FEASIBILITY STUDY

ON

LAOAG CITY URBAN DRAINAGE IMPROVEMENT

APPENDIX A

LAOAG CITY URBAN DRAINAGE IMPROVEMENT

APPENDIX A

LAOAG CITY URBAN DRAINAGE IMPROVEMENT

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CHAPTER I STUDY AREA

1.1 Drainage Basin

The urban area of Laoag City is located on the right (north) bank of the Laoag River 8 km upstream of the river mouth. Most of the urban area is drained by the Daorao-Tupek Creek and only a small portion where local flooding is not so serious directly discharges into the Laoag River. The study area covers the Daorao-Tupec Creek Basin (the Basin) as shown in Fig. A.1.1.

The Basin has a total catchment area of 38.79 km^2 with hilly areas accounting for 11.31 km^2 or around 30 % of the whole. The Basin occupies 38% of the city area of 102.47 km^2 and it is bounded by two (2) municipalities on the north, Bacarra and Vintar.

The Daorao-Tupec Creek originates from a hilly land with an elevation of around 100 m located in the north and northeast of the city. The main channel course is called Tupec in the upper reaches until its confluence with Pandan Creek, and Daorao in the middle and lower reaches. The Daorao-Tupec Creek has two (2) major tributaries, the San Isidro and Pandan creeks.

The catchment area of the Basin is divided into ten (10) sub-basins as shown in Fig. A.1.2. The San Isidro Creek running through the low-lying built-up areas drains an area of 1.99 km^2 at the confluence with the Daorao Creek. The Daorao Creek runs through the northern outskirts of the urban area from east to west and follows a meandering course to the west until 1.5 km upstream from the mouth. Thereafter, it turns toward the north and, after passing the sand dunes, finally empties into the South China Sea. The sand spit extends from south to north.

The mouth of the Daorao Creek is always clogged by sand-drift from the sea. Big-scale floodwaters caused by typhoons open the mouth by flushing the sediment deposits; however, small-scale floodwaters in rainy season and drainage water in dry season flow through the small stream along the eastern fringe of the sand dunes, which joins the Daorao Creek 1.5 km upstream from the mouth, to the southern outlet of the Bacarra River.

The Laoag-Vintar Irrigation Canal diverts irrigation water from the Bacarra-Vintar River Basin to Daorao-Tupec Creek Basin. It originates from the Vintar Intake located 6 km upstream of Vintar town and conveys water to the Daorao-Tupec Creek Basin running around the fringe of the hilly land to the north and northeast of Laoag City. Fig. A.1.3 presents the design discharge distribution of the irrigation canal. The irrigation canal serving the rice fields in the Basin also drains local runoff of the urban area.

1.2 Socio-economic Conditions

1.2.1 Administration and Population

The Daorao-Tupec Creek Basin, with an area of 38.79 km^2, extends over 50 barangays in Laoag City as shown in Fig. A.1.4. The northern part of the Basin is bounded by the municipalities of Bacarra and Vintar. The total administrative area and number of barangays in the city are shown below along with those included in the Basin. The Basin area accounts for 38% of the city territory.

	Land Area (km^2)		No of Barangays	
	Total	Basin	Total	Basin
Laoag City	102.47	38.79	80	50

Laoag City has a total population of 88,336 according to the 1995 population census. The population had increased by 4,580 at a rate of 1.07% per annum on average since 1990. During the 1970's, the average growth rate was 1.22% per annum and it accelerated to 1.79% per annum during the 1980's and 1990's.

The total population of the 50 barangays in the Basin was 57,883 with an average population density of 1,492 persons/km^2. Out of the 88,336 total population, 40,193 or 45.5% resided in the city proper. The average family size in the Basin was 5 persons/family.

According to the National Statistics Office records of 1995, there existed a total housing of 18,612 units in Laoag City. The total housing units in the urban area was 5,466 with Barangay (1) San Lorenzo having the largest number of 348 units and Barangay (14) Sto. Tomas having the least number of 92 units. Among the rural barangays, Barangay (50) Buttong had the largest number of 330 units, while Barangay (33-A) La Paz Proper had the least number of 57 units (Refer to Table A.1.1).

The urban population of Laoag City was 40,717 or 46% of the total population in the 1995 census, as shown in the table below. It increased by 1,842 or 4.7% more than that of the 1990 census at an average rate of 0.93% per annum between 1990 and 1995. This growth rate was lower than the rural growth rate of 1.19%. Some of the increased urban population could not be absorbed by the existing town proper areas so that they emigrated to the surrounding rural areas. As a result, people in the surrounding areas may be counted as rural population. Considering this situation, there is a need to expand the settlement areas for urban growth. Apart from this consideration, the rural population in Laoag City was 47,619 in 1995, accounting for 54% of the total.

Year	Total	Urban		Rural	
	Population	Population	Share	Population	Share
1990	83,756	38,875	46%	44,881	54%
1995	88,336	40,717	46%	47,619	54%
Growth Rate	1.07%	0.93%	-	1.19%	-

The future population of Laoag City will reach up to around 111,400 in the year 2020, according to the NEDA projection. The projected urban population of the city will get to around 49,800 in the year 2020, as shown in the table below. The future urban population was estimated on the assumption that the same growth trend would carry on in the future. The urban population accounts for 45% of the total, the percentage of which slightly went down from 46% in 1995. The rural population was projected to increase to 61,600 or 55% in 2020.

Year	Total	Urban		Rural	
	Population*1	Population	Share	Population	Share
2000	92,678	42,450	46%	50,228	54%
2010	101,801	46,053	45%	55,748	55%
2020	111,449	49,811	45%	61,638	55%

Note: *1 The projection of total population was provided by NEDA, Region I.

1.2.2 Economic Profiles

(1) Agriculture

Laoag City has a total land area of 10,247 hectares of which agriculture occupies an area of 7,710 hectares or 75% of the city land area. Agriculture plays an important role in the economic activity of the city with palay, corn and garlic as major crops. Palay covers about 2,603 hectares with an average yield of 4.26 tons/ hectare, while corn covers about 748 hectares with an average yield of 3.5 tons/hectare and garlic covers about 931 hectares with an average yield of 3.59 tons/hectare. (Refer to Table A.1.1)

(2) Manufacturing and Trading Industry

Laoag City is the center of commerce in the province. There were 469 small and large manufacturing and trading establishments including informal industries in the city in 1995 and the dominant manufacturing industries are sidecar assembly (metal works) and furniture. Food processing such as dried fish, fruit candy and other preserved foods is also one of the important industries. (Refer to Table A.1.1)

(3) Social Infrastructure (Refer to Table A.1.1)

(a) Health Facilities

There are three (3) rural health units, thirteen (13) barangay health stations and four (4) private and government hospitals in the urban area of Laoag City, while only one (1) hospital is available in the rural area. These health facilities serve not only Laoag City but also the nearby towns.

(b) Educational Facilities

Laoag City has 70 units of educational facilities including 13 pre-schools, 40 elementary schools, 13 secondary schools, 3 tertiary schools and 1 university. The tertiary schools are all operated by private institutions and the university is operated by the government.

(4) Physical Infrastructure (Refer to Table A.1.1)

(a) Roads

The roads in the city are classified as concrete, asphalt, concrete/asphalt and gravel roads. The national road in the city consists of 9.54 km concrete, 9.17 km asphalt and 13.76 km concrete/asphalt, while the provincial road and city streets consist of 47.54 km concrete, 20.37 km asphalt and 60.5 km gravel. The barangay roads consist of 54.18 km concrete, 0.84 km asphalt and 221.88 km gravel.

(b) Irrigation Facility

There is only one (1) irrigation system in the city which serves an agricultural land area of 2,555 hectares especially during dry season when water is scarce.

1.3 Land Use

1.3.1 Existing Land Use

The Daorao-Tupec Creek Basin covers a land area of 38.79 km^2 or 3,879 hectares. The existing land use classifications are residential area, hilly land tree area, lowland tree area, orchard, grassland, paddy field, upland crops area, riverbed and sand dune. The respective land areas are shown in Fig. A.1.5 and summarized as follows:

	Area (ha)	
(1) Residential Area	430.8	(11.1%)
(2) Tree Area	1,147.4	(29.6%)
(a) Hilly Land	1,076.3	(27.8%)
(b) Lowland	71.1	(1.8%)
(3) Orchard	20.4	(0.5%)
(4) Grass Land	36.9	(1.0%)
(5) Paddy Field	1,924.9	(49.6%)
(6) Upland Crops Area	231.4	(6.0%)
(7) River Bed	32.4	(0.8%)
(8) Sand Dune	54.8	(1.4%)
Total Area	3,879.0	(100%)

1.3.2 Future Land Use

The Ilocos Norte Provincial Land Use Committee is in the process of preparing the Provincial Physical Framework Plan (PPFP) delineating the direction and extent of expansion of urban and other built-up areas of the city and municipalities within the province, based on the prevailing or existing situation on socio-economic and physical characteristics and the emerging development trends and future growth scenario for the province.

The preferred spatial development strategy of the province drawn from the PPFP study is a combination of agro-industrialization and watershed management. The strategy will guide the province to the direction of the agro-based industrialized regions and cause sustainable utilization of natural resources with minimal agricultural land conversion for urban use and a balanced employment opportunity in both urban and rural areas.

The Laoag City Planning Division prepared the City Land Use Plan in 1996. According to the land use plan, the commercial expansion zone is 100 to 200 m wide along major roads such as the Manila North National Road, Laoag Airport National Road, Laoag-Paoay National Road and Laoag-Vintar Provincial Road. The industrial zone is planned in the southern area of Laoag City near the boundary of the municipality of Paoay. The residential expansion zone is located north of the present built-up area (Barangays 12 15, 16, 17, 18, 19, 20, 21 and 23) and in the left bank of Laoag River (Barangays 45, 46, 47,48-A, 48-B, 49-A, 49-B, 50 and 51).

The expansion of the residential area in the rural area of Laoag City has been deferred because the City Planning Office is expecting that the increase of households in the rural areas will be absorbed by the existing residential area or in the vicinity of the existing residential area.

The land use change which is related to the study of Laoag City Urban Drainage Improvement is the urban expansion toward the north of the city such as (1) the commercial expansion zone along Manila North (Laoag-Bacarra) Road and Laoag-Vintar Provincial Road, and (2) residential expansion zone on the north of the present built-up area (Barangay 12 15, 16, 17, 18, 19, 20, 21 and 23). Fig. A.1.6 shows the location of the proposed expansion areas.

Around 160 ha of farmland or green area will be converted to commercial or residential areas in the above-mentioned zones. The land conversion is given in Table A.1.2.

The urban expansion areas in the vicinity of the Daorao-Tupec Creek are frequently flooded at present. Improvement of the existing drainage system is necessary for the development of commercial and residential lands in these areas.

CHAPTER II EXISTING URBAN DRAINAGE SYSTEM

2.1 General

The urban area of Laoag City is drained by two (2) drainage systems consisting of rivers/creeks, drainage mains, secondary drains and tertiary drains. One system drains most of the urban area into the sea through tertiary drains, secondary drains, drainage mains, San Isidro Creek, Tupec Creek and Daorao Creek. Another system drains the remaining small portion directly into the Laoag River through tertiary drains, secondary drains and drainage mains.

2.2 Conditions of Creeks

2.2.1 Morphological Features

Most of the urban storm water of Laoag City is drained by the San Isidro and Daorao-Tupec creeks. The geomorphologic characteristics of these creeks are described below.

(1) Daorao-Tupec Creek

The Daorao-Tupec Creek is very gentle in slope. The channel bed slope of the downstream from the confluence with Pandan Creek is less than 1/2300, while its upstream is 1/900 on average. The creek meanders at many locations. The average channel width downstream of Daorao Bridge (8 km from river mouth) is around 30 m while the upstream is around 15 m.

No dike is provided along the creek, while small mounds of less than 50 cm in height to protect rice fields are observed in some locations. One control gate is provided at 13.3 km distance from the mouth of the creek to divert water to rice fields for irrigation use in dry season.

The alignment, slope, width and other features of the creek are shown in Fig. A.2.1 and summarized below:

Location (km)	Slope of Channel Bed	Width (m)	Remarks
0.0 to 1.4	Level	33 to 81	Sand dune
1.4 to 4.5	Level	23 to 38	One (1) big bend
4.5 to 8.0	1/2300	25 to 38 *	Three (3) bends
8.0 to 10.5	1/2300	11 to 27	Two (2) bends
10.5 to 13.4	1/800	6 to 22	Four (4) bends

Note * : Excluding the width of Casili Bridge (6.68 km from river mouth): 14.0 m

(2) San Isidro Creek

Storm and waste water from the urban residential area is mainly drained by the San Isidro Creek. The existing alignment of the creek greatly meanders at Section 0.3km upstream from the junction with the Daorao Creek.

The San Isidro Creek is much affected by the backwater of the Daorao Creek. This backwater phenomenon is further aggravated by the San Isidro Creek joining Daorao Creek in the direction of its upstream.

No dike is provided along the creek. The alignment, slope, width and other features are shown in Fig. A.2.2 and summarized below.

Location (km)	Slope of Channel Bed	Width (m)	Remarks
0.0 to 0.8	1/270	7 to 15	except one section *
0.8 to 1.19	1/270	0.9 to 3.8	
1.19 to 1.48	1/650	1.5	box culvert

Note * : The width at Giron Street: 2.4 m

2.2.2 Flood Carrying Capacity

The existing flood carrying capacities of the two creeks, Daorao-Tupec Creek and San Isidro Creek, were assessed by the non-uniform flow calculation method assuming the Manning's roughness coefficient is n = 0.035. In this calculation, the flood carrying capacity was assumed as the bankful capacity of channel sections. The flood carrying capacities of the creeks are tabulated in Table A.2.1 and they are illustrated in Fig. A.2.3. The flood carrying capacities by stretch are estimated as follows:

(1) Daorao-Tupec Creek

Stretch (km)	Discharge Capacity (m^3/s) Left Bank	Right Bank	Remarks
0.0 to 1.4	46 to 123	28 to 875	Sand dune
1.4 to 2.4	15 to 18	21 to 33	
2.4	114	114	Cataban Bridge
2.4 to 5.3	38 to 112	37 to 66	
5.3	273	273	Pila Bridge
5.3 to 6.68	36 to 44	35 to 52	
6.68	60	60	Casili Bridge
6.68 to 8.0	35 to 55	32 to 34	
8.0	123	123	Daorao Bridge
8.0 to 9.35	15 to 98	20 to 66	
9.35	100	100	San Isidro Bridge
9.35 to 10.97	16 to 100	19 to 69	
10.97	88	88	Bacarra Road
10.97 to 13.43	4 to 27	11 to 36	

(2) San Isidro Creek

Stretch (km)	Discharge Capacity (m^3/s) Left Bank	Right Bank	Remarks
0.0 to 0.58	16 to 37	14 to 66	Excluding Bridge*
0.58 to 1.0	2 to 16	2 to 14	
1.0 to 1.48	2 to 3	2 to 3	

Note * : Flood carrying capacity at San Isidro Bridge, 0.2 km, is 138 m^3/s

2.2.3 Mouth Clogging of Daorao Creek

The mouth of Daorao-Tupec Creek is clogged all year round, except during big-scale floods. According to the interview survey with the residents of Brgy. Cataban, floodwaters of the 1967 Typhoon Gening opened sand drift deposits at 1.0 km upstream from the present mouth of the creek. During big-scale floods, the residents dredge a narrow channel by using hand shovels to accelerate the outlet opening by floodwater. The downstream of Daorao Creek is subject to the backwater effect due to its small mouth during flood time.

2.3 Division of Urban Drainage Area

The urban drainage system in Laoag City is illustrated in Fig. A.2.4 and the direction of drainage flow is schematically presented in Fig. A.2.5. The drainage system is of combined type and collects the sewage and storm water all over the urban area of the city. The urban drainage area is divided into 11 sub-drainage areas as shown below.

Drainage Area (ha)		Drainage Area (ha)	
DA-1	53.0	DA-7	80.0
DA-2	94.1	DA-8	42.0
DA-3	23.9	DA-9	36.2
DA-4	11.0	DA-10	23.1
DA-5	17.0	DA-11	38.1
DA-6	83.0	Total = 501.4 ha	

The total urban drainage area of 501.4 hectares covers 333.7 hectares of built-up area and 167.7 hectares of farmland. Among them, 404.0 hectares (DA-1 to DA-8) or 80% are drained by the Daorao-Tupec Creek. The remaining area of 97.4 hectares (DA-9 to DA-11) or 20% are directly drained into the Laoag River.

The San Isidro Creek shoulders 199 hectares (DA-1 to DA-5) or 40% of the total urban drainage area of 501.4 hectares, serving a built-up area of 168.7 hectares.

The central drainage areas of DA-2 and DA-3 are drained into the San Isidro Creek through two drainage mains passing under Laoag-Vintar Irrigation Canal by box culvert. The built-up area ratios of DA-2 and DA-3 are 91% and 100%, respectively,

The Laoag-Vintar Irrigation Canal also drains storm water in the urban areas. Storm water in the catchment area of DA-1 flows into the Laoag-Vintar Irrigation Canal through the drainage channels/pipes or rice fields. Excessive flood water over the capacity of the irrigation canal spills over the bank to the San Isidro Creek. According to the interview with residents, the irrigation canal overflowed at the site of check-gate during the 1996 Typhoon Gloring. The check-gate controls flood water of the irrigation canal.

The area of DA-6 is drained into the Tupec Creeks through rice fields and small drains. The existing drainage system in this area is very poor. According to the land use plan of Laoag City, this area is scheduled to be developed for residential use.

The areas of DA-7 and DA-8 are drained into the Daorao Creek through the drainage channels/pipes and rice fields.

The existing built-up area of 333.7 hectares is mostly covered by drainage main, secondary drain or tertiary drain. Their structure is open channel or pipe. Their lengths are summarized below.

Drainage Main	Secondary Drain	Tertiary Drain
6.53 km	22.38 km	56.33 km

CHAPTER III FLOOD DAMAGE ANALYSIS

3.1 Flood Damage of 1996 Typhoon Gloring

Laoag City was ravaged by Typhoon Gloring in July 1996. The JICA Study Team conducted a detailed flood damage survey through interview with barangay captains and some residents. The data and information obtained include flooded area, flood depth, affected population and inventory of existing assets in the flood prone area. Some of the flood damage data were obtained from the Office of Civil Defense (OCD).

The flood damages of Typhoon Gloring were estimated by combining the data of the above two sources, as shown in Table A.3.1. They are summarized as follows:

	Laoag City	The Basin		
		City Proper	Rural	Total
(1) Affected (Inundated)				
(a) Person	19,697	7,890	3,369	11,259
(b) Family	4,592	1,860	747	2,607
(c) Dwelling Unit	1,907	1,503	545	2,048
(d) Inundation Area (ha)	NA	336	699	1,035
(e) Industrial Establishment (no.)	300	296	2	298
(f) Educational Facility (no.)	43	34	8	42
(g) Health Facility (no.)	10	6	3	9
(h) Road Length (km)	136	100	32	132
(2) Damage Value (Peso)				
(a) Infrastructure	12,138,340	NA	NA	NA
(b) Industrial Establishment	NA	NA	NA	NA
(c) Agriculture	1,009,132	900	351,064	351,964
(d) Fisheries	59,860	9,000	4,500	13,500
(e) Livestock &Poultry	863,600	0	19,400	19,400

NA: Not Available

Fig. A.3.1 shows the distribution of inundation area and depth in the Basin obtained from the interview survey. The inundation area covers a total land area of 1,035 hectares, equivalent to 27% of the total catchment area of the Daorao-Tupec Creek Basin. The breakdown by barangay is presented in Table A.3.1. The inundation area in the city proper covers a total land area of 336 hectares, equivalent to 62% of the total city proper area of 540 hectares.

