches as shown in Figure 2.2.3.
3) An image of the widening is as follows.



4) In the Case 4 and Case 5, the bottleneck at Magapit bridge site is to be widened. In widening of the bottleneck, a construction of a diversion

channel scheme is selected through a comparative study consisting of 2 alternatives of 1) widening the existing low water channel and 2) a construction of a diversion channel. A bridge of continuous PC box girder with 3 spans is proposed across over the proposed diversion channel.

The present land use conditions of the right of way at the bottlenecks to be widened are as follows:

Site	Left bank	Right bank
Tupang	Forest, houses	Corn fields (only dry season)
Nassiping	Forest	-
Magapit	Paddy fields and non-cultivated lands, around 10 small houses	-

For the above 5 cases, the floodwater levels against 1/25 flood, 1/10 flood and 1/5 flood under the present river condition are calculated to grasp the effect of the widening scheme. The extent of the lowering compared with no widening of Case 1 is summarized below.

Case	Extent of lowering of flood water levels (m)							
	Alcala site for respective probable floods			Amulung site for respective probable floods			Buntun Br. site for 1/25 probable flood	Cabagan site for 1/25 probable flood
	1/25	1/10	1/5	1/25	1/10	1/5	1/25	1/25
Case 2	0.50	0.47	0.44	0.33	0.26	0.20	0.13	0.03
Case 3	0.69	0.63	0.58	0.44	0.34	0.26	0.17	0.04
Case 4	0.77	0.69	0.64	0.49	0.37	0.29	0.18	0.04
Case 5	2.33	2.11	1.98	1.27	0.90	0.70	0.42	0.09

The above 5 cases are proposed in the alternative study for formulation of the flood control long-term plan combined with the optimum plans to be selected in the upstream reaches at Alcala, which are described below.

2.2.3 Flood Control Plan in the Reach from Alcala to Buntun Bridge

(1) Flood Control Problem

The critical flood control problems in this reach are frequent inundations extending over the floodplain, and river course shifting (meandering) and riverbank erosions. This reach has suffered from such serious flood damage for centuries. There exist a lot of residential areas, agricultural areas and infrastructures in this reach. Aside from the above, three irrigation development projects has been proposed by NIA to improve the agricultural productivity as enhancement of the regional economy. They are Alcala-Amulung West pump irrigation project, Solana pump irrigation system rehabilitation and extension project, and Iguig-Alcala-Amulung pump irrigation project.

(2) Conceived Alternative Plans

Alternative plans in this reach are prepared with the following viewpoints considering geological features in this reach, which were described in Section of 1.1.3 River Morphology in CHAPTER 1.

1) To stabilize low water channel by means of cut-off channel and riverbank forest zone with incidental effect by the widening of bottlenecks in the downstream narrows.
2) To mitigate flood damage due to frequent inundations by means of dike system.

In setting up alternative countermeasures, a basic idea as mentioned above is to stabilize the existing low water channel by constructing cut-off channels as channel normalization and to maximize land use efficiency by constructing continuous dike system with riverbank forest zone on the left bank. Objectives of the riverbank forest zone are to regulate flood flowing width, reduce sediment damage in the agricultural land over the floodplain and form natural levee by sedimentation.

As another alternative for the continuous dike system, a dike system with partial levees is considered to protect major residential areas and agricultural lands by utilizing the existing natural levees for embankment. In this case, river width will be more than the 1.5 km considering alignments of the existing natural levees.

From the above, the following 4 cases are examined comparatively to select an optimum scheme under a condition of without widening of the bottlenecks in the narrows, as shown in Figure 2.2.4.

Case1: Construction of 2 cut-off channels (Gabut and San Isidro) and 1 continuous dike system with riverbank forest zone (Alcala to Buntun)

Case2: Construction of 1 cut-off channel (Gabut) and 2 dike systems with partial levee (Amulung and Solana)

Case3: Construction of 1 cut-off channel (Gabut) and 2 dike systems with partial levee (Amulung and Solana)

Case4: Construction of 2 dike systems with partial levee (West Amulung and Solana)

For the above components, the comparative study is made in accordance with conditions already discussed in Section 2.1.3 Conditions for Formulating Flood Control Plan. Additional conditions in this reach are as follows.

A national highway as a trunk road in the Region 2 runs along the right bank. The highway is functioning as a flood dike on the right bank at a sufficiently high elevation against floodwater levels in the main channel. In this plan, the national highway is considered as the existing dike on the right bank. However, a part of the national highway near Alcala is subject to inundation by big floods that occur once every several years. A raising scheme will be incorporated in the study.

The present land use conditions of the right of way on the proposed cut-off channels are as follows.

Scheme	Land condition of right of way
Gabut cut-off channel	Old river course, cornfields (only dry season)
San Isidro cut-off channel	Residential area, irrigated paddy fields, cornfields (only dry season)
Dike system	Non-cultivated area, cornfields (only dry season)

(3) Selection of Optimum Plan

Based on the preliminary design for each case under a condition without widening of Magapit narrows, the construction costs are as shown in Table 2.2.1 and benefits were calculated. The economic evaluation result under future economic growth conditions combined with the incorporated 3 irrigation development projects is as follows:

Case	Construction Cost (million Pesos)		Benefit (million Pesos)		Economic IRR (%)	
	Flood Control	Irrigation	Flood Control	Irrigation	Under present condition	Under future condition
1	5,288	2,458	28	1,096	10.0	19.6
2	3,127	1,759	23	666	9.4	19.2
3	2,608	1,638	21	575	9.4	19.1
4	1,416	1,311	18	375	9.1	19.0

Note; The detailed information: refer to Section 10.8 CHAPTER 10.

As seen in the table, Case 1 shows a highest EIRR among the four cases. Considering improvement of agricultural production in order to enhance regional economy, Case 1 is selected as the optimum flood control plan in this reach. An alternative study combining with alternatives in the Magapit narrows described in the above 2.2.2 will be made for the formulation of a flood control plan in the later section 2.3. The optimum plan consists of construction of 2 cut-off channels as channel normalization and 1 dike system with riverbank forest zone in the floodplain.

[From a viewpoint of implementation order, the cut-off channel is firstly constructed and concurrently riverbank forest zone is provided to stabilize the low water channel. After stabilization of the low water channel, dike is to be constructed]

2.2.4 Flood Control Plan in the Reach from Buntun Bridge to Tuguegarao

(1) Flood Control Problem

In this reach, Tuguegarao City, the capital city of the province of Cagayan and a regional center for the Cagayan Valley Region 2 is situated along the Cagayan River and its right tributary, the Tuguegarao River. Flood flowing from both the Cagayan and Tuguegarao Rivers attacks directly the center area of the city. Due to such situational draw back there, the city has been suffering from severe flooding and bank erosion for centuries.

On the other hand, agricultural areas in the hinterlands of Enrile have also been suffering from frequent inundation due to backwater from the Cagayan River and water shortage for cultivation. In order to improve the present agricultural production in the areas, an irrigation development scheme under the Enrile pump irrigation project has been proposed.

In order to protect the capital city area from serious flood problem and to ensure that there is no interruption in the performance of its functions as a capital city and a regional center, countermeasures are studied in the following manner:

(2) Conceived Alternative Plans

The alternatives to cope with the above problems are examined in the following viewpoints.

1) To regulate flow directions of Cagayan for the protection of Tuguegarao city from floodwaters of the Cagayan and Tuguegarao Rivers.
2) To mitigate flood damage due to frequent inundations.

There are two ideas to protect the capital city area from serious riverbank erosions and frequent inundations. One is to improve the existing river and another is to construct a diversion channel or a cut-off channel. The diversion channel or cut-off channel schemes are taken up from the viewpoints of not only the above aspects but also the lower floodwater levels in the upstream reaches.

From the above, the following 3 countermeasures that include river training at the confluence with the Tuguegarao River are comparatively studied under a condition of without widening of bottlenecks in the narrows. Figure 2.2.5 shows the countermeasures in this reach.

Case1: Improvement of the present Cagayan river channel and construction of two dike systems (Tuguegarao and Enrile)

Case2: Construction of Tuguegarao diversion channel and one dike system (Tuguegarao)

Case3: Construction of cut-off channel (Tuguegarao) and two dike systems (Tuguegarao and Enrile)

For the above major components are planned in line with the conditions as already mentioned in the former section 2.1.3 Conditions for Formulating flood Control Plan. Additional conditions in this reach are as follows.

1) The width of the low water channel for diversion is planned at 500 m.
2) For Case 1 and Case 3, a spur dike system is provided to regulate flow direction of the Cagayan River.
3) For Case 2, an intake canal is provided because of change of river course route, as a compensation works for the existing Solana pump station.

The land use conditions of the right of way for the above diversion and cut-off channels are as follows.

Scheme	Land condition of right of way
Diversion channel	Residential area, corn and paddy fields, non-cultivated areas
Cut-off channel	Cornfields (only dry season), river channel
Dike system	Non-cultivated area, cornfields (only dry season)

(3) Selection of Optimum Plan

Based on the preliminary design for each case under a condition without widening of Magapit narrows, the construction costs as shown in Table 2.2.2 and benefits were calculated.

The result of the comparative study under future economic growth conditions combined with the incorporated 1 irrigation project is as follows:

Case	Construction Cost (million Pesos)		Benefit (million Pesos)		Economic IRR (%)	
	Flood Control	Irrigation	Flood Control	Irrigation	Under present condition	Under future condition
1	2,011	560	256	204	15.3	26.0
2	16,025	560	588	204	4.1	10.5
3	4,975	560	837	204	16.4	27.6

Note: The detailed information; refer to Section 10.8 CHAPTER 10.

From the result, Case 3 indicates the highest EIRR. The Case 3 is selected as the optimum flood control plan in and around the capital city. The optimum plan consists of constructions of 1 cut-off channel for channel normalization and 2 dike systems.

2.3 Structural Measures of Flood Control Long Term Plan in the Middle Lower Cagayan

2.3.1 Selection of Optimum Plan

By combining the 5 alternatives for bottleneck widening in the narrows (explained in Section 2.2.2) with the selected 2 optimum plans in the reaches from Alcala to upstream of Tuguegarao (explained in former section 2.2.3 and 2.2.4), a comparative study is made to select an optimum scheme in the following manner.

(1) Alternative Schemes

The following five alternative schemes are comparatively examined and each component of the respective alternatives are as listed below.

Alternative 1

- Without widening of the Magapit narrows
- Construction of 2 cut-off channels and 1 dike system (with riverbank forest zone) in the reach from Alcala to Buntun bridge
- Construction of 1 cut-off channel and 2 dike systems in the reach from Buntun bridge to upstream of Tuguegarao

Alternative 2

- Widening of Tupang (low water channel: widening to 500 m)
- Construction of 2 cut-off channels and 1 dike system (with riverbank forest zone) in the reach from Alcala to Buntun bridge
- Construction of 1 cut-off channel and 2 dike systems in the reach from Buntun bridge to upstream of Tuguegarao

Alternative 3

- Widening of Tupang and Nassiping (low water channel: widening to 500 m)
- Construction of 2 cut-off channels and 1 dike system (with riverbank forest zone) in the reach from Alcala to Buntun bridge
- Construction of 1 cut-off channel and 2 dike systems in the reach from Buntun bridge to upstream of Tuguegarao

Alternative 4

- Widening of Tupang, Nassiping and Magapit (low water channel: widening to 500 m)
- Construction of 2 cut-off channels and 1 dike system (with riverbank forest zone) in the reach from Alcala to Buntun bridge
- Construction of 1 cut-off channel and 2 dike systems in the reach from Buntun bridge to upstream of Tuguegarao

Alternative 5

- Widening of Tupang, Nassiping and Magapit (low water channel: widening to 700 m)
- Construction of 2 cut-off channels and 1 dike system (with riverbank forest zone in the reach from Alcala to Buntun bridge
- Construction of 1 cut-off channel and 2 dike systems in the reach from Buntun bridge to upstream of Tuguegarao

(2) Design Conditions of Alternative Schemes

The 5 alternative schemes are preliminary designed in line with the same manners as mentioned respectively in Section 2.2 Alternative Study on Flood Control Long Term Plans. The high water level at upper end of Tuguegarao cut-off channel is set at almost same level estimated against design discharge in the present river condition to minimize negative impact towards upstream caused by construction of dike system in the reach from Alcala to Tuguegarao. For this purpose, cross-sectional area of cut-off channels is studied in more detail.

(3) Selection of Optimum Scheme

Based on the preliminary design results for each of the alternatives, construction costs were estimated as shown in Table 2.3.1. Through economic evaluation for alternatives with the combined schemes of the said 4 irrigation projects in the reach from Alcala to Tuguegarao, the economic evaluation results under future condition are summarized below.

Alternative	Construction Cost (million Pesos)		Benefit (million Pesos)		Economic IRR (%)	
	Flood Control	Irrigation	Flood Control	Irrigation	Under present condition	Under future condition
1	10,436	3,018	865	1,300	12.5	22.5
2	14,904	3,194	872	1,542	10.5	19.4
3	16,895	3,194	875	1,544	9.6	18.2
4	18,486	5,020	881	1,734	9.0	16.9
5	57,918	5,020	899	1,823	2.9	8.4

Note: The detailed information; refer to Section 10.8 CHAPTER 10.

As seen in the table, Alternative 1 indicates the highest economic internal rate of return. Accordingly the Alternative 1 is selected as the reviewed flood control long-term plan. The widening of Magapit narrows is excluded from the reviewed long-term plan although this scheme remains as one of the components in the framework plan.

(4) Impact towards Up and Downstream Reaches

In case the flood control projects are implemented only in the reach from Alcala to Tuguegarao (only Alternative1), it would cause some impacts on the up and downstream reaches. In this section, such impacts including positive ones were studied.

Lowering of floodwater levels

The lowering of flood levels for the design flood (25-year flood) is estimated for the respective construction stages. The result is as follows compared with those in the present condition. It should be noted that the reach from Namabbalan to Sta Maria is in the present channel condition that has no dike system.

Construction Stage	Lowering of Flood Levels (m)					
	Alcala	Amulung	Iguig	Buntun Bridge	Namabbalan	Sta. Maria
COC only	0.00	0.49	1.41	0.92	0.69	0.36
COC+Dike	0.00	0.21	0.94	0.10	(-) 0.08	(-) 0.04

Note: (-) in the above table means increase of flood level.

Increase of outflow to downstream reach

One of negative impacts is an increase of outflow to downstream reaches. According to estimation of increase of outflow in CHAPTER 10 of the Main Report, increase of the 25 year flood under present river condition is estimated in the lowermost reaches (downstream of confluence with Chico river) at 9.8 % (1,550 m^3/s) for construction of both 3 dike systems and 3 cut-off channels and 4 % (640 m^3/s) for construction of 3 cut-off channels only.

Increase of velocity

Increase of average velocities will be as follows. Such velocities are not so high, however, bank protection works will be considered at affected sites.

Construction stage	Change of Velocity in the upstream reach of COC (m/s)		
	Gabut coc	San Isidro coc	Tuguegarao coc Tuguegarao coc
Present condition	0.97	0.71	1.06
COC only	1.06	0.89	1.30
COC+ Dike	1.26	1.22	1.06

2.3.2 Reviewed Flood Control Long Term Plan

(1) General

The reviewed flood control long-term plan is a sectoral development plan with socially, economically and environmentally viable projects consisting of the reviewed schemes for the middle lower Cagayan from Alcala to Tuguegarao, and

bank protection works in basin wide and other flood control schemes except the projects in the middle lower Cagayan as a given condition. The plan is designed for the economic scale of a 25-year flood. The following is an outline of the reviewed flood control plan (Figure 2.3.1).

(2) Features of Flood Control Projects in Reviewed Long Term Plan

Flood control projects in the middle lower Cagayan from Alcala to Tuguegarao

The structural measures of the reviewed plan consist of dike systems with riverbank forest zone and cut-off channels. The features of the flood control projects in this reach are as follows and presented in Figure 2.3.2.

a) Alcala-Buntun dike system with riverbank forest zone
- Dike length: 38.6 km (Embankment vol.: 6 million m^3)
- Gabut cut-off channel length: 0.9 km (Excavation vol.: 4 million m^3)
- San Isidro cut-off channel length: 2.1 km (Excavation vol.: 7.4 million m^3)
- Drainage culvert: 2 nos. for tributaries, 58 nos for local
- Revetment: 55,000 m^2
- Overflow bridge: 2 sites
- Raising of surface elevation of national highway: 5.5 km (0.5 million m^3)

b) Tuguegarao dike system
- Dike length: 14.3 km (Embankment vol.: 1.7 million m^3)
- Tuguegarao cut-off channel length: 6.7 km (Excavation vol.: 17.5 million m^3)
- Drainage culvert: 21 nos for local
- Revetment and spur dike: 43,000 m^2

c) Enrile dike system
- Dike length: 4.6 km (Embankment vol.: 0.8 million m^3)
- Drainage culvert: 7 nos. for local

Bank protection works in the basin wide

The bank protection works are proposed at 73 sites in the basin including urgent work for 43 sites in the heavily eroded areas (regarding the urgent works, refer to section 10.4.2 in CHAPTER 10. Those locations are presented in Table 2.3.2 and Figure 2.3.3.

Other flood control schemes in the lowermost, middle and upper Cagayan, and Tributaries

Other schemes are the dike systems in the lowermost, middle and upper Cagayan including major tributaries incorporated in the reviewed long-term plan. They

are the dike systems listed below. Those locations and major works are shown in Figure 2.3.1 and Table 2.3.3.

- River mouth- Chico river (Nassiping)
- Tuguegarao- Siffu river
- Siffu- Upstream
- Siffu backwater levee
- Ilagan river
- Magat river

2.3.3 Cost Estimate

In this section, construction cost for the reviewed flood control long-term plan is estimated as below. The composition of the project cost consists of costs of main works, compensation, engineering and administration, and contingencies. The details are as follows.

1) Cost of main works

- Preparatory works: 8% of the total cost of civil works
- Civil work cost
- Miscellaneous: 15 % of the total cost of preparatory and civil works

2) Cost of compensation

- Land cost
- Cost for house (cost for house is included in the Resettlement Plan)
- Others: 10 % of the total cost of land and house

3) Cost of engineering and administration

- Engineering cost: 10 % of the total cost of main works
- Administration cost: 5 % of the total cost of main works

4) Contingency

- Contingency for physical: 15 % of the total cost of the *1)* to *3)*

In line with the above criteria, the project cost excluding cost for resettlement of the reviewed flood control long-term plan is estimated. The estimated project cost is finally Pesos 30.5 billion consisting of Pesos 10.3 billion for the scheme in the middle lower Cagayan from Alcala to Tuguegarao, Pesos 4.4 billion for bank protection works scheme in basin wide and Pesos 15.8 billion for the other schemes in the lowermost, middle and upper Cagayan, as shown in Table 2.3.4 to Table 2.3.6.

2.4 Non-structural Measures

The conceivable measures for the flood control plan are structural measures and non-structural measures. The structural measures mitigate the hazards, while the non-structural measures reduce the vulnerability. The components of the non-structural measures to be discussed below are evacuation system, resettlement and hazard map preparation.

2.4.1 Evacuation System

(1) Flood Forecasting and Warning System

A reliable warning system based on an accurate forecasting is fundamental to an effective evacuation of people at risk to reduce vulnerability. The flood forecasting and warning system comprises several activities such as observation and forecast of floods, judgement of risks, and preparation, issuance and transmission of warning.

Problems of Existing Flood Forecasting and Warning System

Two flood forecasting and warning systems exist at present in the Cagayan River basin, which are the Cagayan Flood Forecasting and Warning System (FFWS) operated by PAGASA and the Magat Dam Flood Forecasting and Warning System (FFWSDO) operated by NIA.

The present status of FFWS and FFWSDO is described in detail in Subsection 1.4.2. Major problems are malfunctioning of water level gauges and warning station, and inefficient flood forecasting and warning.

In order to cope with the problems, the study under special assistance for project sustainability (SAPS Study) on the flood forecasting and warning system was conducted in 1999 by the Overseas Economic Cooperation Fund (OECF). The improvement plans proposed by the SAPS Study are reviewed and judged in this JICA Study and recommended because the same situation exists at present as that during the SAPS Study.

Improvement Plan of Flood Forecasting and Warning System

The proposed improvement plans are presented below, which are based on the review of Cagayan basin part of the SAPS Study.

1) Improvement of FFWS and FFWSDO Facilities: This activity includes,
   - rehabilitation of a telemetering system and restoration of the computer system of FFWS and FFWSDO,
   - provision of telefax communication facility, and,

- supply of spare parts and others.

2) Special FFWS and Disaster Management in Tuguegarao: This activity includes,
   - establishment of a local hydrological observation station in Tuguegarao River, and,
   - local communication network among subcenter, RDCC and members, MDCC, evacuation centers and Barangays.
3) Consultancy and Engineering Services: This activity includes,
   - Improvement to FFWS/FFWSDO,
     a) improvement of flood warning information such as preparation of information materials and dissemination of flow charts, review of flood warning level and simulation of flood, and,
     b) detailed design/ construction supervision/ operation and maintenance of the FFWS/ FFWSDO facilities.
   - Strengthening of Tuguegarao subcenter
     a) preparation of strengthening plan, and,
     b) technical guidance for operation of the subcenter.
   - Community disaster management capacity building in Tuguegarao
     a) enhancement/ design of community flood disaster mitigation such as detailed design, construction supervision and operation and maintenance of local hydrological station and local FFWS communication network, and,
     b) education and training of disaster management staff.

Implementation Cost of Improvement Plan

The following shows result of the cost estimate for the improvement of the existing flood forecasting and warning system including the disaster management system. The estimate is based on that made by the SAPS Study in 1999 and its update done by PAGASA in 2000.

Activities	Amount (Million Pesos)
1. Improvement of FFWS and FFWSDO Facilities	102.5
2. Special FFWS and Disaster Management in Tuguegarao	21.4
3. Consultancy and Engineering Services	86.5
4. Base Cost (1.+2.+3.)	210.4
5. Project Administration Cost (0.2% of Base Cost)	0.4
6. Contingency (15% of Base Cost)	31.6
7. Grand Total	242.4

Annual operation and maintenance cost is assumed to be 3% of the construction cost. Taxes and duties are not included in the above estimates.

(2) Evacuation Center

Evacuation is one of the effective non-structural measures to mitigate vulnerability from flood disasters. The "Calamities and Disaster Preparedness Plan" formulated by NDCC in 1988, provides the details for creation of the operating unit for evacuation service at the regional, provincial, city/municipal and barangay levels.

Problems of Existing Evacuation Center

The existing evacuation system is operated and maintained by RDCC, PDCC, CDCC/MDCC and BDCC in the Cagayan River basin. Major problems in the evacuation center are insufficient supply of drinking water and food, and lack of cooking facilities and comfort rooms in the evacuation centers, which were identified through discussions with OCD officials of Region 2 and interview survey with the City/Municipalities and Barangays concerned made in this JICA Study.

Measures for Improvement and Cost

The evacuation activity is considered to be a local function. LGUs are the main players for the evacuation so that timely evacuation and grasp of the accurate requirements can be attained. Therefore, the problems stated above to be solved by LGUs.

The cost for improvement of the evacuation center is estimated as follows:

Activities		Amount (Million Pesos)
1.	Construction of deep wells and comfort rooms	77.1
2.	Purchase of tents and cooking facility	61.2
3.	Preparation and updating of disaster preparedness plan	13.5
4.	Education and training of DCC staffs and local people	4.4/year

2.4.2 Resettlement

Resettlement area development plan is discussed in Section 4.5 of Annex VIII.

2.4.3 Hazard Map

The hazard map of the Cagayan River basin has been prepared in this JICA Study as shown in Figure 2.4.1 in terms of flood prone area, river bank erosion and soil erosion in the basin. The map will be used to make the people living in the Cagayan River basin aware of the risks from such hazards and to take actions for preparedness.

The following hazard maps are available in the Cagayan River basin:

1) Nationwide hazard map of flood susceptibility (DENR),
2) Map of earthquake-induced shallow landslide and tsunami risk (PHILVOLCS),
3) Hazard maps on pollution, soil erosion, floods, tsunami and volcanoes (Province of Cagayan), and,
4) Flood inundation area map for the 1973 and 1980 floods (1987 Master Plan).

These maps are referred to in the hazard map preparation.

The following data are incorporated in the hazard map:

1) Flood prone area is represented by the flooding area of 1973 flood.
2) The river bank erosion sites are the sites investigated and identified during this JICA Study by the Study Team and DPWH Region 2 as severely eroded banks.
3) The soil erosion area is the area delineated by BSWM, DA in 1995.

CHAPTER 3 FLOOD CONTROL PRIORITY PROJECTS

3.1 Structural Measures

3.1.1 General

In this section, a feasibility study result of the priority projects for flood control in the lower Cagayan is introduced. The priority projects are defined as all flood control projects identified in the reviewed master plan for the lower Cagayan River.

Major items to be discussed are flood control projects subject to the feasibility study and plan formulation criteria, and proposed structural measures for the flood control priority projects for the lower Cagayan River.

3.1.2 Objective Priority Projects subject to Feasibility Study

The feasibility study is conducted for the following flood control projects in the lower Cagayan River. Figures 3.1.1 and 3.1.2 show general locations of each flood control project and urgent bank protection works in the lower Cagayan.

1) Left dike systems in the lower most from river mouth to Nassiping
2) Right dike systems in the lower most from river mouth to Nassiping
3) Left dike systems in the middle lower from Alcala to Tuguegarao
4) Right dike systems in the middle lower from Alcala to Tuguegarao
5) Cut-off channels in the middle lower from Alcala to Tuguegarao

Aside from the above projects, the following urgent bank protection works are incorporated in the lower Cagayan as already studied in Section 10.4.2 in CHAPTER 10 of the Main Report or described in the later section 3.1.5.

6) Urgent bank protection works at 21 sites in the lower Cagayan

3.1.3 Project Formulation Criteria

Summarized below are the criteria for conducting the feasibility study.

General

1) Objective river reaches
   - From river mouth to Cabagan
2) Structural measures to be designed are as follows.
   - Design flood of 25-year flood is applied.
     In the nation wide flood control plan and river dredging program (River Dredging Project II) for 12 major rivers in the Philippines studied in 1982, economic viability was examined in detail and it proved that a 25-

year design flood has the highest economic viability for the first phase plan (long-term plan) in the Cagayan river basin. Subsequently, the 1987 flood control master plan was formulated with 25-year design flood. In line with the above and hydraulic study result in the present study, the same design flood scale has been applied.

The design discharge in the lower Cagayan is summarized below and as shown in Figure 2.1.3 in CHAPTER 2.

: River mouth to confluence with Chico River: 17,900 m^3/s

: Confluence with Chico to Tuguegarao: 17,700 m^3/s

- In river planning and designing, features of river morphology described in Section 1.1.3 River Morphology in CHAPTER 1 are fully considered.
- Dike system consist of dike, maintenance road, drain and tree zone in principle
- Cut-off channels are designed at significant meandering reaches of Gabut, San Isidro and Tuguegarao
- Culverts are provided for local drainage from the landside
- Abandoned river courses created by construction of cut-off channels are conserved as fish ponds and/or retarding basins as it is in principle
- Urgent bank protection works are incorporated as already studied in CHAPTER 10 of the Main Report.

River width and cross-section

3) The river width was designed to have more than $10(A)^{1/2}$, where A is basin area in km^2 in principle. According to that, river width is estimated at 1.7 km at river mouth and 1.5 km at Alcala. Further, taking into account respective site conditions such as the present land use, existing riverbank elevation and channel width, possible resettlement, etc., the river width was determined. The layout of the river width and dike alignment is described in more detail in CHAPTER 4.

   This proposed river width is applied as it is viable for a framework plan with a 100 year probable flood.

4) National highway on the right bank from Alcala to Iguig is functioning as a flood dike, which is actually considered as the existing available dike. It is technically recommendable to utilize the highway as a flood dike by raising surface road elevation because a part of the highway near Alcala is subject to inundation even by small floods. However, in this case, about 2000 households equivalent to 50% of the total ones in the municipalities of Iguig and Amulung are needed to be resettled in accordance with the concept of river area to be explained in the following. Such large-scale resettlement

brings about serious social problems to both the said municipalities and accordingly, right dike alignment is changed towards the riverside to minimize resettlement.

5) River cross-section consists of a low water channel as the existing one and a high water channel newly confined by dikes. The estimated average width of the cut-off channel is designed at 500 m estimated as an average width of the existing low water channel.

6) Earth dike system was designed to confine flood flow. Maintenance road is provided in landside along dike in case there is no available road nearby. The dike section as shown in Figure 3.1.3 is designed as a trapezoidal one as follows.
   - Dike crown elevation: 2 m plus design high water level
   - Dike crown width (inspection road): 7 m
   - Embankment slope: 1 to 3
   - Maintenance road width: 7 m with 4 m wide carriageway
   - Drain

7) An open space confined by both the dikes on the left and right banks is instituted as a river area. In the reach without dike, boundary of the river area is set at 10 m outside of river width at the design high water level. This open space of 10 m will be utilized as a maintenance road in future. The river area is defined as an open limits consisting of water channel and floodplain. The river area will be delineated in detail on the layout map of river channel improvement in the later section in CHAPTER 12.

   In the institution, an ownership of all lands including residential lots within the river area will be transferred to the central government from private with compensation. It should be noted that the transferred lands shall be cultivated by the respective former owners if they implore under a condition that flood damaged agricultural products shall not be compensated.

   Accordingly within the river area, the following activities shall be principally prohibited in a case of no prior approval of DPWH.
   - To use lands and/or open space
   - To construct houses and other structures
   - To use river water
   - To mine riverbed materials
   - To use water surface as fish farm
   - To dump garbage and others

8) Tree zone is designed in combination with the dike. Objectives of the tree zone are to protect earth dike from severe flow attacks eventually and to

mitigate sediment damage to assets and agricultural crops from siltation in the period before construction of dike. Location of the tree zone is selected considering site conditions such as severe flow attack, present land use condition, space availability, etc. The tree zone is thus constructed on the riverside along the dike for a 70 km length of the total dike length of 150 km provided that proper and sustainable river management and maintenance systems are to be established in DPWH Region 2 in cooperation with the related LGUs.

River profile

9) Riverbed profile was proposed at the present mean riverbed elevations. It should be noted that riverbed excavation is not considered in the 1st phase because water level rising is negligible small and excavation work is costly. Meanwhile, the riverbed elevation of cut-off channel was designed at the proposed elevations.
10) Design high water level was set based on calculated water level for design discharge by the non-uniform flow method.
11) Elevation of the dike crown was set adding 2 m free board above the design high water level.