The 1996 flood was considered to be as large as a flood occurring in every 2 to 3 years in the urban areas of the Basin. However, it was the largest since 1992 in the downstream of the Basin.

The higher land in the urban areas suffered from scattered local floods. The low-lying areas along the San Isidro Creek were seriously inundated. The duration of inundation in these areas was about six (6) hours. The duration of inundation in the downstream of the Daorao Creek was about twelve (12) hours.

3.2 Flood Damage Analysis

3.2.1 Cause of Flooding

Heavy rainfall except during typhoons has never induced a serious flood inundation to the existing drainage system in recent years. Some local floods occurred in depressed areas and where the drainage channel was clogged by garbage and siltation. The main causes of the

inundation along the San Isidro Creek and the long flood duration (6 hours) in the urban area are poor flow capacity of the creek, narrow flow sections at bridges and culverts, and backwater effect from the Daorao Creek.

Fig. A.3.2 illustrates the water level of the San Isidro and Daorao creeks of flood with a 5-year return period. Before the improvement, the flood water level upstream of narrow flow sections ascend steeply.

The Laoag River overflowed its right banks at the western fringe of the urban area into the Daorao-Tupec Creek Basin during Typhoon Gloring. It further worsened the flooding situation in the downstream areas of the Daorao-Tupec Creek. The flood flow route at that time is shown in Fig. A.3.1. The mouth clogging of the Daorao Creek also induced inundation in the downstream.

Flood area caused by 1996 Typhoon Gloring is divided into four (4) districts in consideration of main causes of flood damage (refer to Fig. A.3.3).

Districts	Main Causes of Flood Damage	Remarks
City Proper I	- Overflow from Laoag River	
City Proper II	- Poor flow capacity of San Isidro Creek	San Isidro Creek
	- Backwater of Daorao Creek	Basin
City Proper III	- Poor flow capacity of Daorao-Tupec Creek	
	- Backwater of Daorao Creek	
Rural Area	- Overflow from Laoag River	
	- Mouth Clogging of Daorao Creek	
	- Poor flow capacity of Daorao Creek	

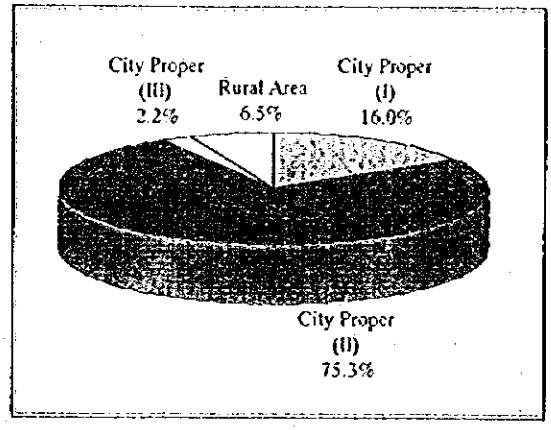
3.2.2 Flood Damage Distribution

Based on the above flood damage survey, the whole damage value was estimated using the value of dwelling units assessed by Laoag City and the flood damage rates evaluated in this study. The flood damage calculation for the properties in the above 4 districts is tabulated in Table A.3.2 and the result is summarized as follows:

(thousand pesos)

Property Item	City Proper I	City Proper II	City Proper III	Rural Area
Residential	1,139	1,960	193	597
Commercial / Industrial	4,566	27,289	436	217
Hospital	400	600	200	600
Education	944	3,505	134	1,079
Agriculture / Fisheries	10	0	0	375
Total	7,059	33,354	963	2,868
Grand Total			44,244	

City Proper II which corresponds to the San Isidro Creek Basin is the most damaged area, as graphically shown below. Around 75% of the total damage was in this area. The next damaged area was City Proper I (16%) where the major cause of flood damage was the overflow of the Laoag River. The rural area in the downstream of the Daorao Creek, shared only 7% of total damage. The damage amount in City Proper III is very small compared to other districts. The damage ratio is around 2% of the total damage.



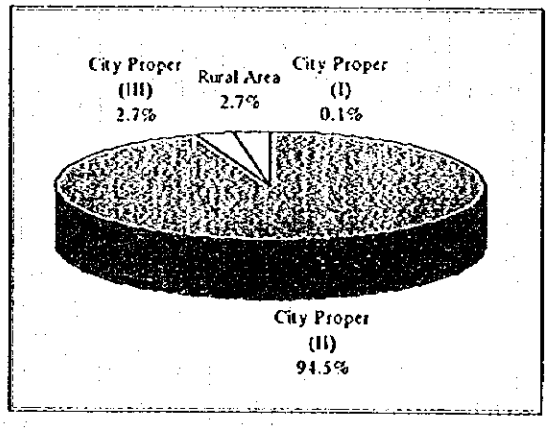
If the overflow of the Laoag River and the mouth clogging of the Daorao Creek had been solved, the flood damage value caused by Typhoon Gloring could have been reduced. The flood duration time in the downstream of the Daorao Creek also could have been shortened from 12 to 4 hours. The details of these reduction of inundation is explained in the next Subsection. The reduced damage amount is presented as follows:

(thousand pesos)

City Proper I	City Proper II	City Proper III	Rural Area
10	33,354	963	956
Total		35,283	

After the improvement of the Laoag River and opening of the mouth of the Daorao Creek, the main flood problem in Laoag City will be the drainage of the San Isidro Creek Basin (1.99 km^2).

Furthermore, the serious flood damage in the City Proper I would be solved.



3.2.3 Effect of Overflow of the Laoag River and Mouth Clogging of the Daorao Creek

The flood inundation in the downstream of the Daorao Creek and a part of the city proper is caused by the overflow of the Laoag River, mouth clogging and poor flow capacity. The total inundation volume is 5.46 million cubic meters (MCM) as shown in Fig. A.3.4. The share of each cause to the inundation area and depth is estimated in this Subsection.

If the overflow from the Laoag River had been prevented and the mouth of the Daorao Creek had been opened prior to Typhoon Gloring, the total inundation volume would be 1.71 MCM, as shown in Figs. A.3.4 and A.3.5.

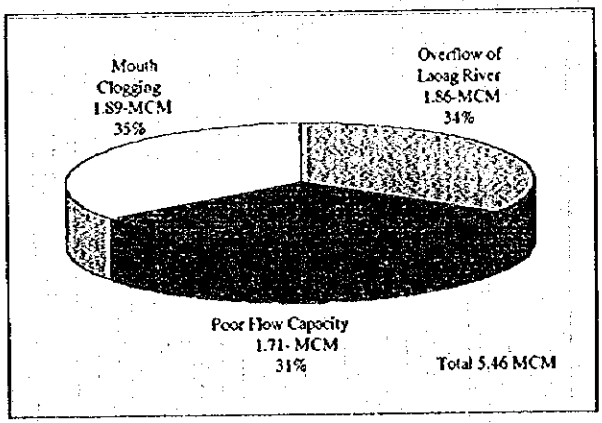
The storage volume, 1.71 MCM, is computed from the data of opening size and the hydrograph at the mouth of the Daorao Creek. The opening size is assumed to be 20 m in width and 1.5 m in depth. The hydrograph at the mouth is given by the rainfall data of Typhoon Gloring without inflow discharge from the Laoag River. (Refer to Fig. A.3.5)

The flood duration time for more than 50 cm of inundation depth is 4 to 5 hours which is about one-third (1/3) of the actual flood duration time (12 hours) of Typhoon Gloring, as shown in Fig. A.3.5. The peak storage volume is 1.71 MCM and the storage volume which corresponds to the inundation depth of less than 50 cm is 0.93 MCM.

Comparison of inundation area with and without the project for the protection works against overflow of the Laoag River and the mouth opening work of the Daorao Creek was carried out, as shown in Fig. A.3.5. The total inundation areas for with and without the project are 265 ha and 676 ha, respectively. (Refer to Fig. A.3.4)

According to the in-depth interview survey, the overflow into Daorao-Tupec Creek Basin was mainly located at three (3) portions, as shown in Fig. A.3.4. The estimated overflow discharges of 23 m^3/s, 45 m^3/s and 18 m^3/s were released for six (6) hours through these portions. Inundation volume of 1.86 MCM was estimated as an overflow volume from the Laoag River.

The share of each cause of flood inundation is presented in the diagram below: In the case of solving the problem of overflow of the Laoag River and mouth clogging of the Daorao Creek, flood damage in the downstream of the Daorao Creek would decrease to one-third (1/3) based on the damage caused by Typhoon Gloring.



CHAPTER IV URBAN DRAINAGE IMPROVEMENT

4.1 Concept of the Urban Drainage Improvement

4.1.1 Target Area

An urgent flood control plan for the San Isidro Creek Basin is proposed to solve the flood inundation problem in Laoag City. The catchment area is 1.99 km^2. The target stretch of the improvement in the Urgent Plan is the San Isidro Creek and the upstream of the Daorao Creek to solve the backwater effect of flood to urban areas and to confine floodwaters in the channel. Two (2) drainage mains (called DM1 and DM2 in this study) connected to the San Isidro Creek are also to be improved. (Refer to Fig. A.4.1)

As a second stage, a long term plan or Master Plan for the San Isidro Creek improvement is proposed considering the future expansion of residential area. The drainage main (called DM3 in this study) for the future residential area covered by catchment area CA-4 (0.83 km^2) is also proposed, as shown in Fig. A.4.1

4.1.2 Design Flood Probability

The Study on the Flood Control for Rivers in Selected Urban Centers by JICA in 1994 had prepared a number of urban drainage improvement plans in four (4) regional cities. A 5-year return period was applied for drainage systems with an area of more than 0.5 km^2, while a 3-year return period was adopted for drainage systems covering an area of less than 0.5 km^2. This is summarized below.

City	Drainage Area (km^2)	Return Period	Population (thousand)
Cebu	0.65 - 2.78	5-year	662
Iloilo	0.50 - 8.02	5-year	335
Tacloban	1.21 - 5.12	5-year	167
	0.14	3-year	
Ormoc	1.03	5-year	144
	0.32	3-year	

Source: National Statistics Office, 1995 Population Census

Likewise, the drainage system in Metro Manila had been improved by applying two kinds of design flood probabilities. This also summarized as follows:

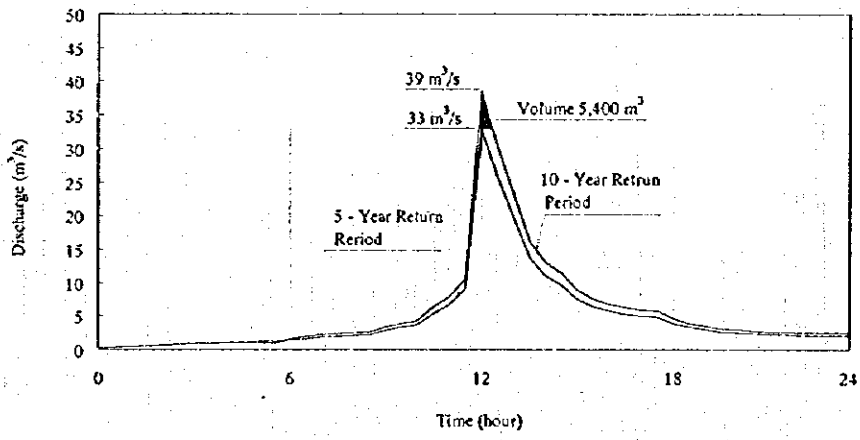
Area/Project	Return Period
Central Metro Manila Area	10-year
Metro Manila Flood Control Project - West of Mangahan Floodway	5-year

On the other hand, the rainfall intensity of Typhoon Gloring in 1996 was not so large, although it brought about a large total rainfall over the Laoag River Basin. The maximum half-hour and one-hour rainfall at Laoag City were 30 mm and 55 mm, respectively, which corresponds to around a 2-year return period. Therefore, the flood of Typhoon Gloring in the target areas of the urban drainage improvement is considered to have a probability of two years.

By referring to similar projects in the Philippines such as those mentioned above, the design flood probability of the Laoag City Urban Drainage Improvement has been thus determined. Based on the results of the present study, the design flood frequency of either a 5-year or a

10-year is applicable for the drainage improvement of San Isidro Creek Basin (1.99 km^2) and the new residential area (0.83 km^2).

According to the comparison of hydrographs of 5-year and 10-year return periods for the San Isidro Creek Basin as graphically presented below, a 10-year return period flood causes the peak inundation volume of 5,400 m^3 for a drainage system of 5-year return period which could flow a peak discharge of 33 m^3/s. Since this peak inundation volume corresponds to around 1 cm depth on an inundation area of 100 ha, the damage amounts of 5-year and 10-year return period floods are almost same, but the project cost of a project with a design flood frequency of 10-year return period is higher than the one with a 5-year return period. Hence, it is concluded that the design flood frequency of 5-year shall be applied for the drainage improvement of San Isidro Creek Basin (1.99 km^2) and the new residential area (0.83 km^2).



4.2 Design Flood Discharge

4.2.1 Design Rainfall

(1) Flood Concentration Time

Flood concentration time was calculated by the following formula which is proposed for urban areas by the Public Works Research Institute of the Ministry of Construction, Japan:

$$Tc = 2.4 \times 10^{-4} (L/S^{0.5})^{0.7}$$

where;

Tc : Concentration time (hour)
L : Length of watercourse (m)
S : Slope of ground surface

Calculation results are shown below:

Drainage Area	L (m)	Slope	Tc (hour)
San Isidro Creek Basin (CA-5)	2,700	1/700	0.6
New Residential Area (CA-4)	2,000	1/800	0.5

(2) Model Hyetograph

The model hyetograph was constructed by using the rainfall data for every 30 minutes interval of the Laoag Raingauge Station considering the above flood concentration time as shown in Fig. A.4.2.

Rainfall intensity-duration-frequency data at Laoag Station were prepared by the Hydrometeorological Investigations and Special Studies Section, Flood Forecasting Branch, PAGASA in 1996, based on 40 years records from 1955 to 1995. The detailed data are shown in Table A.4.1.

The probability of flood in the urban area during Typhoon Gloring was estimated at around two (2) year return period based on the flood concentration time and the rainfall intensity-duration-frequency data. The maximum rainfall intensity of Typhoon Gloring are 30 mm for 30 minutes and 55 mm for 60 minutes.

(3) Basin Mean Rainfall

The proposed model hyetograph which is a point rainfall at Laoag Station was converted to basin mean rainfall by the areal conversion factor.

Since there were no sufficient data to obtain the areal rainfall, Horton's formula, which has been applied to the rivers in Iloilo, Cebu and Ormoc, was adopted for this study. The areal conversion factor was expressed by the following equation:

$$P = Po \cdot EXP\{-0.1 \cdot (0.386 \cdot A)^{0.31}$$

$$f_a = P / Po$$

where;

f_a	:	areal conversion factor
P	:	area rainfall (mm)
Po	:	point rainfall (mm)
A	:	basin area

The areal conversion factor applied was 0.83, since the target area for the Study covers at least the catchment areas CA-1 to CA-5 (20.62 km^2) as shown in Fig. A.4.3.

4.2.2 Flood Runoff Simulation

(1) Channel System Model

Runoff calculation was conducted for the whole basin in the Daorao-Tupec Creek to compute water level from the mouth. The total catchment area of the basin is 38.79 km^2

A channel system model was constructed for the flood runoff calculation of different sub-basins according to shape, stream network and topography. Fig. A.4.3 presents the basin divisions and area of sub-basins which were constructed considering the following locations:

- The junction of main stream with major tributaries;
- The river section bounding catchments with different runoff characteristics; and,
- The existing and proposed structure sites.

The Daorao-Tupec Creek basin was divided into 10 sub-basins related to 6 channels. Based on the basin divisions, the channel system model for the runoff calculation was made, as shown in Fig. A.4.3.

(2) Runoff Model

The Storage Function Method, which was also applied for the runoff calculation of the Laoag River Basin, was employed for the flood runoff computation. The adequacy of the model was already confirmed. Details of the storage function method are explained in the runoff analysis for the Laoag River Basin.

Constants K, p and T for river basin were determined in consideration of future land use as follows:

$$K = 2.5\,k\,A^{0.24}$$
$$p = 0.6$$
$$T = 0.0506\,L - 0.310$$

where;

A	:	catchment area (km^2)
L	:	channel length (km)
k	:	constant of surface flow ($k = (N/I^{0.5})^{0.6}$)
I	:	slope of surface
N	:	equivalent roughness coefficient

Land Condition	Equivalent Roughness Coefficient (N)
Paddy field (Farm)	2
Hill	0.3
Residential (low density)	0.1
Residential (high density)	0.03

The determined constants K for sub-basins are given in Table A.4.2. T equals zero (0) since the computed T is negative.

Constants K and p of channels were estimated by the relation between flood discharge and storage volume of the channels. T was obtained by the following formula:

$$T = 0.00165LI^{0.5}$$

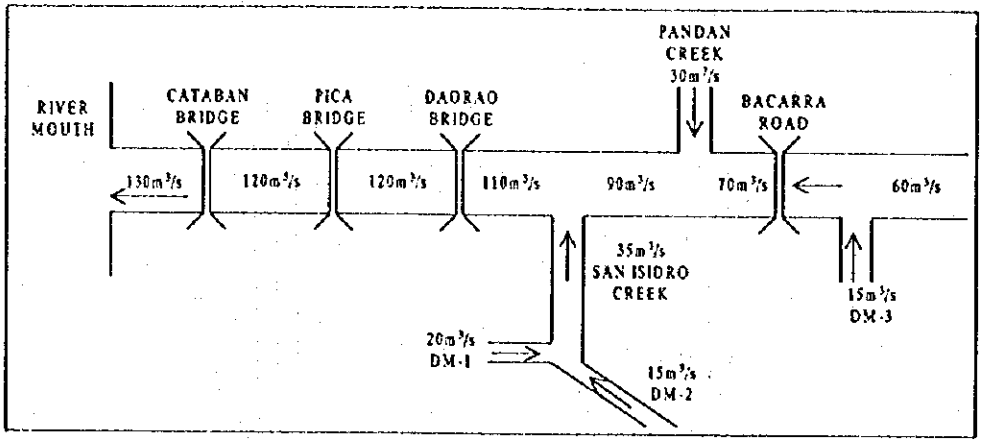
where;

L	:	channel length (km)
I	:	average channel slope

The determined constants K, p and T are given in Fig. A.4.4.

4.2.3 Design Flood Discharge Distribution

Computed design flood discharge is schematically described as follows:



The design discharge of tributaries (DM1 and DM2) of the San Isidro Creek was estimated in consideration of these catchment areas (0.941 km^2 and 0.64 km^2).

4.3 Master Plan of Urban Drainage Improvement

4.3.1 Improvement Measures

The improvement works of the Daorao Creek, San Isidro Creek and drainage mains (DM1, DM2 and DM3) consist of widening and deepening of channels with removal of acute bends and constrictions, and, reconstruction of bottleneck culverts and bridges.

The measures/criteria for the improvement plan are based on the Design Guidelines, Criteria and Standards of the Department of Public Works and Highways (DPWH, Philippines) and the Technical Standards for Rivers and Sabo Facilities (Ministry of Construction, Japan).

(1) Alignment

The upper Daorao Creek and San Isidro Creek will be improved along the existing channel courses except two (2) heavily meandered sections.

The existing course of the upper Daorao Creek heavily meanders around the confluence with the San Isidro Creek (lower meander) and around the conjunction with the Pandan Creek (upper meander). These meandered channel sections will be cut off to secure the smooth flood flow confluence of the main channel and tributaries, as shown in Fig. A.4.5.

The cutoff of the lower meander will shorten the channel length from 290 m to150 m and that of the upper one will reduce the channel distance from 330 m to 70 m.