Measures for coastal erosion and Appari port

1) Aparri municipality presents that the Cagayan river mouth is subject to close by sedimentation. However, cross sections near the river mouth have sufficient flow area and water depth as seen in Figure 1.1.12 which was surveyed at the end of the dry season from April to May in 2000. As explained in the section 1.1.3 in CHAPTER 1, it can be said that there exists no river mouth closing by sedimentation.
2) Aparri municipality also presents coastal erosion in the northern part of the Cagayan River mouth. No detailed data on coastal erosion has been obtained so far. Therefore, it is recommended that the required data such as erosion records, current, drift sand, topographic map and so on be firstly accumulated and the erosion countermeasures should be studied separately from this flood control project.
3) Aparri seaport exists in the river mouth of the Cagayan. However, it is reported that the port is not functioning and/or utilized at present. In case of reopening the port, it should be shifted to International Irene Seaport nearby.

3.1.4 Structural Measures of Priority Projects for the Lower Cagayan River

The structural measures of the flood control priority projects comprise river improvement works designed for a 25-year flood and bank protection works for

the lower Cagayan River from river mouth to Cabagan having a total river length of 150 km.

The 16 proposed river improvement works including urgent bank protection works are outlined below and their locations are as illustrated in Figures 3.1.4 and 3.1.2. Table 3.1.1 itemizes major work items of the above river improvement except those of urgent bank protection works. The delineated river area is presented in the separate Drawing.

Structural measures

Left dike systems in the lower most from river mouth to Nassiping

1) Mabanguc dike
   - Total length: 10.9 km
   - Embankment volume: 1.20 million m^3
   - Maintenance road: 10.9 km
   - Drainage culvert with flap gate: 17 units
2) Catugan dike
   - Total length: 7.4 km
   - Embankment volume: 0.81 million m^3
   - Maintenance road: 7.4 km
   - Tree zone: 4.4 km
   - Drainage culvert with flap gate: 9 units
3) Lasam dike
   - Total length: 7.0 km
   - Embankment volume: 0.91 million m^3
   - Maintenance road: 7.0 km
   - Drainage culvert with flap gate: 12 units

Right dike systems in the lower most from river mouth to Nassiping

4) Camalaniugan dike
   - Total length: 13.1 km
   - Embankment volume: 1.15 million m^3
   - Drainage culvert with flap gate: 19 units
   - Spur dike: LS
5) Lal-lo dike
   - Total length: 12.9 km
   - Embankment volume: 1.04 million m^3
   - Drainage culvert with flap gate: 19 units
6) Gattaran dike
   - Total length: 6.1 km
   - Embankment volume: 0.56 million m^3

- Drainage culvert with flap gate: 9 units

7) Nassiping dike
   - Total length: 9.7 km
   - Embankment volume: 0.47 million m^3
   - Drainage culvert with flap gate: 14 units

Left dike systems in the middle lower from Alcala to Tuguegarao

8) Alcala-Buntun dike
   - Total length: 33.5 km
   - Embankment volume: 6.57 million m^3
   - Maintenance road: 33.5 km
   - Tree zone: 31.0 km
   - Drainage culvert with flap gate: 49 units

9) Enrile dike
   - Total length: 12.2 km
   - Embankment volume: 0.93 million m^3
   - Tree zone: 12.2 km
   - Drainage culvert with flap gate: 18 units

Right dike systems in the middle lower from Alcala to Tuguegarao

10) Tuguegarao dike
   - Total length: 21.3 km
   - Embankment volume: 3.13 million m^3
   - Tree zone: 21.3 km
   - Drainage culvert with flap gate: 31 units

11) Amulung dike
   - Total length: 12.6 km
   - Raising volume: 1.26 million m^3

12) Iguig dike along national highway
   - Total length: 3.2 km
   - Embankment volume: 0.20 million m^3

Cut-off channels in the middle lower from Alcala to Tuguegarao

13) Gabut COC
   - Total length: 0.7 km
   - Excavation volume: 4.62 million m^3
   - Overflow bridge: 1 bridge
   - Sluice with slide gate: 1 unit
   - Bank protection and spur dike: LS

14) San Isidro COC

- Total length: 1.6 km
  - Excavation volume: 9.56 million m^3
  - Overflow bridge: 1 bridge
  - Sluice with slide gate: 1 unit
  - Bank protection: LS

15) Tuguegarao COC
  - Total length: 5.8 km
  - Excavation volume: 19.13 million m^3
  - Bank protection and spur dike: LS

Aside from the above 15 sub projects, the following urgent bank protection works are incorporated in the lower Cagayan improvement work as already mentioned in Section 10.4.2 in CHAPTER 10 or described in the later Section of 3.1.5.

Urgent bank protection works in the lower Cagayan

16) Urgent bank protection work in the lower Cgayan
  - Twenty one (21) sites in the lower Cagayan from river mouth to Cabagan

3.1.5 Urgent Works of Bank Protection for the Lower Cagayan River

The riverbanks of the Cagayan have been locally suffering from severe erosions, which cause casualty, loss of assets and stagnation of economic activities due to interruption of the trunk roads, etc. In order to prevent such damage as well as to improve poverty incidence along the riverine areas, the riverbank protection works are to be urgently implemented at 43 heavily eroded sites in the whole Cagayan River consisting of 21 sites in the lower Cagayan and 22 sites in the middle Cagayan and major tributaries. The feasibility study for the 21 sites in the lower Cagayan was made by the JICA study team and for the 22 sites in the middle Cagayan and tributaries, by Region 2 office, respectively. The result for the 21 sites in the lower Cagayan is explained below.

The 21 sites for the bank protection works in the lower Cagayan are shown in Table 3.1.2 and Figure 3.1.2. The preliminary design of the protection works is made based on the following criteria.

Protection method with high flexibility is adopted considering low construction cost, easier maintenance, effective utilization of local materials, etc. It should be noted that this design is not of a permanent structure resisting any floods permanently, but is a temporary structures, which will need good maintenance and

repair. The following 4 methods are applied depending on site conditions, as shown in Figure 3.1.5.

1) Type A: Slope protection with stepped gabion (thickness:1 m) in combination with riprap for foot protection *(in case no space for densely populated areas)*.
2) Type B: Slope protection by gabion (thickness: 0.5 to 0.3 m) in combination with riprap for foot protection (for sparsely populated areas and roads).
3) Type C: Slope protection by dry masonry (cobble pavement) in combination with riprap for foot protection (in case sufficient space for agricultural lands).
4) Type D: Spur dike (in the case of water depth at foot of the slope is shallow and applied at 2 sites in the lower Tuguegarao River).

For the slope protection methods the top elevation of riprap for foot protection will be at mean sea level□1 m for the tidal reach and average water level□2 m for the other reaches in view of keeping a necessary resistance and to secure stability against shearing forces exerted by overflow and maintenance work on ground. The average water level is defined in this section as water level at questioned section observed in the river cross-sectional survey conducted by the Team in April and May 2000.

Based on the criteria, bank protection works were preliminary designed with due considerations of site and land use conditions, availability of local materials, workability, easier maintenance, sustainability, construction cost, biotope, etc. Figure 3.1.6 shows the designed bank protection works at typical sections. The total construction cost is estimated at Pesos 0.73 billion as shown in Table 3.1.3.

3.2 Non-structural Measures

The Reviewed Master Plan proposes implementation of the flood control non-structural measures in the Cagayan River basin in the early stage, so a feasibility study has been made for the non-structural measures. The non-structural measures consist of 1) evacuation system including the flood forecasting and warning system and evacuation center, and 2) resettlement area development.

3.2.1 Evacuation System Improvement

(1) Improvement of Flood Forecasting and Warning System

Improvement of the two existing flood forecasting and warning systems in combination with the disaster management system is proposed in the reviewed flood control plan as an effective non-structural measures. The flood forecasting

and warning system is effective in the flood disaster mitigation and the existing system can be strengthened with minimum cost. The economic evaluation revealed the EIRR of 18.0% under the future condition in the master plan level.

The feasibility study for the improvement of the existing flood forecasting and warning systems has been made under the following conditions:

a) The improvement concentrates on that for the local flood forecasting and warning system facilities in the Cagayan River basin and does not include a communication system between local and central system in Manila.
b) The improvement aims at strengthening of the Tuguegarao subcenter and capacity building of the community disaster management in Tuguegarao.

The improvement project includes the following items:

a) Improvement of the existing flood forecasting and warning system facilities for FFWS of PAGASA and FFWSDO of NIA:
   - Rehabilitation of telemetering system,
   - Restoration of computer system,
   - Provision of telefax communication facility in RDCC, PDCC and MDCC,
   - Supply of spare parts and others.
b) Improvement of Tuguegarao subcenter and disaster management capacity in Tuguegarao:
   - Establishment of a local hydrological observation station in the Tuguegarao River,
   - Establishment of local communication network among subcenter, RDCC and members, MDCC, evacuation centers and Barangays.
c) Consultancy and Engineering Services:
   - For improvement of FFWS and FFWSDO:
     - Improvement of flood warning information such as preparation of information materials and dissemination flow chart, review of flood warning level, and simulation of floods,
     - Detailed design, construction supervision, and operation and maintenance of the facilities,
   - For strengthening of Tuguegarao subcenter:
     - Preparation of strengthening plans for the Tuguegarao subcenter, and technical guidance for operation of the subcenter,
   - For community disaster management capacity building in Tuguegarao:
     - Enhancement/design of community flood disaster mitigation measures such as detailed design, construction supervision, and operation and maintenance of local hydrological station and local FFWS communication network,
     - Education and training of disaster management staff.

(2) Improvement of Evacuation Center

Improvement of the evacuation center is also proposed in the reviewed flood control plan. Immediate implementation of the improvement is recommended because the smooth operation of the evacuation center will function efficiently to evacuate the residents affected and mitigate flood disaster.

The feasibility study for the improvement of the existing evacuation center has been made under the following conditions:

a) The purpose of the improvement is to provide safe and comfortable evacuation centers and improve Disaster Coordinating Councils' (DCCs') and peoples' capability and preparedness in the evacuation related activities so that local people are willing to be evacuated to the centers and flood damages are mitigated.
b) Local Government Units (LGUs) are the main players for the evacuation of the local people so that the existing problems are recommended to be solved by LGUs.

The improvement project includes the following items:

a) Strengthening of existing evacuation centers
   - Supply of tents to accommodate evacuees,
   - Construction of additional deep wells in the evacuation centers for supply of drinking water,
   - Construction of additional comfort rooms in the evacuation centers,
   - Supply of cooking facilities at the evacuation centers.
b) Strengthening of capability of DCCs
   - Preparation or updating of the disaster preparedness plans including supply plan of sufficient food to the evacuation centers,
   - Training of DCC staffs.
c) Strengthening the capability of the local people
   - Conduct of drills.

3.2.2 Resettlement Area Development

Resettlement area development plan is described in Section 4.5 of Annex VIII.

CHAPTER 4 PRELIMINARY DESIGN OF FLOOD CONTROL PRIORITY PROJECTS

4.1 General

In this section, the preliminary design for structural measures of the priority projects is explained. The explanation of the preliminary design is divided into two parts of river channel improvement, and river and related structures respectively as identified in CHAPTER 3. The details are descried in the following.

4.1.1 Design Criteria

Design criteria described in Section 3.2.1 in CHAPTER 3 are in principle applied to the preliminary design. Other key criteria are as follows.

1) The following design discharges for a 25-year probable flood are adopted in the design.
   - River mouth to confluence with Chico River: 17,900 m^3/s
   - Confluence with Chico to upstream of Tuguegarao: 17,700 m^3/s
2) The present condition for the basis of design is the ones of topographic maps with 1/10,000, 1/5,000 and 1/1,000 scales and channel cross-sections respectively surveyed by the Study Team in 2000.
3) For design of the river improvement works and related structures, Design Guidelines Criteria by DPWH, Philippines and Structural Standard for River Facilities by Ministry of Land, Infrastructure and Transport, Japan are applied in principle.

4.1.2 River Channel Improvement

(1) River Width and Dike Alignment

The following Drawings on the proposed river improvement works are presented in the separate DRAWING BOOK.

- Key Map
- Plan of River Improvement Works
- Detailed Plan of River Improvement Works

1) General Layout

The river width was designed to have more than $10\sqrt{A}$, where A is basin area in km^2 in principle. According to that, river width is estimated at 1.7 km at river mouth and 1.5 km at Alcala. Further, taking into account respective site conditions such as the present land use, existing riverbank elevation and

channel width, possible resettlement, etc., the river width was determined as described later in detail. This proposed river width is applied as it is applicable for a framework plan with a 100 year probable flood.

As explained in CHAPTER3, the river area to be instituted is delineated on the above drawings. It is defined as an open limits consisting of water channel and floodplain confined by proposed dikes and /or present riverbank lines.

The National highway on the right bank from Alcala to Iguig is functioning as a flood dike, which is actually considered as the existing available dike. It is technically recommendable to utilize the highway as a flood dike by raising surface road elevation because a part of the highway near Alcala is subject to inundation even by small floods. However, in this case, about 2000 households equivalent to a 50 % of the total in the municipalities of Iguig and Amulung are needed to be resettled in accordance with the concept of river area as explained in the following. Such large-scale resettlement brings about serious social problem to both the said municipalities and hence, right dike alignment is changed towards more riverside to minimize resettlement.

A tree zone is eventually considered to protect earth dike from severe flow attack. The tree zone is to be provided ahead of dike construction. Therefore, sediment damage to assets and agricultural crops is mitigated due to siltation resulting from decreased velocity in the tree zone. Hence the tree zone is constructed in riverside along the dike for 70 km length of the total dike length of 150 km provided that proper and sustainable river management and maintenance systems are established in DPWH Region 2 in cooperation with the concerned LGUs. Such tree zones are to be provided in the initial stage ahead of dike constructions to regulate flood flows over the floodplain and to stabilize low water channel.

The tree zones were designed at the 4 dike systems of a part of Catugan dike, Alcala-Buntun dike, Tuguegarao dike and Enrile dike.

There are various candidate trees including bamboo for tree zone. They are, Camatchile, Bamboo, Acacia, Gmelina, Narra, etc. From the above candidate ones, Camatchile is selected considering following characteristics.

1) Easier to get plant
2) Easier to root
3) Easier to grownup in the wetted riverbank or floodplain
4) Easier to propagate

Meantime, according to a research data on tree zones, it is ideally to be around 20 m to 50 m in wide in view of decrease of the flow volume passing through the tree zone. According to the criteria in the Ministry of Land, Infrastructure and Transport, Japan, the width is recommended to be more than 20 m. In the Cagayan River, the width is decided at 30 m considering the above research data, criteria, land availability, etc.

A riverbank tree zone has much advantage for river improvement works in viewpoints of nature-oriented river improvement works and ecological landscape improvement. In order to realize this riverbank tree zone, it is important to establish a proper and sustainable river management and maintenance system and related supporting measures. Accordingly, the tree zone is recommended in the river improvement works provided that the proper and sustainable river management and maintenance systems including maintenance cost allocation system are established in the DPWH Region 2 office in cooperation with the related LGUs.

A cut-off channel was designed to lower floodwater levels by improving significant river meander at 3 reaches of Gabut, San Isidro and Tuguegarao. The details are as shown in Figure 4.1.1.

2) Dike Alignment and River Width

The determined dike alignment and river width at each site are as described below.

Mabanguc dike and Camalanuigan dike

In this reach, river channel width is wide enough and residential areas occupy those riverside areas. Accordingly, each dike was aligned along existing riverbank line to enclose residential areas. Average river width is around 1.5 to 2 km.

Catugan dike and Lal-lo dike

Magapit bridge is located at the upper end of this reach. In the Magapit narrow reach, a widening scheme still remains as a prospect for the future, where the low water channel is to be widened to 500 m. Considering such prospects, the right dike at Magapit bridge is set keeping a minimum river width of 500 m, and the right dike enclosing residential areas and the national highway was re-aligned taking off before the left dike alignment. Meantime, rocks and/or harder clayey sand cover the left riverbank in the downstream of the bridge. After passing the said armored riverbank, the left dike alignment starts gradually widening to 1.7 km river width taking into account diffusion

angle of flood flow. At the lower end of the left dike, tree zone is provided to protect dike from severe flow attack. Both dike alignments were thus determined as shown in the drawings.

Lasam dike (lower) and Gattaran dike

There exist residential areas and national highway on the right side, whereas some barangay locate along the left riverbank. The right dike was aligned to confine residential area and the national highway. On the other hand, the left riverine area along a low water channel is subject to frequent inundations and erosion due to severe flow attack not only for the time being but also for the future. In this viewpoint, the left dike was aligned behind the barangay so as to keep a minimum width of 1.7 km from the right dike alignment taking off before the left dike, although it is recognized that a resettlement is consequently brought into barangay located on the left riverbank.

Lasam dike (upper) and Nassiping dike

Nassiping narrow reach is located at the uppermost in this reach of which widening scheme remains as a prospect for the future. Same concept applied in the downstream reaches of Catugan and Lal-lo dikes, and Lasam (lower) and Gattaran dikes, was also adopted in this reach. Consequently, it is recognized that resettlement is needed in the left riverine areas.

Alcala-Buntun dike, and Amulung dike and Iguig dike

The critical flood control problems in this reach are frequent inundations extending over the floodplain, and river course shifting (meandering). There exist a lot of residential areas, agricultural areas and infrastructures in this reach. Aside from the above, irrigation development projects have been proposed by NIA to improve the agricultural productivity as an enhancement of the regional economy.

In this viewpoint, two cut-off channels are proposed to regulate river course smoothly and lower floodwater levels, and left dike for an about 35 km long is constructed facing riverside so as to convert floodplain areas to agricultural lands as wide as possible. A tree zone is provided on the riverside along the dike to protect from high flow conditions eventually and mitigate sediment damage to assets and agricultural crops by siltation due to tree zone in the period before construction of dike. Therefore, the tree zone is to be planted ahead of dike construction.

A low-lying area prone to repeating inundations that locates around the confluence of the Pared River is kept as it is for retarding purpose of flood

flow. This area has been forced being a natural retarding basin for the centuries. That concept is based on a flood control viewpoint considering as a buffer for the 35 km long-continuous dike in the upstream reach to be constructed on the newly formed floodplain in terms of geologic age.

National highway on the right bank from Alcala to Iguig is functioning as a flood dike, which is actually considered as the existing dike. It is technically recommendable to utilize the highway as flood dike by raising surface road elevation because a part of the highway near Alcala is subject to inundation even by small floods. However, in this case, about 2000 households equivalent to a 50 % of the total in the municipalities of Iguig and Amulung are needed to be resettled in accordance with a concept of river area to be explained in the following. Such large-scale resettlement brings about serious social problem into both the said municipalities. Accordingly, dike was constructed more to the riverside to minimize resettlement, as shown in DRAWING BOOK.

The right bank area along the low water channel has a relatively high ground elevation. It is located downstream after passing the turning point with a right angle of the Cagayan River. It is subject to erosion due to severe flow attack not only at the moment but also for the future. For this area, resettlement is needed to improve social welfare thereat although it is fully recognized that a social problem is brought into some barangay.

From the above, the left and right dikes were aligned as shown in the drawings having the river width from around 1.5 to 2 km.

Enrile dike and Tuguegarao dike

In order to protect Tuguegarao city and Enrile town including nearby existing paddy fields, cut-off channel and dike system with the tree zone were proposed. The cut-off channel is constructed in the centerline of the river meander belt (width of amplitude between both banks). No resettlement in this reach is needed as seen in the drawings. The floodplain in the lower half of the cut-off channel is not being cultivated.

At the upper end of the proposed cut-off channel, river width was determined at 1.5 km that is almost same width of the present low water channel. Then, the left dike was aligned along the existing road to protect Enrile town and existing paddy field that is to be rehabilitated by NIA. Meanwhile, the left dike is aligned keeping 1.5 km river width towards the Cataggaman district. The left dike alignment in the lower part of Cataggaman was set so as to

enclose Tuguegarao urban area and connected with the present riverbank in the downstream.

(2) River Cross-section

The river cross-section consists of the existing low water channel and high water channel to be newly confined by dikes. The designed river cross-sections at major points are shown in the separate drawings.

The dike system consists of earth dike, maintenance road and drains. The drain shall be a boundary line of the river area, which is defined as open space confined by both dikes of left and right banks. A standard dike section is a trapezoidal section as shown in Figure 4.1.2 and summarized below in principle.

- Dike crown elevation: 2 m plus design high water level
- Dike crown width: 7 m used for inspection road
- Embankment slope: 1 to 3 considering stability against seepage
- Maintenance road width: 7 m with 4 m wide carriageway
- Drain ditch (boundary line of river area)

As already explained, three (3) cut-off channels were proposed to ease significant river meandering in the upstream reaches of Alcala as shown in Figure 4.1.1. The width of cut-off channel is designed at 500 m that is estimated as an average low water channel width in the up and downstream reaches. The riverbed elevation of the channel is designed at the design riverbed elevation considering the present mean riverbed elevations. The cross-section of cut-off channel consists of compound sections.

The inlet of the abandoned river channel by the newly constructed cut-off channel is closed with excavated earth for an about 100 m wide (closing dike) and its riverbank is protected with revetment works in combination with a series of spur dikes. On the other hand, the remaining abandoned river channel is conserved as retarding basin in inner drainage and for fishponds.

Sluice equipped with slide gate and drainage culvert with flap gate are provided for the dikes. Those are explained in the following Section 12.2.3.

(3) Longitudinal River Profile

A river profile is designed as described below and the designed river profile is shown in Figure 4.1.3 and Table 4.1.1.

Riverbed profile was proposed at the present mean riverbed elevations. It should be noted that riverbed excavation is not considered in the 1st phase because water level rising is negligible small and excavation work is costly. Meanwhile, the

riverbed elevation of cut-off channel was designed at the above-proposed elevations.

Design high water level was set based on the calculated water level for design discharge by non-uniform flow method. Manning's roughness coefficients are 0.04 for low water channel and 0.06 for high water channel with a confined dike, as applied in the reviewed Master Plan.

Elevation of dike crown was set adding 2 m free board above the design high water level.

In the upstream of Alcala, there are 3 irrigation pump stations of Amulung, Iguig and Solana being operated by NIA located at 5 km upstream of Gabut COC, 700 m upstream of San Isidro COC and 1 km downstream of Tuguegarao COC, respectively. Suction levels at respective pump stations are sufficiently low against ordinary water levels in the dry season. Hence it can be said that the construction of cut-off channels does not cause any negative impact against pump operation especially in the dry season as follows.

Pump Station	Suction Level (EL m)	Calculated Water levels after Construction of COC (EL m)	
		River discharge=200 m^3/sec	River discharge=300 m^3/sec
Amulung	-2.37	4.32	4.66
Iguig	-0.12	7.09	7.17
Solana	2.67	7.84	8.20

4.1.3 River and Related Structures

(1) Bank protection and spur dike

In the reach from Alcala to Tuguegarao, three cut-off channels are provided to ease significant river meander resulting in lowering of floodwater levels. The curved riverbank leading to inlet of cut-off channel is protected in combination with bank protection works and a series of spur dike as shown in Figure 4.1.1.

Bank protection works are installed to protect riverbank newly constructed by filling in the abandoned river channel from flow attack. Meantime, a series of spur dike is installed in the low water channel in order to train and to guide river flow towards cut-off-channel smoothly and to reduce flow velocity towards the bank protection works behind. A series of spur dikes are provided only at both the curved inlets of Gabut COC and Tuguegarao COC. It should be noted that this design is not for a permanent structure resisting any flood permanently, but rather temporary structures, which need good maintenance and repair. The details are explained below.

1) Bank Protection Works

Bank protection works consist of gabion and cobblestone pitching. Cobblestone pitching is adopted as foot protection of the bank protection works. The slope of the riverbank is protected by means of gabion.

The necessary diameter of cobblestone can be calculated by the following equations prepared by U.S. Army Corps of Engineer.

$$D_m = \frac{1}{E_1^2 * 2g(\rho_s/\rho_w^{-1})} * V_0^{2*} K$$

Where,

D_m: Necessary diameter of stone (m)

V_0: Design flow velocity (m/s)

ρ_s: Density of stone (kg/m^3), generallyρ_s =2,650kg/ m^3

ρ_w: Density of water (kg/m^3)

g: gravity acceleration (m/s^2)

E_1: experimental coefficient

K: coefficient related to slope inclination

$$K = \frac{1}{\cos\theta^*(1 - \tan^2\theta/\tan^2\Phi)^{1/2}}$$

Where,

θ : angle of slope inclination (°)

Φ : repose angle of stone in the water (Φ=38°for natural stone)

Design flow velocity is calculated as follows.

$$V_0 = \alpha*(1/n^* H_d^{2/3} * I_e^{1/2})$$

Where,

n: coefficient of roughness

H_d: design water depth (m)

I_e: energy gradient

α: coefficient related to river bending

$$\alpha = 1 + \frac{Z}{2H_d} + \frac{B}{2r}$$

Where,

□Z : maximum scouring depth (m)

B: river width (m)

r: curvature radius of bending (m)

According to the equations, necessary diameter of cobblestone is calculated at 0.2 m in Gabut, and 0.1 m in San Isidro and Tuguegarao, respectively as shown below. Hence, a diameter of cobblestone is designed at 0.2 m in average in view of stability against flow velocity.

Item	Gabut COC	San Isidro COC	Tuguegarao COC
□Z	3.0m	0.0m	2.0m
α	1.34	1.00	1.13
V_0	2.52m/s	1.80m/s	1.94m/s
K	1.17	1.17	1.17
D_m	0.2m	0.10m	0.10m

According to research data and experience data in the site in Japan, it is preferably for the thickness to be more than three times the cobblestone diameter. Hence, 1 m thickness of foot protection works is adopted in the protection works.

2) Spur dikes

T and/or L shape spur dikes are adopted depending on individual site conditions to train and guide river flow effectively.

The pitch of the dike layout is generally twice that of the dike length. In Cagayan, the proposed length of dike is different, the pitch is set as the total length of neighboring dikes. The height of dike is designed about 0.2□0.3 times of high water depth as follows referring examples where their effects are noted. Accordingly, average interval length and direct height of spur dike were designed from 70 to 170 m and 4.5 m, respectively.

Item	Gabut COC	Tuguegarao COC
HWL	18.49m	24.53m
Design river bed elevation	0.31m	8.68m
High water depth (h)	18.18m	15.85m
Height of spur dike (h_g)	4.5m	4.5m
h_g/h	0.25	0.28

For the structure of the spur dike, cobblestone riprap is adopted considering effectiveness, workability, easy maintenance, etc. Similarly, the necessary diameter of cobblestone is designed at 0.3 m in Gabut and Tuguegarao for resisting flood flow, respectively as calculated below.

Item	Gabut COC	Tuguegarao COC
□Z	3.0m	2.0m
α	1.24	1.13
V_0	2.52m/s	1.94m/s
K	2.30	2.30
D_m	0.3m	0.2m

(2) Sluice and Culvert

A dike is constructed along the riverbank or in the floodplain to confine flood flow to the river channel. For such inner areas, the inner drainage is interrupted by dike. Accordingly, sluices and culverts are provided for drainages of minor tributaries of local area. For other major tributaries, back levee has been considered in principle.

1) Sluice

The sluice is designed as a reinforced concrete structure with steel slide gate as shown in Figure 4.1.4 and summarized below. In this project, the sluice is provided at the outlet of Pangul River and the Afusing River. The sluice has the flow area (carrying capacity) equal to that of the objective tributary.

2) Culvert

Culvert is designed as the reinforced concrete structure with steel flap gate as shown in Figure 4.1.5. The interval for culverts is 700 m on the average along the dike.

(3) Overflow bridge

At Gabut and San Isidro districts, each community of the barangay is separated due to a construction of the cut-off channel. Accordingly, a bridge is constructed across over the proposed cut-off channel from a viewpoint of compensation to concerned communities so as not to interrupt the current traffic and daily activities.

Overflow bridges are installed at Gabut COC and San Isidro COC. Width of the bridge is designed at 5 m in total with 4.3 m wide carriageway as shown in Figure 4.1.6 in line with barangay road standards considering width and the traffic volume of existing connected roads. Surface road elevation is designed at same elevation of high water channel considering accessibility and availability especially in the rainy season.

4.1.4 Estimation of Bill of Quantities

Work quantities of priority projects are summarized in the following Tables.

Table 4.1.2: Work quantity of priority projects by sub projects

Table 4.1.3: Land acquisition and house compensation in the right of way

The following data on estimation of work quantity are separately compiled in the DATA BOOK.

: Embankment volume for each dike system
: Excavation volume and filling volume of abandoned river inlet
: Gabion and spur dike
: Overflow bridge
: Culvert and Sluice

Other resettlement in the authorized river area is explained in Section 15.1, CHAPTER 15 of the Main Report.

4.2 Non-structural Measures

4.2.1 Flood Forecasting and Warning System Strengthening Project

(1) Improvement of the existing flood forecasting and warning system facilities for FFWS of PAGASA and FFWSDO of NIA:

Rehabilitation of telemetering system

- This item includes replacement of telemetering system and water level sensors.

Restoration of computer system

- This item includes replacement of computer system in Magat Dam to calculate inflow volume and renewal of computer system for flood forecasting analysis at the Tuguegarao subcenter.

Provision of telefax communication facility in RDCC, PDCC and MDCC

- For timely and efficient dissemination of flood warnings, telefax communication facility shall be introduced to the Tuguegarao subcenter, RDCC, PDCC, and CDCC/MDCC.

Supply of spareparts and others

- Spareparts for the rainfall and water level gauging equipment shall be supplied and properly stocked with log books.

(2) Improvement to the Tuguegarao subcenter and disaster management capacity in Tuguegarao:

Establishment of a local hydrological observation station in Tuguegarao River

- Provision of rainfall and water level gauging stations is recommended in the Tuguegarao River in order to monitor the basin rainfall and discharge. The location immediate downstream of the narrow section near Callao Cave is assessed technically the best site taking account of topography and maintenance condition.

Establishment of local communication network among subcenters, RDCC and members, MDCC, evacuation centers and Barangays

- Establishment of telephone and fax communication among the Tuguegarao subcenter, RDCC and members of RDCC.
- Establishment of telephone and fax communication between the Tuguegarao subcenter and CDCC of the Tuguegarao City.
- Establishment of VHF radio communication among CDCC, each Barangay in Tuguegarao and evacuation centers.

(3) Consultancy and Engineering Services:

For improvement of FFWS and FFWSDO

Improvement of flood warning information

- This item includes preparation of information materials and dissemination flow chart, review of flood warning level, and simulation of floods.
- The information materials (flood bulletin) shall include expected raining period, expected gross rainfall, and expected runoff and water level information.
- Terms and their definitions of Alert Water Level, Alarm Water Level and Critical Water Level shall be reviewed.

Detailed design, construction supervision, and operation and maintenance of the facilities

- This item includes detailed design, construction supervision, and operation and maintenance of the telemetering system, computer system and telefax communication facilities.

For strengthening of Tuguegarao subcenter

Preparation of a strengthening plan for the Tuguegarao subcenter and technical guidance for operation of the subcenter

- The strengthening plan will include increase of manpower, improvement of facilities and securing of budget.