The proposed alignment of the Daorao Creek, San Isidro Creek and drainage mains (DM1, DM2, DM3) are shown in Fig. A.4.6.

(2) Longitudinal Profile (Refer to Fig. A.4.7)

The Daorao Creek will be improved to decrease the flood water level in the residential area of the San Isidro Creek basin. The design channel bed will be improved partially for the whole stretch of the Daorao Creek. It will principally follow the existing average channel bed so as to maintain existing channel bed conditions.

The convex channel bed portion of the Daorao Creek from the conjunction with the San Isidro Creek and around 1 km downstream will be excavated. The channel beds of the San Isidro Creek and other drainage mains (DM1 to DM3) are to be excavated until they are not affected by backwater from the Daorao Creek of a 5-year return period flood.

The bed slope of each channel between the upper and lower stretches is set within the ratio of less than 1 : 2 to assure the stability of the channel bed, except in the junction with a tributary.

The flood water level is calculated by non-uniform flow analysis, assuming Manning's roughness coefficient as follows:

Channel Type	Roughness Coefficient
Existing	0.035
Improved (unlined and bank slope lined)	0.030
Improved (full lined: bed and bank slope lined	0.025

The following freeboard are applied:

Channel	Freeboard (m)
Daorao Creek and San Isidro Creek	0.6
Drainage Main (DM1, DM2, DM3)	0.3

The clearance between the design high-water level and the bottom of the lowest member of superstructure of the bridge in the Daorao Creek is set at a minimum of 1.0 m in consideration of floating big size debris such as wood during flood.

The design high-water level in the residential area of the San Isidro Creek is set to be equal or lower than the existing ground level except in the low-lying area so as not to create drainage problems and backwater from the Daorao Creek. It is recommended to raise the ground elevation to at least the topmost channel level in the partial low-lying farm/open space of scattered residential areas.

Fig. A.4.8 shows the comparison of high-water level with/without channel improvement to bring down the water level. The improvement works are given below:

(a) Widening and deepening of the creeks from the stretch 9 km upstream of Daorao Creek to the approach of the Bengang Creek through the San Isidro Creek. The total improvement length is around 1.8 km.

(b) Reconstruction of four (4) bridges and one (1) culvert; namely, Daorao Bridge, Vira Bridge, San Isidro Bridge, a bridge at Giron Street and a box culvert under the irrigation canal.

A culvert along the Bengang Creek (a part of drainage main DM1) passing under the irrigation canal constricts the flood flow and causes inundation of the highland residential area. The design high-water level at the constricted culvert is proposed to be lower than the bottom of irrigation canal with a clearance of 30 cm. The design high-water level is set to be less than 5.9 m, since the elevations of the bottom of irrigation canal and the bottom of upper slab of the box culvert are 6.65 m and 6.2 m, respectively, assuming that the thickness of the upper slab is 45 cm.

The approach stretch (DM1) of the Bengang Creek to the San Isidro Creek is proposed to be deepened at more than 1 to 2 m from the original channel bed. A drop

structure is provided at the connection of the improved stretch and non-improved portion of the Bengang Creek.

(3) Cross Section (Refer to Fig. A.4.9)

A single cross section channel is applied to all channels in view of the following reasons:

(a) It is necessary to minimize land acquisition and house relocation.

(b) Compound cross section channel for small creek and drainage main is uneconomical.

The bank slope for embankment is designed at 1 : 2 and the surface of slope is protected from erosion by sodding. A gentle bank slope at excavated channel is considered for ease of channel maintenance and a limited space is required.

Embankment, in principle, is not adopted for channel improvement in farmlands in the rural area, because it will create artificial drainage problems in farmlands inside the new dike. A sluice is placed under the embankment in low-lying residential area to drain inland flood water.

A revetment or concrete wall, however, is employed along channels in residential area to minimize land compensation and to define the boundary of the channel and the private properties. The cross section types applied for the excavated channel are shown below:

Channel/Land Use	Type of Shape	Bank Slope (V : H)	Slope Protection
Daorao Creek			
Farm/open space	Trapezoidal	1 : 2.0	None
Future residential	Trapezoidal	1 : 1.5	Revetment
San Isidro Creek			
Scattered residential	Trapezoidal	1 : 1.5	Revetment
DM1, DM2 and DM3			
Densely residential	Trapezoidal or Rectangular	1 : 0.5 or Vertical	Revetment or Reinforced Concrete

The cross section with a bank slope of 1 : 1.5 is applied to the portion of the creek in the scattered and future residential areas because of the existing wide farm/open space beside the creek. The cross section with a bank slope of 1 : 0.5 is applied to the portion of the channel in the densely residential areas in view of economical and social aspects. An alternative study of revetment type is described below in the view of economical aspect.

Maintenance roads are provided at both banks in the San Isidro Creek and drainage mains (DM1, DM2 and DM3), except in some portions where space is limited due to encroachment to private property. These roads may be used for strolling along channels. If there is a space behind roads, tree planting is recommended for improvement of the scenery.

4.3.2 Type of Revetment

An alternative study of the revetments with the slope of 1 : 1.5 and 1 : 0.5 was carried out in view of economical aspect. The typical cross sections of creek with these revetments are presented in Fig. A.4.10. Details of the cost estimate are presented in Fig. A.4.10.

The land compensation cost in urban area is estimated based on two (2) items: the unit costs of farmland/open space and the residential area. The results of comparison study indicate that the revetment with the slope of 1 : 1.5 is more economical in the farmland/open space and the costs of both types are almost the same in the residential area as shown below:

(Pesos/linear meter)

Items	Type-A (1 : 1.5)	Type-B (1 : 0.5)
(1) Construction Works	22,700	24,700
(2) Land Compensation Cost		
Farm land / Open Space	1,700	1,500
Residential Area	15,000	13,000
(3) Total		
Farm land / Open Space	24,400	26,200
Residential Area	37,700	37,700

4.3.3 Opening of Mouth of the Daorao Creek

Before the onset of the typhoon season, the mouth of the Daorao Creek should be excavated to have an opening of 20 m in width, 1.5m in depth and 30 m in length for the flood mitigation in the Daorao Creek. The mouth opening should be maintained during the whole rainy season.

The Office of the City Engineer in Laoag has, at present, a set of backhoe (0.6 m^3) and bulldozer (15 ton). These equipment are ordinarily used for road maintenance and other purposes. Acquisition of a set of backhoe (0.6 m^3) and bulldozer (15 ton) are proposed for the opening and maintenance of the mouth during rainy season (May to December). The opening volume is estimated at around 1000 m^3 to be moved out by bulldozer within a half-day period.

4.3.4 Environmental Consideration

A drainage channel performs the combined function of sewage and stormwater collection. During the dry season, stagnant wastewater in the open channel bed spreads a nasty smell in the vicinity of the San Isidro Creek. To minimize these unhealthy and unfavorable environmental situations, an exclusive maintenance flow pipe will be provided at both banks along the improved channel. Wastewater is intercepted in this flow pipe beside the improved channel of the San Isidro Creek basin as shown in Fig. A.4.11.

4.3.5 Improvement Plan

According to the improvement measures described above, the Master Plan of urban drainage improvement for the Daorao Creek, San Isidro Creek and drainage mains (DM1, DM2 and DM3) is proposed in consideration of the future land use plan as shown in Figs. A.4.6, A.4.7 and A.4.9.

The proposed improvement works are summarized below. Details of the dimension of proposed bridges and culverts are presented in Table A.4.3. The acquisition of construction equipment for opening the mouth of Daorao Creek and the placing of wastewater interceptor are included:

Item	Quantity	Contents
Daorao Creek		
Earth Work	1,800 m	Excavation and embankment (DA9.00 - DA10.80)
Revetment	1,060 m	Left bank (DA7.74 - DA10.80) Bank slope lining, 1 : 1.5, wet masonry type
Bridge Work	3 sites	Improvement of Daorao Br. and reconstruction of Vira Br. and Tupec Br.
Mouth Opening	1 set	Acquisition of one set of backhoe (0.6 m3) and bulldozer (15 ton)
Sluice	1 site	Placing under the proposed embankment
San Isidro Creek		
Earth Work	930 m	Excavation and filling (SA0.00 - SA0.93)
Revetment	1,740 m	Bank slope lining, 1 : 1.5, wet masonry type (SH0.06 - SA0.93)
Bridge Work	3 sites	Reconstruction of San Isidro Br., a pedestrian Br., and Giron Street Br.
Drainage Main: DM1		
Earth Work	140 m	Excavation and filling (DM1-0.00 - DM1-0.14)
Revetment	280 m	Bank slope lining, 1 : 0.5, wet masonry type; bed lining
Box Culvert Work	1 site	Reconstruction of culvert under irrigation canal
Drop Work	1 site	Approach to the Bengang Creek
Drainage Main: DM2		
Earth Work	440 m	Excavation and filling (DM2-0.00 - DM2-0.44)
Revetment	880 m	Bank slope lining, 1 : 0.5, wet masonry type; bed lining
Box Culvert Work	4 sites	Reconstruction of culverts under 4 streets
Drainage Main: DM3		
Earth Work	700 m	Excavation and filling (DM3-0.00 - DM3-0.70)
Revetment	1,400 m	Bank slope lining, 1 : 0.5, wet masonry type; bed lining
Box Culvert Work	1 site	Reconstruction of a culvert under one street
Wastewater Interceptor	2,550 m	Placing of waste water interceptor along the improved channel

4.3.6 Estimated Cost

The construction and land compensation cost in the master plan was estimated as tabulated in Table A.4.4. The results are summarized in the table below.

Work Items	Quantity	Amount (million pesos)
I. Construction Cost		135.65
1.1 Preparatory Works (10% of 1.2 and 1.3)		12.33
1.2 Main Works		112.11
(1) Earth Work		19.61
Excavation	158,746 m^3	18.26
Embankment/Filling	15,919 m^3	1.35
(2) Revetment Work	4,420 m	41.29
(3) Bridge and Culvert Work		40.62
Bridge	6 sites	36.50
Box Culvert	6 sites	4.12
(4) Others		10.59
Drop	1 site	0.22
Sluice	1 site	0.25
Waste Water Interceptor	2,550 m	5.02
Mouth Opening	LS	5.10
1.3 Miscellaneous Works (10% of 1.2)		11.21
II. Compensation Cost		12.05
2.1 Land Acquisition	5.65 ha	11.60
2.2 House Resettlement	3 houses	0.45
III. Administration Cost (3% of I and II)	LS	4.43
IV. Engineering Service Cost (16% of I)	LS	21.70
V. Physical Contingency (10% of I, II, III and IV)	LS	17.39
Total		191.22

4.4 Urgent Plan of Urban Drainage Improvement

4.4.1 Improvement Plan

According to the improvement measures of the channel described in the formulation of the Master Plan, the urgent plan of channel improvement for the Daorao Creek, San Isidro Creek and drainage mains (DM1 and DM2) is proposed in consideration of existing land use conditions as shown in Figs. A.4.12 to A.4.14.

After widening and deepening of the portion upstream of San Isidro Bridge and the drainage mains (DM1 and DM2), revetment works have to be carried out. The revetment with a slope of 1 : 1.5 is employed for the San Isidro Creek and the revetment with a slope of 1 : 0.5 is adopted for the DM1 and DM2, as explained in the Master Plan.

The downstream of San Isidro Bridge and the Daorao Creek are to be improved by excavation, since these areas are not urbanized yet.

The proposed improvement works are summarized below. The acquisition of construction equipment for opening of the mouth of Daorao Creek and the placing of wastewater interceptors are included:

Item	Quantity	Contents
Daorao Creek		
Earth Work	900 m	Excavation (DA9.00 - DA9.90)
Bridge Work	2 sites	Improvement of Daorao Br. and reconstruction of Vira Br.
Mouth Opening	1 set	Acquisition of one set of backhoe (0.6 m^3) and bulldozer (15 ton)
San Isidro Creek		
Earth Work	360 m	Excavation (SA0.00 - SA0.36)
Earth Work	570 m	Excavation and filling (SA0.20 - SA0.93)
Revetment	1,140 m	Bank slope lining, 1 : 1.5, wet masonry type (SA0.36 - SA0.93)
Bridge Work	3 sites	Reconstruction of San Isidro Br., a pedestrian Br., and Giron Street Br.
Drainage Main: DM1		
Earth Work	140 m	Excavation and filling (DM1-0.00 - DM1-0.14)
Revetment	280 m	Bank slope lining, 1 : 0.5, wet masonry type; bed lining
Box Culvert Work	1 site	Reconstruction of culvert under irrigation canal
Drop Work	1 site	Approach to the Bengang Creek
Drainage Main: DM2		
Earth Work	440 m	Excavation and filling (DM2-0.00 - DM2-0.44)
Revetment	880 m	Bank slope lining, 1 : 0.5, wet masonry type; bed lining
Box Culvert Work	4 sites	Reconstruction of culverts under 4 streets
Wastewater Interceptor	2,550 m	Placing of waste water interceptor along the improved channel

4.4.2 Structural Design

The structural design is prepared based on the Design Guidelines, Criteria and Standards of the Department of Public Works and Highways (DPWH, Philippines) and the Technical Standards for Rivers and Sabo Facilities (Ministry of Construction, Japan).

(1) Bank Slope Protection Works

The channel improvement works consist mainly of excavation, filling and bank slope protection works. The bank slope of channel is covered with revetment to protect it from erosion by turbulent flood flows, as shown in Fig. A.4.15.

On the crest bank, a 3 m gravel-paved road is constructed for the maintenance work and strolling along the channel.

Depending on the density of residence, two types of revetment, as shown in Fig. A.4.15 are designed for the slope protection work. Type-RA is applied for the San Isidro Creek where scattered residential areas are located and Type-RB is adopted for the DM1 and DM2 where dense residential areas are situated.

Type-RA consists of wet masonry with gravel base and base concrete. Gabion mattress is placed for foot protection in consideration of flood flow velocity of 2 m/s.

Type-RB consists of wet masonry with gravel base, filling concrete and base concrete to stabilize the steep slope. Concrete base is placed on the bottom of the channel because the flood flow velocity is 4 m/s for DM1 and 2 m/s for DM2 and the width of channel bed is narrow (less than 5 m).

(2) Bridge and Culvert

Based on the necessary width of improved channels, the length (L) of bridges and internal width (W) of box culverts are hereinafter proposed in consideration of skew angle of directions of road and channel:

No.	Name of Bridge / Street	Existing L or W	Existing Structure	Proposed L or W	Proposed Structure	Skew Angle	Height *
	Daorao Creek						
Br. 1	Daorao Br.	39.5 m	Bridge	39.5 m	Bridge	45°	5.7
Br. 2	Vira Br.	15.0 m	Bridge	38.2 m	Bridge	90°	5.7
	San Isidro Creek						
Br. 3	San Isidro Br.	12.5 m	Bridge	29.7 m	Bridge	60°	4.7
Br. 4	Pedestrian Br.	14.5 m	Bridge	24.5 m	Bridge	90°	4.3
Br. 5	Giron Street	2.5 m	Culvert	23.3 m	Bridge	90°	3.8
Box 1	Irrigation Canal	4.0 m	Culvert	5.0 m	Culvert	90°	2.8
Box 2	Mckinley Street	2.5 m	Culvert	5.2 m	Culvert	90°	2.7
Box 3	V.Lagasca Street	2.0 m	Culvert	5.1 m	Culvert	90°	2.6
Box 4	A.Castro Street	1.5 m	Culvert	5.0 m	Culvert	90°	2.5
Box 5	Bacarra Road	3.0 m	Culvert	5.0 m	Culvert	90°	2.5

* : Height means design flood water depth and freeboard

Fig. A.4.16 shows the proposed plan and section of bridges. One-span bridge is applied except for the Daorao Bridge, because the bridge pier is an obstacle to flood flow in the narrow channel.

Daorao Bridge is, at present, 39 m in length consisting of 3 spans (12.6 m + 14.9 m + 12.0 m). After replacement work of two abutments and protection work on two piers as shown in Fig. A.4.16, it will be able to flow out the design discharge of a 5-year return period without jumping up the water level of the upstream of the bridge.

Protection work on pier foundation of Daorao Bridge is provided, where the pier/abutment foundation is excavated lower than the existing foundation elevation.

Prestressed concrete bridge (PC) is applied except for the Daorao Bridge, because the proposed span length is more than 20 m. The existing superstructure of Daorao Bridge will still be utilized. Proposed bridge width, total length, span length and bridge type are tabulated below:

No.	Name	Width	Bridge Length (Spans)	Skew Angle	Bridge Type
	Daorao Creek				
Br. 1	Daorao Br.	5.0 m	39.5 m (3 spans: 12.6 m + 14.9 m + 12.0 m)	45°	RC
Br. 2	Vira Br.	5.0 m	38.2 m (1 span)	90°	PC
	San Isidro Creek				
Br. 3	San Isidro Br.	8.5 m	29.7 m (1 span)	60°	PC
Br. 4	Pedestrian Br.	2.0 m	24.5 m (1 span)	90°	PC
Br. 5	Giron Br.	7.5 m	23.3 m (1 span)	90°	PC

The bank slope of upper and lower stretches of a bridge are protected by revetment so as not to scour the back of abutment and the foot of foundation of pier and abutment. The bank slope protection is more than 10 m stretch from the side of bridge.

Fig. A.4.17 shows the proposed plan and section of box culverts. One-box type of culvert is applied, because 2-box type is an obstacle to flood flow in the channels. Dimensions of the internal width and height of proposed box culvert are given below:

No.	Crossing Structure	Width	Height	No. of Box
Box 1	Irrigation Canal	5.0 m	2.8 m	1
Box 2	Mckinley Street	5.2 m	2.7 m	1
Box 3	V.Lagasca Street	5.1 m	2.6 m	1
Box 4	A.Castro Street	5.0 m	2.5 m	1
Box 5	Bacarra Road	5.0 m	2.5 m	1

(3) Other Structures

The drop structure comprises a weir portion and channel bed protection in the downstream apron as well as the channel bed in the upstream of the weir. The structure is shown in Fig. A.4.18.

Fig. A.4.11 shows the structure of the interceptor to drain wastewater from the existing drainage channel and the layout of wastewater interceptor beside the improved channel.

CHAPTER V COST ESTIMATE OF URGENT PLAN

5.1 Construction Work Volume

The construction work volume is summarized as follows:

Work Items		Quantity
I.	Construction Main Works	
	(1) Earth Work	
	Excavation	98,000 m^3
	Filling	8,000 m^3
	(2) Revetment Work	2,300 m
	(3) Bridge and Culvert Work	
	Bridge	5 sites
	Box Culvert	5 sites
	(4) Others	
	Drop	1 site
	Wastewater Interceptor	2,550 m
	Mouth Opening (backhoe and bulldozer)	1 set
II.	Compensation	
	(1) Land Acquisition	2.71 ha
	(2) House Resettlement	None

5.2 Construction Plan and Schedule

Channel improvement is generally executed from the downstream to upstream, but some upstream channel works may be conducted before excavation works of the downstream on condition that the work shall not bring an imbalance of the flow capacity between the upper and downstream stretches.

The filling material is taken from near the selected excavation material. The residual volume of excavation material is as follows:

(1) Excavation Material	:	98,000 m^3
(2) Filling Material	:	8,000 m^3
(3) Residual Excavation Material (1) - (2)	:	90,000 m^3

A land of 4.5 ha is required to dump 90,000 m^3 by assuming the filling height as 2 m. The following three (3) potential dumping sites are identified near the construction site (refer to Fig. A.5.1):

Dumping Site		Land Use	Distance *
Site-A	1.28 ha	Farm/open space in scattered residential area	0 km
Site-B	5.60 ha	Future residential area	1 km
Site-C	3.83 ha	Garbage disposal area / open space	2 km

* Average distance from construction site

The soil dumping of 90,000 m^3 is assumed to be distributed to the above sites. This dumping will disturb the existing land use; on the other hand it will contribute to the development of residential land.

All the construction works will be completed within two (2) years. The channel improvement works and culvert construction will be completed within one (1) year. The overall construction schedule is prepared, as shown in Fig. A.5.2.

5.3 Cost Estimation Criteria

The project cost is estimated on the basis of the following assumptions and conditions.

(1) Constitution of Project Cost

The project cost is composed of construction cost, compensation cost, administration cost, engineering service cost and physical contingency cost. The construction cost includes preparatory works, main works and miscellaneous works. The compensation cost includes land acquisition cost and house resettlement cost.

(2) Price Level

Price level is as of June 1997.

(3) Currency Conversion Rate

Currency conversion rates among US Dollar (US$), Philippine Peso (₱) and Japanese Yen (¥) are as follows:

US$1.00 = ₱26.0 = ¥115.0

(4) Foreign and Local Currency Portions

Foreign currency portion mostly covers costs of equipment and engineering services, and a part of materials.

Local currency portion mainly covers all costs of labor, valued added tax (VAT), compensation, administration, and a part of material cost and engineering service cost.

The following proportion between foreign and local currencies is adopted:

Items	Foreign Currency	Local Currency
1. Materials		
Cement	0.7	0.3
Re-bar	0.8	0.2
Structural Steel	0.9	0.1
Stone Materials	0.4	0.6
Lumber	0.4	0.6
Fuel, Lubricant	0.7	0.3
2. Construction Equipment	0.7	0.3
3. Labor	0.0	1.0
4. Compensation Cost	0.0	1.0
5. Administration Cost	0.0	1.0
6. Engineering Cost	0.9	0.1

(5) Compensation Cost

Compensation cost is estimated based on actual records in the past, land/house tax and market prices.

(6) Government Administration Cost

The cost of project management or administration by the government is assumed as 3% of the construction base cost of civil works and preparation and miscellaneous works.

(7) Engineering Services Cost

Construction supervision is to be carried out by an engineering consultant. The cost of engineering services is adopted at 16% of the construction base cost of civil works and preparation and miscellaneous works.

(8) Physical Contingency

Physical contingency is estimated as 10% of the foreign and local costs.

(9) Price Contingency

Price contingency is provided to cope with price escalation during project implementation. The following rates of price escalation are adopted considering recent inflation rates:

(a) for foreign currency portion

(b) for local currency portion

5.4 Project Cost

5.4.1 Unit Cost

Unit costs consist of direct unit cost comprising material costs, labor costs, equipment costs and indirect costs, including contractor's expenses, overhead, profit, insurance, bond, field supervision and administration, security and safety control, Value Added Tax (VAT), etc. Indirect costs excluding VAT are estimated as a percentage of direct unit cost, i.e., 20%. VAT is 10% of costs of labor and equipment in accordance with the criteria of DPWH.

Unit prices of items such as labor cost, material cost and equipment cost are the basis of the main construction work cost. Labor costs which include all fringe benefits and material costs are based on data collected by the District Office of DPWH in Laoag City. Equipment cost is given on the basis of rental rates authorized by the Associated Construction Equipment Lessor, Inc. of the Philippines (ACEL Equipment Guidebook, 1992).

5.4.2 Estimated Project Cost

The total project cost is estimated at 118.0 million pesos at 1997 prices and 134.8 million pesos including price escalation. These are broken down by work item and currency portion as follows. Details are given in Table A.5.1.

Description	Quantity	Amount (million peso)		
		Foreign Currency	Local Currency	Total
1. Construction Cost		44.54	41.48	86.02
1.1 Preparatory Works (10% of 1.2 and 1.3)		4.05	3.77	7.82
1.2 Main Works		36.81	34.28	71.09
(1) Earth Work		7.65	4.24	11.89
Excavation	98,000 m^3	7.20	4.02	11.22
Filling	8,000 m^3	0.45	0.22	0.67
(2) Revetment Work	2,300 m	3.23	13.24	16.47
(3) Bridge and Culvert		18.13	14.26	32.39
Bridge	5 sites	16.00	12.58	28.58
Culvert	5 sites	2.13	1.68	3.81
(4) Other Works		7.80	2.54	10.34
Drop	1 site	0.18	0.04	0.22
Wastewater Interceptor	2,550 m	3.78	1.24	5.02
Mouth Opening	1 site	3.84	1.26	5.10
1.3 Miscellaneous Work (10% of 1.2)		3.68	3.43	7.11
2. Compensation Cost		0.00	4.74	4.74
2.1 Land Acquisition	2.71 ha	0.00	4.74	4.74
2.2 House Resettlement	None	0.00	0.00	0.00
3. Administration Cost		0.00	2.72	2.72
4. Engineering Services Cost		12.38	1.38	13.76
5. Physical Contingency		5.30	5.43	10.73
6. Total (1+2+3+4+5)		62.22	55.75	117.97

5.5 Disbursement Schedule

The annual disbursement schedule of the urgent project is summarized as follows. For details, see Table A.5.2.

(Unit: million pesos)

Year	Foreign Currency Portion	Local Currency Portion	Total
1999	8.17 (8.50)	7.13 (8.16)	15.30 (16.66)
2000	39.47 (41.89)	37.28 (45.67)	76.75 (87.56)
2001	14.98 (16.21)	10.95 (14.36)	25.93 (30.57)

Note: Costs without parentheses are at 1997 prices, while costs in parentheses include price contingency.

5.6 Operation and Maintenance

The total annual operation and maintenance cost of the project is assumed to be 0.5% of the construction cost for the river improvement. It amounts to 0.43 million pesos after the project is completed in 2001.

CHAPTER VI PROJECT EVALUATION OF URGENT PLAN

6.1 Project Benefit in Financial Terms

6.1.1 Flood Damage Analysis

Based on the calculation results of high water level without drainage channel improvement as shown in Fig. A.4.8 and on the topographic map made in this study, the inundation areas and inundation depths corresponding to the probable flood of a 5-year return period were estimated as presented in Fig. A.6.1.

The inundation areas by 3 ranges of depth are presented below:

Inundation Depth	0.1m to 0.5m	0.5m to 1.0m	1.0m to 1.5m	Total
Inundation Area	100.7 ha	17.2 ha	4.6 ha	122.6 ha

The flood potential damages by each inundation depth of a 5-year flood are tabulated in Table A.6.1. The flood damage value of a 5-year flood is estimated in financial terms in Table A.6.2. Its total is P45.4 million which covers direct damages only. Incidentally, the flood damages of a 2-year flood, similar to Typhoon Gloring in 1996, are enumerated in Table A.3.1. Its total damage value is estimated at P32.7 million, which also covers direct damages only.

6.1.2 Flood Damage and Annual Mitigation Benefit

The flood mitigation benefit in the urgent plan is constituted in the same structure as mentioned in **Section 1.3.1 of Appendix E in Part 2.** They consist of a direct damage and an indirect damage. The direct damage is classified into damages to agricultural production, housing units, industrial facilities and infrastructures. The physical infrastructure damage was assumed to be 20% of the other direct damages, although social infrastructure damage was counted as a sort of direct damage. The indirect damage was assumed at 10% of the above direct damages.

The direct damage is simulated as a product of the number of facilities inundated in the areas flooded, an economic value of inundated property and a damage rate in accordance with inundation depth. The number of affected facilities and the inundation depth are discussed in the previous section. The damage rate is already tabulated in **Part 1.**

The values of damageable assets in the target area are different from the values used in **Part 2,** since the target area is located in the city proper and the assessed values of taxable assets are apparently higher than those in other municipalities as described in the master plan study. Referring to the assessed value by the city assessor of Laoag, the market values of damageable assets are set up as shown in the following table. The assessed values were based on 1995 prices, so they were reassessed using the price index of 111 between 1995 and June 1997.

Damageable Property	Unit	Production, Durable Assets (Building, Equipment, etc.)	Movable (Household Effects, Inventory Stock, etc.)
Irrigated Field	P/ha	18,000	-
Rainfed Field	P/ha	13,700	-
Housing Unit	P/Unit	126,000	38,000
Commercial/Industrial	P/Unit	448,000	210,000
Educational Facilities	P/Unit	569,000	250,000
Hospital/Health Facilities	P/Unit	680,000	600,000

The benefit is estimated in Table A.6.3 for the Urgent Plan. The benefit is estimated under the flood occurrence intervals of 2 and 5 years. The flood mitigation benefit of the Urgent Plan is estimated at P43 million for a 2-year flood and P60 million for a 5-year flood. Thus, the annual benefit of the Urgent Plan is calculated at P26 million in financial terms.

6.2 Criteria of Project Evaluation

The criteria of project evaluation are all-inclusively explained in **Chapter 2 of Appendix E in Part 2**. They are summarized as follows:

6.2.1 Conversion Factors

The economic costs and benefits have to be estimated in real economic terms. The market prices may not be acceptable due to distortions in the society. To deal with this problem, conversion factors are applied as discussed **in Chapter 1 of Appendix E in Part 2**. They are calculated applying shadow wage and shadow exchange rates and elimination of national and local taxes. They are shown in the table below.

	Item	Local/Foreign Separate Estimate		Local/Foreign Combined Estimate
		Local Portion*1	Foreign Portion	
1.	Materials			
	Cement	0.53	1.04	0.88
	Aggregate (Coarse and Fine)	0.68	1.06	0.83
	Steel	0.24	1.06	0.90
	Fuel and Lubricant	0.05	1.21	0.86
	Lumber	0.80	1.04	0.90
	Others	0.72	1.05	0.89
2.	Machinery and Equipment Rental	0.26	1.11	0.85
3.	Labor			
	Skilled	0.93	-	0.93
	Unskilled	0.60	-	0.60
4.	Indirect Costs			
	Overhead, and miscellaneous	0.88	-	0.88
	Profit	0.65	-	0.65
	Value Added Tax*2	0.00	-	0.00
5.	Government Expenditure*3	0.95	-	0.95
6	Engineering Services*4	0.00	1.22	1.10

Note: *1 Including all national and local taxes in the Philippines
*2 Imposed on item numbers (2) and (3) only in this form.
*3 For engineering and administration overhead.
*4 Detailed design and supervising services by foreign consultants

Market price of land has peculiar characteristics as compared with other commodities, especially in urban areas. In this study, most lands already expropriated for riverbeds are utilized for agricultural cultivation. Then, the value of these lands will be evaluated through crop production lost in the expropriation as negative benefit.

6.2.2 Schedule and Evaluation Period

(a)	Base Year	:	Beginning of 1999
(b)	Construction Period	:	The year of 1999 for Detailed Design, two years for construction of major works between 2000 and 2001
(c)	Disbursement Schedule	:	Uniform distribution of project costs during construction period
(d)	Economic Life	:	50 Years after completion of the project
(e)	Evaluation Period	:	50 years after completion of the main flood control works (2002 - 2051)
(f)	Timing of Benefit Accrual	:	In proportion to construction works already completed

6.2.3 Other Criteria

(a)	Price Levels	:	Cost and benefits of the project are set at the end of June, 1997.
(b)	Social Discount rate	:	15% p.a.
(c)	Future Damageable Assets	:	The future flood mitigation benefits are estimated on the basis of population and socio-economic projection. They would be expected to increase in the future, as discussed in **Chapter 2 of Appendix E in Part 2.**

6.3 Economic Benefit

6.3.1 Flood Mitigation Benefits

The project benefit was already estimated in financial terms in Section 6.1. For economic evaluation, it has to be converted into economic terms. To convert the financial values, the conversion factors are applied, discussed in Section 6.2.1 and in further detail calculated in **Section 2.2.1 in Appendix E of Part 2.** As a result, the economic unit values of beneficial facilities are tabulated in the following table.

Damageable Property	Unit	Production, Durable Assets (Building, Equipment, etc.)	Movables (Household Effects, Inventory Stock, etc.)
Irrigated Field	P/ha	17,200	-
Rainfed Field	P/ha	11,300	-
Housing Unit	P/Unit	104,600	31,500
Commercial/Industrial	P/Unit	376,300	176,400
Educational Facilities	P/Unit	472,300	207,500
Hospital/Health Facilities	P/Unit	571,200	504,000

Using the above economic unit values, the benefit is estimated under the flood occurrence intervals of 2 and 5 years. Table A.6.4 shows the estimated value of flood reduction by return period and the annual benefit of the Urgent Plan. The annual benefit is estimated at P22 million in economic terms.

The annual benefit under future conditions is computed in conformity with the projection of regional economy and population. The annual benefits in the year 2000, 2010 and 2020 are P26 million, P41 million and P55 million, respectively, as also shown in the table.

The flood mitigation benefits are assumed to accrue in proportion to the completion of the construction works. The full benefits would accrue just after the completion of the entire construction works. Although the annual benefits are constant during the economic life under present conditions as shown in Table A.6.6, the benefits under future conditions are expected to increase annually in proportion to the economic growth and population expansion in the basin, as seen in Table A.6.7.

6.3.2 Negative Benefits

For the implementation of the project, some areas have to be expropriated for riverbeds and dikes. These areas include 1.3 ha of irrigated agricultural lands for cropping.. Crop production cannot be carried out when the construction works begin. This inactivity is considered as negative benefit of the project. The net income is estimated at 18,500 pesos per ha, referring to **Table C.5.7 in Appendix C of Part 1.**

This negative benefit is enumerated for present conditions in Table A.6.6. Under future conditions, the unit yield of rice is assumed to be double of the present yield (2.4 ton/ha) in the year 2020. These negative benefits are enumerated in Table A.6.7.

6.4 Economic Cost

The financial construction cost is estimated at P118 million in total as estimated in Section 5.4 of Chapter V. It consists of the following items:

(1) Main construction cost;
(2) Compensation cost;
(3) Government administration cost;
(4) Engineering service cost; and,
(5) Physical contingency cost.

As discussed in Section 2.3 of Appendix E in Part 2, the main construction cost is divided into work types in terms of component schemes. In this Laoag City Urban Drainage Project, these work types comprises (a) earth work, (b) revetment work, and (c) bridge and culvert work. The construction cost of the respective work types consist of (i) materials, (ii) machinery and equipment rental, (iii) labor, and (iv) indirect costs. Then, the economic cost of the work types is converted from the financial costs applying the conversion factors discussed in Section 6.2.1. Both financial and economic costs are tabulated in Table A.6.5. As a result, the respective work types can have overall conversion factors by means of

comparing economic costs against the corresponding financial costs. The results of these conversion factors are shown in the table. They are summarized as follows.

(Unit: Million Pesos for cost figures)

Priority Project	Financial Cost	Economic Cost	Conversion Factor
Earth Work	11.9	9.9	0.83
Revetment Work	16.5	11.3	0.69
Bridge and Culvert Work	32.4	25.7	0.79
Other Works	10.3	9.7	0.93
Total	71.1	56.5	0.80

The entire cost of the Urgent Plan is calculated applying the above overall conversion factors to main works and the conversion factors in Section 6.2.1 to the other cost items such as government administration cost, engineering service cost and physical contingency cost. The land acquisition cost is evaluated by negative benefit, as discussed in the previous Section. The price contingency cost is excluded from economic cost. As a result, the entire economic cost is calculated at ₱95 million, as shown in Table A.6.6. Since the financial total cost is ₱118 million, the economic construction cost corresponds to 80% of the financial one.

The construction cost is disbursed in compliance with the construction schedule which is discussed in the previous Section. The table below shows the annual amounts for the construction period.

Year	Annual Disbursement (Million Pesos)
1999	11
2000	62
2001	22
Total	95

The operation and maintenance (O&M) cost is annually required during the economic life of the project. The O&M cost is assumed to aggregate at 0.5% of the total direct construction cost. The annual cost for O&M of the project amounts to ₱0.34 million after the project is completed in 2001.

6.5 Economic Evaluation

6.5.1 Economic Viability

In this section, the project viability of the urgent plan is examined from the economic point of view. The economic total cost aggregates to ₱95 million. The economic benefits are assumed to accrue in conformity with the construction schedule. The annual flow is shown in Table A.6.7 under present conditions and Table A.6.8 under future conditions. EIRR is 22.0% in the former case and 31.9% in the latter case. Other indices of economic evaluation are in the table below. Thus, the proposed project looks feasible from the economic point of view, since the EIRRs are clearly over 15% of the social discount rate in the country.

Item	EIRR (%)	B/C*1	NPV*1 (Million Pesos)
Under Future Conditions	31.9	2.45	105
Under Present Conditions	22.0	1.47	34

Note *1: Discounted at 15%

6.5.2 Sensitivity Test

The cost and benefits were estimated with discretion by respective experts in this feasibility study. In spite of that, some uncertainty still exists in the estimation. In particular, the case with long implementation period and/or expectation of future growth have high risks from the viewpoint of judgment on project viability. In this context, thus, the sensitivity test is introduced as regards the following aspects, in consideration of sensitive factors for project feasibility.

(1) 10% higher than the cost estimated

(2) 10% lower than the benefits expected

(3) In case that the regional economy grows under other scenarios, i.e., high or low scenario as discussed in GRDP projection in Section 7.3 of Appendix A in Part 1.

The influence of the above phenomena is calculated independently. The results are presented under future conditions. As shown in the table below, the EIRRs for every aspect exceed 29%. This means that the economic efficiency of the Urgent Plan is much higher than the rate expected as social discount rate of 15%. Therefore, the objective projects are feasible from the economic viewpoint.

Item	EIRR (%)	B/C*1	NPV*1 (Million Pesos)
Base Conditions	31.9	2.45	105
(1) 10% Costs Up	29.5	2.23	98
(2) 10% Benefits Down	29.2	2.21	87
(3-1) High Growth Scenario	36.6	3.10	152
(3-2) Low Growth Scenario	29.8	2.19	87

Note *1: Discounted at 15%

6.6 Evaluation of Socio-economic Impact

6.6.1 Creation of Job Opportunity and Activation of Regional Economy

The implementation of the proposed project creates opportunities of temporary jobs during the construction period. The temporary workers are estimated at 64,900 man-days in total, which are divided into 13,300 man-days of skilled workers and 51,600 man-days of unskilled workers during the two years between 2000 and 2001. Besides these temporary workers, most construction materials will be procured from inside and outside of the basin. Moreover, support services and other materials for the construction works are required. These support businesses result in creating another job opportunity, and it will contribute to activation of the regional economy.

6.6.2 Improvement of Social Amenity and Public Hygiene

People in the urgent plan area had experienced habitual floods, always living in fear of flood menace. Besides, people are exposed to unsanitary conditions after the flood disaster.

Due to the implementation of the urgent plan proposed in this study, people in the area will be relieved from the menace of floods. This will result in the emergence and subsequent pervasion of positive mental climate among inhabitants in the area, because they will be able to enjoy their living conditions and industrial activities with little worries about flood.

CHAPTER VII ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Existing Environmental Conditions

7.1.1 General

The urban area of Laoag City is located on the right bank of the Laoag River, about 8 km upstream of the river mouth. The urban area is drained by two drainage systems. One is the Daorao-Tupec Creek system which covers most of the urban area. Another system covers the remaining part of the urban area which is directly drained into the Laoag River through the street drainage.

The study for Laoag City Urban Drainage was carried out for the drainage system of Daorao-Tupec Creek which covers most of the urban area. The existing environmental conditions of the Daorao-Tupec Creek drainage area are generally the same as the conditions already described in the Environmental Impact Assessment (EIA) for the Sabo and Flood Control Project of the Laoag River Basin. This Chapter, therefore, describes the existing environmental conditions of the drainage creeks which are different from the conditions of the sabo and flood control project area, particularly in terms of vegetation, fish and wildlife.