For community disaster management capacity building in Tuguegarao

Enhancement/design of community flood disaster mitigation

- This item includes detailed design, construction supervision, and operation and maintenance of local hydrological station and local FFWS communication network.

Education and training of disaster management staff

- The Public Information Drive (PID) should be upgraded and implemented as a formal program in order to realize the regular disaster management education, especially focusing on the local residents.

(4) Cost Estimate

Cost for the Flood Forecasting and Warning System Strengthening Project is estimated as follows:

Million Pesos

Activities	Amount
1. Improvement of FFWS and FFWSDO Facilities	
1.1 Rehabilitation of Telemetering System	
a) FFWS	89.3
b) FFWSDO	0.0
1.2 Restoration of Computer System	
a) FFWS	1.2
b) FFWSDO	0.4
1.3 Provision of Telefax Communication Facility (RDCC/PDCC/MDCC)	2.4
1.4 Spareparts and Others	9.2
Total of 1.	102.5
2. Special FFWS and Disaster Management in Tuguegarao	
2.1 Establishment of Local Hydrological Observation Stations	6.2
2.2 Local Communications Network	
a) Among Subcenter, RDCC and Members	7.2
b) Among MDCC, Evacuation Centers and Barangays	8.0
Total of 2.	21.4
3. Consultancy and Engineering Services	
3.1 Improvement of FFWS/FFWSDO	
a) Improvement of flood warning information	13.2
b) D/D, S/V, O/M of FFWS/FFWSDO facilities	17.2
3.2 Strengthening of Tuguegarao Subcenter	6.5
3.3 Community Disaster Management Capacity Building in Tuguegarao	
a) Enhancement/Design of Community Flood Disaster Mitigation	9.9
b) Education and Training of Disaster Management Staff	39.7
Total of 3.	86.5
4. Base Cost (1.+2.+3.)	210.4
5. Project Administration Cost (0.2% of Base Cost)	0.4
6. Contingency (15% of Base Cost)	31.6
7. Grand Total	242.4

Annual operation and maintenance cost is assumed to be 3% of the construction cost. Taxes and duties are not included in the above estimates.

4.2.2 Evacuation Center Strengthening Project

(1) Strengthening of existing evacuation centers

Supply of tents

- Tents are recommended for temporary accommodation for excess evacuees during calamity in case the designated evacuation centers are full of evacuees. Required number of the tents (a capacity of 12 persons) is estimated at 1,204 numbers as shown in Table 4.2.1 on condition that 2 years probable flood occurs in the Lower Cagayan River basin and the additional schools are used as the evacuation centers as well as the present evacuation centers designated.

  The additional schools were selected on condition that maximum inundation areas around schools are less than 0.5m judging from the flood inundation map for 2 year probable flood shown in Figure 4.2.1.

Construction of additional deep wells and comfort rooms, and supply of cooking facilities

- Construction of the additional deep wells to supply drinking water and comfort rooms in the evacuation centers, and supply of the cooking facilities to the centers are requisite in order to improve the existing centers.
- Required number of the additional deep wells is estimated at 271 on condition that an evacuation center shall have two wells or one well shall be used by 150 persons.
- Required number of the additional comfort rooms is estimated at 1,512 on condition that a comfort room shall be used by 25 persons. An idea of the comfort rooms is presented in Figure 4.2.2.
- Required number of the cooking facilities is estimated at 10,180 on condition that a facility shall be used by 5 persons.

(2) Strengthening of capability of DCCs

Preparation or updating of the disaster preparedness plans

- In order to attain smooth and efficient operation of community disaster management systems, the disaster preparedness plans shall be prepared or updated by each CDCC/MDCC and BDCC.

Training of DCC staffs

- Yearly training shall be made for staffs of PDCC, CDCC/MDCC and BDCC.

(3) Strengthening of capability of the local people

Conduct of drills

- Yearly drill shall be made for local people, and managed by CDCC/MDCC and BDCC.

(4) Cost Estimate

Cost for the Evacuation Center Strengthening Project is estimated as follows:

Million Pesos

Activities		Amount
1.	Purchase of tents	55.4
2.	Construction of deep wells	24.9
3.	Construction of comfort rooms	52.2
4.	Purchase of cooking facility	5.9
5.	Preparation and updating of disaster preparedness plan	13.5
6.	Education and training of DCC staffs and local people	4.4/year

4.2.3 Resettlement Site Development Project

The resettlement area development plan is presented in Section 5.3 of Annex VIII.

Tables

Table 1.2.1 Critical Bank Erosion Sites in Cagayan River and Tributaries

Serial No	River	City/Town	Location	Object to be Protected	Length(m)	Cross sectional length(m)	Area(m)	Remarks
1	Cagayan	Camalaniugan	Agusi	Res.area, national road, paddy fields	1,000	21	21,000	
2			Camalaniugan	Res.area, national road	500	22	11,000	
3		Lal-lo	Tucalana	Res.area, national road	1,000	28	28,000	
4			Sta. Maria	Res.area, national road, cornfields	1,000	30	30,000	
5			Magapit	Res.area, national road, non cultivated areas	1,000	32	32,000	
6		Gattaran	Gattaran	Res.area, national road, cornfields	1,000	32	32,000	
7		Alcala	Tupang	National road, cornfields	1,000	12	12,000	
8		Dugayong	Dugayong	Municipal road, irrigation canal, paddy fields	300	28	8,400	
9		Amulung	Babayuan	Res.area, municipal road, cornfields	200	14	2,800	
10		Iguig	San Vicente	Res.area, provincial road, paddy fields	800	45	36,000	
11		Solana	Natappian	Res.area, cornfields, provincial road	500	28	14,000	
12		Tuguegarao	Cataggaman	Res.area, municipal road	800	45	36,000	
13		Enrile	Jct. Enrile	Res.area, provincial road, cornfields	500	20	10,000	
14			Alibago	Res.area, cornfields, municipal road	350	24	8,400	
15		Tuguegarao	Namabbalan	Res.area, national road, paddy fields	1,800	24	43,200	
16		Sta. Maria	Sta. Maria	Residential, municipal road, cornfields	2,000	26	52,000	
17		Cabagan	Cabagan	Res.area, cornfields, municipal road	4,000	28	112,000	
18	Tuguegarao	Tuguegarao	Bagumbayan	Res.area, municipal road	100	25	2,500	
19			Larion	Cornfields	250	16	4,000	
20			Caggay	Res.area, national road, non cultivated areas	500	28	14,000	
21			Tanza	Res.area, municipal road, non cultivated area	200	28	5,600	
22	Cagayan	Lasam	Lasam	Res.area, provincial road, cornfields	1,000	25	3,750	
23		Ilagan	Baringin	Res.area	800	25	20,000	
24		Gamu	Upi	Res.area	200	25	5,000	
25	Chico	Piat	Maguilling	Res.area, municipal road	600	15	9,000	
26	Siffu	Roxas	Sitio Gabit	Res.area	250	15	3,750	
27			San Placido	Res.area	350	15	5,250	
28	Ilagan	Ilagan	Malalam	Res.area	1,200	15	18,000	
29			Camunatan	Res.area	2,000	15	30,000	
30	Cagayan	Angadanan	Centro I	Res. Area and agri.lands	1,500	25	37,500	
31		Cauayan	Basingin	Res. Area and agri.lands	2,500	25	62,500	
32			Alicaocao	Res. Area and agri.lands	2,000	25	50,000	
33		Reina Mercedes	District I	Agricultural lands	2,500	25	62,500	
34		Jones	San Vicente	Residential area	300	25	7,500	
35			Brgy. I	Residential area	700	25	17,500	
36			Brgy. II	Residential area	2,000	25	50,000	
37		Echague	Dammang East	Residential/cornfields	300	25	7,500	
38		San Agustin	Laoag	National road/cornfields	300	25	7,500	
39		Jones	Disimpit	Residential/national road/cornfields	1,000	25	25,000	
40		Echague	Pangal Sur	Residential/national road	150	25	3,750	
41		Echague	Dammang West	Cornfields	100	25	2,500	
42		San Agustin	Dappig	Cornfields	500	25	12,500	
43		Echague	Gucab	Residential/cornfields	600	25	15,000	
44		Jones	Dalibubon	Residential/national road	1,000	25	25,000	
45	Magat	Bambang	Cupas	Agri.lands, national road	1,000	15	15,000	
46		Bambang	Macate	Agri.lands, national road	1,000	15	15,000	
47		Bayombong	Lingay	Agri.lands, national road	1,000	15	15,000	
48		Solano	Bugnay	Agricultural lands	2,000	15	30,000	
49		Solano	Crifang	Agricultural lands	800	15	12,000	
50		Solano	Dadap	Agricultural lands	700	15	10,500	
51		Solano	Bangar	Agricultural lands	200	15	3,000	
52		Bagabag	Pogoncino	Agricultural lands	1,500	15	22,500	
53	Sta. Fe	Bambang	Barat	Agricultural lands	2,000	15	30,000	
54	Magat	Bayombong	Busilac	Agricultural lands	1,500	15	22,500	
55	Sta. Fe	Bambang	Almaguer	Agricultural lands	2,000	15	30,000	
56	Magat	Bayombong	Magsaysay	Agricultural lands	1,000	15	15,000	
57	Sta. Fe	Bambang	Indiana	Agricultural lands	1,500	15	22,500	
58	Magat	Bambang	Sto. Domingo	Agri.lands, national road	600	15	9,000	
59	Sta. Fe	Bambang	Salinas	Res.area, national road	500	15	7,500	
60	Magat	Bayombong	Maddiangat	Agricultural lands	1,500	15	22,500	
61	Magat	Bayombong	Bonfal Proper	Agricultural lands	1,000	15	15,000	
62	Magat	Bayombong	Vista Hills	Agri.lands, national road	500	15	7,500	
63	Matuno	Bambang	San Leonardo	Agricultural lands	2,000	15	30,000	
64	Sta. Fe	Aritao	Banganan	Res.area, national road, agri.lands	1,500	15	22,500	
65	Sta. Fe	Sta. Fe	Poblacion	Res.area, national road, agri.lands	500	15	7,500	
66	Sta. Cruz	Kayapa	Cabanglasan	Agri.lands,municipal road	1,000	15	15,000	
67	Sta. Cruz	Kayapa	Pingkian	Agri.lands,municipal road	700	15	10,500	
68	Apayan River	Dupax del Norte	Lamo	Agricultural lands	2,000	15	30,000	
69	Benay	Dupax del Sur	Palabotan	Agricultural lands	500	15	7,500	
70	Benay	Dupax del Sur	Dupax	Agricultural lands	600	15	9,000	
71	Apatan	Dupax del Norte	Bitnong	Agricultural lands	300	15	4,500	
72	Apatan	Dupax del Norte	Mungia	Agricultural lands	300	15	4,500	
73	Sta. Cruz	Kayapa	San Fabian	Agricultural lands	300	15	4,500	

Data source: Site reconnaissance by the Study Team and detailed survey by the respective district offices in the Region II

Table 1.2.2 Recorded Major Disasters from 1987 to 1999 in the Republic of the Philippines

YEAR	TYPE OF DISASTERS & NUMBER OF OCCURRENCES	CASUALTIES			AFFECTED		HOUSES DAMAGE		COST OF DAMAGE IN BILLION PESOS
		DEAD	INJURED	MISSING	FAMILIES	PERSONS	TOTALLY	PARTIALLY	
1987	TYPHOONS (6)	1,020	1,455	213	668,628	3,882,534	242,336	345,370	4.083
	DROUGHT (1)				203,345	1,002,100			0.707
	STORM SURGE (1)				540	2,700			0.045
TOTAL		**1,020**	**1,455**	**213**	**872,513**	**4,887,334**	**242,336**	**345,370**	**4.835**
1988	TYPHOONS (5)	429	468	195	1,173,994	6,081,566	134,344	355,459	8.676
	EARTHQUAKE (MINDORO OCC.)				650	2,600			0.835
TOTAL		**429**	**468**	**195**	**1,174,644**	**6,084,166**	**134,344**	**355,459**	**9.511**
1989	FLOODING (1)	101	79	148	81,152	459,730	25	303	0.392
	TYPHOONS (7)	382	1,087	89	502,600	2,582,822	56,473	184,584	4.494
TOTAL		**483**	**1,166**	**237**	**583,752**	**3,042,552**	**56,498**	**184,887**	**4.886**
1990	DROUGHT (1)				220,269	1,189,309			3.386
	TYPHOONS (8)	670	1,392	262	1,265,652	6,661,474	223,535	636,742	12.678
	JULY 16 - EARTHQUAKE	1,283	2,786		227,918	1,255,248	25,207	77,249	12.200
TOTAL		**1,953**	**4,178**	**262**	**1,713,839**	**9,106,031**	**248,742**	**713,991**	**28.264**
1991	DROUGHT (1)				47,987	254,282			1.631
	MT. PINATUBO ERUPTION	850	184		249,371	1,180,132	40,867	67,862	10.424
	ORMOC CITY DISASTER	5,101	292		43,397	223,985	5,232	25,272	1.044
	LAHAR I	16	9	2	33,497	161,541	2,378	444	0.494
	TYPHOONS (2)	5,199	355	1,281	150,894	759,335	15,468	83,664	4.584
TOTAL		**11,166**	**840**	**1,283**	**525,146**	**2,579,275**	**63,945**	**177,242**	**18.177**
1992	DROUGHT (1)				209,255	1,027,103			4.094
	LAHAR II	6	7		19,932	96,102	1,712		0.551
	FLASHFLOOD /FLOODINGS	28		3	15,405	81,478	102	78	0.135
	TYPHOONS (7)	117	95	53	352,944	1,755,811	3,314	8,006	5.071
TOTAL		**151**	**102**	**56**	**597,536**	**2,960,494**	**5,128**	**8,084**	**9.851**
1993	TYPHOONS (13)	794	1,634	200	1,446,031	7,465,711	164,174	444,909	19.987
	MT. MAYON ERUPTION	80	9		21,600	106,917			0.073
	FLOODING (4)	32	4	17	72,997	375,058	274	432	1.085
	RED TIDE				24,598	11,743		336	
TOTAL		**906**	**1,647**	**217**	**1,565,226**	**7,959,429**	**164,448**	**445,677**	**21.145**
1994	LAHAR III	20	1		11,805	55,961	1,648	37	0.414
	TYPHOONS (14)	242	247	48	617,228	3,056,232	58,567	223,358	3.198
	EARTHQUAKE (ORIENTAL MINDORO)	83	430	8	22,452	134,712	1,530	6,036	0.515
TOTAL		**345**	**678**	**56**	**651,485**	**3,246,905**	**61,745**	**229,431**	**4.127**
1995	TYPHOONS (9)	1,204	3,025	642	1,561,334	7,693,526	294,147	719,124	15.256
	MOUNT PARKER	34		23	12,381	60,853	410	287	0.720
TOTAL		**1,238**	**3,025**	**665**	**1,573,715**	**7,754,379**	**294,557**	**719,411**	**15.976**
1996	TYPHOONS (10)	124	124	50	260,581	1,255,289	2,690	17,559	2.834
TOTAL		**124**	**124**	**50**	**260,581**	**1,255,289**	**2,690**	**17,559**	**2.834**
1997	TYPHOONS (5)	77	36	6	391,250	1,965,867	546	6,775	0.596
	TRAIN ACCIDENT	10	36						
	OZONE DISCO FIRE	160	52						
	ARMED-CONFLICT	8	9		13,176	76,431			
TOTAL		**255**	**133**	**6**	**404,426**	**2,042,298**	**546**	**6,775**	**0.596**
1998	TYPHOONS (4)	490	866	104	1,590,905	7,322,133	137,020	406,347	17.017
	FLOODING (6)	16	21	17	79,161	127,044	146	64	0.095
	EL NIÑO PHENOMENON								8.310
	PALAWAN FOREST FIRES	2			162	468			0.441
	CEBU PACIFIC AIR CRASH	99							
TOTAL		**607**	**887**	**121**	**1,670,228**	**7,449,645**	**137,166**	**406,411**	**25.863**
1999	(JAN-JUN ONLY) FLOODINGS /FLASHFLOODS (37)	90	24	14	193,189	966,420	46	15	1.008
	LANDSLIDES (17)	35	4		902	4,756	12		0.007
	TYPHOONS	10	23	1	7,089	36,225	29	244	0.217
TOTAL		**135**	**51**	**15**	**201,180**	**1,007,401**	**87**	**259**	**1.232**
GRAND TOTAL		**18,812**	**14,754**	**3,376**	**11,794,271**	**59,375,198**	**1,412,232**	**3,610,556**	**147.297**

Source: Department of National Defense, OFFICE OF CIVIL DEFENSE,Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Philippines (1/10)
(1990)

NATURE	AKANG	BISING	EMANG	NORMING	RUPING	WELING	ANING	BIDANG
A. Date of Occurrence	Mar. 12-15	Mar 23-28	July 12-16	Aug. 20-27 Sept. 2- 4	Sept. 5-11	Oct. 12-15	Dec. 8	Dec. 8-11
B. Origin	East of Mindanao	805 Kms. East of Surigao	LPA of Visayas, Batanes	East of Samar	East of Visayas	1,040 ENE of Catanduanes	1,140 Kms. ESE of Catanduanes	34 Kms NE of Legaspi City
C. Maximum Winds	19 Kph	185 Kph	110 Kph	150 Kph	110 Kph	185 Kph	110 Kph	110 Kph
D. Land Fall	Surigao Del	Dinapit Islan	Nueva Ecija	Panay Island	Vicinity of Sorsogon	Cagayan	Western Samar	Sorsogon
E. Exit	Surigao del Sur, Mis. Or.	Vicinity of Antique & Aklan	Vicinity of Lingayen, Gulf, Pangasinan	Abra	Over Cavite	Abra	Isabela	Palawan
D. Areas Affected	Regions X-2 & XI-1	Regions VIII-3; VII-2 & X-1	Region 1-2 and III-5	Regions 1-3; III-2; IV-2 & VI-3	Regions III-1; IV-4; V-3 & VII-1, NCR	Region II-3 & I-5	Eastern Luzon, Batanes Grp. And Eastern &	Regions I-5; III-4 & V-2
E. Casualties								
Dead	64	8	8	36	50		2	508
Injured	17			42	53		2	1,278
Missing	8			3			5	246
Population								
F. Affected								
Families	42,193	16,440	6,697	52,171	130,219	5,591	2,337	1,010,004
Persons	227,269	81,355	32,974	213,431	568,675	27,959	11,521	5,498,290
G. Homeless								
Families	361	40	3	456	684		20	222,026
Persons	2,115	240	24	2,476	3,324		120	1,048,024
H. Damages								
1. Houses								
Totally	306	40	3	456	684		20	222,026
Partially	2,684		594	513	1,961		105	630,885
2. Properties Breakdown								
Agri. Production (million Pesos)								
Livestocks	0.493	0.041		0.167	0.378			946.460
Fishpond	73.967		0.084		112.255			
Crops	27.480	16.828	5.012	6.201	1,336.540			
Private Prop	1.245		7.700					7,565,077
Infrastructure								
Roads & Bridges (million Pesos)	69.727	27.481	10.797	29.782	27.391			
Public Works (million Pesos)	13.375	10.905		1.705	1.911			1,369.720
Flood Control (million Pesos)	13.843	4.800	1.225	6.762	23.725			
DSWD (million Pesos)	1,637,317	578,265	337,982	1,508,402	3,675,938			19,889,681
DOH Donation of European (million)								3.251
Community thru PNRC (Metric tons, asst. supplies)								614.600
Population Served:								
Families	40,544	11,239	6,697	34,890	74,817			534,350
Persons	208,172	52,290	41,042	194,818	412,391			2,281,898
Relief & Rehab Cost (million Pesos)								
DPWH								150
DSWD								40
DECS								24
DOH								15
DA								15
DND								11
DOTC								4
DENR								3
DOST/PAGASA								1
LGU'S								93
Total (million Pesos)								356

Source:Department of National Defense, OFFICE OF CIVIL DEFENSE, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (2/10)
(1991)

DESCRIPTION	T.S. AURING	TYPHOON "DIDING"	TYPHOON "ETANG	TYPHOON "TRINING"	T. STORM "URING"	TYPHOON "YAYANG"	TOTAL
A. Date of Occurrence	March 10-14	June 13-15	July 8-11	Oct. 23-30	Nov. 2-16	Oct. 14-20	
B. Origin	East of Mindanao	Active LPA ESE of Surigao City	LPA East of Samar	East of Catanduanes	900 Kms ESE of Borongan, Samar	1,250 Kms ESE of Aparri, Cagayan	
C. Center Winds	110 Kms	140 Kms	65 Kph		120 Kms	205 Kms	
D. Area Affected:	Region IV, Quezon	Region V, Catanduanes	CAR, NCR, REGS. I & III	CAR, REGS. I & II	NCR, REGS. I, III, IV, V & VIII	CAR, NCR, REGS. I, II & III	
E. Areas declared under State of Calamity	REG. XIII (Maguindanao) Kabuntalan, Datu Piang & (Sultan Kudarat) Bagumbayan & Esperanza (Lanao del Sur) Traka, Malundo & Maguing	REG. I, Ilocos Norte & Sur, Aringay, Agoo, Bangar & La Union. REG. II - Cagayan, Isabela & Nueva Vizcaya, Sadipen, La Union; CAR - Abra, Benguet, Ifugao, Kalinga Apayao, Mt. Prov. & Baguio City	CAR - Ifugao, Benguet, baguio City, Abra & Kalinga Apayao; REG. I - Ilocos S & N, Pangasiana, Mt. Prov., Laoag City & Dagupan City. REG. III - Bulacan	REG. I - Ilocos Norte REG. II - Cagayan	REG. III - Bataan, Bulacan, Zambales, Pampanga, Angeles City, Olongapo City. REG. IV - Cavite, Batangas, Laguna, Quezon, marinduque, Cavite City, tagaytay city, San Pablo city, Lucena City & Rizal REG. V- Albay, Masbate, Sorsogon, Legaspi City, Cam Sur & Norte, Iriga City and Naga City.	REG. I - Ilocos Sur, La Union, Pangasinan, Dagupan city & San Carlos City. REG. II- Isabela, nueva Vizcaya & Quirino. REG. III - Tarlac, N. E., Cabanatuan City, Palayan City. REG. IV - Aurora CAR - ifugao, Kalinga-Apayao, Benguet, Baguio City.	
D. Casualties							
Dead	13	90	44	119	58	47	**386**
Injured	3	386	21	192	121	364	**1,087**
Missing	40	3	3	28	15		**89**
E. Affected Population							
Families	12,282	95,269	97,911	39,095	135,245	109,961	**502,600**
Persons	73,184	488,757	505,756	219,178	682,699	551,043	**2,582,822**
F. Homeless							
Families	652	8,845	1,157	14,138	12,883	19,270	**57,157**
Persons	3,011	44,288	6,096	84,828	70,420	115,620	**324,263**
G. Damages to: Houses							
Totally	652	8,845	1,157	14,064	12,273	19,270	**57,157**
Partially	4,392	46,269	24,638	19,245	37,699	48,940	**325,535**
Properties (Million Pesos)	74.353	1,362.850	579.958	192.181	1,393.50	883.077	**4,494.367**
Breakdown (Million Pesos)							
Crops	6.613	911.174	230.688	74.197	653,156	776.387	**655,153.839**
Livestocks	0.057	4.633	19.743				**24.433**
Fish Pond		7.096	37.648		471.164	1.872	**517.780**
Public Works	20.111	222.300	89.881	24.374	197.478	64.070	**622.372**
Roads & Bridges	45.572	217.65	198.942	35.552	60.093	40.698	**598.507**
Private Prop			3.056	58.058	11.605	0.050	**75.260**
H. Relief Operations Population Served							
PNRC (Million Pesos)							
Families	2,386	18,125	63,123	9,824	79,610	57,303	**246,225**
Persons	13,272	94,902	361,332	52,725	469,236	291,307	**1,363,494**
DSWD (Million Pesos)							
Families	3,563	33,810	63,835	14,003	125,834	32,281	**280,416**
Persons	20,854	168,012	333,830	77,363	663,316	156,812	**1,483,574**
Estimated Cost (Relief) (Million Pesos)							
PNRC -	0.136	2.759	0.442	0.282	2.661	1.207	**8.068**
DSWD -	0.056	1.103	3.407	0.384	8.068	1.032	**14.822**
Estimated Cost(Rehab) (Million Pesos)							
DSWD		38.062	3.711	4.091	27.332	13.489	**86.685**
DA		15.000	20.000			13.000	**48.000**
DOH					0.008	3.547	**4.055**
DPWH		50.000	20.000	30.000		20.440	**120.44**

Source:Department of National Defense, OFFICE OF CIVIL DEFENSE, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (3/10)
(1992)

DESCRIPTION	TYPHOON "KONSING" (ELI)	T. DEPRESSION "DITANG" (GARY") 9207	TROPICAL STORM "GLORING"	TROPICAL STORM "ISANG"	TYPHOON "LUSING" (OMAR) 9215	TROPICAL STORM "MARING"	TYPHOON "PARING" (COLLEEN)	TOTAL
A. PERIOD OF OCCURRENCE	JULY 9-12	JULY 17-21	AUG. 16-18	AUG. 26-31	AUG. 31 - SEPT. 5	SEPT. 18-23	OCT. 18-27	
B. REGIONS AFFECTED	I & III	I, II, III & NCR	III, IV & NCR	CAR, I & II	I, II & CAR	I, II, III & CAR		
NO. OF PROVINCES	4	9	6	8	10	17	2	**56**
NO. OF MUNICIPALITIES			45	37	35	195	10	**322**
NO. OF BARANGAYS			556	131	94	854	19	**1,654**
NO. OF CITIES		5	2		3	4	1	**15**
C. POPULATION AFFECTED								
FAMILIES	1,027	27,902	148,049	23,677	31,787	113,686	6,816	**352,944**
PERSONS	5,135	134,417	725,956	114,084	171,603	570,136	34,480	**1,755,811**
D. CASUALTIES								
DEAD	3	36	22	19	10	27	1	**118**
MISSING	19	6	4	1	1	18	4	**53**
INJURED		77		1	1	13	3	**95**
E. DAMAGES								
1. HOUSES								
TOTALLY	5	478	1,428	214	393	785	11	**3,314**
PARTIALLY	15	1,305	3,072	197	145	3,272		**8,006**
2. PROPERTIES (million Pesos)								
AGRICULTURE	**8.500**	**248.663**	**912.934**	**2.805**	**264.771**	**1,172.953**	**0.890**	**2,611.516**
CROPS	7.000	108.344	877.604		234.436	1,131.943		2,359.327
LIVESTOCKS		4.572	5.021	COMBINED	0.335	4.479	COMBINED	14.407
FISHPONDS	1.500	135.747	30.309		30.000	36.531		234.087
INFRASTRUCTURE	**9.562**	**231.254**	**434.199**	**169.688**	**632.538**	**974.162**	**0.100**	**2,433.503**
ROADS & BRIDGES	5.832	168.056	288.953	85.013	348.339	737.760		1,633.953
PUBLIC BUILDINGS	2.500	9.198	3.320	30.150	3.240	34.340	COMBINED	82.748
FLOOD CONTROL	1.230	36.000	141.926	54.525	280.959	202.062		716.792
PRIVATE PROPERTIES	3.000	5.109			5.435	8.190	0.225	21.959
OTHERS		3.633						3.633
TOTAL	**21.062**	**470.659**	**1,347.133**	**172.493**	**902.744**	**2,155,305**	**1.215**	**5,070.611**
F. RELIEF OPERATIONS								
1. POPULATION PNRC								
FAMILIES	1,000	19,019	11,224	38,774	2,484	5,685		**78,186**
PERSONS	3,730	92,513	60,519	201,390	14,904	33,785		**406,841**
2. AMOUNT OF RELIEF (Pesos)								
DSWD	83.751	919,668	5,036,519	12,306,264	665,043	1,800,000		20,811,245
PNRC	45,434	951,809	66,902	1,527,765	62,909	1,055,377		3,710,196
G. REHABILITATION OPERATIONS CALAMITY FUND								
LGU'S		6,250,000		2,600,000				18,850,000
DPWH					14,460,000			14,460,000

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (4/10)
(1993)

DESCRIPTION	TYPHOON "GORING"	TROPICAL STORM "HULING"	TYPHOON "UPENG"	TROPICAL STORM " RUBING"	TROPICAL STORM " SALING"	TROPICAL STORM " WALDING"	TROPICAL STORM " YEYENG"	TYPHOON "KADIANG"	TYPHOON "HUSING"	TROPICAL STORM "LURING"	TOTAL
A. Date of Occurrence	JUNE 25-27	JULY 7-9	AUG. 6-8	AUG. 16-19	AUG. 22-26	SEPT. 8-20	SEPT. 13-16	SEPT. 30 - OCT. 7	OCT. 28- NOV. 2	NOV. 19-22	
B. Origin	Caroline Island	Active LPA East of Surigao	1,300 kms. ENE of Catanduanes	380 Kms ENE of Catanduanes	Eastern Samar	Northern Luzon	LPA East of Samar	LPA East of Aurora	East of Virac Catanduanes	LPA over the Catanduanes	
C. Center Winds	220 Kph	85 Kph	95 Kph	95 Kph	95 Kph	110 Kph		120 Kph	175 Kph		
D. Areas Affected											
Provinces	19	3	2	11	2	1	3	20	14	4	**79**
Municipalities	67	7	2	39	26	6	18	228	117	11	**521**
Barangays	1,836		3	289			40	3,232	1,031		**6,431**
Cities	8			7	1		1	9	3	1	**30**
E. Casualties											
Dead	75	2		5	4			128	21	8	**241**
Injured	121			1	1			37	7	1	**168**
Missing	13							26	5	4	**48**
F. Population Affected											
Families	153,949	180	105	57,427	3,830	2,368	7,035	415,813	83,026	7,065	**730,798**
Persons	812,830	548	630	269,396	22,308	14,208	37,610	2,060,677	455,170	43,327	**3,716,704**
G. Homeless											
Families	35,069			243	143			2,249	1,627		**39,332**
Persons	177,307			1,458	858			11,245	8,135	30	**199,039**
H. Damages to: Houses											
Totally	35,069		1	243	143			2,249	1,838		**39,543**
Partially	79,695			361	698			9,078	12,841		**102,673**
Properties (million Pesos)	2,774.453	4,121	0.015	98.347	156.928	1.318	37.373	8,752.316	1,585.164	27.680	**13,437.715**
Agricultural Products (million Pesos)	994.694	0.971		8.276	15.307	0.729	16.219	7,192,884	1,153.598	20.000	**9,540.442**
Private Properties (million Pesos)	44.685		0.015		1.607	0.090		0.400	0.620	0.080	**47.497**
Infrastructure (million Pesos)		3.150		90,071	2.250	0.499	21.154	1,559.032	430.946	7.600	**3,849.776**
I. Extent of Assistance Population Served (DSWD & NGO's)											
Families	37,699	158		13,152		2,368	4,600	128,895	30,202	1,259	**218,333**
Persons	178,042	883		654,523		14,208	24,453	679,026	153,973	7,239	**1,122,277**
(PNRC & NGO's)											
Families	54,244							28,319			**82,563**
Persons	2,722,425							126,728			**2,849,153**
Estimated Cost of Assistance DSWD (Pesos)	1,805,845	50,000		1,007,164			265,188	16,493,001	2,471,243		**22,092,440.96**
PNRC (US$)	No Costing				No costing	No costing		7,500		No Costing	**7,500**