7.1.2 Vegetation

Vegetation covering the area surrounding Daorao Creek and its tributaries was surveyed and common names were identified. Photographs of samples were shown to the Biological Department of the Mariano Marcos State University to confirm their names. List of the non-dipterocarps, bamboo and grasses observed at site are shown in Table A.7.1.

(1) Upper Reach of Creek (Tupec Creek)

The creek has a steep bank slope and a single flow section. Both banks consist of 2 to 3 meters of grassland bounded by paddy fields. Grasslands are covered with Kogon or weeds. Trees on the bank are Bamboo, Camachile, Bulala, Duhat, Guava, etc. Density of trees is not so much. Paddy fields adjacent to the creek are being planted with rice or corn only due to high water level. Stagnated water surface is covered by floating vegetation such as Kangkong or Water Hyacinth.

(2) Daorao Creek (Upstream of Junction with San Isidro Creek)

Growth of trees are dense along the bank of this creek. Kinds of trees are Bulala, Acacia, Bamboo, Mango, Camachile, Mabolo, etc.

(3) Drainage Main DM1 and DM2 Confluent to the San Isidro Creek

Drainage Main DM1 and DM2 are bounded by housing lots and paddy fields. Trees planted on housing lots are mostly domesticated ones such as Acasia, Mango, Tamarind, Banana, Kamias, Ipil-ipil, Coconut, Palm Tree, Narra, etc. Aquatic vegetation is not found except small quantities of algae at the drain pipe for domestic sewage.

(4) San Isidro Creek

The upper reaches of San Isidro Creek which is an open space covered with weeds has adjacent paddy fields. Trees grow on the other side. The middle and lower reaches have relatively wide spaces and gentle slope of banks which are densely covered with grass. Dense grass covering the ground is Cadena de Amor. Trees observed are of many varieties such as Banana, Ipip-ipil, Bulala, Acacia, Bamboo, Mango, Camachile, Kapok, etc. Well grown Narra and Acasia are planted at the downstream of San Isidro Bridge.

(5) Daorao Creek (between confluence of San Isidro Creek and Vira Bridge)

The Creek flows in an open space of less trees. The banks along this stretch are covered with Cadena de Amor and weeds. Some portions of the water surface are covered with Kangkong. Kinds of trees grown are Acacia, Bulala and Banana.

(6) Daorao Creek (downstream of Vira Bridge up to 1.5Km point from river mouth)

The creek flows from the urban area and enters the rural area. The creek meanders in a gentle sloped farmland. The banks form a small terrace with growths of trees such as Bamboo, Banana, Camachile, Star Apple, Acacia, Ipil-ipil, Mango, Duhat, Bulala, etc. Bulala is the tree dominant in the area. The bank elevation on the lower stretches of this section gradually becomes the same with the water level and reed grass growth is dense. Water Hyacinth and Kangkong are seen but partially cover only the water surface. Dense Water Hyacinth prevail at the mouth of the creek.

(7) Estuary of Daorao Creek

The Daorao Creek flows into the sand dune area and finally empties into the South China Sea. Vegetation along the creek are Kandaruma and "Lidda" (Talahib).

(8) Threatened, Endangered or Rare Species of Plants

Based on the vegetation survey conducted and on available secondary information, no threatened, endangered or rare species of plants have been identified in the Daorao-Tupec Creek System. Table A.7.1 shows the observed flora and fauna along the Daorao-Tupec Creek drainage system.

7.1.3 Fish and Wildlife

Aquatic fauna and wildlife in and around Daorao Creek and its tributaries were surveyed and their common names were identified through the available secondary information. There was no information on wildlife inhabiting the area. The list of fishes and aquatic fauna observed or identified through the secondary information is given in Table A.7.1.

(1) Upper reach of Creek (Tupec Creek)

There is small domestic or industrial sewage inflow to this creek. Information from local residents show that the fish catches are Tilapia, Carp, Mudfish, Catfish and Eel. Golden snails (Kuhol) were observed at the bank of the creek. This golden snail was imported from Taiwan and expanded nationwide due to its high productivity.

(2) Daorao Creek (upper reach)

One set of fish trap was observed at the confluence with San Isidro Creek. According to the owner's information, fishes caught are Tilapia, Carp, Mudfish and Gurami but catches differ in season and amount. Fingerlings of Gurami were observed in the water during the survey.

(3) Drainage Main DM1 and DM2 and San Isidro Creek

The water flow is shallow and polluted with domestic sewage; however, Mudfish and Golden Snails were observed.

(4) Daorao Creek (lower reach up to 1.5Km point from river mouth)

There was no fish observed except for Golden Snails. Boys fishing in the place informed of catching Tilapia. The downstream of the creek has a deep and wide water flow. Fish density becomes high. From the residents' information, the catches are Tilapia and Freshwater Shrimp and the quantity of Tilapia per catch is about 3 kg.

(5) Estuary of Daorao Creek

Bocasit (snail) and Tokmem (clam) were taken by some women in this area at the time of survey. They dip into the water, look for Bocasit or Tokmem and catch with their bare hands. There was no information on fish in this area, but many fishponds breeding Tilapia exist nearby or in the sand dunes.

(6) Threatened, Endangered or Rare Species of Plants

Aquatic fauna noted in Daorao Creek were Tilapia, Carp, Mudfish, Catfish, Eel, Gurami, Freshwater Shrimp, Golden Snail (kuhol), Black Snail, Bocasit (snail), Tokmem (clam), Frog, etc. The water quality of the Daorao creek is polluted due to the wastewater entry from the urban area and agricultural waste. The pollution of the creek may not have reached the critical level as habitat for the above listed aquatic fauna. The suspended and dissolved solids and nitrogen will act as nutrients for these fauna.

Based on the survey and on secondary information, no threatened, endangered or rare species of aquatic fauna were identified in the Daorao-Tupec Creek System.

7.2 Future Environmental Conditions without the Project

It is essential to weigh the project's benefits against its impacts, comparing the future condition without the project against the condition where the project is implemented. Hence the future environmental conditions without the project are presented in this section.

Without the project, environmental conditions would remain the same except the following aspects.

7.2.1 Hydrology of the Daorao Creek

If the built-up area of Laoag City is expanded to the farmlands without the project, drainage conditions of the middle reaches of the creek, namely, from the downstream of Tupec Creek to the Vira Bridge of Daorao Creek including the confluent tributaries, would worsen by the concentration of flood discharge. Development of residential and commercial areas will require heightening of lands, so that the storage capacity of farmlands will become less.

Water quality of Daorao Creek as well as the San Isidro Creek, DM1 and DM2 will deteriorate further due to the use of more detergents and edible oil following the uplift of citizens' life. This problem is not directly related with the project, but should be considered in future for the conservation of human life.

7.2.2 Vegetation and Aquatic Fauna

Vegetation covering the project site is likely to remain the same without the proposed drainage improvement project. Aquatic fauna will also remain the same as the existing conditions, unless water pollution is otherwise accelerated.

7.2.3 Land and Resources Use

The expansion of the built-up area would be slow. The annual impact of flooding will still restrict the development of the urban area.

7.2.4 Socio-economic Aspects

Without any major socio-economic input into the area, the present socio-economic condition is expected to change slowly. The development of the urban area in accordance with the land use plan of Laoag City would be restricted or disturbed by the annual impact of flooding.

7.3 Environmental Impact Assessment

7.3.1 General

The potential impacts of the proposed project to the environment during the construction and operation phases were predicted and assessed. The construction phase will include channel excavation, earth filling and the construction of revetment, bridge, culvert, etc. These structures are all relatively small earth/aggregate/concrete structures along the riverbanks or within the riverbeds. On the other hand, the operation phase will be the use of these passive structures.

Identification of the potential environmental impacts was done by evaluating the project's features and operations against the known list of potential impacts identified by various sources for this type of project.

The above prediction and assessment presents the effects of the unmitigated impacts. The necessary measures to reduce or eliminate the impacts are proposed in the environmental management plan.

7.3.2 Prediction and Assessment of Impacts

Construction Phase Impacts

The identified potential impacts during the construction phase are water pollution, air pollution, noise generation, soil erosion, fish and wildlife disturbance, vegetation loss, land acquisition/house relocation, loss of archaeological/historical assets, traffic disturbance and local labor employment. Most of these impacts are short-term in nature.

(1) Water Pollution

The existing average water quality during dry season in the Daorao Creek is estimated, based on the tests conducted in the course of the Feasibility Study, as shown below.

Water Quality Parameter	Daorao Creek
pH	7.4
Conductivity	162
Total Phosphorus (mg/l)	0.28
BOD (mg/l)	1.8
Total Dissolved Solids (mg/l)	287
Total Suspended Solids (mg/l)	32
Nitrate (NO^3) (mg/l)	0.98
Oil and Grease (mg/l)	2.6
Dissolved Oxygen (mg/l)	5.9
Coliforms (MPN/100 ml)	260

Note : Water quality except for Coliform was observed in Feb.-Mar. 1997. Coliform was observed in June 1997.

The channel dredging and widening would be the source of water pollution. About 98,000 m^3. of soil will be excavated in the Urgent Urban Drainage Improvement. The dredging and widening will be done underwater. This means the water flows of these creeks are mixed with some soil. Suspended soils in the flow will be carried to the downstream of creeks. Turbidity of flow may increase and continue to about 4 to 5 km downstream during the period of dredging and widening works. The suspended soils, however, will soon be deposited at the stagnated points of flow. The impact to the habitat of fish is moderate due to the absence of toxic and hazardous material in the soil and water.

(2) Air Pollution

Air pollution would come from the use of heavy construction equipment and dust generation activities. However, this will be minimal since the number of heavy construction equipment is limited. On the other hand, unpleasant smell would also come from the excavated soils, if excavated material is wet and contain much decomposed organic material.

(3) Noise Generation

Operation of various construction equipment will be the major source of noise during construction works. This noise would be felt by the public especially in the residential areas. The operation of the construction equipment would be shifting daily and the number of construction equipment to be used is limited, so that the nuisance will be very short-lived and, therefore, minimal.

(4) Soil Erosion

Soil erosion might occur due to various earth-moving activities. However, this erosion is considered small since the clearing of sites of vegetation is limited.

(5) Fish and Wildlife Disturbance

During the excavation and revetment works of the creeks, habitat circumstances of the fishes and other aquatic fauna living in the area will be completely destroyed. Most fishes can take refuge in other areas but some aquatic fauna such as golden snail will be killed. Considering that the actual population of these fauna is low and they are categorized in the non-threatened fauna, the impact to the life of fishes and other aquatic fauna would be negligible.

Further, inland fishery production in the Daorao Creek is very low and it is limited to the downstream reaches. The existing fish species are Tilapia, Catfish, Mudfish, Eel and Gurami, all of which are not threatened, endangered or rare species.

No wildlife has been identified in the project sites.

During construction, a small number of fishes in the downstream may be affected by the suspended solids in the flow caused by the construction tail-water. However, this impact is expected to be only during the construction period and normal condition will be restored after construction.

(6) Vegetation Loss

There are some bushes and small trees along the banks of the Creek. Water hyacinth and other floating vegetation are identified within the creek. No threatened, endangered or rare species of plant and vegetation are identified among them. No significant negative impacts are expected in terms of vegetation cover since the clearing of vegetation is small.

(7) Land Acquisition and House Relocation

The required land acquisition and house relocation for the project are estimated as follows.

Item	Quantity
Land Acquisition (ha)	2.71
Farmland/Open Space (ha)	2.70
Residential Land (ha)	0.01
House Relocation (No.)	none

These land acquisitions are considered small compared to the beneficial land area of the project.

(8) Loss of Archaeological and Historical Assets

No stone age remains have been found in Ilocos Norte. Some Chinese historical properties in Tang, Sun, Yuan and Ming ages have been found along the coastal areas. However, no historical site in the project area is registered in the National Historical Institute.

(9) Traffic Disturbance

Traffic disturbance would come from the transportation of excavated soils. However, the impact on traffic is considered negligible, since the existing traffic volume in the project area and soil transportation volume are small.

(10) Local Labor Improvement

The project creates opportunities of temporary jobs during the construction period. The requirement of temporary laborers during the 2-year construction period is estimated as follows.

Kind of Laborer	Labor Force (man-day)
Skilled Laborer	13,000
Unskilled Laborer	52,000
Total	65,000

Besides these temporary workers, a lot of support services for the construction works will be required in the project area. These support services will create another job opportunity.

The environmental impacts of the project during the construction phase are summarized in Table A.7.2.

Operation Phase Impacts

The identified potential impacts during the operation phase are described below.

(1) Hydrological and River Morphological Changes

The project will not cause hydrological and river morphological changes.

(2) Water Pollution, Air Pollution and Noise

The project will not generate water pollution loads, air pollution loads and noise during the operation phase.

(3) Geological Destruction

No geological destruction is expected during the operation phase since the proposed structures are small.

(4) Ecological Loss and Disturbance

(a) Loss of Wildlife Habitat

There is no wildlife habitat in the project area.

(b) Disruption of Fish Spawning Grounds

The concrete lining of the riverbanks may reduce the spawning grounds of fish. However, the revetment works are limited to the San Isidro Creek (a tributary of Daorao Creek) where no fish has been identified.

(5) Aesthetic Impairment

(a) Aesthetic Impairment of Landscape

The proposed structures will not impair the landscape since they are small in size.

(b) Visual Impairment of Historical and Cultural Resources

There are no historical and cultural resources in the project area.

(6) Loss of Natural Resources Use

(a) Loss of Fishing Area

There is no fishing area around the proposed structure sites.

(b) Impairment of Navigation

There are no navigation activities in the project area.

(c) Damage to Economically Valuable Natural Resources

The project will not cause damage to the other economically valuable natural resources.

(7) Socio-economic Impact

(a) Reduction of Economic Loss

The project will reduce the existing flood damage on house buildings, household effects, commercial and industrial properties, physical and social infrastructures, etc.

(b) Reduction of Heath Risk

Floodwater carries toilet wastes, garbage and mud to the houses every flood time. Waterborne diseases frequently break out from these deposits. The project will reduce such health risk.

(c) Increase of Available Residential Land

According to the land use plan of the City, the residential area expansion is expected on the north of the existing built-up areas. However, this area is subject to flooding of the Daorao Creek at present. The project will enhance the residential land development.

The environmental impacts of the project during the operation phase are also summarized in Table A.7.2.

TABLES

Table A.1.1(1) Inventory of Major Assets in Laoag City

(A) Population/Household, Agriculture, Health, Education and Industrial Establishment

No.	Name of Barangay	Population	Household	Land Area (km2)	Agricultural Area (ha)*		Health Facility			Educational Facility				Industrial Establishment	
					Irrigated	Rainfed	Hospital	RHU	BHS	Pre School	Elem.	Second	Tertiary	Manufacturing	Trading
1	San Lorenzo (Pob.)	2,650	348	1.064	23						1			2	
2	Santa Joaquina (Pob.)	1,895	307	0.740				1		1				2	
3	Nstra. Sra. Del Rosario (Pob.)	1,018	118	0.152								1		1	2
4	San Guillermo (Pob.)	1,358	178	0.193					1	1	1			6	3
5	San Pedro (Pob.)	1,711	219	0.238								2	1	8	8
6	San Agustin (Pob.)	1,686	203	0.109						1	1	1	1	1	
7 - A	Nstra. Sra. De Natividad (Pob.)	1,227	160	0.084										4	5
7 - B	Nstra. Sra. De Natividad (Pob.)	1,011	120	0.132						2	1	1		3	1
8	San Vicente (Pob.)	1,317	153	0.099							1			1	11
9	Santa Angela (Pob.)	923	125	0.101										1	51
10	San Jose (Pob.)	1,076	140	0.143			1							1	9
11	Santa Balbina (Pob.)	1,481	185	0.140						1	1	1		12	26
12	San Isidro (Pob.)	1,746	234	0.267											6
13	Nstra. Sra. De Visitacion (Pob.)	1,158	143	0.193	18					2	2	1	1	2	26
14	Santo Tomas (Pob.)	1,257	92	0.046			1							2	14
15	San Guillermo (Pob.)	1,020	255	0.125						2	1	1		9	12
16	San Jacinto (Pob.)	900	169	0.148										6	69
17	San Francisco (Pob.)	1,309	115	0.148										4	31
18	San Quirino (Pob.)	1,100	118	0.259			1							5	13
19	Santa Marcela (Pob.)	1,158	199	0.231						1	2				3
20	San Miguel (Pob.)	1,019	162	0.240										1	4
21	San Pedro (Pob.)	1,398	215	0.328										2	8
22	San Andres (Pob.)	1,214	190	0.080											2
23	San Matias (Pob.)	2,119	270	0.992	35		1			1	1			1	3
24	Nstra. Sra. De Consolacion (Pob.)	957	162	0.100										1	
25	Santa Cayetana (Pob.)	978	159	0.108											
26	San Marcelinno (Pob.)	1,027	195	2.146										2	1
27	Nstra. Sra. De Soledad (Pob.)	1,310	183	0.255	16									5	2
28	San Bernardo (Pob.)	1,442	154	1.011	185			1			1	1		3	
29	Santo Tomas (Pob.)	864	195	1.065	42									1	1
30 - B	Santa Maria	1,060	174	1.872	141				1						
30 - A	Suyo	580	114	0.304	15						1				
31	Talingaan	884	164	5.665	10	67									
52 - B	Lataag	700	143	1.898	107										
52 - A	San Mateo	548	68	0.462	90				1		1				2
53	Rioeng	1,204	196	2.160	135						1			2	
54 - B	Camangaan	599	103	1.434	88										1
54 - A	Lagui-Sail	1,564	212	5.963	192						1				
55 - A	Barit-Pandan	1,564	267	3.126	120						1			1	3
55 - B	Salet-Bulangon	1,357	260	3.770	200						1				
55 - C	Vira	863	260	2.483	117						1				
57	Pila	1,437	223	2.721	128				1		1				

Table A.1.1(2) Inventory of Major Assets in Laoag City

(A) Population/Household, Agriculture, Health, Education and Industrial Establishment

No.	Name of Barangay	Population	Household	Land Area (km2)	Agricultural Area (ha)*		Health Facility			Educational Facility				Industrial Establishment	
					Irrigated	Rainfed	Hospital	RHU	BHS	Pre School	Elem.	Second	Tertiary	Manufacturing	Trading
58	Casili	689	118	0.992	74						1				
59 - B	Dibua North	619	98	2.025	80				1						
59 - A	Dibua South	686	120	2.141	80						1				
60 - A	Caaoacan	1,219	180	0.493					1		1				
60 - B	Madiladig	1,067	264	3.697	130				1		1				
61	Cataban	555	113	1.486	105						1				
62 - A	Navotas North	695	128	0.803	80				1					1	
62 - B	Navotas South	664	112	1.667	90						1				
32 - C	La Paz East	1,253	209	0.060								1			
32 - B	La Paz West	752	155	1.066										1	
32 - A	La Paz East	991	162	0.313										4	
33 - B	La Paz Proper	809	117	0.106					1		1				
33 - A	La Paz Proper	710	57	0.396								1		1	
34 - B	Gabu Norte East	971	128	0.030							1				
34 - A	Gabu Norte West	625	112	0.870					1						
35	Gabu Sur	1,356	253	1.066											2
36	Araniw	682	78	0.915		28					1			2	3
37	Calayab	1,691	277	4.083	23	44						1		2	
38 - A	Mangato East	784	111	1.095		72		1							
38 - B	Mangato West	757	146	1.014		60								1	
39	Santa Rosa	549	102	1.328		70					1			1	
40	Balatong	1,586	287	4.668		80					1			1	
41	Balacad	1,103	203	4.334	10	30					1				
42	Apaya	785	157	2.338	16	64								1	
43	Cavit	776	153	0.694		45					1				
44	Zamboanga	931	160	1.596		60									1
45	Tangid	804	157	1.312	70						1				2
46	Nalbo	1,388	230	1.052		45			1					3	2
47	Bengcag	1,432	226	2.136	74									4	
48 - A	Cabungaan North	1,326	269	1.570		55			1		1				1
48 - B	Cabungaan South	1,046	144	1.172		50									
49 - A	Darayday	840	361	1.314		90					1				
49 - B	Raraburan	791	144	0.696		65									
50	Buttong	2,074	330	1.604		80	1			1	2	1	1	1	
51 - A	Nangalisan East	1,010	147	0.591		5								14	10
51 - B	Nangalisan West	752	122	0.313		15								4	1
56 - A	Bacsil North	757	270	3.527	31	25			1		1				
56 - B	Bacsil South	1,122	177	5.109	30	24									
	Total	88,336	14,227	102.467	2,555	1,074	5	3	13	13	40	13	4	130	339

Note: *Total agricultural area, 7,710, hectares, includes potential agricultural land assessed by the City Assesor's Office.

Pob.: Poblacion (City Proper)

Table A.1.1(3) Inventory of Major Assets in Laoag City

(B) National Roads, Provincial / City Roads and Barangay Roads

ROADS	Road (km)			
	Concrete	Asphalt	Asphalt/Concrete	Gravel
NATIONAL ROADS				
Manila North Road			5.777	
Laoag-Airport Road	6.900			
Laoag-Sarrat Road			4.470	
Laoag-Paoay-Balacad Road		9.169		
Bonifacio-Ablan-Castro Street			2.347	
Bonifacio-Calipolapo-T.Pasion Road	2.353			
Laoag-Cadre Road			1.168	
Los Martirez De la Patria	0.288			
Sub Total of National Roads	9.541	9.169	13.762	
PROVINCIAL & CITY ROADS				
San Mateo - Lataag Bacsil Road	1.050			3.565
Laoag-Salet-Pasaqui-Vintar Road	0.350			1.898
Laoag-Ganagan Road	0.415			2.749
Laoag-Darayday Road				2.964
Laoag-Caaoacan Road	7.000			1.540
Laoag-Vintar Road	4.270	0.240		
Laoag-Navotas Road	0.650	0.100		2.109
Laoag-Vintar-Sarrat Road	0.150			3.385
Laoag-Vira Road	0.410			1.596
Prov'l. High Sch.-Vira Road	0.600			3.531
Laoag-La Paz Road	5.150	2.164		1.742
Barit Reservoir Road		0.200		0.834
Cavit-Gabu Norte Road	1.482			0.332
Pila-Dibua Norte Road	0.100			2.400
Navotas-Cataban Road	0.875	0.100		1.025
Cataban-Masayad Road	0.250			2.75
Siazon-Agustin Road	0.375			2.125
Abadilla Street	0.350	0.133		0.245
Don Mauricio Castro Avenue	0.083	0.418		
Almazan Street				0.380
A. Mabini Street		1.933		
Ambaristo Street				0.770
A. Novales Street	0.250			0.272
Andres Castro Street	0.190	0.414		0.238
Anacleto Del Rosario Street	0.495			
A. Bonifacio Street	0.319			
A. Regidor Street	0.166			0.222
5 De Agosto 1912 Street	0.200			0.170
Bagumbayan Street	1.614	0.450		
Balintawak Street	0.378	1.035		
Gov. Ablan Avenue	0.246			
Biaknabato Street	0.440			0.220
Blas Cid Street	0.160			
Claro Caluya Street	0.072	0.134		0.094
Diego Silang Street	0.100			0.446
Dandan Street	0.348			
Evangelista Street #2	0.123			0.422
Evangelista Street #1		0.162		0.128
Emilio Jacinto Street	0.360			0.427
Francisco Rivera Street				0.797
F.Roxas Street				0.080
Evangelista Street				0.160
Don Eleuterio Ruiz Street	0.255	0.329		0.016
Gov. Villanueva Street	0.183	0.078		0.257
F. Calderon Street	0.170			0.376
Gen. Malvar Street	0.180	0.636		
Guerrero Street		0.100		0.310

Table A.1.1(4) Inventory of Major Assets in Laoag City

(B) National Roads, Provincial / City Roads and Barangay Roads

ROADS	Road (km)			
	Concrete	Asphalt	Asphalt/Concrete	Gravel
Gen. G. Del Pilar Street				0.823
Gen. Antonio Luna Street	2.740	0.600		
Hernando Street	0.105			0.700
Herrera Street				0.491
Jose Zulueta Street	0.100	0.260		
Jose M. Basa Street	0.316			0.114
Jose Palma Street	0.091			0.140
Juan Luna Street	2.150	0.340		
Katipunan Street	0.290			0.547
Lincoln Street				0.621
Legaspi Street				0.586
Lopez Jaena St. (Tupas Ave.)	0.176	0.068		0.332
Lampitoc Street	0.315			0.345
Listo Street	0.090			0.100
Magallanes Street				0.496
Norayta Street	0.60			0.441
Marina Dizon Street	0.052	0.228		
P. Matias Castro Street	0.120			0.501
Manuel Nolasco Street	0.268	0.603		0.698
Gen Hizon Street	0.917	1.306		
M. Bitanga Street				0.249
M.H. Del Pilar Street	1.723			
A.P. Santos Street	0.315			0.605
Mckinley Street	1.728	0.200		
N. Adriano Street				0.300
Natalia Del Castillo Street				0.465
O. Franco Street				0.220
Prieto Street				0.481
Don Vicente Llanes Avenue	0.520	0.332		1.112
Don Severo Hernando Street	1.033			0.955
Paco Roman Street	0.347	0.534		0.490
Proscritos De Guam Street				0.080
P. Zamora Street (Gomburza)	0.882	1.630		
Gov. P. Lazaro Avenue		1.258		
Rajah Matanda Street	0.115			0.436
R. Hidalgo Street	0.664	0.116		
Salcedo Street				0.501
Solidaridad Street				0.586
Soriano Street				0.360
Salvador Street				0.150
Valentin Lagasca Street	0.481	0.224		1.693
D.J. Samonte Street		2.350		
Pasion Avenue (1913 St.)		1.041		1.202
4 De Abril 1908 Street				0.694
Teodora Alonzo Street	0.210			0.430
Zacarias Flores Street	0.415	0.255		0.098
Lakandula Street				0.220
Soliman Street				0.506
Torres Bugallon Street				0.020
Herbosa Street				0.320
Magat Salamat Street				0.291
M. Gomez Street	0.870	0.400		0.330
Gov. Solano Street				0.200
Prov'l. Capitol Road	0.100			
Sub Total of Provincial & City Roads	47.542	20.371	0.000	60.504

Table A.1.1(5) Inventory of Major Assets in Laoag City

(B) National Roads, Provincial / City Roads and Barangay Roads

ROADS	Road (km)			
	Concrete	Asphalt	Asphalt/Concrete	Gravel
BARANGAY ROADS				
30 - B Santa Maria	0.520	-		10.88
30 A Suyo	0.315	-		2.090
31 Talingaan	0.835	-		5.015
52 - B Lataag	0.850	-		8.000
52 - A San Mateo	0.325	-		0.825
53 Rioeng	0.635	-		4.535
54 - B Camangaan	0.325	-		2.871
54 - A Lagui-Sail	1.375	-		7.161
55 - A Barit-Pandan	0.585	0.840		5.225
55 - B Salet-Bulangon	0.675	-		3.255
55 - C Vira	0.385	-		5.465
57 Pila	1.535	-		7.135
58 Casili	0.685	-		4.605
59-B Dibua North	1.250	-		4.100
59-A Dibua South	1.815	-		4.455
60-A Caaoacan	1.250	-		3.675
60-B Madiladig	1.035	-		3.185
61 Cataban	0.365	-		1.335
62-A Navotas North	0.735	-		2.285
62-B Navotas South	0.545	-		2.125
32-C La Paz East	-	-		-
32-B La Paz West	2.300	-		-
32-A La Paz East	1.470	-		-
33-B La Paz Proper	1.220	-		1.220
33-A La Paz Proper	1.680	-		1.680
34-B Gabu Norte East	2.545	-		0.495
34-A Gabu Norte West	2.115	-		0.736
35 Gabu Sur	2.235	-		3.715
36 Araniw	1.635	-		3.915
37 Calayab	3.675	-		14.700
38-A Mangato East	0.865	-		1.165
38-B Mangato West	1.035	-		4.165
39 Santa Rosa	2.145	-		4.005
40 Balatong	2.580	-		5.075
41 Balacad	3.250	-		14.228
42 Apaya	0.840	-		4.511
43 Cavit	0.565	-		3.635
44 Zamboanga	0.765	-		6.370
45 Tangid	0.635	-		9.340
46 Nalbo	0.445	-		7.551
47 Bengcag	0.385	-		6.065
48-A Cabungaan North	0.480	-		9.02
48-B Cabungaan South	0.535	-		8.139
49-A Darayday	0.425	-		2.525
49-B Raraburan	0.475	-		2.535
50 Buttong	0.750	-		4.9
51-A Nangalisan East	0.615	-		1.835
51-B Nangalisan West	0.855	-		3.965
56-A Bascil North	0.860	-		3.39
56-B Bacsil South	0.755	-		4.285
Sub Total of Barangay Roads	54.175	0.840	0.000	221.387
Total of National/Provincial/City Roads and Barangay Roads	111.258	30.380	13.762	281.891
Grand Total	437.291 Km			

Table A.1.2 Future Land Use Plan of the Daorao-Tupee Creek Basin

FUTURE LAND USE PLAN	EXISTING LAND USE								
	Residential Area	Tree Area	Orchard Area	Grass Land	Paddy Field	Upland Crops	Sand Dune	River Bed	Future Land Use Total
Residential Area	430.8	15.3	1.2	6.2	131.5	9.3	0.0	0.0	594.3
Tree Area		1,132.1							1,132.1
Orchard Area			19.2						19.2
Grass Land				30.7					30.7
Paddy Field					1,793.4				1,793.4
Upland Crops						222.1			222.1
Sand Dune							54.8		54.8
River Bed								32.4	32.4
Existing Land Use Total	430.8	1,147.4	20.4	36.9	1,924.9	231.4	54.8	32.4	3,879.0

Table A.2.1 Flood Carrying Capacities of Rivers

(1) Daorao-Tupec Creek

Location	Flood Carrying Capacity (m^3/s)	
	Left Bank	Right Bank
0.00	123	874
0.50	46	72
1.00	91	28
1.50	15	33
2.00	18	21
2.40	114	114
2.50	38	37
3.00	65	42
3.50	59	46
4.00	50	49
4.50	58	46
5.00	112	66
5.30	273	273
5.50	36	50
6.00	40	35
6.50	44	52
6.68	60	60
7.00	55	32
7.50	35	34
8.00	123	123
8.25	25	21
8.50	98	30
8.75	19	66
9.00	25	36
9.25	15	20
9.35	100	100
9.50	100	23
9.75	73	19
9.85	26	24
10.00	16	69
10.25	38	30
10.50	38	27
10.75	38	40
10.97	88	88
11.50	22	22
12.00	23	22
12.50	27	36
13.00	4	11
13.30	18	18
13.43	25	25

(2) San Isidro Creek

Location	Flood Carrying Capacity (m^3/s)	
	Left Bank	Right Bank
0.00	29	49
0.20	138	138
0.25	24	61
0.37	37	53
0.50	26	66
0.58	16	14
0.75	5	6
0.81	6	6
0.87	5	5
1.00	2	2
1.09	2	2
1.19	3	3
1.48	3	3

Table A 3.1(1) Flood Damage in Laoag City by 1996 Typhoon Gloring

No.	Name of Barangay	Affected			Inundation Area (ha)	Industrial Establishment (no.)	Educational Facility (no.)	Health Facility (no.)	Road (km)					Damage Value (Peso)			
		Population	Families	Dwelling Units					Concrete	Asphalt	Gravel	Earth	Total	Agriculture	Fisheries	Livestock & Poultry	Infrastructure
1	San Lorenzo (Pob.)	354	86	50	1.74	2	1	-	3.94	1.683	5.01		10.633				
2	Santa Joaquina (Pob.)	-	-	-	55.72	2	1	1	3.16	1.35	4.02		8.53				
3	Nstra. Sra. Del Rosario (Pob.)	336	89	67	8.12	3	-	-	0.132	0.056	0.168		0.356				
4	San Guillermo (Pob.)	127	38	25	7.43	9	2	1	0.84	0.36	1.06		2.26				
5	San Pedro (Pob.)	-	-	-	13.29	8	3	-	0.52	0.22	0.66		1.4				
6	San Agustin (Pob.)	352	83	70	3.80	1	4	-	0.47	0.20	0.60		1.27				
7 - A	Nstra. Sra. De Natividad (Pob.)	-	-	-	2.60	9	-	-	0.37	0.16	0.47		1				
7 - B	Nstra. Sra. De Natividad (Pob.)	192	48	38	8.34	4	4	-	0.57	0.25	0.73		1.55				
8	San Vicente (Pob.)	464	116	93	4.06	10	1	-	0.39	0.162	0.50		1.052				
9	Santa Angela (Pob.)	412	103	82	2.05	26	-	-	0.22	0.095	0.28		0.595				
10	San Jose (Pob.)	216	54	43	2.20	3	-	1	0.186	0.081	0.237		0.504				
11	Santa Balbina (Pob.)	240	75	48	10.10	34	3	-	0.55	0.23	0.693		1.473				
12	San Isidro (Pob.)	605	152	121	16.10	6	-	-	1.044	0.45	1.332		2.826				
13	Nstra. Sra. De Visitacion (Pob.)	438	28	88	8.80	28	6	-	0.84	0.36	1.06		2.26				
14	Santo Tomas (Pob.)	262	52	52	2.10	13	1	-	0.18	0.072	0.225		0.477				
15	San Guillermo (Pob.)	231	47	46	16.36	19	3	-	0.486	0.207	0.621		1.314				
16	San Jacinto (Pob.)	322	87	64	7.78	60	-	-	0.512	0.224	0.656		1.392				
17	San Francisco (Pob.)	285	60	5	9.99	24	-	-	0.448	0.196	0.574		1.218				
18	San Quirino (Pob.)	-	-	-	8.05	11	-	1	0.678	0.288	0.858		1.824				
19	Santa Marcela (Pob.)	304	76	61	8.32	2	2	-	0.50	0.215	0.64		1.355				
20	San Miguel (Pob.)	195	65	39	8.36	2	-	-	0.416	0.18	0.532		1.128				
21	San Pedro (Pob.)	110	22	22	7.83	4	-	-	0.572	0.244	0.728		1.544				
22	San Andres (Pob.)	211	50	42	-	1	-	-	0.060	0.0255	0.075		0.1605				
23	San Matias (Pob.)	120	20	24	71.30	3	2	1	3.879	1.665	4.941		10.485	180			
24	Nstra. Sra. De Consolacion (Pob.)	465	116	93	-	1	-	-	0.215	0.095	0.275		0.585				
25	Santa Cayetana (Pob.)	353	70	70	2.10	-	-	-	0.169	0.072	0.216		0.457				
26	San Marcelinno (Pob.)	328	82	66	4.40	3	-	-	8.397	3.6	10.683		22.68				
27	Nstra. Sra. De Soledad (Pob.)	680	170	136	4.80	4	-	-	0.56	0.235	0.705		1.5				
28	San Bernardo (Pob.)	163	41	33	40.10	2	1	1	2.634	1.128	3.354		7.116				
29	Santo Tomas (Pob.)	125	30	25	-	2	-	-	4.167	1.782	5.301		11.25	720	9,000		
30 - B	Santa Maria	855	175	142	-	-	-	1	2.04	-	3.80		5.84				
30 - A	Suyo	78	15	16	33.20	-	1	-	0.315	-	2.090		2.405				
31	Talingaan	75	15	-	-								0	73,272			
52 - A	San Mateo	-	-	-	-	-	-	-					0	27,273			
52 - B	Lataag	150	40	-	-												
53	Rioeng	384	96	77	9.30	1	1	-	0.318	-	2.268		2.586	1,080			
54 - B	Camangaan	-	-	-	23.06	1	-	-	0.26	-	2.297		2.557	28,033			
54 - A	Lagui-Sail	305	69	61	140.00	-	1	-	0.688	-	3.805		4.493				
55 - A	Barit-Pandan	-	-	-	-								0				
55 - B	Salet-Bulangon	120	29	24	59.80	-	-		0.068	-	0.326		0.394				
55 - C	Vira				12.08	-	-	-	0.019	-	0.273		0.292	720			
57	Pila	995	199	166	119.00		1	1	0.614	-	2.854		3.468	46,713			
58	Casili	-	-	-	27.20	-	1	-	0.103	-	0.691		0.794	171,813		17,000	
59 - B	Dibua North	-	-	-	14.20	-	1	-	0.25	-	0.82		1.07				
59 - A	Dibua South	-	-	-	4.53								0			2,400	
60 - A	Caaoacan	387	105	55	110.00	-	1	1	0.75	-	2.205	-	2.955		3,000		
60 - B	Madiladig	20	4	4	48.30	-			0.828	-	2.548	-	3.376	2,160	1,500		
61	Catuban	-	-	-	98.60	-	1	-	0.310	-	1.134		1.444				
	Sub Total for City Proper (Poblacion)	7,890	1,860	1,503	336	296	34	6	37	16	47	0	100	900	9,000	0	
	Sub Total for Rural	3,369	747	545	699	2	8	3	7	0	25	0	32	351,064	4,500	19,400	
	Total for the Basin	11,259	2,607	2,048	1,035	298	42	9	44	16	72	0	132	351,964	13,500	19,400	

Table A 3.1(2) Flood Damage in Laoag City by 1996 Typhoon Gloring

No.	Name of Barangay	Affected			Inundation Area (ha)	Industrial Establishment	Educational Facility	Health Facility	Road (km)					Damage Value (Peso)			
		Population	Families	Dwelling Units					Concrete	Asphalt	Gravel	Earth	Total	Agriculture	Fisheries	Livestock & Poultry	Infrastructure
32 - C	La Paz East	-	-	-	-	-	-	-	-	-	-	-	0				
32 - B	La Paz West	241	60	48	-	-	-	-	-	-	-	-	0				
32 - A	La Paz East	242	51	41	-	-	-	-	-	-	-	-	0		7,350		
33 - B	La Paz Proper	605	121	97	-	-	-	-	-	-	-	-	0				
33 - A	La Paz Proper	182	45	36	-	-	-	-	-	-	-	-	0				
34 - B	Gabu Norte East	516	129	103	-	-	-	-	-	-	-	-	0				
34 - A	Gabu Norte West	607	121	97	-	-	-	-	-	-	-	-	0				
35	Gabu Sur	494	128	102	-	-	-	-	-	-	-	-	0				
36	Araniw	245	80	64	-	-	-	-	-	-	-	-	0				
37	Calayab	-	-	-	-	-	-	-	-	-	-	-	0				
38 - A	Mangato East	-	-	-	-	-	-	-	-	-	-	-	0	2,880			
38 - B	Mangato West	-	-	-	-	-	-	-	-	-	-	-	0				
39	Santa Rosa	321	75	60	-	-	-	-	-	-	-	-	0				
40	Balatong	489	105	84	-	-	-	-	-	-	-	-	0				
41	Baluarad	283	58	46	-	-	-	-	-	-	-	-	0				
42	Apuya	109	26	21	-	-	-	-	-	-	-	-	0				
43	Cavit	331	80	64	-	-	-	-	-	-	-	-	0	51,273	5,700	3,000	
44	Zamboanga	248	50	40	-	-	-	-	-	-	-	-	0	75,273	3,000	228,000	
45	Tangid	339	70	56	-	-	-	-	-	-	-	-	0				
46	Nalbo	616	154	123	-	-	-	-	-	-	-	-	0			600,000	
47	Bengcag	-	-	-	-	-	-	-	-	-	-	-	0				
48 - A	Cabungaan North	-	-	-	-	-	-	-	-	-	-	-	0	82,273	2,160	12,000	
48 - B	Cabungaan South	135	34	27	-	-	-	-	-	-	-	-	0	90,273			
49 - A	Darayday	115	29	23	-	-	-	-	-	-	-	-	0				
49 - B	Raraburan	-	-	-	-	-	-	-	-	-	-	-	0	40,000			
50	Buttong	383	81	65	-	-	-	-	-	-	-	-	0	43,273			
51 - A	Nangalisan East	908	227	182	-	-	-	-	-	-	-	-	0				
51 - B	Nangalisan West	832	208	166	-	-	-	-	-	-	-	-	0	400			
56 - A	Bacsil North	192	52	42	-	1	-	1	0.735	-	2.285	-	3.02	42,750	6,550		
56 - B	Bacsil South	-	-	-	-	-	1	-	0.218	-	0.85	-	1.068	75,500	7,350		
62 - A	Navotas North	5	1	1	-	1	-	-	-	-	-	-	0	27,273	14,250	1,200	
62 - B	Navotas South	-	-	-	-	-	-	-	-	-	-	-	0	126,000			
	Sub Total for outside of the Basin	8,438	1,985	1,588	0	2	1	1	0.953	0	3.135	0	4.088	657,168	46,300	844,200	
	Grand Total for the City	19,697	4,592	3,636	1,035.09	300	43	10	44.621	16	75.450	0	135.957	1,009,132	59,800	863,600	12,138,340