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (5/10)
(1994)

DESCRIPTION	TYPHOON "AKANG"	TROPICAL STORM "ENSING"	T. D. "DELING"	T. D. "GADING"	TYPHOON "ILIANG"	T. D. "LOLENG"	T. D. "NORMING"	T. S. "OYANG" T. D. "PASING"	TYPHOON "RITANG"	T. STORM "WELING"	TYPHOON "KATRING"	TYPHOON "GARDING"	TOTAL
A. Date of Occurrence	JAN 4-6	APRIL 1-9	MAY 24-26	JUNE 21-24	JULY 7-10	JULY 10-11	JULY 18-19	JULY 25-29	AUG. 4-7	SEPT. 7-11	OCT. 18-21	DEC. 19-23	
B. AREAS AFFECTED (REGIONS)	IV & V	VI, VII, VIII & X	VII	III & NCR	I, II & III		I & III	I, III, IV, VI, XI & ARRM	I & CAR	I & II	III & IV & NCR	IV, V, VI, VII & VIII & X	**13**
Cities /Provinces	Palawan, Albay, Sorsogon & Legaspi City	Negros Occ., Cebu, Bohol, Leyte, Surigao N., Agusan N. Camiguin, La Carlota, Cadiz, Bago, Silay, Ilo-Ilo, Toledo, Lapu-Lapu, Madaue, Surigao & Butuan	Bohol. Davao Or., Cotabato	Central Luzon & MM	La Union, Ilocos S., Pangasinan, Laoag city, Ilocos N., Kalinga Apayao & Bataan, Bulacan, Zambales, Tarlac & Pampanga		Pampanga & Bataan, Bulacan. N. E. Ilocos S., Zambales, Olongapo City	Pangasinan, La Union, Pampanga, Zambales, bataan, tarlac, Cavite, Rizal, Ilo-Ilo & Lanao Sur	Pangasinan, Ilocos N., La Union & Abra	Ilocos N., Pangasinan, Cagayan		Quezon, Albay, Aklan, Antique, Capiz, Roxas City, Ilo-Ilo, Ilo-Ilo City, Negros Occ., Cebu, Cebu City, Lapu City, Biliran, Eastern, Samar, Leyte, Ormoc City & Tacloban	**38/19**
Barangays	117	213	4	10	794		450	497	79	184		82	**2,430**
Municipalities	20	53	11	7	85		39	52	12	26			**305**
C. Casualties													
Dead	45	19	1	3	11		12	48	4	10	45	44	**242**
Injured	26	72			21		9	9			24	86	**247**
Missing	17	10			6		1	2		1	6	5	**48**
D. Population Affected													
Families	9,909	118,061	1,822	11,010	32,700		127,647	60,129	3,303	15,605	59,097	177,945	**617,228**
Persons	49,159	587,671	8,788	56	166,564		616,860	336,069	16,838	70,597	287,737	857,837	**3,054,232**
Homeless													
Families	522	15,601	10		2,174		101	505	29	28	14,596	28,778	**62,344**
Persons	3,132	78,093	54		11,051		606	3,030	174	168	74,216	172,668	**343,192**
E. Damages to: Houses													
Totally	522	11,824	10		2,174		101	505	29	28	14,596	28,778	**58,567**
Partially	3,039	56,048	31		11,589		204	689	68	60	44,472	107,158	**223,358**
Properties (P/M)													
Infrastructure (million Pesos)	32.050	147.514	12.900		126,395		4.360	49.422	2.108	66.036	213.629	286.867	**941.099**
Agriculture (million Pesos)	47.514	163.153	131.607		26.172		0.120	81.307	5.238	117.609	946.677	360.674	**1,880.071**
Private Properties (million Pesos)		96.993	0.815		2.736			3.055			272.877		**376.476**
TOTAL (million Pesos)	79.664	407.660	145.322		155.303		4.480	133.784	7.346	183.645	1,433.180	647.541	**3,197.740**
F. Population Served													
Families	3,107	9,753		2,943	7,471		8,779	26,686	1,345	6,269	13,004	11,544	**90,901**
Persons	15,420	42,466		12,793	38,680		42,160	127,156	5,312	26,196	62,659	61,373	**434,215**
AMT. OF ASSISTANCE (million Pesos)	1,065,528	1,126,134	128,300	385,188	213,554		1,103,104	6,581,670	41,659	361,728	3,955,762	3,454,020	**#########**
G. Calamity Fund Releases (million Pesos)	15,200	22.818			3.100		1.200	16,200	0.500	11,000	49,900	34,000	**153.918**

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (6/10)
(1995)

DESCRIPTION	TYPHOON "AURING"	TROPICAL STORM "KARING"	TYPHOON "GENING"	TYPHOON "HELMING"	TYPHOON "ISING"	TYPHOON "LUDING"	TROPICAL STORM "MAMENG"	TROPICAL STORM "PEPANG"	TYPHOON "ROSING"	TYPHOON "SENDANG"	TYPHOON "TRINING"	TOTAL
A. Date of Occurrence	May 31 - June 8	July 27 - 31	Aug. 25-31	Sept. 02.05	Sept. 14-17	Sept. 21-22	Sept. 27 - Oct. 1	Oct. 26-30	Oct. 31 - Nov. 3		Dec. 26-30	
B. AREAS AFFECTED (REGIONS) REGION	III & IV	I, II, III & CAR	I, II, III, IV & V	III	I & III	I	I, III ,IV, V, VI, VII, VIII, X & NCR	IV, VI, VII & VIII	I, II, III, IV, V, VIII, NCR & CAR		VII, VIII, XI & XIII	
	Romblon, Pampanga & Albay	La Union, Pangasinan, Zambales, Pampanga & Mt. Province	Pangasinan, Ilocos Norte, batanes, Zambales, Pampanga, Albay, Metro Manila	Pampanga, Tarlac, Zambales & Bataan	Pangasinan & Pampanga	La Union & Ilocos Norte						
Municipalities	5	17	31	21	22	11	147	80	437	5	104	**880**
Barangays		131	263	10	186	27	1,014	1,306	516	7	1,004	**4,464**
Cities			8	1	1		13	11	21	1	2	**58**
C. Casualties												
Dead	6	2	3	8	1	1	133	116	916	11	7	**1,204**
Injured							108	49	2,860	1	2	**3,020**
Missing	2	2	3			3	130	125	376	3	4	**648**
D. Population Affected												
Families	427	12,734	39,357	24,043	6,432	1,611	241,430	234,522	960,777	7,065	45,145	**1,573,543**
Persons	2,118	68,186	195,885	104,416	34,590	5,422	1,240,668	1,254,774	4,583,618	4,053	229,191	**7,722,921**
E. Damages to: Houses												
Totally	151		72	713		15	13,234	53,907	226,843	8	176	**295,119**
Partially	337		261	458		293	21,862	156,979	530,808		7,222	**718,220**
Properties (P/M)												
Infrastructure	28,000	100,083	92,475	3,150			1,296,649	174,270	1,726,844	3,700	202,036	**3,627,207**
Agriculture		35,063	68,678	4,764	39,851		1,876,076	232,671	9,036,741		178,726	**11,472,570**
Private Properties		27,900	9,187	0.350	139,680			16,576	86,187			**279,530**
F. Population Served Evaluated												
Families	141	3,137	1,217	1,983	862	2,295	30,747	108,428	120,704	726	1,602	**271,842**
Persons	670	13,701	5,757	9,671	5,276	9,947	147,820	556,864	636,648	4,001	5,320	**1,395,675**
AMT. OF ASSISTANCE (Pesos)		1,807,392	1,418,295	1,974,637	6,172,642	6,269,045	23,074,000	7,218,000	33,445,000			**81,379,011**
G. Calamity Fund Releases (million Pesos)	8,000		19,000			2,300	240,476	29,400	104,600			**403,776**
Rehabilitation							20,017	16,195	164,000			**200,212**
Foreign Donation									22,000 Cash & Kind			**22,000**

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (7/10)
(1996)

DESCRIPTION	TYPHOON "ASIANG"	TYPHOON "BIRING"	TYPHOON "KONSING"	TYPHOON "GLORING"	TYPHOON "HUANING"	TYPHOON "LUSING"	TYPHOON "MARING"	TYPHOON "NINGNING"	TYPHOON "SENIANG"	TYPHOON "TOYANG"	TOTAL
A. Date of Occurrence	Feb. 28 - Mar. 2	April 5 - 9	May 11 - 16	July 21 - 27	July 27 - 31	Aug. 18 - 21	Sept. 5 - 8	Sept. 10 - 11	Oct. 14 - 19	Nov. 4-10 to 12-15	
B. AREAS AFFECTED (REGIONS) REGION	VI & VIII	V,VI & VIII	V	NCR, CAR, I, II & III * IV	I, III,IV, NCR & CAR	I, II & CAR	II	I, II & CAR	CAR, II & IV	I, CAR, IV, V, VI, VII, VIII & IX, X, XI & CARAGA & ARRM	
PROVINCES	Capiz, Leyte	Capiz, Leyte, Samar, Sorsogon			5	Pangasinan, La Union, Cagayan, Quirino, Isabela,	Cagayan	Mt. Province	4	21	
Municipalities	9			196	25	32	1	2	33	80	**378**
Barangays	64			1,754	212	256	8	3	358	173	**2,828**
Cities					3					8	**11**
C. Casualties											
Dead	2	3		72	5	4	6		8	24	**124**
Injured				50	3	1	22		16	5	**97**
Missing				24	7				6	12	**49**
D. Population Affected											
Families	1,411	315		143,853	38,259	22,967	1,614	11	33,418	18,733	**260,581**
Persons	8,221	1,000		686,250	192,651	118,249	9,297	67	150,609	88,945	**1,255,289**
E. Damages to:											
Houses											
Totally	14			714	1	79	887	1	747	247	
Partially	51			6,790	19	1,051	727	2	6,629	2,290	
Properties (million Pesos)											
Infrastructure	7,520	6.010	0.700	722.604	18	38.992	10.776	40.261	43.480	74.269	**962.612**
Agriculture	37,339	34.516		1,397.650		53.541	10.395	1.376	160.261	159.127	**17.378**
Private Properties		0.075					13.055			4.248	
F. Population Served											
Evacuated											
Families				73,306	11,208	20,566		11		5,202	**110,293**
Persons				334,852	54,962	105,030		67		26,457	**521,368**
AMT. OF ASSISTANCE (Pesos)				3,417,287	691,820	880,116		715	147,409	346,505	**5,483,852**
G. Calamity Fund Releases (million Pesos)											
Rehabilitation		1.000		34.510	13.650				3.800	4.800	**57.760**
Foreign Donation											

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effects of the Destructive Tropical Cyclones in the Republic of the Phillipines (8/10)
(1997)

DESCRIPTION	TYPHOON "BINING"	TYPHOON "ELANG"	TYPHOON "HULING"	TYPHOON "IBIANG"	TYPHOON "MILING"	TYPHOON "NARSING"	TOTAL
A. Date of Occurrence	MAY 26 - 28	JULY 18 - 23	JUL. 31 - AUG. 6	AUG. 21- 28	AUG.	OCT. 16 - 23	
B. AREAS AFFECTED (REGIONS)	I, III, IV, VI & NCR	VI	III	I, III, IV, NCR, VI & XI	II	CAR, I & II	7
REGIONS	(ILOCOS SUR, LA UNION, MM. BULACAN, ZAMBALES, BATAAN, PAMPANGA, CAVITE, RIZAL & AKLAN	(NEGROS OCCIDENTAL & ANTIQUE)	(ZAMBALES, PAMPANGA & BATAAN	(LA UNION, PANGASINAN, BUL., BATAAN, ZAMBALES, TARLAC, N. E. BATANGAS, RIZAL, ILO-ILO, DAVAO OR. SARANGANI &	(BATANES)	(APAYAO, KALINGA, ILOCOS NORTE, CAGAYAN & ISABELA)	26
MUNICIPALITIES	34	2	4	151		65	**257**
BARANGAYS	357	8	28	1,801		870	**1,784**
CITIES	(9 IN MM & OLONGAPO CITY)		(OLONGAPO CITY)	(9 IN METRO M., CAB. CITY, OLONGAPO, ANGELES, PALAYAN, CAVITE, BATS. ILO-ILO, DAVAO, BAGUIO)			**17**
C. Casualities							
Dead	39	2		36		14	**91**
Injured	23	2		11		8	**44**
Missing	4			2		2	**8**
D. Population Affected							
Families	82,598	1,086	3,239	304,327	2,000	49,048	**440,298**
Persons	413,260	5,365	15,115	1,521,125	6,000	243,896	**2,209,763**
E. Damages to:							
Houses							
Totally	262	1	11	272		1,779	**2,325**
Partially	354	1	41	6,379		13,771	**20,546**
Properties (million Pesos)							
Infrastructure	79.466	0.150	7.4	172.478	1.120	188.955	449.569
Agriculture	5.202	0.704		280.594	4.875	261.162	552.537
Private Properties	20.175			23.46	0.412		44.049
	104.843	**0.854**	**7.4**	476.534	6.407	450.117	1,046.155
F. Population Served							
Families	53,576			78,255		19,476	**151,307**
Persons	225,903			378,892		97,106	**701,901**
Evacuated:							
Families	29,092			32,837			**61,929**
Persons	143,903			136,410			**280,174**
G. Amount of Assistance (million Pesos)	1,308.594			20,225.800		4,027.000	**25,561.4**
H. Calamity Fund Releases (million Pesos)	8.600			107.000	6.000	5.500	**127.1**

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effective of the Destructive Tropical Cyclones in the Republic of the Philippines (9/10)
(1998)

DESCRIPTION	TYPHOON "EMANG" AND	TYPHOON "ILIANG"	TYPHOON "LOLENG"	TYPHOON "NORMING"	TOTAL
A. PERIOD OF OCCURRENCE	SEPT. 15 - 20	OCT. 11 - 14	OCT. 15 - 25	DEC. 9 - 12	
B. REGIONS AFFECTED	REGS. I, II, III, IV, NCR & CAR	REGS. I, II, III, IV, V & CAR	REGS. I, II, III, IV, V, VI & VIII	REGS. III, IV, V, VI, & VIII	
NO. OF PROVINCES	16	23	40	17	**96**
NO. MUNICIPALITIES	132	420	341	80	**973**
NO. OF BARANGAYS	1,873	2,735	2,667	516	**7,791**
NO. OF CITIES	15	8	8	2	**33**
C. POPULATION AFFECTED					
FAMILIES	335,699	268,468	910,912	75,826	**1,590,905**
PERONS	1,749,414	1,344,556	3,902,673	326,490	**7,323,133**
D. CASUALTIES					
DEAD	108	46	303	33	**490**
INJURED	22	63	751	30	**866**
MISSING	10	29	29	36	**104**
E. DAMAGES TO:					
1. HOUSES					
TOTALLY	10,900	26,305	96,581	3,234	**137,020**
PARTIALLY	33,343	59,539	307,042	6,423	**406,347**
2. PROPERTIES					
(billion Pesos)	**3.794**	**5.375**	**6.787**	**1.061**	**17.017**
AGRICULTURE	3.250	3.125	3.695	0.644	10.714
INFRASTRUCTURE	0.544	1.764	2.316	0.279	4.903
OTHERS		0.486	0.766	0.138	1.400
F. RELIEF OPERATION AND EVACUATION					
1. TOTAL EVACUATED					
FAMILIES	12,333	8,336	383,867	6,240	**410,776**
OERSONS	63,954	41,399	1,855,242	38,837	**1,999,432**
EVAC. CENTERS	330	214	2,355	182	**3,081**
2. POPULATION SERVED					
FAMILIES	126,565	188,197	383,867	8,159	**706,788**
PERSONS	668,374	925,399	1,855,242	42,186	**3,491,201**
3. ESTIMATED COST (million Pesos)					
(RELIEF)	13.689	10.835	30.222	1.444	**56.190**
4. CALAMITY FUND (million Pesos)					
RELEASED	20.500	10.000	55.000	1.000	**86.500**

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.3 Summary on the Effective of the Destructive Tropical Cyclones in the Republic of the Philippines (10/10)
(1999)

DESCRIPTION	TROP. DEPRESSION	TROPICAL STORM	TYPHOON "ISING"	TROPICAL STORM	TROP. DEPRESSION	TYPHOON "PEPANG"	TROPICAL STORM	TROPICAL STORM
A. DATE OF OCCURRENCE	JUNE 4-6	JULY 21 - 26	JULY	AUG. 18 - 21	SEPT. 10 - 15	OCT. 2 - 6	OCT. 15 - 18	NOV. 7 - 9
B. REGIONS AFFECTED	III	I, II, III, NCR & CAR	28 - AUG. 1III	I, II, III & CAR	III	I, II & CAR	V & VIII	V, VI & VII
NO. OF PROVINCES	1	6	8	9	1	8	2	4
NO. OF MUNICIPALITIES		14	87	33	6	115		50
NO. OF CITIES		1	2		7	3		2
NO. OF BARANGAYS		43	748	211	8	1,297	9	139
C. POPULATION AFFECTED								
FAMILIES	302	11	263,324	7,089	1,050	84,089	3,290	23,110
PERSONS	1,601	55	1,245,917	35,222	4,633	444,770	5,791	54,152
D. CASUALTIES								
DEAD		1	45	10	1	18	1	24
INJURED			2	23	2	22		7
MISSING			2	1		3		9
E. DAMAGES TO:								
1. HOUSES								
TOTALLY	76	3	31	34	52	2,336		256
PARTIALLY	151		163	373	112	11,091		11,092
2. PROPERTIES								
(milliion Pesos)	**82.900**	**23.514**	**1,290.263**	**157.836**		**436.570**		584.409
AGRICULTURE	76.614	2.511	987.673	29.432		198.313		366.089
INFRASTRUCTURE	6.230	21.030	305.590	128.404		232.673		220.320
PVT. PROPERTIES	0.056					5.584		
3. EVAC. POPULATION								
FAMILIES			7,734					8,353
PERSONS			37,015					20,551
EVAC. CENTERS			170					

Source:Department of National Defense, NATIONAL DISASTER COORDINATING COUNCIL, Camp Aguinaldo, Quezon City

Table 1.2.4 Flood Damages due to Typhoon in Region II/CAR (1/3)

Year	Date	Name of Typhoon	Affected Area	Damage (1,000 Pesos)	Casualities		
					Dead	Injured	Missing
1970	Oct. 10-15	Sening	Nueva-Vizcaya	373	No	No	No
1971	Jul. 22-26	Sisang	No effect in Region II except 1 dead in				
1972	Jun. 24-25	Konching	No effect in Region II				
1973	Oct. 2-9	Luming	Batanes	195	-	-	-
			Cagayan	4,500			
			Isabela	663			
			K-Apayao	950			
			N-Vizcaya	748			
	Nov. 23-26	Openg	No Detailed damage data				
1974	Jan. 10-11	Basiang	Quirino	252			
			N-Vizcaya				
			(Solano)	550			
			(Bayombong)	951			
	Jul. 18-21	Iliang	Isabela	3,010			
	Oct. 8-12	Susang	Cagayan	5,474			
			K-Apayao	291			
			Isabela	12,059			
	Oct. 14-17	Tering	Isabela	1,744			
			Cagayan	3,549			
	Oct. 28-Nov.	Wening	Cagayan	394			
			K-Apayao	21,997			
			N-Vizcaya	8,544			
			Isabela	12,851			
			Quirino	492			
1975	Oct. 9-13	Mameng	Batanes	2,710			
1976	Jun. 22-Jul.	Huaning	Batanes	3,550			
			Ifugao	274			
			N-Vizcaya	513			
			K-Apayao	25			
			Quirino	150			
1977	Sep. 14-23	Openg	Cagayan	5,310		-	6
			Isabela		1	-	-
	Nov. 10-17	Unding	Quirino	1,128			
			N-Vizcaya	1,150			
1978	Oct. 25-27	Kading	Cagayan	3,656	22	10	9
			Quirino	17,055	1	-	13
			Isabela	3,623	2	-	5
			K-Apayao	525	9	-	-
			Ifugao	427	5	-	5
			N-Vizcaya	1,418	14	-	-
1979	Jul. 29-Aug.	Ising	Batanes, Cagayan & Isabela	3,980			
	Aug. 3-6	Luding	Northern Luzon				
	Aug. 9-15	Mameng	Cagayan	-	-	-	-
			Isabela	-	-	-	-
			Batanes	500	-	-	-
1980	Nov. 1-7	Aring	Cagayan	343,792	26		
			Isabela	83,893	16		11
			N-Vizcaya	69,450	27		12
			Quirino	63,596	4		
			K-Apayao	5,165			

Table 1.2.4 Flood Damages due to Typhoon in Region II/CAR (2/3)

Year	Date	Name of Typhoon	Affected Area	Damage (1,000 Pesos)	Casualities		
					Dead	Injured	Missing
			Ifugao	23,073			
			Batanes	600			
1981	Jul. 3-5	Elang	N-Vizcaya	783	1		
			Quirino	5,253			
	Sep. 16-21	Rubing	Cagayan	64,003	3	-	-
			K-Apayao	7,812			
			Quirino	1,308			
			Isabela	370			
			N-Vizcaya	420			
			Batanes	184			
	Nov. 22-27	Anding	Isabela	-	1		
			N-Vizcaya	1,040			
			Quirino	11,884			
1982	Oct. 12-15	Weling	Cagayan	37,243	12	15	-
			Isabela	14,159	71	144	21
			K-Apayao	10,672	13	24	9
1983	Sep. 3-8	Herming	Sta. Ana	6,895			
			Gonzaga	205			
			Aparri	1,500			
			Lallo	40			
			Isabela		2		
1984	Aug. 27-31	Maring	Cagayan	20,676	25	-	8
			Isabela	1,560	1	-	-
			Quirino	55			
			K-Apayao	40,198	-	-	-
			Ifugao		1		
1985	Jun. 20-24	Kuring	Batanes	4,150			
			Ifugao	1,400			
			Isabela	13,407			
			Quirino	2,740			
			K-Apayao	2,549	11		
			N-Vizcaya	4,858	3	69	
			Cagayan		1		
	Oct. 16-19	Saling	K-Apayao	32			
			Quirino	670			
			Ifugao	30			
			N-Vizcaya	12,305	1		
			Isabela	3,080			
1986	Jul. 6-10	T Gading	Regions 1 to 4 & NCR	679,000	106	16	-
	Aug. 17-Sep.	T Miding	Regions 1,3,4,6 & NCR	263,000	17	4	-
	Oct. 6-7	TD Oyang	Regions 3,4,4-A & NCR	54,000	26	27	21
1987	Aug. 8-13	T Herming	Regions 4,5,8	2,065,000	85	414	-
	Aug. 13-19	T Ising	Regions 2,3	115,000	5	-	-
	Aug. 22	Storm Surge	Aparri, Cagayan	45,000	-	-	-
	Sep. 4-10	T Neneng	Regions 1,2	92,000	-	-	-
	Oct. 21-25	T Pepang	Regions 1,2	519,000	100	79	13
	Nov. 23-27	T Sisang	Regions 4,5,8	1,119,000	100	79	-
	Dec. 14-18	T Trining	Regions 4,5,8	173,000	22	35	20
1988	May 30-Jun. 3	T Biring	Regions 3,4 & NCR	27,000	8	2	1
	Jul. 16-19	T Huaning	Regions 1,2	240,000	6	-	-
	Oct. 21-26	T Unsang	Regions 1 to 11	5,636,000	157	316	-
	Nov. 1-5	TS Welpring	Regions 4,6,8,9,10	24,000	41	1	1
	Nov. 5-8	T Yoning	Regions 4 to 9	2,748,000	217	149	133

Table 1.2.4 Flood Damages due to Typhoon in Region II/CAR (3/3)

Year	Date	Name of Typhoon	Affected Area	Damage (1,000 Pesos)	Casualities		
					Dead	Injured	Missing
1989	May 15-19	TS Biring	Regions 2 to 5 & NCR	74,000	13	3	40
	Jul. 14-17	T Goring	Regions 1 to 4,6	1,363,000	90	386	-
	Sep. 7-12	T Openg	Regions 1,3 & NCR	580,000	44	21	3
	Oct. 2-7	T Rubing	Regions 1,2, & CAR	191,000	119	192	28
	Oct. 9-10	T Saling	Regions 1,3,4,5,8&NCR	1,394,000	58	121	-
	Oct. 14-20	T Tasing	Regions 1 to 3 NCR &	883,000	47	363	-
	Nov. 16-22	TS Unsing	Regions 2,3,4,8 & NCR	8,000	11	1	-
1990	Jun. 18-23	T Bising	Regions 1 to 4,8,10, NCR & CAR	200,000	64	17	8
	Jun. 24-28	T Klaring	Regions 1 to 3,9	60,000	8	-	-
	Aug. 24-27	T Heling	Regions 1 to 4 CAR	45,000	36	42	3
	Aug. 28-30	T Iliang	Regions 1 to 4	1,520,000	50	53	-
	Sep. 5-8	T Loleng	Regions 1,2	-	-	-	-
	Nov. 10-14	T Ruping	Regions 4 to 12	10,846,000	508	1278	-
1991	Mar. 10-14	TS Auring	Region 4 (Quezon)	-	14	6	-
	Jul. 8-11	T Etang	Region 4 (Bataan)	-	-	2	3
	Oct. 23-30	T Trining	Regions 1,2 & CAR	3,469,000	82	55	-
	Nov. 14-18	T Yayang	Region 4	70,000	2	-	-
1992	Jul. 9-12	T Konsing	Regions 2,3	21,000	3	-	-
	Aug. 16-18	T Gloring	Regions 3,4 & NCR	1,347,000	22	-	-
	Aug. 26-31	T Isang	Regions 1,2 CAR	173,000	19	1	-
	Aug. 31-Sep.	T Lusing	Regions 1,2 CAR	903,000	10	1	-
	Sep. 18-23	TS Maring	Regions 1,2,3 & CAR	2,155,000	27	13	-
	Oct. 18-27	T Paring	Regions 1,2,3 & CAR	1,000	1	4	-
1993	Jun. 23-27	T Goring	Regions 1to 4, CAR &	2,775,000	75	121	13
	Sep. 8-12	TS Walding	Region 2	51,000	2	-	9
1994	Jan. 4-6	A T Akang	Regions 4,5	79,600	45	26	17
	Jul. 7-10, Jul. 10-11	ET Iliang & TS Loleng	Regions 1 to 3	155,300	11	21	6
	Jul. 25-29	HTS Oyang	Regions 1,3,4,6,7 ARM	133,800	48	9	2
	Aug. 4-7	T Ritang	Region 1 & CAR	7,300	4	-	-
	Sep. 7-11	JTS Weling	Regions 1,2	183,600	10	-	1
	Oct. 18-21	KT Katring	Regions 3,4 & NCR	1,400	45	24	6
	Dec. 19-23	KT Garding	Regions 4 to 8, 10	647,500	44	86	5
1995	May 31-Jun. 8	TY Auring	Regions 3 to 5	67,500	6	-	2
	Jul. 27-31	TS Karing	Regions 1 to 3 & CAR	163,000	2	-	2
	Aug. 25-31	T Gening	Regions 1 to 5	170,200	3	3	-
	Sep. 27-Oct.	TS Mameng	Regions 1, 3 to 8, 10 & NCR	3,172,700	133	108	130
	Oct. 26-30	TS Pepang	Regions 4, 6 to 8	423,500	116	49	125
	Oct. 31-Nov.	T Rosing	Regions 1 to 5, 7, NCR & CAR	10,818,700	916	2860	376
	Dec. 24-26	Flooding	Cagayan	291,200	1	-	-
	Dec. 24-26	Flooding	Isabela	329,600	-	-	15
	Dec. 24-26	Flooding	Nueva Vizcaya	2,000	-	-	-

Source:Office of Civil Defense

Table 1.3.1 Ongoing Flood Control Projects in Region 2 Office (for the year 2000)

Serial No	Project Name	Location	Implementing Agency (District Office)	Kind of Works	Budget Allocation (Pesos1,000)	Scheduled Date of Completion
1	Minanga river control project	Gonzaga	Cagayan 1st	Concrete revetment	500	Oct.
2	Protection works along Cagayan valley road	Alcala	Cagayan 1st	Drainage canal	75	Jul.
3	Protection works along Cagayan valley road	Aparri	Cagayan 1st	Drainage canal	75	Jul.
4	Protection works along Gattaran-Bolos road	Baggao	Cagayan 1st	Slope protection	75	Jul.
5	Protection works along Dugo-San Vicente road	Buguey	Cagayan 1st	Slope protection	75	Jul.
6	Protection works along Cagayan valley road	Camalaniugan	Cagayan 1st	Drainage canal	75	Jul.
7	Protection works along Gataran-Bolos road	Gattaran	Cagayan 1st	Slope protection	75	Jul.
8	Protection works along Cagayan valley road	Lal-Lo	Cagayan 1st	Drainage canal	75	Jul.
9	Protection works along Dugo-San Vicente road	Sta.Ana	Cagayan 1st	Slope protection	75	Jul.
10	Protection works along Dugo-San Vicente road	Sta.Tresita	Cagayan 1st	Slope protection	75	Jul.
11	Protection works along Dugo-San Vicente road	Gonzaga	Cagayan 1st	Slope protection	75	Jul.
12	Cagayan river control project	Alcala	Cagayan 1st	Concrete revetment	350	Aug.
13	Cagayan river control project	Aparri	Cagayan 1st	Concrete revetment	350	Aug.
14	Cagayan river control project	Camalaniugan	Cagayan 1st	Concrete revetment	350	Aug.
15	Cagayan river control project	Gattaran	Cagayan 1st	Concrete revetment	350	Aug.
16	Cagayan river control project	Lal-Lo	Cagayan 1st	Concrete revetment	350	Aug.
17	Lucba river control project	Abulug	Cagayan 2nd	Concrete revetment	1,580	Jun.
18	Zinundungan river control project	Lasam	Cagayan 2nd	Concrete revetment	690	May
19	Claveria river control project	Claveria	Cagayan 2nd	Gabion spur dike	570	May
20	Pamploma river control project	Pamplona	Cagayan 2nd	Dike	500	May
21	Malag river control project	Rizal	Cagayan 2nd	Dike	460	May
22	Cagayan river control project	Tuguegarao	Cagayan 3rd	Spur dike	1,250	Dec.
23	Cagayan river control project	Tuguegarao	Cagayan 3rd	Spur dike	1,250	Dec.
24	San Ignacio river bank protection project	Ilagan	Isabela 1st	Concrete revetment	1,000	Mar.
25	Cagayan river control project	Cabagan	Isabela 1st	Concrete revetment	2,000	Apr.
26	Aurora flood control project	Aurora	Isabela 2nd	Bank protection	1,500	Jun.
27	Siffu river control project	Roxas	Isabela 2nd	Concrete revetment	1,500	Jun.
28	Cagayan river control project	Angadanan	Isabela 3rd	Gabion bank protection	1,000	Jun.
29	Cagayan river control project	Cauayan	Isabela 3rd	Gabion bank protection	1,430	Jun.
30	Cagayan river control project	Reina Mercedez	Isabela 3rd	Concrete revetment	1,400	Jun.
31	Magat river control project	San Mateo	Isabela 3rd	Gabion spur dike	820	May
32	Magat river control project	Luna	Isabela 3rd	Gabion spur dike	650	Apr.
33	Gucab river control project	Echague	Isabela 4th	Gabion	1,510	May
34	Jones drainage system project	Jones	Isabela 4th	Drainage canal	480	Apr.
35	Dammang river control project	Echague	Isabela 4th	Gabion	1,510	May
36	Magat river control project	Bayombong	Nueva Viscaya	Dike and revetment	259	May
37	Magat river control project	Bayombong	Nueva Viscaya	Dike and revetment	225	May
38	Magat river control project	Bayombong	Nueva Viscaya	Dike and revetment	225	May
39	Magat river control project	Solano	Nueva Viscaya	Dike and revetment	225	May
40	Magat river control project	Solano	Nueva Viscaya	Dike and revetment	225	May
41	Magat river control project	Solano	Nueva Viscaya	Dike and revetment	187	May
42	Magat river control project	Bagabag	Nueva Viscaya	Dike and revetment	187	May
43	Magat river control project	Bambang	Nueva Viscaya	Dike and revetment	187	Apr.
44	Magat river control project	Bambang	Nueva Viscaya	Dike and revetment	187	May
45	Magat river control project	Bambang	Nueva Viscaya	Dike and revetment	187	Apr.
46	Sta.Cruz river control project	Bambang	Nueva Viscaya	Dike and revetment	187	Mar.
47	Protection of La Union- Quirino road	Kayapa	Nueva Viscaya	Dike and revetment	345	Mar.
48	Sta.Fe river control project	Sta.Fe	Nueva Viscaya	Dike and revetment	187	Apr.
49	Sta.Fe river control project	Aritao	Nueva Viscaya	Dike and revetment	187	Mar.
50	Ponggo flood control project	Nagtipunan	Quirino	Gabion type bank protection	665	Jun.
51	Poblacion Norte flood control project	Maddela	Quirino	Gabion type bank protection	620	May
52	Diduyon flood control project	Maddela	Quirino	Gabion type bank protection	573	Apr.
53	Construction of protection along Cordon-Aurora road	Cabarroguis	Quirino	Canal lining and bank protection	467	Apr.
54	Abbag flood control project	Maddela	Quirino	Gabion type bank protection	467	Apr.
55	Dumadate flood control project	Quirino	Quirino	Gabion type bank protection	267	Mar.
56	Bank protection along Cordon-Maddela road	Aglipay	Quirino	Bank protection	267	Mar.
57	Lined canal and bank protection along Cordon- Aurora road	Aglipay	Quirino	Lined canal and bank protection	207	Apr.
58	Anak flood control project	Nagtipunan	Quirino	Gabion type bank protection	467	Apr.
59	Mahatao interior flood control project	Mahatao	Batanes	Gravity retaining wall	1,080	Jul.
60	Gaat flood control project	Itbayat	Batanes	Gravity retaining wall	580	Jul.
61	Charatayan-Panda flood control project	Basco	Batanes	Gravity retaining wall	340	Jul.