Table A.3.2 Flood Damage Value by Typhoon Gloring 1996

Area / Facility		Market Value (Pesos/Unit)	No.	Damage Rate	Damage Value (1000 Pesos)
1. CITY PROPER I					
a. Residential	Housing Unit*3	146,000	520	0.015	1,139
	Household Effects	39,000	520	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	453,000	42	0.180	3,425
	Inventory Stock	214,000	42	0.127	1,141
c. Hospital/Health Facilities	Depreciable Assets*5	680,000	2	0.180	245
	Inventory Stock	612,000	2	0.127	155
d. Educational Facilities	Depreciable Assets*6	569,000	7	0.180	717
	Inventory Stock	255,000	7	0.127	227
e. Agriculture					1
f. Fisheries					9
g. Livestock & Poultry					0
					7,059
2. CITY PROPER II					
a. Residential	Housing Unit*3	146,000	895	0.015	1,960
	Household Effects	39,000	895	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	453,000	251	0.180	20,467
	Inventory Stock	214,000	251	0.127	6,822
c. Hospital/Health Facilities	Depreciable Assets*5	680,000	3	0.180	367
	Inventory Stock	612,000	3	0.127	233
d. Educational Facilities	Depreciable Assets*6	569,000	26	0.180	2,663
	Inventory Stock	255,000	26	0.127	842
e. Agriculture					0
f. Fisheries					0
g. Livestock & Poultry					0
					33,354
3. CITY PROPER III					
a. Residential	Housing Unit*3	146,000	88	0.015	193
	Household Effects	39,000	88	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	453,000	4	0.180	326
	Inventory Stock	214,000	4	0.127	109
c. Hospital/Health Facilities	Depreciable Assets*5	680,000	1	0.180	122
	Inventory Stock	612,000	1	0.127	78
d. Educational Facilities	Depreciable Assets*6	569,000	1	0.180	102
	Inventory Stock	255,000	1	0.127	32
e. Agriculture					0
f. Fisheries					0
g. Livestock & Poultry					0
					963
4. RURAL AREA					
a. Residential	Housing Unit*7	73,000	545	0.015	597
	Household Effects	39,000	545	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	453,000	2	0.180	163
	Inventory Stock	214,000	2	0.127	54
c. Hospital/Health Facilities	Depreciable Assets*5	680,000	3	0.180	367
	Inventory Stock	612,000	3	0.127	233
d. Educational Facilities	Depreciable Assets*6	569,000	8	0.180	819
	Inventory Stock	255,000	8	0.127	259
e. Agriculture					351
f. Fisheries					5
g. Livestock & Poultry					19
					2,868

Source: NSO; Laoag City Assessor's Office

Note: *1 Unit values of facilities are based on values assessed by the city assesor.

*2 Values are converted through pirce index of 1.11 between 1995 and April 1997, and 1.02 between 1996 and April 1997.

*3 Weighted average of P113,885 in 1995 was reassessed to P126,000 applying the index 1.11.

*4 Weighted average of P403,584 in 1995 was reassessed to P448,000 applying the index 1.11.

*5 Weighted average of P612,364 in 1995 was reassessed to P680,000 applying the index 1.11.

*6 Weighted average of P512,273 in 1995 was reassessed to P569,000 applying the index 1.11.

*7 Weighted average of P66,214 in 1995 was reassessed to P73,000 applying the index 1.11.

Table A.4.1 Rainfall Intensity-Duration-Frequency Data

Return Period (yrs.)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs.	6 hrs.	12 hrs.	24 hrs.
2	14.2	22.2	29.1	35.2	45.5	55.1	62.2	73.5	82.2	88.8	99.5	108.8	143.7	184.0	213.2
3	17.2	26.5	34.6	41.7	53.5	64.7	73.2	86.9	97.8	106.5	120.6	132.5	175.6	224.4	262.6
5	20.3	31.0	40.4	48.5	62.0	74.9	84.8	101.1	114.2	125.1	142.8	157.5	209.3	267.1	314.7
10	24.3	36.8	47.9	57.3	73.0	88.0	99.8	119.3	135.4	149.1	171.4	189.7	252.8	322.1	381.9
15	26.6	40.1	52.1	62.3	79.1	95.4	108.2	129.6	147.4	162.6	187.6	207.9	277.3	353.1	419.9
20	28.2	42.3	55.1	65.7	83.4	100.6	114.1	136.8	155.7	172.1	198.9	220.6	294.4	374.9	446.4
25	29.4	44.1	57.4	68.4	86.7	104.6	118.6	142.3	162.2	179.4	207.6	230.4	307.7	391.6	466.9
50	33.2	49.6	64.4	76.6	97.0	116.9	132.6	159.4	182.0	201.9	234.4	260.7	348.4	443.2	529.9
100	37.0	55.0	71.4	84.8	107.1	129.1	146.5	176.4	201.8	224.2	261.1	290.7	388.8	494.3	592.5

Source: PAGASA, based on the data from 1955 to 1995

Table A.4.2 Parameter of Basin for Runoff Model

	Sub-basin	Area (ha)	Land Use (ha)				Roughness Coefficient N	Slope I	k	K
			Residential		Hill	Farm				
			High	Low						
1	CA-1	947.0	0.0	58.6	258.7	629.7	1.42	0.0048	6.1	26.2
2	CA-2	497.0	0.0	63.5	230.2	203.3	0.97	0.0063	4.5	16.5
3	CA-3	336.0	0.0	21.2	166.0	148.8	1.04	0.0111	3.9	13.0
4	CA-4	83.0	30.4	45.6	4.0	3.0	0.15	0.0013	2.4	5.7
5	CA-5	199.0	78.3	117.5	3.2	0.0	0.08	0.0014	1.6	4.7
6	CA-6	160.0	5.5	17.7	36.7	100.1	1.33	0.0026	7.1	19.9
7	CA-7	288.0	0.0	10.0	116.7	161.3	1.25	0.0021	7.3	23.5
8	CA-8	357.0	42.0	31.6	33.6	249.8	1.44	0.0029	7.2	24.4
9	CA-9	604.0	0.0	29.2	318.9	255.9	1.01	0.0014	7.2	27.7
10	CA-10	408.0	0.0	22.1	240.0	145.9	0.90	0.0015	6.6	23.1
Total		3879.0	243.3	329.9	1408.0	1897.8				

Table A.4.3 Dimension of Existing and Proposed Bridges and Culverts

BRIDGE

No.	Name	Station	Existing			Proposed			Creek
			Width (m)	Length (m)	Type	Width (m)	Length (m)	Type	
BR1	Daorao Bridge	DA-8.00	5.0	39.5	RC Bridge	5.0	39.5	RC Bridge	Daorao
BR2	Vira Bridge	DA-9.35	5.0	15.0	RC Bridge	5.0	38.2	PC Bridge	Daorao
BR3	San Isidro Bridge	SA-0.36	8.5	12.5	RC Bridge	8.5	29.7	PC Bridge	San Isidro
BR4	Pedisterian Bridge	SA-0.53	2.0	14.5	Steel Bridge	2.0	24.5	PC Bridge	San Isidro
BR5	Giron Bridge	SA-0.74	7.5	2.5	Box Culvert	7.5	23.3	PC Bridge	San Isidro
BR6	Tupec Bridge	DA-10.62	9.0	15.5	RC Bridge	9.0	24.8	PC Bridge	Daorao

Note: Width means road width. Length means bridge length

BOX CULVERT

No.	Name of Crossing Street/Structure	Station	Existing			Proposed			Drainage Main
			Width (m)	Height (m)	Type	Width (m)	Height (m)	Type	
Box1	Irrigational Canal	DM1-0.06	4.0	1.2	Box Culvert	5.0	2.8	Box Culvert	DM1
Box2	Mckinley Street	DM2-0.06	2.5	1.4	Box Culvert	5.2	2.7	Box Culvert	DM2
Box3	V.Lagasca Street	DM2-0.12	2.0	1.9	Box Culvert	5.1	2.6	Box Culvert	DM2
Box4	A.Castro Street	DM2-0.34	1.5	1.0	Box Culvert	5.0	2.5	Box Culvert	DM2
Box5	Bacarra Road	DM2-0.44	3.0	0.5	Box Culvert	5.0	2.5	Box Culvert	DM2
Box6	Irrigation Road	DM3-0.45				4.0	2.8	Box Culvert	DM3

Note: Width means internal width of box culvert. Height means internal height of box culvert

Table A.4.4 (1) Estimated Cost of Master Plan

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
I. Construction Cost				135,653
1.1 Preparatory Works (10% of 1.2 and 1.3)				12,332
1.2 Main Works				112,110
(1) Earth work				19,609
Excavation	m3	115	158,746	18,256
Embankment/Filling	m3	85	15,919	1,353
(2) Revetment Work (L=5,050 m)				41,291
Revetment Type RA				
Gravel	m3	510	6,214	3,169
Top Concrete	m3	2,500	504	1,260
Base Concrete	m3	3,500	1,316	4,606
Wet Masonry	m3	1,950	7,357	14,346
			Sub-total	23,381
Gabion Mattress	m3	1,300	1,569	2,040
Revetment Type RB				
Gravel	m3	510	3,457	1,763
Top&backfill Concrete	m3	2,500	2,012	5,030
Base Concrete	m3	3,500	562	1,967
Wet Masonry	m3	1,950	3,646	7,110
			Sub-total	15,870
(3) Bridge and Culvert Work				40,625
Bridge				36,501
Br1 (W=5m,L=39.5m)	m2	25,000	237	5,925
Br2 (W=5m,L=38.2m)	m2	28,000	229	6,412
Br3 (W=8.5m,L=29.7m)	m2	28,000	252	7,056
Br4 (w=2m,L=24.5m)	m2	28,000	98	2,744
Br5 (w=7.5m,L=23.3m)	m2	28,000	175	4,900
Br6 (w=9.0m,L=24.8m)	m2	28,000	248	6,944
Removal of Existing Bridge	m3	3,000	840	2,520
Box Culvert				4,124
Box1 (5.0*2.8*6.0)	pcs	282,000	1	282
Box2 (5.2*2.7*30.0)	pcs	1,434,000	1	1,434
Box3 (5.1*2.6*7.0)	pcs	328,000	1	328
Box4 (5.0*2.5*25.0)	pcs	1,144,000	1	1,144
Box5 (5.0*2.5*10.0)	pcs	458,000	1	458
Box6 (4.0*2.8*7.0)	pcs	286,000	1	286
Removal of Existing Box Culvert	m3	3,000	64	192
(4) Others				10,585
Waste Water Interceptor				5,015
RC Pipe 0.6m	m	1,900	1,700	3,230
RC Pipe 0.8m	m	2,100	850	1,785
Sluice	pcs	250,000	1	250
Drop	pcs	220,000	1	220
Mouth Opening				5,100
Backhoe (0.6m3)	pcs	2,200,000	1	2,200
Bulldozer (15t)	pcs	2,900,000	1	2,900
1.3 Miscellaneous Works (10% of 1.2)				11,211
II. Compensation Cost				12,050
2.1 Land Acquisition				11,600
Farm Open Space	ha	1,700,000	5.5	9,350
Residential Area	ha	15,000,000	0.15	2,250
2.2 House Resettlement	houses	150,000	3	450
III. Administration Cost (3% of I and II)				4,431
IV. Engineering Service Cost (16% of I)				21,704
Total of I, II, III and IV				173,838
V. Physical Contingency (10% of I, II, III and IV)				17,384
Grand Total				191,222

Table A.4.4 (2) Estimated Cost of Master Plan (Breakdown of Construction Cost)

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
1. Deorao Creek				
(1) DA-9.00~DA-9.69				16,401
Excavation	m3	115	28,428	3,269
Bridge				
Br1 (W=5m,L=39.5m)	m2	25,000	237	5,925
Br2 (W=5m,L=38.2m)	m2	28,000	229	6,412
			Sub-total	12,337
Removal of Existing Bridge				
Br1 (W=5m,L=39.5m)	m3	3,000	130	390
Br2 (W=5m,L=15m)	m3	3,000	135	405
			Sub-total	795
(2) DA-9.85~DA-10.80				23,590
Excavation	m3	115	46,634	5,363
Embankment/Filling	m3	85	12,551	1,067
			Sub-total	6,430
Revetment Type RA				
Gravel	m3	510	2,279	1,162
Top Concrete	m3	2,500	191	478
Base Concrete	m3	3,500	498	1,743
Wet Masonry	m3	1,950	2,608	5,086
			Sub-total	8,469
Gabion Mattress	m3	1,300	594	772
Bridge Br6 (w=9.0m,L=24.8m)	m2	28,000	248	6,944
Removal of Existing Bridge				
Br6 (W=9.0m,L=15.5m)	m3	3,000	325	975
2. San Isidro Creek				
(1) SA-0.00~SA-0.93				38,102
Excavation	m3	115	54,246	6,238
Embankment/Filling	m3	85	2,728	232
			Sub-total	6,470
Revetment Type RA				
Gravel	m3	510	3,935	2,007
Top Concrete	m3	2,500	313	783
Base Concrete	m3	3,500	818	2,863
Wet Masonry	m3	1,950	4,749	9,261
			Sub-total	14,914
Gabion Mattress	m3	1,300	975	1,268
Bridge				
Br3 (W=8.5m,L=29.7m)	m2	28,000	252	7,056
Br4 (w=2m,L=24.5m)	m2	28,000	98	2,744
Br5 (w=7.5m,L=23.3m)	m2	28,000	175	4,900
			Sub-total	14,700
Removal of Existing Bridge				
Br3 (W=8.5m,L=12.5m)	m3	3,000	230	690
Br5 (W=7.5m,L=2.5m)	m3	3,000	20	60
			Sub-total	750
3. Drainage Main				
(1) DM1: DM1-0.00~DM1-0.14				2,761
Excavation	m3	115	3,133	360
Filling	m3	85	282	24
			Sub-total	384
Revetment RB				
Gravel	m3	510	355	181
Top&backfill Concrete	m3	2,500	379	948
Base Concrete	m3	3,500	61	214
Wet Masonry	m3	1,950	367	716
			Sub-total	2,059

Table A.4.4 (3) Estimated Cost of Master Plan (Breakdown of Construction Cost)

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
Box1 (5.0*2.8*6.0)				
Base gravel	m3	510	7.08	4
Base Concrete	m3	2,500	3.54	9
Reinforced Concrete	m3	5,800	46.44	269
			Sub-total	282
Removal of Existing Box1	m3	3,000	12	36
(2) DM2: DM2-0.000~DM2-0.44				9,202
Excavation	m3	115	7,533	866
Filling	m3	85	358	30
			Sub-total	896
Revetment RB				
Gravel	m3	510	1,072	547
Top&backfill Concrete	m3	2,500	583	1,458
Basis concrete	m3	3,500	193	676
Wet Masonry	m3	1,950	1,095	2,135
			Sub-total	4,816
Box 2 (5.2*2.7*30.0)				
Base gravel	m3	510	36.60	19
Base Concrete	m3	2,500	18.30	46
Reinforced Concrete	m3	5,800	236.10	1,369
			Sub-total	1,434
Removal of Existing Box2	m3	3,000	8	24
Box 3 (5.1*2.6*7.0)				
Base gravel	m3	510	8.40	4
Base Concrete	m3	2,500	4.20	11
Reinforced Concrete	m3	5,800	53.90	313
			Sub-total	328
Removal of Existing Box3	m3	3,000	8	24
Box 4 (5.0*2.5*25.0)				
Base gravel	m3	510	29.50	15
Base Concrete	m3	2,500	14.75	37
Reinforced Concrete	m3	5,800	188.25	1,092
			Sub-total	1,144
Removal of Existing Box4	m3	3,000	10	30
Box5 (5.0*2.5*10.0)				
Base gravel	m3	510	11.80	6
Base Concrete	m3	2,500	5.90	15
Reinforced Concrete	m3	5,800	75.30	437
			Sub-total	458
Removal of Existing Box5	m3	3,000	16	48
(3) DM3-0.00~DM3-0.70				11,242
Excavation	m3	115	16,772	1,929
Revetment RB				
Gravel	m3	510	2,030	1,035
Top&backfill Concrete	m3	2,500	1,050	2,625
Base Concrete	m3	3,500	308	1,078
Wet Masonry	m3	1,950	2,184	4,259
			Sub-total	8,997
Box Culvert				
Box 6 (4.0*2.8*6.0)				
Base gravel	m3	510	6.86	3
Base Concrete	m3	2,500	3.43	9
Reinforced Concrete	m3	5,800	47.18	274
			Sub-total	286
Removal of Existing Box6	m3	3,000	10	30

Table A.5.1 (1) Estimated Cost of Urgent Plan

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
I. Construction Cost				86,020
1.1 Preparatory Works (10% of 1.2 and 1.3)				7,820
1.2 Main Works				71,091
(1) Earth work				11,893
Excavation	m3	115	97,528	11,216
Filling	m3	85	7,970	677
(2) Revetment Work (L=2,300 m)				16,473
Revetment Type RA				
Gravel	m3	510	2,381	1,214
Top Concrete	m3	2,500	205	513
Base Concrete	m3	3,500	536	1,876
Wet Masonry	m3	1,950	2,649	5,166
			Sub-total	8,769
Gabion Mattress	m3	1,300	639	831
Revetment Type RB				
Gravel	m3	510	1,427	728
Top&backfill Concrete	m3	2,500	962	2,405
Base Concrete	m3	3,500	254	889
Wet Masonry	m3	1,950	1,462	2,851
			Sub-total	6,873
(3) Bridge and Culvert Work				32,390
Bridge				28,582
Br1 (W=5m,L=39.5m)	m2	25,000	237	5,925
Br2 (W=5m,L=38.2m)	m2	28,000	229	6,412
Br3 (W=8.5m,L=29.7m)	m2	28,000	252	7,056
Br4 (w=2m,L=24.5m)	m2	28,000	98	2,744
Br5 (w=7.5m,L=23.3m)	m2	28,000	175	4,900
Removal of Existing Bridge	m3	3,000	515	1,545
Box Culvert				3,808
Box1 (5.0*2.8*6.0)	pcs	282,000	1	282
Box2 (5.2*2.7*30.0)	pcs	1,434,000	1	1,434
Box3 (5.1*2.6*7.0)	pcs	328,000	1	328
Box4 (5.0*2.5*25.0)	pcs	1,144,000	1	1,144
Box5 (5.0*2.5*10.0)	pcs	458,000	1	458
Removal of Existing Box Culvert	m3	3,000	54	162
(4) Others				10,335
Waste Water Interceptor				5,015
RC Pipe 0.6m	m	1,900	1,700	3,230
RC Pipe 0.8m	m	2,100	850	1,785
Drop	pcs	220,000	1	220
Mouth Opening				5,100
Backhoe (0.6m3)	pcs	2,200,000	1	2,200
Bulldozer (15t)	pcs	2,900,000	1	2,900
1.3 Miscellaneous Works (10% of 1.2)				7,109
II. Compensation Cost				4,740
2.1 Land Acquisition				4,740
Farm/Open Space	ha	1,700,000	2.7	4,590
Residential Area	ha	15,000,000	0.01	150
2.2 House Resettlement	houses	150,000	0	0
III. Administration Cost (3% of I and II)				2,723
IV. Engineering Service Cost (16% of I)				13,763
Total of I, II, III and IV				107,246
V. Physical Contingency (10% of I, II, III and IV)				10,725
Grand Total				117,971