Total : 61 projects **Allocated budget : 33,100,000 Pesos**

Source: DPWH CY 2000 Infrastructure Program Region II, Feb. 2000

Table 1.3.2 Proposed Flood Control Projects in Region 2 Office (for the year 2001)

Serial No.	Project Name	Location	Implementing Agency (District Office)	Kind of Works	Budget Allocation (Pesos1,000)
1	Cagayan river flood control project	Alcala	Cagayan 1st	Concrete revetment	1,000
2	Cagayan river flood control project	Apari	Cagayan 1st	Concrete revetment	1,000
3	Cagayan river flood control project	Gattaran	Cagayan 1st	Concrete revetment	1,000
4	Cagayan river flood control project	Lallo	Cagayan 1st	Concrete revetment	1,000
5	Protection works along JGCCSMBPR	Baggao	Cagayan 1st	Slope protection for erosion	440
6	Protection works along DSVR	Buguey	Cagayan 1st	Slope protection for erosion	440
7	Protection works along JGCCSMBPR	Gattaran	Cagayan 1st	Slope protection for erosion	1,000
8	Protection works along DSVR	Gonzaga	Cagayan 1st	Slope protection for erosion	440
9	Protection works along DSVR	Sta. Ana	Cagayan 1st	Slope protection for erosion	440
10	Protection works along DSVR	Sta.Teresita	Cagayan 1st	Slope protection for erosion	440
11	Minanga river control project	Gonzaga	Cagayan 1st	Revetment	1,800
12	Matalag river control project	Rizal	Cagayan 2nd	Revetment	1,500
13	Zinundungan river control project	Lasam	Cagayan 2nd	Revetment	3,000
14	Pamplona river control project	Pamplona	Cagayan 2nd	Dike	1,000
15	Lubcan river control project	Lubucan	Cagayan 2nd	Revetment	2,000
16	Claveria river control project	Claveria	Cagayan 2nd	Revetment	2,000
17	Claveria drainage system along road	Claveria	Cagayan 2nd	Lined canal	1,500
18	Nannarian flood control project	Penablanca	Cagayan 3rd	Gabion spurdike	3,700
19	Camasi flood control project	Penablanca	Cagayan 3rd	lined canal	700
20	Various flood control projects		Cagayan 3rd		2,600
21	Angasinan river control project	Ilagan	Isabela 1st	Spurdike	2,500
22	Baculud river control project	Ilagan	Isabela 1st	Concrete revetment	2,000
23	Various flood control projects		Isabela 1st		6,500
24	Siffu river control project	Roxas,Sitio	Isabela 2nd	Gabion spurdike	3,000
25	siffu river control project	Roxas,Ana	Isabela 2nd	SSP revetment	3,000
26	Aurora flood control project	Aurora	Isabela 2nd	Gabion bank protection	3,000
27	Siffu river control project	Burgos	Isabela 2nd	Gabion bank protection	3,000
28	Cagayan river control project	Angadanan	Isabela 3rd	Concrete revetment	2,000
29	Cagayan river control project	Cauayan	Isabela 3rd	Concrete revetment	3,950
30	Cagayan river control project	Reina Mercedes	Isabela 3rd	Concrete revetment	2,670
31	Magat river control project	San Mateo	Isabela 3rd	Gabion spudike	2,730
32	Magat river control project	Luna	Isabela 3rd	Gabion spudike	650
33	Jones town proper drainage system	Jones	Isabela 4th	Lined canal	1,700
34	Protection works along National road	Magsaysay	Isabela 4th	Lined canal	3,000
35	San Agustin town drainage system	San Agustin	Isabela 4th	Lined canal	1,300
36	Sta. Fe river control project	Bambang	Nueva Viscaya	Gabion revetment/dike	1,000
37	Magat river control project	Bayombong	Nueva Viscaya	Gabion revetment/dike	500
38	Magat river control project	Magsaysay	Nueva Viscaya	Gabion revetment/dike	500
39	Various flood control projects		Nueva Viscaya		3,000
40	Ponggo flood control project	Nagtipuanan	Quirino	Gabion bank protection	2,000
41	Poblacion Norte flood control project	Maddela	Quirino	Gabion bank protection	2,500
42	Diduyon flood control project	Maddela	Quirino	Gabion bank protection	2,000
43	Abbag flood control project	Maddela	Quirino	Gabion bank protection	2,500
44	Anak flood control project	Nagtipunan	Quirino	Gabion bank protection	1,000
45	Lusod flood control project	Maddela	Quirino	Gabion bank protection	1,500
46	Dumatat flood control project	Cabarroguis	Quirino	Gabion bank protection	500
47	Charatayan Panda Padangan FCP	Basco	Batanes	Retaining wall	4,500
48	Mahatao flood control project	Mahatao	Batanes	Retaining wall	2,000
49	Ivana flood control project	Ivana	Batanes	Retaining wall	2,000

Total Budget : 49 projects Budget to be allocated : 93,500,000 Pesos

Source : DPWH YEAR 2001 Infrastructure Program Region II, 20 July 2000

Table 1.3.3 Ongoing and Proposed Flood Control Projects by LGUs (Pesos million)

Ongoing Projects by Cagayan Province

Project	Location	Works	Budget
River control	Centro, Abulug	Riverbank protection	0.50
Anti-erosion and river control	Tuguegarao river	Riverbank protection	0.76
Total			1.26

Proposed Projects by Nueva Viscaya Province

Project	Location	Works	Budget
Bagumbayan flood control	Dupax del Sur	Bank protection	-
Road protection	Solano	Slope protection	-
Construction of earth dike	Bayombong	Earth dike	-
Road protection	Bambang	Slope protection	-
Road protection	Solano	Slope protection	-
Road protection	Kayapa	Slope protection	-
Road protection	Solano	Slope protection	-
Road protection	Solano	Slope protection	-
Road protection	Sta.Fe	Slope protection	-
Road protection	Dupax del Sur	Slope protection	-
Total			-

Proposed Projects by Tuguegarao City

Project	Location	Works	Budget
River control (Phase VIII)	Centro	Riverbank protection	1.25
Cagayan River control	Caggay	Riverbank protection	1.25
River control (Phase IV)	Centro	Riverbank protection	3.00
Cagayan River control	Cataggaman	Riverbank protection	3.50
Total			9.00

Ongoing Projects by Ilagan City

Project	Location	Works	Budget
Ilagan dredging works	Cagayan river	Canalization	0.20

Proposed Projects by Ilagan City

Project	Location	Works	Budget
Flood control	Camunaran section	Riverbank protection	10.00
Flood control	Baculod	Riverbank protection	10.00
Flood control	Alinguigan 2nd	Riverbank protection	10.00
Flood control	Mulalum	Riverbank protection	10.00
Flood control	Aggasian	Riverbank protection	10.00
Flood control	Fugu	Riverbank protection	10.00
Flood control	Cab 17-21	Riverbank protection	10.00
Flood control	Cab 9-11	Riverbank protection	10.00
Flood control	Cab 7	Riverbank protection	10.00
Flood control	Cab 4	Riverbank protection	10.00
Flood control	?	Riverbank protection	10.00
Total			110.00

Note; All proposed projects above are not authorized yet and still in waiting approval.

Table 1.4.1 Existing Evacuation Centers (1/9)

1. Municipality of Aparri, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Sanja	1 Sanja Elementary School	8	8	6 x 8	30	1	2	4	Cellphone	Not flooded
Dodan	2 Dodan Elementary School	11	11	7 x 8	30	1	1	7	Cellphone	Flooded area
Macanaya	3 Macanaya Elementary School	9	9	6 x 8	30	Open Well	1	6	Cellphone	Flooded area
Linao	4 Linao Elementary School	9	9	6 x 8	30	1	1	5	Cellphone	Not flooded
Minanga	5 Minanga Elementary School	12	12	6 x 8	30	1	1	2	Cellphone	Not flooded
Gadang	6 Gaddang Elementary School	12	12	7 x 8	50	1	1	3	Cellphone	Flooded area
Bulala Sur	7 Bulala Sur Elementary School	3	3	6 x 8	30	1	1	3	Cellphone	Not flooded
Tallungan	8 Tallungan Elementary School	16	16	6 x 7	40	1	1	16	Cellphone	Flooded area
Toram	9 Toran Elementary School	15	15	6 x 7	40	1	1	14	Cellphone	Flooded area
	10 Aparri District Hospital	This hospital can't be used as an evacuation center.								
Bulla Norte	11 Bulala Norte Elementary School	8	8	6 x 8	30	1	1	6	Cellphone	Not flooded
Bisagu	12 Bisagu Elementary School	7	7	6 x 8	30	1	1	6	Cellphone	Not flooded
–	13 Aparri East Central School	47	48	6 x 8	40	1, 3	3	40	Cellphone	Not flooded
–	14 Paddaya Elementary School	13	13	6 x 8	40	1	1	12	Cellphone	Not flooded
–	15 Punta Elementary School	20	20	6 x 8	40	1	1	6	Cellphone	Not flooded
–	16 San Antonio Elementary School	13	13	6 x 7	40	1	1	8	Cellphone	Flooded area
–	17 Naura Elementary School	21	NA	6 x 8	40	2	1	17	Cellphone	Not flooded
	Total	**224**	**204**				**17**	**155**		

* Sources of potable water
1. Deep well with pump
2. Deep well with tank (electricity)
3. NAWASA (private supplier)
4. Others

** Communication facilities
1. Cellphones
2. Landline
3. Radio communication
4. Others

Data Source:

(1) JICA Study Team's interview to each evacuation center and relevant LGU, August 2000 - October 2001

(2) Integrated Regional Disaster Management, RDCC - Region 02

Table 1.4.1 Existing Evacuation Centers (2/9)

2. Municipality of Camalaniugan, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m^2)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Ziminila	1 Ziminila Elementary School	11	11	48	25	1	1	2	1-Cellphone	
Minanga	2 Minanga Elementary School	11	11	48	25	None	0	3	1-Cellphone	
Casili	3 Casili Elementary School	11	6	48	25	1	1	4	1-Cellphone	
Julian Olivas	4 Julian Olivas Barangay Hall	1	1	48	50	None	0	NA		
Catotoran Norte Catotoran Sur	5 Catotoran Elementary School	13	11	48	30	None	0	6	1-Cellphone	
Alilinu	6 Alilinu Elementary School	8	5	48	30	None	0	5	1-Cellphone	
Agusi	7 Central School	21	5	48	30	None	0	13	1-Cellphone	
Catotoran Norte Catotoran Sur	8 Barangay Hall	1	1	30	30	None	0	1	None	
Alilinu	9 Barangay Hall	1	1	30	25	None	0	1	None	
Alilinu	10 Day Care Center	1	1	30	25	None	0	2	None	
Alilinu	11 Health Center	1	1	30	25	None	0	1	2-Cellphone	
Agusi	12 Day Care Center	1	1	18	30	Jet matic pump	1	4	2-Cellphone	
	Total	**81**	**55**				**3**	**42**		

3. Municipality of Allacapan, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Binubungan	1 Binubungan Elementary School	2	2	7 x 8	NA	None	0	1	None	Not flooded
Burot	2 Burot Elementary School	2	2	7 x 8	NA	Jet matic	1	1	None	Not flooded
Pacac	3 Pacac East Elementary School	8	8	7 x 8	NA	None	0	1	None	Not flooded
–	4 Allacapan Central Elementary School	30	NA	NA	NA	1	4	20	None	Not flooded
–	5 Bulo Elementary School	3	NA	7 x 8	NA	1	1	1	None	Not flooded
	Total	**45**	**12**				**6**	**24**		

Table 1.4.1 Existing Evacuation Centers (3/9)

4. Municipality of Lallo, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Alaguia	1 Alaguia Elementary School	5	5	7 x 8	30	None	0	2	None	Flooded area
Lalafugan	2 Lalafugan Elementary School	6	6	7 x 8	30	1	1	4	None	Flooded area
San Lorenzo	3 San Lorenzo Elementary School	6	6	7 x 8	30	None	0	5	None	
San Antonio	4 San Antonio Elementary School	3	3	7 x 8	NA	None	0	1	None	Not flooded
Maxingal	5 Maxingal Elementary School	14	11	6 x 8	30	2	1	14	Cellphone	Flooded area
Bagumbayan	6 Bagumbayan Elementary School	17	0	7 x 8	40	2	1	17	Cellphone	Flooded area
San Jose	7 San Jose Elementary School	18	17	6 x 7	32	2	1	15	Cellphone	Flooded area
Catayaoan	8 Catayaoan Elementary School	17	2	6 x 8	50	2	1	19	Cellphone	Flooded area
Catugan	9 Catugan Elementary School	NA	NA	NA	NA	NA	NA	NA	NA	
Sta. Maria	10 Sta. Maria Elementary School]	12	15	6 x 8	40	1	2	12	Cellphone	Flooded area
Jurisdiccion	11 Jurisdiccion Elementary School	6	0	7 x 8	35	1	2	4	Cellphone	Flooded area
Cagoran	12 Cagoran Elementary School	1	1	7 x 8	30	None	0	1	None	
Bangag	13 Bangag Elementary School	3	NA	NA	NA	None	0	2	None	Not flooded
Logac	14 Logac Elementary School	6	6	7 x 8	30	None	0	11	None	Not flooded
Binag	15 Binag Elementary School	3	3	7 x 8	30	None	0	1	None	
Dalaya	16 Dalaya Primary School	3	3	7 x 8	30	None	0	0	None	Flooded area
Paranum	17 Paranum Primary School	2	2	7 x 8	30	None	0	0	None	Flooded area
	Total	**122**	**80**				**9**	**108**		

Table 1.4.1 Existing Evacuation Centers (4/9)

5. Municipality of Gattaran, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Aguiguican	1 Aguiguican Elementary School	12	10	6 x 7	25	1	1	10	Cellphone	Not flooded
Casicallan Sur	2 Casicallan Sur Elementary School.	5	5	6 x 8	25	None	0	5	Cellphone	Not flooded
L:uis Adviento	3 Luis Adviento Primary School	4	4	6 x 7	25	1	1	3	None	Not flooded
Centro Sur	4 Centro Sur Elementary School	29	19	6 x 7	25	None	0	13	Cellphone	Not flooded
Dummun	5 Dummun Elementary School	6	3	7 x 8	40	1	1	5	Cellphone	Not flooded
Ganzano	6 Ganzano Elementary School	3	3	7 x 8	40	1	1	2	Cellphone	Not flooded
Sta. Maria	7 Sta. Maria Elementary School	2	2	7 x 8	50	2	1	2	Cellphone	Flooded Area
Guising	8 Guising Elementary School	8	8	7 x 8	50	1	1	8	Cellphone	Flooded Area
Lapogan	9 Lapogan Elementary School	6	6	7 x 8	40	1	1	10	Cellphone	Not flooded
San Vicente	10 San Vicente Elementary School	10	3	7 x 8	50	1	1	4	Cellphone	Not flooded
Cullit	11 Cullit Elementary School	8	NA	7 x 8	NA	1	1	6	None	Flooded Area
Tubungan Este	12 Tubungan Este Elementary School	2	0	7 x 8	NA	1	1	2	None	Flooded Area
Newagac	13 Newagac Elementary School	10	0	7 x 8	30	1	1	3	None	Flooded Area
Capiddigan	14 Capiddigan Elementary School	6	5	7 x 8	30	1	1	2	None	Not flooded
Bangatan	15 Bangatan Elementary School	6	5	7 x 8	30	1	1	2	None	Not flooded
Calaoagan Basit	16 Calaoagan Basit Elementary School	6	5	7 x 8	30	1	1	2	None	Not flooded
	Total	**123**	**78**				**14**	**79**		

6. Municipality of Lasam, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Minanga Sur	1 Minanga Sur Elementary School	3	3	6 x 8	25	1	1	2	None	
Lasam	2 Lasam Elementary School	33	30	6 x 8	25	1	3	10	None	
	Total	**36**	**33**				**4**	**12**		

Table 1.4.1 Existing Evacuation Centers (5/9)

7. Municipality of Sto. Niño, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Abariongan Uneg	1 Abariongan Uneg Elementary School	6	5	6 x 7	30	None	0	2	Cellphone	Flooded area
Lipatan	2 Lipatan Elementary School	4	4	6 x 7	30	None	0	1	None	Not flooded
Balani	3 Balani Elementary School	2	2	6 x 7	30	None	0	2	None	Not flooded
Campo	4 Campo Elementary School	2	2	5 x 7, 6 x 7	40	None	0	3	Cellphone	Not flooded
Niug Sur	5 Niug Sur Elementary School	6	6	6 x 7	35	None	0	2	None	Not flooded
Sta. Felicitas	6 Sta. Felicitas Elementary School	2	2	6 x 7	25	None	0	1	None	Not flooded
Tamucu	7 Tamucu Elementary School	2	2	6 x 7	25	None	0	1	None	Not flooded
Matalao	8 Matalao Elementary School	6	6	6 x 7	30	1	1	3	NA	NA
–	9 Tabang Elementary School	10	10	6 x 7	35	1	1	3	Cellphone	Not flooded
–	10 Lubo Elementary School	7	7	6 x 7	35	1	1	3	None	Not flooded
–	11 Sto. Niño Central School	25	25	6 x 7	50	Electric Motor	1	28	Cellphone	
–	12 Lattac Elementary School	5	5	6 x 7	30	1	1	2	None	Not flooded
–	13 Municipal Gymnasium	1	1	(600 m²)	1000	None	0	4	Radio	
–	14 Sta. Maria Elementary School	1	1	6 x 7	25	None	0	None	None	Not flooded
–	15 Calassitan Elementary School	2	2	6 x 7	25	None	0	1	None	Not flooded
–	16 Callapangan Elementary School	3	3	6 x 7	25	None	0	1	None	Not flooded
–	17 Abariongan West Elementary School	6	6	6 x 7	30	None	0	2	Cellphone	Not flooded
–	18 Namangcayan Elementary School	6	6	6 x 7	30	1	1	2	Cellphone	Not flooded
–	19 Dungao Elementary School	7	7	6 x 7	30	None	0	2	Cellphone	Flooded area
	Total	**103**	**102**				**6**	**63**		

Table 1.4.1 Existing Evacuation Centers (6/9)

8. Municipality of Alcala, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Damurog	1 Damurog Elementary School	6	0	7 x 8	35	1	1	4	Cellphone	Flooded area
Jurisdiction	2 Jurisdiction Elementary School	11	0	7 x 8	35	1	1	11	None	Flooded area
Afusing Batu	3 Afusing Batu Elementary School	4	0	7 x 8	NA	1	1	2	Cellphone	Flooded area
Afusing Daga	4 Afusing Daga Elementary School	12	12	7 x 8	50	1	1	12	None	Flooded area
Pared	5 Pared Barangay Hall	1	1	6 x 7	50	1	1	1	Cellphone	Flooded area
Baybayog	6 Baybayog Elementary School	10	9	7 x 8	50	1	1	9	Cellphone	Flooded area
–	7 Pinucpuc Elementary School	8	NA	7 x 8	50	1	1	1	None	Flooded area
	Total	**52**	**22**				**7**	**40**		

9. Municipality of Amulung, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Baccuit	1 Baccuit Elementary School	7	0	($48m^2$)	NA	1	1	5	Cellphone	Flooded area
Abolo	2 Abolo Elementary School	2	0	7 x 8	NA	None	0	2	Cellphone	Flooded area
Aggurit	3 Aggurit Elementary School	NA	NA	NA	NA	NA	NA	NA	NA	
–	4 Amulung East Central School	19	19	7 x 8	NA	1	1	3	Cellphone	Not Flooded
–	5 Calamagui Central School	5	5	7 x 8	NA	None	0	2	Cellphone	Not Flooded
–	6 Estefanion Elementary School	9	9	7 x 8	NA	1	1	2	Cellphone	Not Flooded
	Total	**42**	**33**				**3**	**14**		

Table 1.4.1 Existing Evacuation Centers (7/9)

10. Municipality of Iguig, Province of Cagayan
(No data is available)

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
	NA									

11. Municipality of Solana, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Dassum	1 Dassum Elementary School	18	18	6 x 7	NA	2	1	18	Radio & Landline	
Malacibibi	2 Malalcibibi Elementary School	9	NA	6 x 7	NA	1	1	2	None	
Bauan East	3 Bauan East Elementary School	16	18	6 x 7	NA	1	1	16	None	
–	4 Dassum High School	7	7	7 x 8	NA	1	1	7	Radio	
–	5 Malacabibi Barangay Hall	1	1	8 x 10	35	1	1	None	None	
–	6 Dassun Barangay Hall	1	1	6 x 7	30	1	1	None	None	
	Total	**52**	**45**				**6**	**43**		

Table 1.4.1 Existing Evacuation Centers (8/9)

12. City of Tuguegarao, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Linao East	1 Linao Barangay Gym	1	1	8 x 8	200	None	0	2	Landline	
Atulayan Sur	2 KKK Bldg. / Barangay Hall	1	1	6 x 7	50	None	0	1	None	
Annafunan East	3 East Central Elementary School	NA	NA	NA	NA	NA	NA	NA	NA	
Bagay	4 West Central Elementary School	69	1	6 x 7	50	2, 3	2	55	Landline	
Buntun	5 North Central Elementary School	46	46	7 x 8	20	1, 3	2	50	Landline & Radio	
Tanza	6 Cagayan National High School	62	20	7 x 8	40	2, 3	2	20	Landline	
Penge-Ruyu	7 Caritan Norte Elementary School	12	12	7 x 8	40	1, 3	2	9	Landline	
Centro 10	8 Annafunan Elementary School	34	36	7 x 8	40	1, 3 (All Rms)	35	9	Landline	
Centro 11	9 Atulayan Elementary School	12	NA	7 x 8	35	1, 3	2	2	Landline	
Centro 12	10 Linao Elementary School	27	27	6 x 8	40	2, 3	4	27	Landline	
–	11 Buntun Elementary School	12	12	7 x 8	50	1	1	9	Landline	
–	12 Gosi Elementary School	13	12	7 x 8	30	Jetmatic	1	9	Landline	
–	13 Dadda Chapel	NA	NA	NA	NA	NA	NA	NA	NA	
–	14 Namabbalan Sur Day Care Center	1	1	6 x 8	30	2	1	1	None	
–	15 Cataggaman Pardo Elementary School	10	10	7 x 8	40	3	1	10	Landline	
–	16 Cataggaman Viejo Elementary School	36	36	7 x 8	50	3	1	26	Landline	
–	17 Paluwa Elementary School	12	12	7 x 8	NA	1, 3	3	8	Landline	
–	18 Bagay Elementary School	17	0	NA	NA	1	1	2	None	
–	19 Namabbalan Norte Elementary Sch.	7	7	7 x 8	30	Electric motor	1	4	Landline	
–	20 Tagga Gymnasium	1	1	18 x 12	250	NA	NA	NA	NA	
–	21 Tagga Elementary School	10	4	7 x 8	25	Electric motor	1	12	Landline, Cellphone	
	Total	**383**	**239**				**60**	**256**		

Table 1.4.1 Existing Evacuation Centers (9/9)

13. Municipality of Enrile, Province of Cagayan

Flood Prone Areas	List of Evacuation Centers	Total No. of Rooms (No.)	Rms. Available during Calamity (No.)	Area of A Room (m x m)	Capacity of Room (No. of heads per room)	Potable Water Supply		Available CR (No.)	Communication Facilities**	Remarks
						Source Facility*	No. of Facility (No.)			
Brgy. Villa Maria	1 Simbaban	1	1	15 x 30	NA	3	1	2	Landline	
Brgy. 2 (part of Poblacion)	2 Enrile North Central School	27	7	7 x 8	30	2	1	12	None	
Brgy. San Jose	3 Municipal Building	1	1	5 x 6	NA	3	1	2	Landline, Radio	
Brgy. San Roque	4 Magalalag Elementary School	16	4	7 x 8	NA	1	2	6	Cellphone	
Brgy. Batu	5 Maddarulug Norte Elementary School	7	7	7 x 8	30	1	1	4	None	
Brgy. Lanna	6 Maddarulug Sur Elementary School	6	6	7 x 8	30	1	1	3	None	
	Total	**58**	**26**				**7**	**29**		

Table 1.5.1 Existing Flood Control Structures in Cagayan River Basir

District Office	Earth Dike		Spur Dike		Revetment		Main Drainage Canal		Lateral Drainage Canal		Estero	
	Sites	Length(km)	Sites	Length(km)	Sites	Length(km)	Sites	Length(km)	Sites	Length(km)	Sites	Length(km)
Cagayan I	-	-	2	0.284	19	2.804	-	-	-	-	10	11.000
Cagayan II	-	-	1	0.164	5	0.633	-	-	-	-	5	5.500
Cagayan III	-	-	11	2.146	5	1.205	-	-	1	1.690	5	6.100
Isabela I	3	0.125	5	0.452	26	5.444	7	3.145	12	3.372	10	11.360
Isabela II	-	-	7	0.453	4	0.815	21	3.860	-	-	6	2.210
Isabela III	-	-	1	0.012	8	0.799	-	-	1	4.988	4	4.600
Isabela IV	-	-	1	0.250	6	0.825	-	-	3	5.670	4	4.100
Nueva Vizcaya	-	-	44	2.308	38	10.425	1	6.000	-	-	12	13.850
Quirino	1	0.600	11	0.494	11	1.698	-	-	-	-	5	5.850
Total	4	0.725	83	6.563	122	24.648	29	13.005	17	15.720	61	64.570

Source : Inventory Survey by DPWH, Region II Offic

Table 1.5.2 Principal Features of Magat Dam and Major Intake Weirs

Magat Dam			
Location	Oscariz, Ramon , Isabela		
Completion date	October-82		
Purpose	Irrigation and hydroelectric generation		
Dam			
	Type	Zoned earth rock fill	
	Direct height	114	m
	Crest length	4,160	m
	Crest elevation	200	EL m
Spillway			
	Width (m)	164	m
	Radial gates	7	sets
	Orifice gates	2	sets
	Discharge capacity	30,600	cu.m/s
Reservoir			
	Full supply level (FSL)	193.0	EL m
	Maximum flood level (MFL)	197.6	EL m
	Storage capacity at FSL	1.08	billion cu.m
	Storage capacity at MFL	1.26	billion cu.m
Power house			
	Installed capacity	360	MW
	Additional capacity	180	MW
	Total	540	MW
Irrigation service			
	Service area	95,000	ha

Maris Diversion Weir (Maris Dam)			
Location	Oscariz, Ramon, Isabela		
Completion date	August-82		
Purpose	Irrigation		
Weir			
	Type	Ogee type concrete weir	
	Direct height	10.5	m
	Crest length	102.00	m
	Crest elevation		EL m
Scouring sluice			
	Sluice gate	2	sets
	Stoplog gate	16	sets
Sluiceway			
	North gate	2	sets
	South gate	2	sets
Service area		88,400	ha

Chico Diversion Weir			
Location	Bo. Ngipen, Tabuk		
Completion date	December-83		
Purpose	Irrigation		
Weir			
	Type	Ogee type concrete weir	
	Direct height	5.65- 7.00	m
	Crest length	759	m
	Crest elevation	204.50	EL m
	Probable afflux elevation	207.55	EL m
Scouring sluice			
	Sluice gate	2	sets
Sluiceway			
	Left sluiceway	4 bays with 2 steel gate(2.5×3.8m)	
	Right sluiceway	1 bay with 2 steel gate(2.06×1.32m)	
Siphon			
	Length	733	m
	Diameter of conduit	3-3.8	m
Service area		17,600	ha

Source : NIA, Region II Office

Table1.5.3 Principal Features of Irrigation Pump Stations along Cagayan River

Item/Name of Station	Magapit	Amulung	Iguig	Solana
Location	Magapit	Baculud	Minanga	Solana
Completion date	May-85	Jun-82	Sep-83	Dec-80
Service Area(ha)	11,457	(H):1,371 (L): 801	776	2,780
Water Requirement(cu.m/s)	21.081	(H):2.523 (L): 1.474	1.427	5.33
Water Level(EL,m)				
HHWL	11.00	20.00	20.00	48.45
MWL(Wet season)	1.24	6.30	8.02	36.10
MWL(Dry season)	0.46	4.52	7.08	34.60
LWL	0.00	1.40	4.00	34.10
Pump Plant				
Type	Vertical mixed flow pump with volute casing			
Numbers	4	(H): 3 (L): 1	3	4
Diameter of Suction Pipe(mm)	1,800	(H): 700 (L): 800	600	700
Diameter of Discharge Pipe(mm)	1,500	(H): 600 (L): 800	500	700
Suction Pipe Level(EL,m)	0.70[0.70]	(H): 5.21[-2.37] (L): 5.21[-2.37]	7.46[-0.12]	31.30[2.67]
Discharge Pipe Level(EL,m)	14.00[14.00]	(H): 23.00[15.42] (L): 17.00[9.42]	19.50[-11.92]	52.15[23.95]
Actual Head(m)	13.30	(H): 17.79 (L): 11.79	12.04	16.80
Total Head(m)	14.60		13.70	18.50
Pump Capacity(cu.m/min/unit)	340	(H): 70.5 (L): 80.0	37.6	60

Note: 1. At Solana station, three pump plants will be added soon.

2. [ ] indicates assumed elevation in terms of mean sea leval

Source: NIA Region II Office

Table 1.5.4 Principal Features of Major Bridges

River	Name of Bridge	Bridge Type	Completion Year	No. of Span	Total Length (m)	Width (m)	Remarks
		Suspension		1			
		RC-I beam		1			
		Truss		2			
Cagayan	Magapit	RCDG	1980	2	376.00	7.32	
	Buntun	Truss Comp.I-beam	1968	8 5	1,098.00	7.32	
	Gamu	Truss Comp.I-beam	1964	3 8	442.00	6.75	
	Naguilian	Truss Comp.I-beam	2000	8 5	687.80	7.32	
	Dalibubon	Continuous box culvert	-	30	210.00	5.60	ongoing
	Jones	PC	1982	22	154.00	3.34	
Chico	Itawes	PC	-	29	283.00	4.00	ongoing
	Tuao	PC	1984	6	42.00	4.00	
	Calanan	Truss	-	5	-	-	
	Pinukpuk	Truss	-	-	-	-	
		Truss		1			
Dummon	Dummon	RCDG	1945	2	89.14	6.10	
		I-beam		2			
Pared	Pared	DCRG	1946	8	226.32	7.32	
Tuguegarao	Pinacanauan	RCDG	1992	8	303.84	6.70	
Pinacanauan	San Pablo	RCDG	1998	7	279.15	7.32	
Tumauini	Arcon	Truss	1946	3	121.14	6.20	
	Minanga	RCDG	1973	11	339.90	7.32	
Siffu	Siffu	RCDG	1971	20	300.00	6.75	
Mallig	Mallig	RCDG	1974	14	210.00	6.75	
Ilagan	Mallam	PCDG	1996	10	487.84	9.52	
Magat	Magat	Truss	1978	-	274.00	12.00	
	San Lorenzo	PSDG	1996	-	483.90	7.32	
	Batu	PSDG	-	-	345.63	7.32	
Abian	Abian	Comp.I-beam	-	7	108.22	6.75	
Sta.Fe	Cupas	Truss	-	6	279.00	-	
	Indiana	PSCG	-	-	98.40	6.70	
	Sta.Fe	RCDG	-	1	24.30	6.70	
Ganano	Ganano	Truss	1975	3	73.20	7.32	
	Ipil	Truss	1975	3	73.20	7.32	
	Buluarte	-	-	-	-	-	
Diaddi	Calao 1	Truss	1975	1	130.00	7.32	
	Calao 2	RCDG	-	-	-	-	

Source: DPWH Region II office

Table 2.2.1(1) Cost Estimate of Preliminary Study (Alcala to Buntun Bridge)

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Case-1	**Construction of 2 cut-off channels and 1 diking systen**					
1	Main Works				3,847	
	Preparatory work				248	8 %
	Excavation				1,837	
	Gabut COC	cu.m	4,100,000	135	554	
	San Isidro COC	cu.m	9,500,000	135	1,283	
	Embankment				1,027	
	Amulung - Solana	cu.m	5,400,000	174	940	
	Raising of Highway	cu.m	500,000	174	87	
	Revetment				99	
	Closing dike at Gabut	sq.m	35,000	1,800	63	
	Closing dike at San Isidro	sq.m	20,000	1,800	36	
	Drainage culvert				123	
	Culvert for tributary	place	2	5,634,000	12	
	Culvert for local drainage	place	59	1,878,000	111	
	Irrigation canal and aqueduct				1	
	San Isidro	m	1,000	200	1	
	Bridge				10	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	2,000	2,405	5	
	Miscellaneous				502	15 % of the above
2	Compensation				173	
	Land acquisition	sq.m	2,450,000	17	42	
	House	nos	955	120,000	115	
	Others				16	10 %
3	Engineering & Administration				578	
	Engineering				385	10 % of (1)
	Administration				193	5 % of (1)
4	Contingency				690	15 % of (1+2+3)
	Total				5,288	
Case-2	**Construction of 1 cut-off channel and 2 diking systems**					
1	Main Works				2,341	
	Preparatory work				151	8 %
	Excavation				554	
	Gabut COC	cu.m	4,100,000	135	554	
	San Isidro COC	cu.m	0	135	0	
	Embankment				1,132	
	Amulung	cu.m	4,700,000	174	818	
	Solana	cu.m	1,300,000	174	227	
	Raising of Highway	cu.m	500,000	174	87	
	Revetment				63	
	Closing dike at Gabut	sq.m	35,000	1,800	63	
	Closing dike at San Isidro	sq.m	0	1,800	0	
	Drainage culvert				130	
	Culvert for tributary	unit	1	5,634,000	6	
	Culvert for local drainage	unit	66	1,878,000	124	
	Irrigation canal and aqueduct				0	
	San Isidro	m	0	200	0	
	Bridge				5	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	0	0	0	
	Miscellaneous				306	15 % of the above
2	Compensation				25	
	Land acquisition	sq.m	1,270,000	17	22	
	House	nos	0	120,000	0	
	Others				3	10 %
3	Engineering & Administration				353	
	Engineering				235	10 % of (1)
	Administration				118	5 % of (1)
4	Contingency				408	15 % of (1+2+3)
	Total				3,127	

Table 2.2.1(2) Cost Estimate of Preliminary Study (Alcala to Buntun Bridge)

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Case-3	**Construction of 1 cut-off channel and 2 diking systems**					
1	Main Works				1,953	
	Preparatory work				126	8 %
	Excavation				554	
	Gabut COC	cu.m	4,100,000	135	554	
	San Isidro COC	cu.m	0	135	0	
	Embankment				836	
	Amulung	cu.m	3,000,000	174	522	
	Solana	cu.m	1,300,000	174	227	
	Raising of Highway	cu.m	500,000	174	87	
	Revetment				63	
	Closing dike at Gabut	sq.m	35,000	1,800	63	
	Closing dike at San Isidro	sq.m	0	1,800	0	
	Drainage culvert				114	
	Culvert for tributary	unit	1	5,634,000	6	
	Culvert for local drainage	unit	57	1,878,000	108	
	Irrigation canal and aqueduct				0	
	San Isidro	m	0	200	0	
	Bridge				5	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	0	0	0	
	Miscellaneous				255	15 % of the above
2	Compensation				20	
	Land acquisition	sq.m	1,030,000	17	18	
	House	nos	0	120,000	0	
	Others				2	10 %
3	Engineering & Administration				294	
	Engineering				196	10 % of (1)
	Administration				98	5 % of (1)
4	Contingency				341	15 % of (1+2+3)
	Total				2,608	
Case-4	**Construction of 2 diking systems**					
1	Main Works				1,055	
	Preparatory work				68	8 %
	Excavation				0	
	Gabut COC	cu.m	0	135	0	
	San Isidro COC	cu.m	0	135	0	
	Embankment				732	
	Amulung	cu.m	2,400,000	174	418	
	Solana	cu.m	1,300,000	174	227	
	Raising of Highway	cu.m	500,000	174	87	
	Revetment				0	
	Closing dike at Gabut	sq.m	0	1,800	0	
	Closing dike at San Isidro	sq.m	0	1,800	0	
	Drainage culvert				117	
	Culvert for tributary	unit	0	5,634,000	0	
	Culvert for local drainage	unit	62	1,878,000	117	
	Irrigation canal and aqueduct				0	
	San Isidro	m	0	200	0	
	Bridge				0	
	Gabut	sq.m	0	0	0	
	San Isidro	sq.m	0	0	0	
	Miscellaneous				138	15 % of the above
2	Compensation				17	
	Land acquisition	sq.m	820,000	17	15	
	House	nos	0	120,000	0	
	Others				2	10 %
3	Engineering & Administration				159	
	Engineering				106	10 % of (1)
	Administration				53	5 % of (1)
4	Contingency				185	15 % of (1+2+3)
	Total				1,416	

Table 2.2.2(1) Cost Estimate of Preliminary Study (Buntun Bridge to Upstream of Tuguegarao)

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Case-1	**Present route**					
1	Main Works				1,485	
	Preparatory work				96	8 %
	Excavation				203	
	lower Tuguegarao river	cu.m	1,500,000	135	203	
	Embankment				296	
	Tuguegarao	cu.m	1,000,000	174	174	
	Enrile	cu.m	700,000	174	122	
	Parapet wall				132	
	Tuguegarao city	sq.m	24,000	5,460	132	
	Revetment				0	
	Closing dike	sq.m	0	1,800	0	
	Revetment				521	
	Gabion	sq.m	235,000	1,800	423	
	Spur dike	cu.m	135,000	720	98	
	Drainage culvert				40	
	Culvert for tributary	place	1	5,634,000	6	
	Culvert for local drainage	place	18	1,878,000	34	
	Bridge				3	
	National highway	sq.m	0	17,850	0	
	Submerged	sq.m	1,000	2,405	3	Tuguegarao R.
	Intake canal				0	
	Canal	m	0	200	0	
	Gate	nos.	0	5,634,000	0	
	Miscellaneous				194	15 % of the above
2	Compensation				39	
	Land	sq.m	110,000	17	2	
	House	nos.	270	120,000	33	
	Others				4	10 %
3	Engineering & Administration				224	
	Engineering				149	10 % of (1)
	Administration				75	5 % of (1)
4	Contingency				263	15 % of (1+2+3)
	Total				2,011	
Case-2	**Tuguegarao diversion channel**					
1	Main Works				11,932	
	Preparatory work				769	8 %
	Excavation				7,641	
	Tuguegarao diversion	cu.m	56,600,000	135	7,641	
	Embankment				767	
	Tuguegarao	cu.m	3,800,000	174	662	
	Enrile	cu.m	600,000	174	105	
	Parapet wall				0	
	Tuguegarao city	sq.m	0	5,460	0	
	Revetment				74	
	Closing dike	sq.m	41,000	1,800	74	
	Revetment				911	
	Gabion	sq.m	506,000	1,800	911	
	Spur dike	cu.m	0	720	0	
	Drainage culvert				91	
	Culvert for tributary	place	0	5,634,000	0	
	Culvert for local drainage	place	48	1,878,000	91	
	Bridge				113	
	National highway	sq.m	6,000	17,850	108	
	Submerged	sq.m	2,000	2,405	5	
	Intake canal				9	
	Canal	m	12,000	200	3	
	Gate	nos.	1	5,634,000	6	
	Miscellaneous				1,557	15 % of the above
2	Compensation				211	
	Land	sq.m	8,580,000	17	147	
	House	nos.	360	120,000	44	
	Others				20	10 %
3	Engineering & Administration				1,791	
	Engineering				1,194	10 % of (1)
	Administration				597	5 % of (1)
4	Contingency				2,091	15 % of (1+2+3)
	Total				16,025	

Table 2.2.2(2) Cost Estimate of Preliminary Study (Buntun Bridge to Upstream of Tuguegarao)

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Case-3	**Tuguegarao cut-off channel**					
1	Main Works				3,676	
	Preparatory work				237	8 %
	Excavation				2,133	
	Tuguegarao COC	cu.m	15,800,000	135	2,133	
	Embankment				453	
	Tuguegarao	cu.m	1,900,000	174	331	
	Enrile	cu.m	700,000	174	122	
	Parapet wall				0	
	Tuguegarao city	sq.m	0	5,460	0	
	Revetment				78	
	Closing dike	sq.m	43,000	1,800	78	
	Revetment				234	
	Gabion	sq.m	108,000	1,800	195	
	Spur dike	cu.m	54,000	720	39	
	Drainage culvert				61	
	Culvert for tributary	place	1	5,634,000	6	
	Culvert for local drainage	place	29	1,878,000	55	
	Bridge				0	
	National highway	sq.m	0	17,850	0	
	Submerged	sq.m	0	2,405	0	
	Intake canal				0	
	Canal	m	0	200	0	
	Gate	nos.	0	5,634,000	0	
	Miscellaneous				480	15 % of the above
2	Compensation				98	
	Land	sq.m	5,160,000	17	89	
	House	nos.	0	120,000	0	
	Others				9	10 %
3	Engineering & Administration				552	
	Engineering				368	10 % of (1)
	Administration				184	5 % of (1)
4	Contingency				649	15 % of (1+2+3)
	Total				4,975	

Table 2.3.1(1) Cost Estimate of Alternative Plans for Flood Control Long Term Plan

Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Alternative-1 Without widening (present condition)					
1 Main Works				7,656	
Preparatory work				493	8 %
Excavation				3,902	
Magapit Narrows	cu.m	0	282	0	
Gabut COC	cu.m	4,000,000	135	540	
San Isidro COC	cu.m	7,400,000	135	999	
Tuguegarao COC	cu.m	17,500,000	135	2,363	
Embankment				1,567	
Raising of Highway	cu.m	500,000	174	87	
Amulung-Solana	cu.m	6,000,000	174	1,044	
Tuguegarao	cu.m	1,700,000	174	296	
Enrile	cu.m	800,000	174	140	
Revetment				177	
Closing dike at Gabut	sq.m	35,000	1,800	63	
Closing dike at San Isidro	sq.m	20,000	1,800	36	
Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
Revetment				333	
Gabion	sq.m	163,000	1,800	294	
Spur dike	cu.m	54,000	720	39	
Drainage culvert				174	
Culvert for tributary	unit	2	5,634,000	12	
Culvert for local drainage	unit	86	1,878,000	162	
Irrigation canal and aqueduct				1	
San Isidro	m	1,000	200	1	
Bridge				10	
Magapit	sq.m		17,850	0	
Gabut	sq.m	2,000	2,405	5	
San Isidro	sq.m	2,000	2,405	5	
Miscellaneous				999	15 % of the above
2 Compensation				270	
Land	sq.m	7,207,000	17	124	
House	nos	1,005	120,000	121	
Others				25	10 %
3 Engineering & Administration				1,148	
Engineering				766	10 % of (1)
Administration				383	5 % of (1)
4 Contingency				1,361	15 % of (1+2+3)
Total				10,436	
Alternative-2 Widening of one bottleneck at Tupang (channel width: 500m)					
1 Main Works				11,016	
Preparatory work				710	8 %
Excavation				6,694	
Magapit Narrows	cu.m	9,900,000	282	2,792	
Gabut COC	cu.m	4,000,000	135	540	
San Isidro COC	cu.m	7,400,000	135	999	
Tuguegarao COC	cu.m	17,500,000	135	2,363	
Embankment				1,480	
Raising of Highway	cu.m	500,000	174	87	
Amulung-Solana	cu.m	5,500,000	174	957	
Tuguegarao	cu.m	1,700,000	174	296	
Enrile	cu.m	800,000	174	140	
Revetment				177	
Closing dike at Gabut	sq.m	35,000	1,800	63	
Closing dike at San Isidro	sq.m	20,000	1,800	36	
Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
Revetment				333	
Gabion	sq.m	163,000	1,800	294	
Spur dike	cu.m	54,000	720	39	

Table 2.3.1(2) Cost Estimate of Alternative Plans for Flood Control Long Term Plan

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
	Drainage culvert				174	
	Culvert for tributary	unit	2	5,634,000	12	
	Culvert for local drainage	unit	86	1,878,000	162	
	Irrigation canal and aqueduct				1	
	San Isidro	m	1,000	200	1	
	Bridge				10	
	Magapit	sq.m		17,850	0	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	2,000	2,405	5	
	Miscellaneous				1,437	15 % of the above
2	Compensation				291	
	Land	sq.m	7,560,000	17	130	
	House	nos	1,115	120,000	134	
	Others				27	10 %
3	Engineering & Administration				1,653	
	Engineering				1,102	10 % of (1)
	Administration				551	5 % of (1)
4	Contingency				1,944	15 % of (1+2+3)
	Total				14,904	

Alternative-3 Widening of two bottleneck at Tupang and Nassiping (channel width: 500m)

1	Main Works				12,498	
	Preparatory work				805	8 %
	Excavation				7,991	
	Magapit Narrows	cu.m	14,500,000	282	4,089	
	Gabut COC	cu.m	4,000,000	135	540	
	San Isidro COC	cu.m	7,400,000	135	999	
	Tuguegarao COC	cu.m	17,500,000	135	2,363	
	Embankment				1,376	
	Raising of Highway	cu.m	400,000	174	70	
	Amulung-Solana	cu.m	4,900,000	174	853	
	Tuguegarao	cu.m	1,900,000	174	331	
	Enrile	cu.m	700,000	174	122	
	Revetment				177	
	Closing dike at Gabut	sq.m	35,000	1,800	63	
	Closing dike at San Isidro	sq.m	20,000	1,800	36	
	Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
	Revetment				333	
	Gabion	sq.m	163,000	1,800	294	
	Spur dike	cu.m	54,000	720	39	
	Drainage culvert				174	
	Culvert for tributary	unit	2	5,634,000	12	
	Culvert for local drainage	unit	86	1,878,000	162	
	Irrigation canal and aqueduct				1	
	San Isidro	m	1,000	200	1	
	Bridge				10	
	Magapit	sq.m		17,850	0	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	2,000	2,405	5	
	Miscellaneous				1,631	15 % of the above
2	Compensation				318	
	Land	sq.m	8,570,000	17	147	
	House	nos	1,182	120,000	142	
	Others				29	10 %
3	Engineering & Administration				1,875	
	Engineering				1,250	10 % of (1)
	Administration				625	5 % of (1)
4	Contingency				2,204	15 % of (1+2+3)
	Total				16,895	

Table 2.3.1(3) Cost Estimate of Alternative Plans for Flood Control Long Term Plan

Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
Alternative-4 Widening of three bottleneck at Tupang, Nassiping and Magapit (channel width: 500m)					
1 Main Works				13,694	
Preparatory work				882	8 %
Excavation				8,936	
Magapit Narrows	cu.m	17,800,000	282	5,020	
Gabut COC	cu.m	4,000,000	135	540	
San Isidro COC	cu.m	7,500,000	135	1,013	
Tuguegarao COC	cu.m	17,500,000	135	2,363	
Embankment				1,376	
Raising of Highway	cu.m	400,000	174	70	
Amulung-Solana	cu.m	4,900,000	174	853	
Tuguegarao	cu.m	1,900,000	174	331	
Enrile	cu.m	700,000	174	122	
Revetment				177	
Closing dike at Gabut	sq.m	35,000	1,800	63	
Closing dike at San Isidro	sq.m	20,000	1,800	36	
Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
Revetment				333	
Gabion	sq.m	163,000	1,800	294	
Spur dike	cu.m	54,000	720	39	
Drainage culvert				174	
Culvert for tributary	unit	2	5,634,000	12	
Culvert for local drainage	unit	86	1,878,000	162	
Irrigation canal and aqueduct				1	
San Isidro	m	1,000	200	1	
Bridge				28	
Magapit	sq.m	1,000	17,850	18	
Gabut	sq.m	2,000	2,405	5	
San Isidro	sq.m	2,000	2,405	5	
Miscellaneous				1,787	15 % of the above
2 Compensation				325	
Land	sq.m	8,800,000	17	151	
House	nos	1,192	120,000	144	
Others				30	10 %
3 Engineering & Administration				2,055	
Engineering				1,370	10 % of (1)
Administration				685	5 % of (1)
4 Contingency				2,412	15 % of (1+2+3)
Total				18,486	
Alternative-5 Widening of three bottleneck at Tupang, Nassiping and Magapit (channel width: 700m)					
1 Main Works				43,414	
Preparatory work				2,797	8 %
Excavation				33,089	
Magapit Narrows	cu.m	103,500,000	282	29,187	
Gabut COC	cu.m	4,000,000	135	540	
San Isidro COC	cu.m	7,400,000	135	999	
Tuguegarao COC	cu.m	17,500,000	135	2,363	
Embankment				1,116	
Raising of Highway	cu.m	300,000	174	53	
Amulung-Solana	cu.m	3,600,000	174	627	
Tuguegarao	cu.m	1,800,000	174	314	
Enrile	cu.m	700,000	174	122	
Revetment				177	
Closing dike at Gabut	sq.m	35,000	1,800	63	
Closing dike at San Isidro	sq.m	20,000	1,800	36	
Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
Revetment				333	
Gabion	sq.m	163,000	1,800	294	
Spur dike	cu.m	54,000	720	39	

Table 2.3.1(4) Cost Estimate of Alternative Plans for Flood Control Long Term Plan

	Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
	Drainage culvert				174	
	Culvert for tributary	unit	2	5,634,000	12	
	Culvert for local drainage	unit	86	1,878,000	162	
	Irrigation canal and aqueduct				1	
	San Isidro	m	1,000	200	1	
	Bridge				64	
	Magapit	sq.m	3,000	17,850	54	
	Gabut	sq.m	2,000	2,405	5	
	San Isidro	sq.m	2,000	2,405	5	
	Miscellaneous				5,663	15 % of the above
2	Compensation				436	
	Land	sq.m	12,110,000	17	208	
	House	nos	1,563	120,000	188	
	Others				40	10 %
3	Engineering & Administration				6,513	
	Engineering				4,342	10 % of (1)
	Administration				2,171	5 % of (1)
4	Contingency				7,555	15 % of (1+2+3)
	Total				57,918	

Table 2.3.2 Bank Protection Works in the Reviewed Flood Control Long Term Plan

Serial No	River	City/Town	Location	Object to be Protected	Length(m)	Cross sectional length(m)	Area(m)	Remarks
1	Cagayan	Camalaniugan	Agusi	Res.area, national road, paddy fields	1,000	21	21,000	
2			Camalaniugan	Res.area, national road	500	22	11,000	
3		Lal-lo	Tucalana	Res.area, national road	1,000	28	28,000	
4			Sta. Maria	Res.area, national road, cornfields	1,000	30	30,000	
5			Magapit	Res.area, national road, non cultivated areas	1,000	32	32,000	
6		Gattaran	Gattaran	Res.area, national road, cornfields	1,000	32	32,000	
7		Alcala	Tupang	National road, cornfields	1,000	12	12,000	
8		Dugayong	Dugayong	Municipal road, irrigation canal, paddy fields	300	28	8,400	
9		Amulung	Babayuan	Res.area, municipal road, cornfields	200	14	2,800	
10		Iguig	San Vicente	Res.area, provincial road, paddy fields	800	45	36,000	
11		Solana	Natappian	Res.area, cornfields, provincial road	500	28	14,000	
12		Tuguegarao	Cataggaman	Res.area, municipal road	800	45	36,000	
13		Enrile	Jct. Enrile	Res.area, provincial road, cornfields	500	20	10,000	
14			Alibago	Res.area, cornfields, municipal road	350	24	8,400	
15		Tuguegarao	Namabbalan	Res.area, national road, paddy fields	1,800	24	43,200	
16		Sta. Maria	Sta. Maria	Residential, municipal road, cornfields	2,000	26	52,000	
17		Cabagan	Cabagan	Res.area, cornfields, municipal road	4,000	28	112,000	
18	Tuguegarao	Tuguegarao	Bagumbayan	Res.area, municipal road	100	25	2,500	
19			Larion	Cornfields	250	16	4,000	
20			Caggay	Res.area, national road, non cultivated areas	500	28	14,000	
21			Tanza	Res.area, municipal road, non cultivated area	200	28	5,600	
22	Cagayan	Lasam	Lasam	Res.area, provincial road, cornfields	1,000	25	3,750	
23		Ilagan	Baringin	Res.area	800	25	20,000	
24		Gamu	Upi	Res.area	200	25	5,000	
25	Chico	Piat	Maguilling	Res.area, municipal road	600	15	9,000	
26	Siffu	Roxas	Sitio Gabit	Res.area	250	15	3,750	
27			San Placido	Res.area	350	15	5,250	
28	Ilagan	Ilagan	Malalam	Res.area	1,200	15	18,000	
29			Camunatan	Res.area	2,000	15	30,000	
30	Cagayan	Angadanan	Centro I	Res. Area and agri.lands	1,500	25	37,500	
31		Cauayan	Basingin	Res. Area and agri.lands	2,500	25	62,500	
32			Alicaocao	Res. Area and agri.lands	2,000	25	50,000	
33		Reina Mercedes	District I	Agricultural lands	2,500	25	62,500	
34		Jones	San Vicente	Residential area	300	25	7,500	
35			Brgy. I	Residential area	700	25	17,500	
36			Brgy. II	Residential area	2,000	25	50,000	
37		Echague	Dammang East	Residential/cornfields	300	25	7,500	
38		San Agustin	Laoag	National road/cornfields	300	25	7,500	
39		Jones	Disimpit	Residential/national road/cornfields	1,000	25	25,000	
40		Echague	Pangal Sur	Residential/national road	150	25	3,750	
41		Echague	Dammang West	Cornfields	100	25	2,500	
42		San Agustin	Dappig	Cornfields	500	25	12,500	
43		Echague	Gucab	Residential/cornfields	600	25	15,000	
44		Jones	Dalibubon	Residential/national road	1,000	25	25,000	
45	Magat	Bambang	Cupas	Agri.lands, national road	1,000	15	15,000	
46		Bambang	Macate	Agri.lands, national road	1,000	15	15,000	
47		Bayombong	Lingay	Agri.lands, national road	1,000	15	15,000	
48		Solano	Bugnay	Agricultural lands	2,000	15	30,000	
49		Solano	Crifang	Agricultural lands	800	15	12,000	
50		Solano	Dadap	Agricultural lands	700	15	10,500	
51		Solano	Bangar	Agricultural lands	200	15	3,000	
52		Bagabag	Pogoncino	Agricultural lands	1,500	15	22,500	
53	Sta. Fe	Bambang	Barat	Agricultural lands	2,000	15	30,000	
54	Magat	Bayombong	Busilac	Agricultural lands	1,500	15	22,500	
55	Sta. Fe	Bambang	Almaguer	Agricultural lands	2,000	15	30,000	
56	Magat	Bayombong	Magsaysay	Agricultural lands	1,000	15	15,000	
57	Sta. Fe	Bambang	Indiana	Agricultural lands	1,500	15	22,500	
58	Magat	Bambang	Sto. Domingo	Agri.lands, national road	600	15	9,000	
59	Sta. Fe	Bambang	Salinas	Res.area, national road	500	15	7,500	
60	Magat	Bayombong	Maddiangat	Agricultural lands	1,500	15	22,500	
61	Magat	Bayombong	Bonfal Proper	Agricultural lands	1,000	15	15,000	
62	Magat	Bayombong	Vista Hills	Agri.lands, national road	500	15	7,500	
63	Matuno	Bambang	San Leonardo	Agricultural lands	2,000	15	30,000	
64	Sta. Fe	Aritao	Banganan	Res.area, national road, agri.lands	1,500	15	22,500	
65	Sta. Fe	Sta. Fe	Poblacion	Res.area, national road, agri.lands	500	15	7,500	
66	Sta. Cruz	Kayapa	Cabanglasan	Agri.lands,municipal road	1,000	15	15,000	
67	Sta. Cruz	Kayapa	Pingkian	Agri.lands,municipal road	700	15	10,500	
68	Apayan River	Dupax del Norte	Lamo	Agricultural lands	2,000	15	30,000	
69	Benay	Dupax del Sur	Palabotan	Agricultural lands	500	15	7,500	
70	Benay	Dupax del Sur	Dupax	Agricultural lands	600	15	9,000	
71	Apatan	Dupax del Norte	Bitnong	Agricultural lands	300	15	4,500	
72	Apatan	Dupax del Norte	Mungia	Agricultural lands	300	15	4,500	
73	Sta. Cruz	Kayapa	San Fabian	Agricultural lands	300	15	4,500	

Data source: Site reconnaissance by the Study Team and detailed survey by the respective district offices in the Region II

Table 2.3.3 Quantities of Major Works of Other Schemes in the Reviewed Flood Control Long Term Plan (lowermost,middle and upper reaches)

Stretch	Dike length (km)		Embankment (103m3)		Revetment (103m2)		Land acquisition (103m2)	
	Left	Right	Left	Right	Left	Right	Left	Right
Main Cagayan R.								
Mouth - Alcala	31.4	51.3	4,528	4,731	□□	284.6	1,265	1,574
Tuguegarao - Siffu jct.	60.5	58.5	7,574	9,057	119.2	75.8	2,270	2,487
Siffu jct. - Upstream	33.4	33.6	2,463	3,510	98.6	□□	875	969
Subtotal (1)	125.3	143.4	14,565	17,298	217.8	360.4	4,410	5,030
Backwater Levee (2)	19.0	21.7	2,932	2,547	□□	52.6	704	569
Subtotal (1)+ (2)	144.3	165.1	17,497	19,845	217.8	413.0	5,114	5,599
Tributaries								
Ilagan R.	11.0	7.9	1,010	889	39.4	□□	260	246
Magat R.	31.7	34.3	3,871	2,192	□□	□□	1,142	728
Subtotal (3)	42.7	42.2	4,881	3,081	39.4	□□	1,402	974
Total (1)+(2)+(3)	187.0	207.3	22,378	22,926	257.2	413.0	6,516	6,573
Total (Left+Right)	394.3		45,304		670.2		13,089	

Table 2.3.4 Project Cost of Reviewed Flood Control Long Term Plan (from Alcala to Tuguegarao)

Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
1 Main Works				7,656	
Preparatory work				493	8 %
Excavation				3,902	
Magapit Narrows	cu.m	0	282	0	
Gabut COC	cu.m	4,000,000	135	540	
San Isidro COC	cu.m	7,400,000	135	999	
Tuguegarao COC	cu.m	17,500,000	135	2,363	
Embankment				1,567	
Raising of Highway	cu.m	500,000	174	87	
Amulung-Solana	cu.m	6,000,000	174	1,044	
Tuguegarao	cu.m	1,700,000	174	296	
Enrile	cu.m	800,000	174	140	
Revetment				177	
Closing dike at Gabut	sq.m	35,000	1,800	63	
Closing dike at San Isidro	sq.m	20,000	1,800	36	
Closing dike at Tuguegarao	sq.m	43,000	1,800	78	
Revetment				333	
Gabion	sq.m	163,000	1,800	294	
Spur dike	cu.m	54,000	720	39	
Drainage culvert				174	
Culvert for tributary	unit	2	5,634,000	12	
Culvert for local drainage	unit	86	1,878,000	162	
Irrigation canal and aqueduct				1	
San Isidro	m	1,000	200	1	
Bridge				10	
Magapit	sq.m		17,850	0	
Gabut	sq.m	2,000	2,405	5	
San Isidro	sq.m	2,000	2,405	5	
Miscellaneous				999	15 % of the above
2 Compensation				270	
Land	sq.m	7,207,000	17	124	
House	nos	1,005	120,000	121	
Others				25	10 %
3 Engineering & Administration				1,148	
Engineering				766	10 % of (1)
Administration				383	5 % of (1)
4 Contingency				1,361	15 % of (1+2+3)
5 Total including house compensation				10,436	
Total excluding house compensation				10,283	

Note: House compensation cost is included in this estimate.
Total cost excluding house compensation for study of integration of master plan is 10,283 million pesos and house compensation cost is estimated in the resettlement plan.

Table 2.3.5 Project Cost of Other Schemes in the Reviewed Flood Control Long Term Plan (lowermost,middle and upper reaches)

Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
1 Main Works				11,765	
Preparatory work				758	8 %
Embankment				7,886	
Mouth-Chico river	cu..m	9,259,000	174	1,612	
Tuguegarao-Shiffu river	cu..m	16,631,000	174	2,894	
Siffu- Upstream	cu..m	5,973,000	174	1,040	
Siffu backwater levee	cu..m	5,479,000	174	954	
Ilagan river	cu..m	1,899,000	174	331	
Magat river	cu..m	6,063,000	174	1,055	
Revetment				1,209	
Mouth-Chico river	sq.m	284,600	1,800	513	
Tuguegarao-Shiffu river	sq.m	195,000	1,800	351	
Siffu- Upstream	sq.m	99,000	1,800	179	
Siffu backwater levee	sq.m	52,600	1,800	95	
Ilagan river	sq.m	39,000	1,800	71	
Magat river	sq.m	0	1,800	0	
Drainage culvert				377	
Mouth-Chico river	nos	42	1,878,000	79	
Tuguegarao-Shiffu river	nos	60	1,878,000	113	
Siffu- Upstream	nos	34	1,878,000	64	
Siffu backwater levee	nos	21	1,878,000	40	
Ilagan river	nos	10	1,878,000	19	
Magat river	nos	33	1,878,000	62	
Miscellaneous				1,535	15 % of the above
2 Compensation				248	
Land				225	
Mouth-Chico river	sq.m	2,839,000	17	49	
Tuguegarao-Shiffu river	sq.m	4,757,000	17	81	
Siffu- Upstream	sq.m	1,844,000	17	32	
Siffu backwater levee	sq.m	1,273,000	17	22	
Ilagan river	sq.m	506,000	17	9	
Magat river	sq.m	1,870,000	17	32	
Others				23	10 %
3 Engineering & Administration				1,766	
Engineering				1,177	10 % of (1)
Administration				589	5 % of (1)
4 Contingency				2,067	15 % of (1+2+3)
Total				15,846	

Data siurce: The Master Plan Study on The Cagayan River Basin Water Resources Development, Supporting Report Aug. 1987 by JICA (page; FC-84)

Table 2.3.6 Project Cost of Bank Protection Works in the Reviewed Flood Control Long Term Plan (in basin wide)

Work item	Unit	Work quantity	Unit cost (Pesos)	Amount (Mil. Pesos)	Remarks
1 Main Works				3,298	
Preparatory work				213	8 %
Revetment				2,654	
Gabion	sq.m	1,474,000	1,800	2,654	
Miscellaneous				431	15 % of the above
2 Compensation				18	
Land/House	sq.m	910,000	17	16	
Others				2	10 %
3 Engineering & Administration				495	
Engineering				330	10 % of (1)
Administration				165	5 % of (1)
4 Contingency				572	15 % of (1+2+3)
Total				4,383	

Table 3.1.1 Major Work Items of River Improvement Works for All Flood Control Projects in the Lower Cagayan

Dike Systems in the lower Cagayan from river mouth to Tuguegarao

Name	Length (km)	Embankment volume (cu.m)	Culvert (unit)	Sluice (unit)	Maintenance road (km)	Tree zone (km)	Right of way (sq.m)	Revetment(sq.m)/ Spur dike(cu. m)
1. Left dikes in the lowermost from river mouth to Nassiping								
1) Mabanguc	10.870	1,196,000	17	-	10.870	-	511,000	
2) Catugan	7.380	812,000	9	-	7.380	4.400	347,000	
3) Lasam	7.030	909,000	12	-	7.030	-	352,000	
2. Right dikes in the lowermost from river mouth to Nassiping								
1) Camalaniugan (1)	9.150	1,007,000	13	-	-	-	339,000	Spur dike 19,000
Camalaniugan (2) with revetmen	3.970	143,000	6	-	-	-	44,000	Revetment 26200
2) Lal-lo (1)	11.060	1,021,000	16	-	-	-	376,000	
Lal-lo (2) with revetmen	1.810	18,000	3	-	-	-	10,000	Revetment 6900
3) Gattaran	6.070	560,000	9	-	-	-	206,000	
4) Nassiping	9.720	467,000	14	-	-	-	243,000	
3. Left dikes in the middle lower from Alcala to Tuguegarao								
1) Alcala-Buntun	33.540	6,574,000	49	2	33.540	30.970	2,985,000	
2) Enrile	12.190	927,000	18	-	-	6.460	744,000	
4. Right dikes in the middle lower from Alcala to Tuguegarao								
1) Tuguegarao	21.280	3,134,000	31	-	-	19.780	1,766,000	
2) Amulung Dike	12.600	1,257,000	-	-	-	-	353,000	
3) Iguig dike	3.200	196,000	-	-	-	-	90,000	

Cut-off Channels in the middle lower from Alcala to Tuguegarao

Name	Length (km)	Channel width (m)	Excavation volume (cu.m)	Filling of old channel(cu.m)	Bank protection (sq.m)	Riprap (cu.m)	No.of bridge (bridge)	Right of way (sq.m)
5. Gabut cut-off channel								
1) Gabut coc	0.700	500	4,623,000	5,974,000	40,000	69,000	1	350,000
6. San Isidro cut-off channel								
1) San Isidro coc	1.600	500	9,563,000	7,930,000	26,000	35,000	1	800,000
7. Tuguegarao cut-off channel								
1) Tuguegarao coc	5.800	500	19,134,000	7,472,000	32,000	95,000	-	2,900,000

Table 3.1.2 Urgent Bank Protection Works in the Lower Cagayan River

Serial No	River	City/Town	Location	Object to be Protected	Length(m)	Remarks
1	Cagayan	Camalaniugan	Agusi	Res.area, national road, paddy fields	1,000	
2			Camalaniugan	Res.area, national road	500	
3		Lal-lo	Tucalana	Res.area, national road	1,000	
4			Sta. Maria	Res.area, national road, cornfields	1,000	
5			Magapit	Res.area, national road, non cultivated areas	1,000	
6		Gattaran	Gattaran	Res.area, national road, cornfields	1,000	
7		Alcala	Tupang	National road, cornfields	1,000	
8		Dugayong	Dugayong	Municipal road, irrigation canal, paddy fields	300	
9		Amulung	Babayuan	Res.area, municipal road, cornfields	200	
10		Iguig	San Vicente	Res.area, provincial road, paddy fields	800	
11		Solana	Natappian	Res.area, cornfields, provincial road	500	
12		Tuguegarao	Cataggaman	Res.area, municipal road	800	
13		Enrile	Jct. Enrile	Res.area, provincial road, cornfields	500	
14			Alibago	Res.area, cornfields, municipal road	350	
15		Tuguegarao	Namabbalan	Res.area, national road, paddy fields	1,800	
16		Sta. Maria	Sta. Maria	Residential, municipal road, cornfields	2,000	
17		Cabagan	Cabagan	Res.area, cornfields, municipal road	4,000	
18	Tuguegarao	Tuguegarao	Bagumbayan	Res.area, municipal road	100	
19			Larion	Cornfields	250	
20			Caggay	Res.area, national road, non cultivated areas	500	
21			Tanza	Res.area, municipal road, non cultivated area	200	

Table 3.1.3 Result of Economic Evaluation

Location No.	Location	Financial Cost	Economic Cost		Economic	EIRR (%)		Priority
			Initial Invetement	O/M	Benefit after Completion	Under Present Conditions	Under Future Conditions	Order on Economic
		(Million Pesos)	(Million Pesos)	(Mil. Pesos/Yr)	(Mil. Pesos/Yr)			Efficiency
1	Agusi	47.1	39.99	0.15	3.89	9.2	17.8	10
2	Camalaniugan	30.3	25.74	0.10	4.70	17.8	29.4	1
3	Tucalana	61.7	52.40	0.20	5.08	12.3	22.2	4
4	Sta. Maria	45.1	38.27	0.14	3.51	8.6	17.0	17
5	Magapit	31.8	27.00	0.10	1.15	3.1	9.2	20
6	Gattaran	30.2	25.64	0.10	2.93	8.7	17.1	12
7	Tupang	10.8	9.21	0.03	0.90	9.6	18.1	9
8	Dugayong	9.5	8.03	0.03	0.74	8.7	17.1	13
9	Babayuan	6.7	5.67	0.02	0.77	13.2	23.2	3
10	San Vicente	75.9	62.44	0.23	8.88	13.8	24.0	2
11	Nattapian	32.3	27.39	0.10	3.18	11.1	20.5	5
12	Cataggaman	102.2	83.49	0.30	9.33	10.7	19.9	7
13	Jct. Enrile	13.5	11.43	0.04	1.05	8.7	17.1	15
14	Alibago	10.9	9.22	0.03	0.85	8.7	17.1	14
15	Namabbalan	64.6	54.80	0.21	5.90	10.3	19.3	8
16	Sta. Maria	47.6	40.32	0.15	3.70	8.7	17.0	16
17	Cabagan	80.8	68.25	0.26	6.19	8.5	16.9	19
18	Bagumbayan	10.2	8.70	0.03	1.01	11.1	20.4	6
19	Larion	0.8	0.70	0.00	0.02	2.3	7.8	21
20	Caggay	11.0	9.33	0.04	0.86	8.8	17.2	11
21	Tanza	2.8	2.41	0.01	0.22	8.6	17.0	18
	Whole Works	725.9	606.97	2.29	64.87	10.2	19.2	-

Table 4.1.1 Longitudinal Dimensions of River Improvement Works in the Lower Cagayan River (1/5)

Station	Sec-No	Distance	Commulative Distance	Top of Dike	High Water Level	Calculated Water Level (W=1/25)	Left Bank Elevation	Right Bank Elevation	Mean Riverbed	Deepest Riverbed	Design Riverbed
		(km)	(km)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)
CG 0+000.00A	000-A	0.00	0.00	4.35	2.35	1.38	1.26	2.24	-3.62	-6.64	-4.99
CG 0+000.00B	000-B	0.65	0.65	4.85	2.85	2.52	1.11	2.24	-3.44	-7.07	-4.95
CG 0+000.00	00000	0.54	1.19	5.27	3.27	3.11	1.53	2.24	-3.67	-7.07	-4.91
CG 0+500.00	00050	0.36	1.55	5.55	3.55	3.44	1.08	2.37	-4.50	-7.78	-4.89
CG 1+000.00	00100	0.66	2.22	6.06	4.06	3.68	1.37	1.72	-3.56	-7.66	-4.85
CG 1+500.00	00150	0.47	2.69	6.17	4.17	3.86	1.53	1.69	-3.57	-8.00	-4.82
CG 2+000.00	00200	0.52	3.21	6.29	4.29	4.01	0.73	0.77	-3.13	-7.89	-4.79
CG 2+500.00	00250	0.50	3.72	6.40	4.40	4.14	1.40	1.11	-2.54	-8.08	-4.75
CG 3+000.00	00300	0.52	4.24	6.52	4.52	4.28	0.56	0.62	-2.74	-9.27	-4.72
CG 3+500.00	00350	0.48	4.72	6.63	4.63	4.41	1.02	1.30	-2.31	-8.87	-4.69
CG 4+000.00	00400	0.42	5.14	6.72	4.72	4.52	1.47	1.64	-1.96	-6.65	-4.66
CG 4+500.00	00450	0.11	5.25	6.74	4.74	4.59	1.63	1.30	-3.15	-8.58	-4.66
CG 5+000.00	00500	0.69	5.94	6.89	4.89	4.71	1.79	1.15	-3.39	-6.73	-4.61
CG 5+500.00	00550	0.85	6.79	7.08	5.08	4.87	2.36	2.28	-2.82	-5.30	-4.56
CG 6+000.00	00600	0.71	7.50	7.24	5.24	5.04	0.77	2.08	-2.63	-6.50	-4.52
CG 6+500.00	00650	0.45	7.95	7.34	5.34	5.17	1.16	2.31	-3.13	-8.73	-4.49
CG 7+000.00	00700	0.54	8.49	7.46	5.46	5.30	1.31	2.00	-1.98	-11.89	-4.46
CG 7+500.00	00750	0.47	8.96	7.56	5.56	5.43	4.46	2.37	-1.40	-13.46	-4.43
CG 8+000.00	00800	0.55	9.52	7.68	5.68	5.60	3.02	2.92	-1.46	-11.15	-4.39
CG 8+500.00	00850	0.56	10.08	7.81	5.81	5.79	2.24	2.88	-2.12	-15.48	-4.36
CG 9+000.00	00900	0.40	10.48	7.90	5.90	5.88	2.14	2.72	-2.22	-12.74	-4.33
CG 9+500.00	00950	0.63	11.11	8.04	6.04	6.01	2.65	3.14	-2.29	-7.07	-4.29
CG 10+000.00	01000	0.45	11.56	8.14	6.14	6.08	2.15	3.10	-2.80	-7.24	-4.26
CG 10+500.00	01050	0.44	12.01	8.24	6.24	6.14	2.41	4.03	-2.57	-9.70	-4.24
CG 11+000.00	01100	0.54	12.54	8.36	6.36	6.21	6.51	4.58	-3.08	-11.51	-4.20
CG 11+500.00	01150	0.51	13.05	8.47	6.47	6.30	10.70	5.41	-2.73	-12.67	-4.17
CG 12+000.00	01200	0.60	13.65	8.60	6.60	6.40	7.31	3.64	-1.76	-7.27	-4.13
CG 12+500.00	01250	0.54	14.19	8.72	6.72	6.47	14.49	3.07	-0.89	-7.79	-4.10
CG 13+000.00	01300	0.67	14.86	8.87	6.87	6.55	17.69	4.23	-1.74	-6.98	-4.06
CG 13+500.00	01350	0.54	15.40	8.99	6.99	6.63	12.70	3.54	-2.03	-12.10	-4.02
CG 14+000.00	01400	0.53	15.94	9.11	7.11	6.73	18.88	6.05	-2.58	-10.79	-3.99
CG 14+500.00	01450	0.50	16.44	9.22	7.22	6.82	11.28	6.23	-2.89	-9.63	-3.96
CG 15+000.00	01500	0.36	16.80	9.30	7.30	6.90	10.70	9.26	-3.46	-9.38	-3.94
CG 15+500.00	01550	0.53	17.33	9.42	7.42	7.01	7.31	5.86	-3.23	-7.63	-3.90
CG 16+000.00	01600	0.41	17.74	9.51	7.51	7.10	14.49	8.13	-2.89	-8.17	-3.88
CG 16+500.00	01650	0.63	18.38	9.65	7.65	7.26	17.69	4.82	-3.29	-7.57	-3.84
CG 17+000.00	01700	0.76	19.14	9.82	7.82	7.48	20.99	4.19	-2.32	-7.70	-3.79
CG 17+500.00	01750	0.46	19.60	9.92	7.92	7.57	19.45	4.22	-2.40	-12.96	-3.76
CG 18+000.00	01800	0.56	20.15	10.04	8.04	7.74	10.51	4.40	-2.70	-17.49	-3.73
CG 18+500.00	01850	0.62	20.77	10.18	8.18	7.90	9.39	3.79	-2.46	-10.68	-3.69
CG 19+000.00	01900	0.45	21.22	10.28	8.28	7.99	6.00	9.32	-0.97	-7.23	-3.66
CG 19+500.00	01950	0.49	21.70	10.39	8.39	8.14	6.60	7.05	-2.89	-8.19	-3.63
CG 20+000.00	02000	0.67	22.37	10.54	8.54	8.26	5.20	4.99	-2.72	-4.49	-3.59
CG 20+500.00	02050	0.77	23.14	10.71	8.71	8.34	5.20	5.57	-1.85	-3.91	-3.54
CG 21+000.00	02100	0.51	23.65	10.82	8.82	8.39	5.20	5.90	-1.32	-3.40	-3.51
CG 21+500.00	02150	0.62	24.27	10.96	8.96	8.49	6.70	7.03	-0.36	-2.90	-3.47
CG 22+000.00	02200	0.45	24.73	11.06	9.06	8.54	6.80	6.34	0.48	-4.05	-3.44
CG 22+500.00	02250	0.61	25.34	11.20	9.20	8.60	5.80	7.17	-0.49	-5.13	-3.40
CG 23+000.00	02300	0.44	25.78	11.30	9.30	8.85	7.60	10.27	-0.69	-5.76	-3.37
CG 23+500.00	02350	0.57	26.35	11.43	9.43	8.99	7.60	8.73	-0.89	-5.75	-3.34
CG 24+000.00	02400	0.61	26.97	11.57	9.57	9.04	8.50	8.61	-2.21	-5.30	-3.30
CG 24+500.00	02450	0.47	27.44	11.67	9.67	9.13	8.10	9.90	-2.35	-4.47	-3.27
CG 25+000.00	02500	0.53	27.96	11.79	9.79	9.25	8.40	9.26	-2.11	-4.96	-3.24
CG 25+500.00	02550	0.52	28.48	11.91	9.91	9.49	15.00	10.07	-1.69	-6.35	-3.21
CG 26+000.00	02600	0.43	28.92	12.01	10.01	9.34	22.23	10.64	-0.77	-7.49	-3.18
CG 26+500.00	02650	0.57	29.48	12.14	10.14	9.51	12.81	9.17	-2.08	-8.34	-3.14
CG 27+000.00	02700	0.43	29.91	12.24	10.24	9.61	13.10	7.80	-2.60	-7.97	-3.12
CG 27+500.00	02750	0.54	30.45	12.36	10.36	9.76	10.24	8.87	-2.78	-7.05	-3.08
CG 28+000.00	02800	0.54	30.99	12.48	10.48	9.84	9.11	8.65	-3.91	-6.58	-3.05
CG 28+250.00	02825	0.39	31.39	12.57	10.57	9.80	10.55	8.37	-3.27	-9.55	-3.02
CG 28+500.00	02850	0.29	31.68	12.63	10.63	10.04	9.87	8.60	-10.86	-26.37	-3.01
CG MAGAPIT BRIDGE	MAGAP	0.13	31.80	12.66	10.66	9.63	15.84	16.21	-3.18	-27.36	-3.00
CG 28+750.00	02875	0.13	31.94	12.69	10.69	10.07	9.50	11.67	-5.96	-21.17	-2.99
CG 29+000.00	02900	0.23	32.16	12.73	10.73	9.99	8.31	16.49	-3.39	-21.51	-2.98

Table 4.1.1 Longitudinal Dimensions of River Improvement Works in the Lower Cagayan River (2/5)

Station	Sec-No	Distance	Commulative Distance	Top of Dike	High Water Level	Calculated Water Level (W=1/25)	Left Bank Elevation	Right Bank Elevation	Mean Riverbed	Deepest Riverbed	Design Riverbed
		(km)	(km)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)
CG 29+250.00	02925	0.23	32.40	12.77	10.77	10.23	8.09	11.67	-4.24	-18.59	-2.96
CG 29+500.00	02950	0.18	32.58	12.80	10.80	10.31	9.98	12.00	-4.47	-19.28	-2.95
CG 29+750.00	02975	0.20	32.78	12.84	10.84	10.40	12.33	13.61	-4.22	-20.54	-2.94
CG 30+000.00	03000	0.26	33.04	12.89	10.89	10.55	10.76	10.59	-3.20	-15.99	-2.92
CG 30+250.00	03025	0.19	33.22	12.93	10.93	10.58	10.77	12.53	-3.71	-19.54	-2.91
CG 30+500.00	03050	0.21	33.43	12.97	10.97	10.68	7.81	12.85	-5.42	-17.28	-2.90
CG 30+750.00	03075	0.18	33.61	13.00	11.00	10.72	8.58	9.18	-7.59	-23.42	-2.89
CG 31+000.00	03100	0.21	33.83	13.04	11.04	10.70	11.76	10.23	-3.21	-11.15	-2.87
CG 31+250.00	03125	0.31	34.14	13.10	11.10	10.76	27.95	8.57	-5.31	-12.28	-2.85
CG 31+500.00	03150	0.26	34.40	13.15	11.15	10.93	47.34	8.84	-4.50	-15.29	-2.84
CG 31+750.00	03175	0.26	34.66	13.20	11.20	11.01	27.90	9.11	-4.19	-14.47	-2.82
CG 32+000.00	03200	0.37	35.03	13.27	11.27	11.19	41.57	9.79	-2.09	-19.40	-2.80
CG 32+250.00	03225	0.35	35.37	13.34	11.34	11.26	23.53	10.01	-1.83	-11.53	-2.78
CG 32+500.00	03250	0.50	35.87	13.43	11.43	11.37	17.06	8.83	-2.20	-11.97	-2.74
CG 32+750.00	03275	0.59	36.46	13.54	11.54	11.49	25.03	8.31	-1.74	-8.53	-2.71
CG 33+000.00	03300	0.25	36.72	13.59	11.59	11.46	30.00	9.61	-1.98	-6.96	-2.69
CG 33+500.00	03350	0.50	37.21	13.68	11.68	11.59	10.40	8.84	-1.76	-7.11	-2.66
CG 34+000.00	03400	0.85	38.07	13.84	11.84	11.71	9.50	10.17	-1.88	-13.14	-2.61
CG 34+500.00	03450	0.55	38.62	13.94	11.94	11.85	14.00	9.27	-2.12	-10.23	-2.57
CG 35+000.00	03500	0.77	39.39	14.09	12.09	11.94	28.40	9.60	-1.11	-4.17	-2.52
CG 35+500.00	03550	0.55	39.94	14.19	12.19	12.01	10.10	10.49	-0.48	-4.24	-2.49
CG 36+000.00	03600	0.49	40.43	14.28	12.28	12.08	9.60	9.90	-1.67	-5.57	-2.46
CG 36+500.00	03650	0.49	40.92	14.37	12.37	12.17	9.80	9.42	-1.94	-6.75	-2.43
CG 37+000.00	03700	0.52	41.44	14.47	12.47	12.22	9.00	8.88	-2.32	-6.76	-2.40
CG 37+500.00	03750	0.48	41.92	14.56	12.56	12.19	8.90	14.30	-1.99	-7.45	-2.37
CG 38+000.00	03800	0.47	42.39	14.65	12.65	12.35	9.20	14.39	-2.12	-6.07	-2.34
CG 38+500.00	03850	0.45	42.84	14.74	12.74	12.43	9.10	15.62	-1.40	-20.56	-2.31
CG 39+000.00	03900	0.54	43.39	14.84	12.84	12.56	9.20	13.38	-0.17	-2.55	-2.27
CG 39+500.00	03950	0.47	43.86	14.93	12.93	12.65	8.30	14.33	0.59	-4.48	-2.24
CG 40+000.00	04000	0.33	44.18	14.99	12.99	12.68	8.20	13.04	2.47	-2.73	-2.22
CG 40+500.00	04050	0.23	44.41	15.03	13.03	12.70	8.20	10.59	1.91	-2.82	-2.21
CG 41+000.00	04100	0.24	44.65	15.08	13.08	12.69	20.00	11.18	2.82	-2.90	-2.20
CG 41+500.00	04150	0.18	44.83	15.11	13.11	12.70	26.40	12.39	2.90	-2.72	-2.18
CG 42+000.00	04200	0.48	45.31	15.20	13.20	12.79	47.70	12.45	1.40	-3.38	-2.15
CG 42+500.00	04250	0.50	45.81	15.29	13.29	12.84	24.00	12.44	0.71	-2.70	-2.12
CG 43+000.00	04300	0.46	46.27	15.38	13.38	12.91	22.20	12.32	0.45	-3.26	-2.09
CG 43+500.00	04350	0.50	46.77	15.47	13.47	12.98	20.00	12.40	-0.68	-3.58	-2.06
CG 44+000.00	04400	0.52	47.30	15.57	13.57	13.06	10.10	12.59	-0.79	-4.68	-2.03
CG 44+500.00	04450	0.69	47.98	15.70	13.70	13.19	9.20	12.75	-0.10	-6.02	-1.99
CG 45+000.00	04500	0.54	48.52	15.80	13.80	13.25	18.00	12.74	-1.14	-8.30	-1.95
CG 45+500.00	04550	0.49	49.01	15.89	13.89	13.39	10.00	12.51	-0.67	-4.41	-1.92
CG 46+000.00	04600	0.51	49.52	15.99	13.99	13.54	10.70	13.81	-0.43	-6.73	-1.89
CG 46+500.00	04650	0.52	50.04	16.09	14.09	13.59	11.40	13.70	-0.89	-8.61	-1.86
CG 47+000.00	04700	0.80	50.84	16.24	14.24	13.89	25.28	13.93	-0.58	-2.04	-1.81
CG 47+500.00	04750	0.78	51.62	16.39	14.39	14.12	28.76	14.09	-0.35	-5.01	-1.76
CG 48+000.00	04800	0.64	52.26	16.51	14.51	14.24	16.53	12.57	1.55	-1.83	-1.72
CG 48+500.00	04850	0.47	52.73	16.60	14.60	14.29	13.90	13.55	1.66	-2.70	-1.69
CG 49+000.00	04900	0.65	53.38	16.72	14.72	14.36	17.90	12.99	1.61	-2.64	-1.65
CG 49+500.00	04950	0.91	54.30	16.89	14.89	14.42	30.90	13.59	0.17	-3.79	-1.59
CG 50+000.00	05000	0.49	54.78	16.98	14.98	14.38	15.50	14.33	-0.39	-4.82	-1.56
CG 50+250.00	05025	0.41	55.20	17.06	15.06	14.38	11.28	14.03	-1.03	-6.99	-1.54
CG 50+500.00	05050	0.34	55.53	17.12	15.12	14.42	13.00	15.92	-2.01	-6.41	-1.52
CG 50+750.00	05075	0.55	56.09	17.22	15.22	14.38	55.24	15.76	-2.19	-9.15	-1.48
CG 51+000.00	05100	0.28	56.36	17.27	15.27	14.68	36.10	14.91	-0.69	-3.84	-1.46
CG 51+250.00	05125	0.22	56.58	17.31	15.31	14.79	68.01	15.01	0.50	-3.63	-1.45
CG 51+500.00	05150	0.26	56.84	17.36	15.36	14.92	20.75	15.81	2.00	-3.99	-1.43
CG 51+750.00	05175	0.33	57.17	17.42	15.42	15.09	55.35	16.04	1.46	-2.82	-1.41
CG 52+000.00	05200	0.27	57.44	17.47	15.47	15.15	13.35	15.78	0.41	-3.07	-1.40
CG 52+250.00	05225	0.24	57.68	17.52	15.52	15.19	13.94	16.19	0.24	-2.55	-1.38
CG 52+500.00	05250	0.24	57.93	17.57	15.57	15.21	22.40	18.62	-0.09	-3.71	-1.37
CG 52+750.00	05275	0.26	58.18	17.62	15.62	15.23	13.90	21.65	-0.66	-5.31	-1.35
CG 53+000.00	05300	0.29	58.47	17.67	15.67	15.22	15.15	24.47	-1.11	-15.99	-1.33
CG 53+250.00	05325	0.21	58.68	17.71	15.71	15.33	14.84	19.05	-3.70	-15.92	-1.32
CG 53+500.00	05350	0.30	58.98	17.77	15.77	15.23	15.62	16.77	-3.09	-18.94	-1.30

Table 4.1.1 Longitudinal Dimensions of River Improvement Works in the Lower Cagayan River (3/5)

Station	Sec-No	Distance	Commulative Distance	Top of Dike	High Water Level	Calculated Water Level (W=1/25)	Left Bank Elevation	Right Bank Elevation	Mean Riverbed	Deepest Riverbed	Design Riverbed
		(km)	(km)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)	(EL m)
CG 53+750.00	05375	0.22	59.20	17.81	15.81	15.44	15.93	18.98	-3.93	-27.00	-1.29
CG 54+000.00	05400	0.16	59.36	17.84	15.84	15.33	16.78	21.64	1.05	-12.58	-1.28
CG 54+250.00	05425	0.27	59.63	17.89	15.89	15.47	16.93	17.85	-0.01	-8.94	-1.26
CG 54+500.00	05450	0.30	59.93	17.95	15.95	15.55	16.32	20.56	0.48	-9.09	-1.24
CG 54+750.00	05475	0.34	60.27	18.01	16.01	15.63	16.12	16.59	2.66	-3.25	-1.22
CG 55+000.00	05500	0.20	60.47	18.05	16.05	15.69	16.25	15.27	2.20	-3.01	-1.21
CG 55+250.00	05525	0.31	60.78	18.11	16.11	15.76	17.03	14.12	1.56	-2.34	-1.19
CG 55+500.00	05550	0.26	61.04	18.16	16.16	15.81	17.21	13.94	1.25	-1.61	-1.17
CG 55+750.00	05575	0.27	61.31	18.21	16.21	15.86	16.10	13.99	0.74	-1.59	-1.15
CG 56+000.00	05600	0.30	61.61	18.27	16.27	15.88	16.80	16.67	0.24	-2.08	-1.14
CG 56+250.00	05625	0.23	61.84	18.31	16.31	15.87	16.89	15.15	-0.53	-5.34	-1.12
CG 56+500.00	05650	0.17	62.01	18.34	16.34	15.87	19.82	16.02	-2.71	-12.34	-1.11
CG 56+750.00	05675	0.22	62.22	18.38	16.38	15.92	20.09	17.77	-5.53	-22.87	-1.10
CG 57+000.00	05700	0.19	62.41	18.42	16.42	16.01	17.46	17.66	-3.73	-21.69	-1.09
CG 57+250.00	05725	0.41	62.82	18.50	16.50	15.96	13.92	15.98	-0.35	-10.93	-1.06
CG 57+500.00	05750	0.48	63.30	18.59	16.59	16.06	15.33	16.85	-0.59	-4.05	-1.03
CG 57+750.00	05775	0.25	63.55	18.64	16.64	16.10	13.49	16.32	-0.66	-4.47	-1.01
CG 58+000.00	05800	0.27	63.82	18.69	16.69	16.15	14.72	17.36	-0.97	-2.78	-1.00
CG 58+250.00	05825	0.31	64.13	18.75	16.75	16.19	15.21	17.49	-1.11	-4.89	-0.98
CG 58+500.00	05850	0.24	64.37	18.80	16.80	16.26	13.77	18.40	-0.23	-6.81	-0.96
CG 58+750.00	05875	0.26	64.63	18.85	16.85	16.41	12.14	16.92	-3.57	-15.39	-0.95
CG 59+000.00	05900	0.25	64.88	18.90	16.90	16.26	14.13	17.44	0.90	-8.60	-0.93
CG 59+250.00	05925	0.27	65.15	18.95	16.95	16.49	17.30	18.70	0.47	-9.90	-0.91
CG 59+500.00	05950	0.25	65.40	19.00	17.00	16.59	17.47	16.99	0.16	-3.71	-0.90
CG 59+750.00	05975	0.28	65.68	19.05	17.05	16.64	16.65	15.93	0.13	-3.20	-0.88
CG 60+000.00	06000	0.30	65.99	19.11	17.11	16.66	16.89	15.90	-0.15	-5.56	-0.86
CG 60+250.00	06025	0.28	66.27	19.16	17.16	16.69	18.10	15.92	-1.33	-12.21	-0.84
CG 60+500.00	06050	0.29	66.56	19.21	17.21	16.91	16.88	15.89	-0.19	-13.10	-0.83
CG 60+750.00	06075	0.28	66.84	19.26	17.26	16.89	13.26	15.76	1.00	-10.18	-0.81
CG 61+000.00	06100	0.24	67.08	19.30	17.30	17.02	13.47	15.80	-1.94	-18.26	-0.79
CG 61+250.00	06125	0.24	67.32	19.35	17.35	16.92	15.32	17.07	-1.55	-4.69	-0.78
CG 61+500.00	06150	0.37	67.69	19.42	17.42	17.10	8.83	17.26	-0.76	-3.51	-0.76
CG 61+750.00	06175	0.27	67.97	19.47	17.47	17.26	9.70	18.63	0.82	-2.55	-0.74
CG 62+000.00	06200	0.46	68.42	19.56	17.56	17.34	11.17	19.69	0.47	-2.79	-0.71
CG 62+500.00	06250	0.62	69.04	19.68	17.68	17.55	14.40	28.20	3.30	-4.33	-0.67
CG 63+000.00	06300	0.53	69.57	19.78	17.78	17.60	14.40	33.80	0.53	-2.24	-0.64
CG 63+500.00	06350	0.57	70.15	19.89	17.89	17.64	14.40	19.80	2.61	-1.37	-0.60
CG 64+000.00	06400	0.59	70.74	19.96	17.96	17.69	13.40	18.70	0.98	-1.44	-0.49
CG 64+500.00	06450	0.45	71.19	20.01	18.01	17.72	14.30	15.10	1.07	-1.38	-0.41
CG 65+000.00	06500	0.59	71.78	20.08	18.08	17.73	11.50	13.80	1.33	-1.20	-0.31
CG 65+500.00	06550	0.48	72.26	20.14	18.14	17.75	11.10	15.90	1.61	-1.53	-0.22
CG 66+000.00	06600	0.51	72.77	20.20	18.20	17.77	10.00	13.60	3.25	-0.83	-0.13
GABUT COC	GAB01	0.40	73.17	20.25	18.25	17.79	10.00	14.00	3.76	-0.05	-0.05
GABUT COC	GAB02	1.00	74.17	20.37	18.37	17.93	13.00	12.80	3.94	0.13	0.13
GABUT COC	GAB03	1.00	75.17	20.49	18.49	18.06	13.70	15.10	4.13	0.31	0.31
CG 75+500.00	07550	0.40	75.57	20.54	18.54	18.09	12.50	16.20	3.28	0.89	0.38
CG 76+000.00	07600	0.51	76.08	20.60	18.60	18.15	11.50	16.10	3.55	0.31	0.48
CG 76+500.00	07650	0.52	76.59	20.66	18.66	18.24	13.40	15.70	3.49	-0.48	0.57
CG 77+000.00	07700	0.49	77.09	20.72	18.72	18.35	12.20	15.50	2.74	-2.47	0.66
CG 77+500.00	07750	0.50	77.58	20.78	18.78	18.37	12.50	15.30	2.10	-1.77	0.75
CG 78+000.00	07800	0.55	78.13	20.84	18.84	18.42	12.50	15.10	-0.20	-7.05	0.85
CG 78+500.00	07850	0.50	78.64	20.90	18.90	18.58	12.90	15.10	-1.72	-28.56	0.94
CG 79+000.00	07900	0.35	78.99	20.94	18.94	18.70	12.20	15.50	0.29	-15.07	1.01
CG 79+500.00	07950	0.71	79.70	21.02	19.02	18.79	12.20	15.90	3.68	-0.79	1.13
CG 80+000.00	08000	0.11	79.81	21.03	19.03	18.78	12.20	15.30	4.91	-1.48	1.16
CG 80+500.00	08050	0.29	80.10	21.06	19.06	18.79	12.20	14.90	6.50	0.54	1.21
CG 81+000.00	08100	0.13	80.23	21.08	19.08	18.84	13.90	15.40	3.89	1.65	1.23
CG 81+500.00	08150	0.71	80.93	21.16	19.16	18.88	13.70	16.10	4.53	2.40	1.36
CG 82+000.00	08200	0.67	81.60	21.24	19.24	18.90	14.30	16.50	2.02	-15.71	1.48
CG 82+500.00	08250	0.61	82.21	21.31	19.31	18.94	11.60	14.10	3.35	-2.15	1.59
CG 83+000.00	08300	0.56	82.77	21.38	19.38	18.99	14.40	17.40	3.45	0.77	1.69
CG 83+500.00	08350	0.55	83.32	21.44	19.44	19.02	14.40	17.40	4.22	2.10	1.79
CG 84+000.00	08400	0.50	83.82	21.50	19.50	19.06	14.10	16.60	3.00	-0.40	1.88
CG 84+500.00	08450	0.52	84.33	21.56	19.56	19.12	13.40	18.70	2.95	-0.88	1.98

Table 4.1.1 Longitudinal Dimensions of River Improvement Works in the Lower Cagayan River (4/5)

Station	Sec-No	Distance (km)	Commulative Distance (km)	Top of Dike (EL m)	High Water Level (EL m)	Calculated Water Level (W=1/25) (EL m)	Left Bank Elevation (EL m)	Right Bank Elevation (EL m)	Mean Riverbed (EL m)	Deepest Riverbed (EL m)	Design Riverbed (EL m)
CG 85+000.00	08500	0.51	84.84	21.62	19.62	19.22	14.70	12.90	2.73	-1.00	2.07
CG 85+500.00	08550	0.51	85.35	21.68	19.68	19.27	13.20	15.30	2.36	0.92	2.16
CG 86+000.00	08600	0.50	85.85	21.74	19.74	19.37	14.40	15.70	3.59	1.14	2.25
CG 86+500.00	08650	0.60	86.45	21.81	19.81	19.40	14.80	16.70	4.75	-2.14	2.36
CG 87+000.00	08700	0.52	86.97	21.87	19.87	19.47	12.20	20.50	4.20	-0.92	2.46
CG 87+500.00	08750	0.54	87.51	21.93	19.93	19.51	13.20	21.50	6.14	3.91	2.55
CG 88+000.00	08800	0.53	88.04	21.99	19.99	19.59	13.10	22.30	4.42	1.67	2.65
CG 88+500.00	08850	0.46	88.50	22.04	20.04	19.62	12.30	25.00	5.86	2.20	2.74
SAN ISIDRO COC	SAN01	0.50	89.00	22.10	20.10	19.72	12.90	22.50	5.45	2.83	2.83
SAN ISIDRO COC	SAN02	1.00	90.00	22.22	20.22	19.87	13.80	18.80	5.63	3.01	3.01
SAN ISIDRO COC	SAN03	1.00	91.00	22.34	20.34	20.03	16.90	17.80	5.81	3.19	3.19
SAN ISIDRO COC	SAN04	1.20	92.20	22.48	20.48	20.22	16.30	20.50	6.03	3.41	3.41
CG 97+000.00	09700	0.50	92.70	22.54	20.54	20.25	16.30	20.00	6.46	3.72	3.50
CG 97+500.00	09750	0.10	92.80	22.55	20.55	20.30	16.00	28.00	6.44	4.80	3.52
CG 98+000.00	09800	0.23	93.03	22.58	20.58	20.38	15.00	20.00	6.48	5.28	3.56
CG 98+500.00	09850	0.59	93.62	22.65	20.65	20.39	17.00	19.00	5.93	4.62	3.67
CG 99+000.00	09900	0.88	94.50	22.75	20.75	20.63	13.20	18.70	4.73	2.38	3.83
CG 99+500.00	09950	0.52	95.02	22.81	20.81	20.73	14.80	18.50	5.38	3.58	3.92
CG 100+000.00	10000	0.58	95.60	22.88	20.88	20.80	15.10	17.60	6.18	3.16	4.03
CG 100+500.00	10050	0.53	96.13	22.94	20.94	20.90	13.80	20.00	6.79	1.77	4.12
CG 101+000.00	10100	0.47	96.60	23.00	21.00	20.94	15.00	21.50	6.67	3.02	4.21
CG 101+500.00	10150	0.54	97.15	23.06	21.06	21.03	17.50	22.80	6.78	1.76	4.31
CG 102+000.00	10200	0.55	97.69	23.12	21.12	21.08	18.00	20.00	4.79	-1.48	4.41
CG 102+500.00	10250	0.48	98.17	23.18	21.18	21.14	18.80	20.00	7.13	2.30	4.49
CG 103+000.00	10300	0.56	98.73	23.25	21.25	21.20	18.50	20.00	6.49	2.15	4.60
CG 103+500.00	10350	0.59	99.32	23.32	21.32	21.21	17.00	30.00	6.26	1.90	4.70
CG 104+000.00	10400	0.57	99.89	23.39	21.39	21.30	17.40	21.00	6.65	-3.27	4.81
CG 104+500.00	10450	0.47	100.36	23.45	21.45	21.33	17.40	19.30	8.70	0.52	4.89
CG 105+000.00	10500	0.51	100.87	23.51	21.51	21.41	17.40	20.00	7.08	1.81	4.98
CG 105+500.00	10550	0.60	101.47	23.58	21.58	21.45	17.50	21.30	7.39	1.85	5.09
CG 106+000.00	10600	0.55	102.02	23.64	21.64	21.47	16.90	16.60	5.17	2.78	5.19
CG 106+500.00	10650	0.52	102.54	23.70	21.70	21.48	20.60	17.30	5.00	2.97	5.29
CG 107+000.00	10700	0.48	103.02	23.76	21.76	21.52	20.20	17.60	4.21	-7.08	5.38
CG 107+500.00	10750	0.52	103.54	23.82	21.82	21.51	20.60	14.30	6.08	-1.42	5.47
CG 108+000.00	10800	0.49	104.04	23.88	21.88	21.58	20.00	14.70	8.19	0.00	5.56
CG 108+500.00	10850	0.53	104.56	23.94	21.94	21.72	19.60	14.90	7.28	0.73	5.66
CG 109+000.00	10900	0.81	105.37	24.04	22.04	21.81	17.40	18.30	7.01	4.80	5.80
CG 109+500.00	10950	0.56	105.93	24.11	22.11	21.85	18.30	18.30	6.56	2.14	5.90
CG 110+000.00	11000	0.51	106.45	24.17	22.17	21.93	18.40	18.30	7.37	5.17	6.00
CG 110+500.00	11050	0.65	107.10	24.25	22.25	21.98	19.10	18.00	5.53	0.36	6.12
CG 111+000.00	11100	0.59	107.69	24.32	22.32	22.02	18.90	18.00	6.25	4.56	6.22
CG 111+500.00	11150	0.53	108.22	24.38	22.38	22.09	19.00	19.60	6.54	3.86	6.32
CG 112+000.00	11200	0.51	108.73	24.44	22.44	22.14	19.00	20.10	6.87	3.52	6.41
CG 112+500.00	11250	0.49	109.22	24.50	22.50	22.17	22.70	20.20	6.51	4.18	6.50
CG 113+000.00	11300	0.52	109.74	24.56	22.56	22.24	23.80	20.20	5.53	-0.85	6.60
CG 113+500.00	11350	0.52	110.26	24.62	22.62	22.32	26.40	20.30	5.58	0.19	6.69
CG 114+000.00	11400	0.65	110.91	24.70	22.70	22.40	29.30	20.70	5.99	3.72	6.81
CG 114+500.00	11450	0.64	111.55	24.78	22.78	22.48	34.80	21.80	6.58	4.70	6.93
CG BONTON BRIDGE	BONTO	0.08	111.63	24.79	22.79	22.48	33.60	23.10	7.88	6.13	6.94
CG 115+000.00	11500	0.37	112.00	24.86	22.86	22.53	28.60	20.60	9.24	6.50	7.01
TUGUEGARAO COC	TUG01	0.50	112.50	24.95	22.95	22.59	32.40	18.90	10.40	7.10	7.10
TUGUEGARAO COC	TUG02	1.10	113.60	25.15	23.15	22.75	26.00	16.50	10.60	7.30	7.30
TUGUEGARAO COC	TUG03	1.10	114.70	25.35	23.35	23.00	24.00	16.80	10.81	7.50	7.50
TUGUEGARAO COC	TUG04	1.10	115.80	25.55	23.55	23.05	22.00	16.80	11.01	7.70	7.70
TUGUEGARAO COC	TUG05	1.10	116.90	25.75	23.75	23.09	20.30	20.00	11.21	7.90	7.90
TUGUEGARAO COC	TUG06	1.10	118.00	25.95	23.95	23.27	21.30	18.00	11.41	8.10	8.10
TUGUEGARAO COC	TUG07	1.10	119.10	26.15	24.15	23.53	22.30	18.10	11.61	8.30	8.30
TUGUEGARAO COC	TUG08	1.10	120.20	26.35	24.35	23.92	20.80	20.50	11.81	8.50	8.50
TUGUEGARAO COC	TUG09	1.00	121.20	26.53	24.53	24.24	20.40	20.40	11.99	8.68	8.68
CG 128+500.00	12850	0.50	121.70	26.62	24.62	24.50	23.90	20.00	12.96	7.08	8.77
CG 129+000.00	12900	0.84	122.54	26.77	24.77	24.59	21.90	20.00	12.64	9.93	8.92
CG 129+500.00	12950	0.58	123.12	26.87	24.87	24.67	21.30	22.70	11.67	9.58	9.03
CG 130+000.00	13000	0.54	123.66	26.97	24.97	24.79	22.70	23.10	12.98	10.22	9.13
CG 130+500.00	13050	0.54	124.19	27.07	25.07	24.85	23.00	32.50	12.48	8.71	9.22

Table 4.1.1 Longitudinal Dimensions of River Improvement Works in the Lower Cagayan River (5/5)

Station	Sec-No	Distance (km)	Commulative Distance (km)	Top of Dike (EL m)	High Water Level (EL m)	Calculated Water Level (W=1/25) (EL m)	Left Bank Elevation (EL m)	Right Bank Elevation (EL m)	Mean Riverbed (EL m)	Deepest Riverbed (EL m)	Design Riverbed (EL m)
CG 131+000.00	13100	0.51	124.71	27.16	25.16	24.91	24.30	25.30	12.61	10.27	9.32
CG 131+500.00	13150	0.48	125.19	27.25	25.25	24.96	24.50	25.50	12.82	11.03	9.41
CG 132+000.00	13200	0.52	125.71	27.34	25.34	25.01	24.50	24.20	12.11	10.01	9.50
CG 132+500.00	13250	0.50	126.21	27.43	25.43	25.13	25.35	24.20	12.41	9.56	9.59
CG 133+000.00	13300	0.51	126.71	27.52	25.52	25.27	26.20	24.20	12.59	9.30	9.68
CG 133+500.00	13350	0.49	127.20	27.61	25.61	25.33	25.75	23.95	12.12	9.47	9.77
CG 134+000.00	13400	0.54	127.74	27.67	25.67	25.38	25.30	23.70	12.26	10.02	9.87
CG 134+500.00	13450	0.48	128.22	27.73	25.73	25.44	25.45	23.10	11.52	9.95	9.96
CG 135+000.00	13500	0.49	128.72	27.79	25.79	25.55	25.60	22.50	11.52	9.52	10.05
CG 135+500.00	13550	0.51	129.22	27.85	25.85	25.64	25.10	22.50	11.21	9.41	10.14
CG 136+000.00	13600	0.51	129.73	27.91	25.91	25.74	24.60	22.50	11.53	8.97	10.23
CG 136+500.00	13650	0.51	130.24	27.97	25.97	25.81	24.75	22.75	12.02	8.29	10.32
CG 137+000.00	13700	0.50	130.74	28.03	26.03	25.77	24.90	23.00	11.55	6.99	10.41
CG 137+500.00	13750	0.54	131.28	28.09	26.09	25.74	24.60	24.65	12.15	6.71	10.51
CG 138+000.00	13800	0.58	131.85	28.16	26.16	26.10	24.30	26.30	11.79	8.08	10.62
CG 138+500.00	13850	0.51	132.37	28.22	26.22	26.17	24.30	27.15	11.94	9.17	10.71
CG 139+000.00	13900	0.49	132.86	28.28	26.28	26.18	24.30	28.00	13.96	8.74	10.80
CG 139+500.00	13950	0.87	133.73	28.38	26.38	26.24	24.80	28.90	15.15	10.24	10.96
CG 140+000.00	14000	0.80	134.54	28.48	26.48	26.31	25.30	29.80	15.57	9.86	11.11
CG 140+500.00	14050	0.79	135.33	28.57	26.57	26.36	24.40	28.20	15.19	11.48	11.25
CG 141+000.00	14100	0.50	135.83	28.63	26.63	26.43	23.50	26.60	14.21	10.98	11.34
CG 141+500.00	14150	0.59	136.42	28.70	26.70	26.46	23.35	25.75	12.94	10.86	11.45
CG 142+000.00	14200	0.50	136.92	28.76	26.76	26.52	23.20	24.90	13.14	10.13	11.54
CG 142+500.00	14250	0.51	137.43	28.82	26.82	26.58	23.05	24.80	13.52	10.36	11.63
CG 143+000.00	14300	0.47	137.90	28.88	26.88	26.65	22.90	24.70	13.86	9.93	11.72
CG 143+500.00	14350	0.42	138.31	28.93	26.93	26.69	22.21	23.55	14.73	10.00	11.79
CG 144+000.00	14400	0.38	138.70	28.98	26.98	26.75	21.81	22.40	13.60	10.46	11.86
CG 144+500.00	14450	0.48	139.18	29.04	27.04	26.76	22.16	24.60	15.10	11.53	11.95
CG 145+000.00	14500	0.52	139.70	29.10	27.10	26.85	22.60	26.80	13.55	10.94	12.04
CG 145+500.00	14550	0.53	140.23	29.16	27.16	26.89	20.77	26.40	13.60	11.43	12.14
CG 146+000.00	14600	0.71	140.94	29.24	27.24	26.90	26.50	26.00	13.13	11.47	12.27
CG 146+500.00	14650	0.60	141.54	29.31	27.31	26.90	26.50	26.00	12.56	10.96	12.38
CG STA. MARIA BRIDGE	STA M	0.08	141.62	29.32	27.32	26.98	26.50	26.00	13.38	10.16	12.39
CG 147+000.00	14700	0.58	142.20	29.39	27.39	27.04	26.50	26.00	15.01	4.97	12.50
CG 147+500.00	14750	0.85	143.05	29.49	27.49	27.25	26.80	26.70	16.21	10.36	12.65
CG 148+000.00	14800	1.10	144.15	29.62	27.62	27.47	27.10	27.40	16.53	12.20	12.85
CG 148+500.00	14850	0.94	145.08	29.73	27.73	27.54	26.85	27.40	15.35	10.22	13.02
CG 149+000.00	14900	0.60	145.68	29.80	27.80	27.59	26.60	27.40	14.43	11.87	13.13
CG 149+500.00	14950	0.59	146.27	29.87	27.87	27.65	26.30	27.10	14.87	11.35	13.24
CG 150+000.00	15000	0.51	146.78	29.93	27.93	27.73	26.00	26.80	14.33	9.42	13.33
CG 150+500.00	15050	0.55	147.33	29.99	27.99	27.84	25.50	26.70	14.77	9.79	13.43
CG 151+000.00	15100	0.48	147.81	30.05	28.05	27.89	25.00	26.60	15.75	10.06	13.52
CG 151+500.00	15150	0.50	148.31	30.11	28.11	28.01	25.75	26.35	15.77	10.44	13.61
CG 152+000.00	15200	0.51	148.82	30.17	28.17	28.07	26.50	26.10	15.43	2.89	13.70
CG 152+500.00	15250	0.46	149.28	30.22	28.22	28.05	25.40	24.55	15.00	9.32	13.79
CG 153+000.00	15300	0.50	149.78	30.28	28.28	28.12	24.30	23.00	14.84	10.52	13.88
CG 153+500.00	15350	0.50	150.28	30.34	28.34	28.19	23.80	24.90	15.22	10.64	13.97
CG 154+000.00	15400	0.50	150.78	30.40	28.40	28.31	23.30	26.80	15.02	10.19	14.06
CG 154+500.00	15450	0.48	151.26	30.46	28.46	28.31	20.85	25.88	13.39	9.45	14.15
CG 155+000.00	15500	0.43	151.69	30.51	28.51	28.38	18.80	26.34	12.91	10.36	14.22
CG 155+500.00	15550	0.53	152.22	30.57	28.57	28.45	21.39	26.15	12.84	9.11	14.32
CG 156+000.00	15600	0.51	152.73	30.63	28.63	28.46	23.02	26.95	14.32	10.54	14.41

Table 4.1.2 Work Quantity of Priority Projects (1/3)

Work item		Unit	Work quantity	Remarks
Left Dike System in the reach from River Mouth to Nassiping				
1 Main Works				
Preparatory work		LS		1.5 % of direct works
Embankment				
	Mabanguc dike	cu.m	1,196,000	
	Catugan Sur dike	cu.m	812,000	
	Lasam dike	cu.m	909,000	
Maintenance road				
	Mabanguc dike	sq.m	43,500	
	Catugan Sur dike	sq.m	29,500	
	Lasam dike	sq.m	28,100	
Tree zone	Catugan Sur dike	sq.m	132,000	
Culvert				
	Mabanguc dike	unit	17	
	Catugan Sur dike	unit	9	
	Lasam dike	unit	12	
2 Compensation				
Land				
	Cornfield	sq.m	764,000	
	Paddy field	sq.m	420,000	
	Residential lot	sq.m	26,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
Right Dike System in the reach from River Mouth to Nassiping				
1 Main Works				
Preparatory work		LS		1.5 % of direct works
Embankment				
	Camalaniugan dike	cu.m	1,150,000	
	Lal-lo dike	cu.m	1,039,000	
	Gattaran dike	cu.m	560,000	
	Nassiping dike	cu.m	467,000	
Bank protection (wetmasonry)				
	Camalaniugan dike	sq.m	26,200	
	Lal-lo dike	sq.m	6,900	
Spur dike	Aparri	cu.m	19,000	
Culvert				
	Camalaniugan dike	unit	19	
	Lal-lo dike	unit	19	
	Gattaran dike	unit	9	
	Nassiping dike	unit	14	
2 Compensation				
Land				
	Corn field	sq.m	1,158,000	
	Paddy field	sq.m	12,000	
	Residential lot	sq.m	48,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				

Table 4.1.2 Work Quantity of Priority Projects (2/3)

Work item		Unit	Work quantity	Remarks
Alcala- Buntun Dike System in the reach from Alcala to Buntun Brige				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Embankment		cu.m	6,574,000	
Inspection road		sq.m	134,200	
Tree zone		sq.m	929,000	
Culvert		unit	49	
Sluice		unit	2	
2 Compensation				
Land	Corn field	sq.m	2,985,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
5 Total				
Right Dike System in the reach from Alcala to Buntun Brige				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Embankment				
	Amulung Dike	cu.m	1,257,000	
	Iguig Dike	cu.m	196,000	
Tree zone		sq.m	0	
2 Compensation				
Land	Corn field	sq.m	290,000	
	Paddy field	sq.m	130,000	
	Residential lot	sq.m	23,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
Tuguegarao Dike System system in the reach from Buntun Bridge to Tuguegarao				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Embankment		cu.m	3,134,000	
Maintenance road		sq.m	0	
Tree zone		sq.m	593,000	
Culvert		unit	31	
2 Compensation				
Land	Corn field	sq.m	1,625,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
Enrile Dike System system in the reach from Buntun Bridge to Tuguegarao				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Embankment		cu.m	927,000	
Maintenance road		sq.m	0	
Tree zone		sq.m	194,000	
Culvert		unit	18	
2 Compensation				
Land	Corn field	sq.m	744,000	

Table 4.1.2 Work Quantity of Priority Projects (3/3)

Work item		Unit	Work quantity	Remarks
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
Gabut Cut-off Channel in the reach from Alcala to Buntun Bridge				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Excavation		cu.m	4,623,000	
Bank protection (gabion)		sq.m	40,000	
(ripprap)		cu.m	50,000	
Spur dike		cu.m	19,000	
Bridge (overflow type)		sq.m	1,290	
2 Compensation				
Land	Corn field	sq.m	350,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
San Isidro Cut-off Channel in the reach from Alcala to Buntun Bridge				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Excavation		cu.m	9,563,000	
Bank protection (gabion)		sq.m	26,000	
(riprap)		cu.m	35,000	
Bridge (overflow type)		sq.m	1,290	
Relocation of irrigation canal		m	1,000	
2 Compensation				
Land				
	Corn field	sq.m	80,000	
	Paddy field	sq.m	600,000	
	Residential	sq.m	120,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				
Tuguegarao Cut-off Channel in the reach from Alcala to Buntun Bridge				
1 Main Works				
Preparatory work		LS	1	5 % of direct works
Excavation		cu.m	19,134,000	
Bank protection (gabion)		sq.m	32,000	
(riprap)		cu.m	66,000	
Spur dike		cu.m	29,000	
2 Compensation				
Land	Corn field	sq.m	2,900,000	
House		nos	0	To resettlement plan
3 Engineering & Administration				
Engineering		LS	1	12 % of (1)
Administration		LS	1	3 % of (1)
4 Contingency		LS	1	11.8 % of (1+2+3)
5 VAT		LS	1	10 % of (1)
6 Total				

Table 4.1.3 Land Acquisition and House Compensation in the Right of Way

Dike Name	Length (km)	Base Width of Dike (m)	Right of Way (sq.m)			
			Total	Corn Field and Others	Paddy Field	Residential
Left dike system in the reach from River Mouth to Nassiping						
Mabanguc	10.870	47	511,000	434,000	51,000	26,000
Gatugan	7.380	47	347,000	330,000	17,000	0
Lasam	7.200	50	352,000	0	352,000	0
Total			1,210,000	764,000	420,000	26,000
Right dike system in the reach from River Mouth to Nassiping						
Camalanuigan	13.120	37	383,000	366,000	0	17,000
Lal-lo	12.870	34	386,000	367,000	0	19,000
Gattaran	6.070	34	206,000	206,000	0	0
Nassiping	9.720	25	243,000	219,000	12,000	12,000
Total			1,218,000	1,158,000	12,000	48,000
Alcala~Buntun dike system in the reach from Alcala to Buntun Bridge						
Alcala~Buntun	31.840	89	2,985,000	2,985,000	0	0
Right dike sytsem in the reach from Alcala to Buntun Bridge						
Amulung	12.600	28	353,000	282,000	71,000	0
Iguig	3.200	28	90,000	8,000	59,000	23,000
			443,000	290,000	130,000	23,000
Tuguegarao dike sytsem in the reach from Buntun Bridge to Tuguegarao						
Tuguegarao	19.580	83	1,625,000	1,625,000	0	0
Enrile dike system in the reach from Buntun Bridge to Tuguegarao						
Enrile	12.190	61	744,000	744,000	0	0
		COC width				
Gabut coc in the reach from Alcala to Buntun Bridge						
Gabut	0.700	500	350,000	350,000	0	0
San Isidro coc in the reach from Alcala to Buntun Bridge						
San Isidro	1.600	500	800,000	80,000	600,000	120,000
Tuguegarao coc in the reach from Buntun Bridge to Tuguegarao						
Tuguegarao	5.800	500	2,900,000	2,900,000	0	0

Table 4.2.1 Capacity of Evacuation Centers and Required Number of Tent

	City/Municipalit	Present Capacity (persons)	Affected People 2yr flood (persons)	Capacity is sufficient or not	Additional capacity required (persons)	Available school (no)	Available school, Capacity (persons)	Required capacity of tent (persons)	Required number of tent (no)
1	Aparri	6,750	1,600						
2	Camalaniugan	2,372	2,705	Not sufficient	333	0	0	333	28
3	Allacapan	1,350	0						
4	Lallo	2,970	6,195	Not sufficient	3,225	0	0	3,225	269
5	Gattaran	3,330	1,990						
6	Lasam	1,080	1,050						
7	Sto Nino	3,580	610						
8	Alcala	930	1,055	Not sufficient	125	1	240	0	
9	Amulung	990	5,745	Not sufficient	4,755	13	3120	1,635	137
10	Iguig	0	2,860	Not sufficient	2,860	8	2400	460	39
11	Solana	1,583	11,850	Not sufficient	10,267	5	1500	8,767	731
12	Tuguegarao	11,816	9,520						
13	Enrile	2,010	4,370	Not sufficient	2,360	10	2400	0	
	Total								1,204