Table A.5.1 (2) Estimated Cost of Urgent Plan (Breakdown of Construction Cost)

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
1. Daorao Creek				
(1) DA-9.00~DA-9.90				17,387
Excavation	m3	115	36,996	4,255
Bridge				
Br1 (W=5m,L=39.5m)	m2	25,000	237	5,925
Br2 (W=5m,L=38.2m)	m2	28,000	229	6,412
			Sub-total	12,337
Removal of Existing Bridge				
Br1 (W=5m,L=39.5m)	m3	3,000	130	390
Br2 (W=5m,L=15m)	m3	3,000	135	405
			Sub-total	795
2. San Isidro Creek				
(1) SA-0.00~SA-0.36				1,953
Excavation	m3	115	16,984	1,953
(2) SA-0.36~SA-0.93				29,454
Excavation	m3	115	32,882	3,781
Filling	m3	85	7,330	623
			Sub-total	4,404
Revetment Type RA				
Gravel	m3	510	2,381	1,214
Top Concrete	m3	2,500	205	513
Base Concrete	m3	3,500	536	1,876
Wet Masonry	m3	1,950	2,649	5,166
			Sub-total	8,769
Gabion Mattress	m3	1,300	639	831
Bridge				
Br3 (W=8.5m,L=29.7m)	m2	28,000	252	7,056
Br4 (w=2m,L=24.5m)	m2	28,000	98	2,744
Br5 (w=7.5m,L=23.3m)	m2	28,000	175	4,900
			Sub-total	14,700
Removal of Existing Bridge				
Br3 (W=8.5m,L=12.5m)	m3	3,000	230	690
Br5 (W=7.5m,L=2.5m)	m3	3,000	20	60
			Sub-total	750
3. Drainage Main				
(1) DM1: DM1-0.00~DM1-0.14				2,761
Excavation	m3	115	3,133	360
Filling	m3	85	282	24
			Sub-total	384
Revetment Type RB				
Gravel	m3	510	355	181
Top&backfill Concrete	m3	2,500	379	948
Base Concrete	m3	3,500	61	214
Wet Masonry	m3	1,950	367	716
			Sub-total	2,059

Table A.5.1 (3) Estimated Cost of Urgent Plan (Breakdown of Construction Cost)

Work Items	Unit	Unit Cost (Pesos)	Quantity	Amount (1000 Pesos)
Box1 (5.0*2.8*6.0)				
Base gravel	m3	510	7.08	4
Base Concrete	m3	2,500	3.54	9
Reinforced Concrete	m3	5,800	46.44	269
			Sub-total	282
Removal of Existing Box1	m3	3,000	12	36
(2) DM2: DM2-0.000~DM2-0.44				9,202
Excavation	m3	115	7,533	866
Filling	m3	85	358	30
			Sub-total	896
Revetment Type RB				
Gravel	m3	510	1,072	547
Top&backfill Concrete	m3	2,500	583	1,458
Basis concrete	m3	3,500	193	676
Wet Masonry	m3	1,950	1,095	2,135
			Sub-total	4,816
Box Culvert				
Box2 (5.2*2.7*30.0)				
Base gravel	m3	510	36.60	19
Base Concrete	m3	2,500	18.30	46
Reinforced Concrete	m3	5,800	236.10	1,369
			Sub-total	1,434
Removal of Existing Box2	m3	3,000	8	24
Box3 (5.1*2.6*7.0)				
Base gravel	m3	510	8.40	4
Base Concrete	m3	2,500	4.20	11
Reinforced Concrete	m3	5,800	53.90	313
			Sub-total	328
Removal of Existing Box3	m3	3,000	8	24
Box4 (5.0*2.5*25.0)				
Base gravel	m3	510	29.50	15
Base Concrete	m3	2,500	14.75	37
Reinforced Concrete	m3	5,800	188.25	1,092
			Sub-total	1,144
Removal of Existing Box4	m3	3,000	10	30
Box5 (5.0*2.5*10.0)				
Base gravel	m3	510	11.80	6
Base Concrete	m3	2,500	5.90	15
Reinforced Concrete	m3	5,800	75.30	437
			Sub-total	458
Removal of Existing Box5	m3	3,000	16	48

Table A.5.2 Annual Disbursement Schedule of Urgent PLan

(million pesos)

Description	TOTAL			1999			2000			2001		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1. Construction Cost	44.54	41.48	86.02	0.00	0.00	0.00	33.40	32.71	66.11	11.14	8.77	19.91
1.1 Preparatory Works (10% of 1.2 and 1.3)	4.05	3.77	7.82	0.00	0.00	0.00	4.05	3.77	7.82	0.00	0.00	0.00
1.2 Main Works	36.81	34.28	71.09	0.00	0.00	0.00	26.68	26.31	52.99	10.13	7.97	18.10
(1) Earth Works	7.65	4.24	11.89	0.00	0.00	0.00	7.65	4.24	11.89	0.00	0.00	0.00
Excavation	7.20	4.02	11.22	0.00	0.00	0.00	7.20	4.02	11.22	0.00	0.00	0.00
Filling	0.45	0.22	0.67	0.00	0.00	0.00	0.45	0.22	0.67	0.00	0.00	0.00
(2) Revetment Work	3.23	13.24	16.47	0.00	0.00	0.00	3.23	13.24	16.47	0.00	0.00	0.00
(3) Bridge and Culvert Work	18.13	14.26	32.39	0.00	0.00	0.00	8.00	6.29	14.29	10.13	7.97	18.10
Bridge	16.00	12.58	28.58	0.00	0.00	0.00	8.00	6.29	14.29	8.00	6.29	14.29
Box Culvert	2.13	1.68	3.81	0.00	0.00	0.00	0.00	0.00	0.00	2.13	1.68	3.81
(4) OtherWorks	7.80	2.54	10.34	0.00	0.00	0.00	7.80	2.54	10.34	0.00	0.00	0.00
Drop	0.18	0.04	0.22	0.00	0.00	0.00	0.18	0.04	0.22	0.00	0.00	0.00
Waste Water Intercepter	3.78	1.24	5.02	0.00	0.00	0.00	3.78	1.24	5.02	0.00	0.00	0.00
Mouth Opening	3.84	1.26	5.10	0.00	0.00	0.00	3.84	1.26	5.10	0.00	0.00	0.00
1.3 Miscellaneous Works (10% of 1.2)	3.68	3.43	7.11	0.00	0.00	0.00	2.67	2.63	5.30	1.01	0.80	1.81
2. Compensation Cost	0.00	4.74	4.74	0.00	4.74	4.74	0.00	0.00	0.00	0.00	0.00	0.00
3. Administration Cost	0.00	2.72	2.72	0.00	0.91	0.91	0.00	0.91	0.91	0.00	0.91	0.91
4. Engineering Service Cost	12.38	1.38	13.76	7.43	0.83	8.26	2.48	0.27	2.75	2.48	0.27	2.75
5. Physical Contingency	5.30	5.43	10.73	0.74	0.65	1.39	3.59	3.39	6.98	1.36	1.00	2.36
Sub-Total (1 to 5)	62.22	55.75	117.97	8.17	7.13	15.30	39.47	37.28	76.75	14.98	10.95	25.93
5. Price Contingency	3.98	12.83	16.81	0.33	1.03	1.36	2.42	8.39	10.81	1.23	3.41	4.64
6. Total (1+2+3+4+5)	66.20	68.58	134.78	8.50	8.16	16.66	41.89	45.67	87.56	16.21	14.36	30.57

Table A.6.1 Flood Potential Damage by a 5-year Return Period

Brgy. No.	Population *		Damage Property and Inundational Depth															
	Total	Damaged	Dwelling Units				Health/Hospital				Educational				Commercial/Industrial			
			0.1 - 0.5 m	0.5 - 1.0 m	1.0 - 1.5 m	Total	0.1 - 0.5 m	0.5 - 1.0 m	1.0 - 1.5 m	Total	0.1 - 0.5 m	0.5 - 1.0 m	1.0 - 1.5 m	Total	0.1 - 0.5 m	0.5 - 1.0 m	1.0 - 1.5 m	Total
4	136	52	9	0	0	9	1	0	0	1	2	0	0	2	9	0	0	9
5	1,027	390	70	0	0	70	0	0	0	0	3	0	0	3	16	0	0	16
6	506	192	34	0	0	34	0	0	0	0	4	0	0	4	1	0	0	1
7A	128	49	9	0	0	9	0	0	0	0	0	0	0	0	9	0	0	9
7B	1,011	378	67	0	3	70	0	0	0	0	4	0	0	4	4	0	0	4
8	1,054	401	65	11	0	76	0	0	0	0	1	0	0	1	11	1	0	12
9	831	284	17	50	0	67	0	0	0	0	0	0	0	0	18	31	0	49
10	1,076	409	29	65	0	94	0	1	0	1	0	0	0	0	4	6	0	10
11	1,481	535	55	58	3	116	0	0	0	0	2	1	0	3	21	16	0	37
12	1,397	504	52	49	13	114	0	0	0	0	0	0	0	0	3	2	0	5
13	1,100	397	67	6	0	73	0	0	0	0	5	0	0	5	25	1	0	26
14	1,257	406	70	3	0	73	0	0	0	0	0	0	0	0	14	1	0	15
15	918	314	55	2	0	57	0	0	0	0	3	1	0	4	18	2	0	20
16	855	270	45	10	0	55	0	0	0	0	0	0	0	0	44	6	0	50
17	1,178	22	4	0	0	4	0	0	0	0	0	0	0	0	2	0	0	2
18	990	8	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0
19	695	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	612	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	839	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	425	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1,907	362	65	0	0	65	0	0	0	0	1	1	0	2	4	0	0	4
24	287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	294	33	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
26	411	70	13	0	0	13	0	0	0	0	0	0	0	0	2	0	0	2
27	524	80	14	0	0	14	0	0	0	0	0	0	0	0	6	0	0	6
28	288	109	20	0	0	20	1	0	0	1	1	1	0	2	3	0	0	3
Total	21,227	5,265	767	254	19	1,040	3	1	0	4	26	4	0	30	214	66	0	280

* San Isidro Creek Basin only.

Table A.6.2 Flood Damage Value by 5-year Return Period Inundation

Area / Facility		Unit Value (Pesos/Unit)	No.	Damage Rate	Damage Value (1000 Pesos)
1. Inundation Depth = Less than 0.5m					
a. Residential	Housing Unit*3	126,000	767	0.015	1,450
	Household Effects	38,000	767	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	448,000	214	0.180	17,257
	Inventory Stock	210,000	214	0.127	5,707
c. Hospital/Health Facilitie	Depreciable Assets*5	680,000	3	0.180	367
	Inventory Stock	600,000	3	0.127	229
d. Educational Facilities	Depreciable Assets*6	569,000	26	0.180	2,663
	Inventory Stock	250,000	26	0.127	826
Sub-total					28,498
2. Inundation Depth = 0.5m - 1.0m					
a. Residential	Housing Unit*3	126,000	254	0.046	1,472
	Household Effects	38,000	254	0.000	0
b. Commercial/Industrial	Depreciable Assets*4	448,000	66	0.314	9,284
	Inventory Stock	210,000	66	0.276	3,825
c. Hospital/Health Facilitie	Depreciable Assets*5	680,000	1	0.314	214
	Inventory Stock	600,000	1	0.276	166
d. Educational Facilities	Depreciable Assets*6	569,000	4	0.314	715
	Inventory Stock	250,000	4	0.276	276
Sub-total					15,952
3. Inundation Depth = More than 1.0m					
a. Residential	Housing Unit*3	126,000	19	0.091	218
	Household Effects	38,000	19	0.263	190
b. Commercial/Industrial	Depreciable Assets*4	448,000	0	0.419	0
	Inventory Stock	210,000	0	0.378	0
c. Hospital/Health Facilitie	Depreciable Assets*5	680,000	0	0.419	0
	Inventory Stock	600,000	0	0.378	0
d. Educational Facilities	Depreciable Assets*6	569,000	0	0.419	0
	Inventory Stock	250,000	0	0.378	0
Sub-total					408
4. Total					
a. Residential	Housing Unit				3,140
	Household Effects				190
b. Commercial/Industrial	Depreciable Assets*4				26,541
	Inventory Stock				9,533
c. Hospital/Health Facilitie	Depreciable Assets*5				581
	Inventory Stock				394
d. Educational Facilities	Depreciable Assets*6				3,378
	Inventory Stock				1,102
Grand Total					44,858

Source: NSO; Laoag City Assessor's Office

Note: *1 Unit values of facilities are based on values assessed by the city assesor.
*2 Values are converted through pirce index of 1.11 between 1995 and April 1997, and 1.00 between 1996 and June 1998.
*3 Weighted average of P113,885 in 1995 was reassessed to P126,000 applying the index 1.11.
*4 Weighted average of P403,584 in 1995 was reassessed to P448,000 applying the index 1.11.
*5 Weighted average of P612,364 in 1995 was reassessed to P680,000 applying the index 1.11.
*6 Weighted average of P512,273 in 1995 was reassessed to P569,000 applying the index 1.11.
*7 Weighted average of P66,214 in 1995 was reassessed to P73,000 applying the index 1.11.

Table A.6.3 Damageable Property, Flood Damage and Flood Control Benefit of Urgent Plan in Financial Terms

Item	Return Period (Year)	
	2	5
I. Affected Population and Area		
1 Affected Population (Persons)	4,475	5,256
2 Area Inundated (ha)	109	122
II. Inundated Property		
1 Agricultural Land (ha)		
a. Irrigated Field	0	0
b. Rainfed Field	0	0
2 Buildings (Nos)		
a. Housing Units	895	1,040
b. Commercial/Factory	251	280
c. Educational Facility	26	30
d. Hospital/Health Facility	3	4
III. Estimated Value of Damaged Property (Million Pesos)		
1. Direct Damage Total	39.3	53.8
a. Agricultural Production	0.0	0.0
- Irrigated Field	0.0	0.0
- Rainfed Field	0.0	0.0
b. Housing Units	1.7	3.3
- Housing Unit	1.7	3.1
- Household Effects	0.0	0.2
c. Commercial/Factory	26.9	36.1
- Depreciable Assets	20.2	26.5
- Inventory Stock	6.7	9.5
d. Infrastructure	10.6	14.4
- Social Infrastructure	4.1	5.5
* Educational Facilites	3.5	4.5
- Depreciable Assets	2.7	3.4
- Inventory Stock	0.8	1.1
* Medical Facilites	0.6	1.0
- Depreciable Assets	0.4	0.6
- Inventory Stock	0.2	0.4
- Physical Infrastructure	6.5	9.0
2. Indirect Damage	3.9	5.4
3. Total	43.2	59.2
IV. Annual Benefit under Present Condition (in Million Pesos)		
Annual Benefit	10.8	26.2

Table A.6.4 Flood Damages Mitigated and Economic Annual Benefit of Urgent Plan in Economic Terms

Item	Return Period (Year)	
	2	5
I. Estimated Value of Damaged Property (Million Pesos)		
1. Direct Damage Total	32.7	44.7
a. Agricultural Production	0.0	0.0
- Irrigated Field	0.0	0.0
- Rainfed Field	0.0	0.0
b. Housing Units	1.4	2.8
- Housing Unit	1.4	2.6
- Household Effects	0.0	0.2
c. Commercial/Factory	22.6	30.3
- Depreciable Assets	17.0	22.3
- Inventory Stock	5.6	8.0
d. Infrastructure	8.7	11.7
- Social Infrastructure	3.2	4.2
* Educational Facilites	2.9	3.7
- Depreciable Assets	2.2	2.8
- Inventory Stock	0.7	0.9
* Medical Facilites	0.3	0.5
- Depreciable Assets	0.3	0.5
- Inventory Stock	0.0	0.0
- Physical Infrastructure	5.4	7.5
2. Indirect Damage	3.3	4.5
3. Total	35.9	49.2
II. Annual Benefit under Present Conditions (in Million Pesos)		
Annual Benefit	9.0	21.8
III. Projection of Benefit under Future Conditions (Million Pesos at 1996 Constant Prices)		
1. In the year 2000	10.8	26.0
2. In the year 2010	16.9	40.8
3. In the year 2020	22.9	55.3

Table A.6.5(1) Conversion Factor by Work Types

(1) Earth Work (Unit: Pesos)

Item	Total Construction Cost in Financial Value	Local Currency Portion			Foreign Currency Portion			Total Construction Cost in Economic Value
		Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	
Main Work								
1. Materials	0.9	0.3	-	0.0	0.6	-	0.75	0.8
a. Cement	0.0	0.0	0.53	0.0	0.0	1.0	0.00	0.0
b. Aggregate (Coarse & Fine)	0.0	0.0	0.68	0.0	0.0	1.1	0.00	0.0
c. Steel	0.0	0.0	0.24	0.0	0.0	1.1	0.00	0.0
d. Fuel & Lubricant	0.9	0.3	0.05	0.0	0.6	1.2	0.75	0.8
e. Lumber	0.0	0.0	0.80	0.0	0.0	1.0	0.00	0.0
f. Others	0.0	0.0	0.72	0.0	0.0	1.1	0.00	0.0
2. Machinery & Equipment Rent:	7.8	2.4	0.57	1.4	5.4	1.1	5.98	7.3
3. Labor	0.4	0.4	-	0.4	0.0	-	0.00	0.4
a. Skilled Workers	0.4	0.4	0.93	0.4	0.0	0.0	0.00	0.4
b. Unskilled Workers	0.0	0.0	0.60	0.0	0.0	0.0	0.00	0.0
4. Indirect Costs	2.8	2.8	-	1.4	0.0	-	0.00	1.4
a. Overhead & Miscellaneous	0.9	0.9	0.86	0.8	0.0	0.0	0.00	0.8
b. Profit	0.9	0.9	0.65	0.6	0.0	0.0	0.00	0.6
c. VAT*1	0.9	0.9	0.00	0.0	0.0	0.0	0.00	0.0
Total	11.9	5.9	-	3.2	6.0	-	6.73	9.9
Conversion Factor								**0.83**

Note: *1 Imposed on (2) Machinery & Equipment Rental and (3) Labor only.

Table A.6.5(2) Conversion Factor by Work Types

(2) Revetment Work (Unit: Pesos)

Item	Total Construction Cost in Financial Value	Local Currency Portion			Foreign Currency Portion			Total Construction Cost in Economic Value
		Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	
Main Work								
1. Materials	5.1	2.9	-	1.8	2.3	-	2.41	4.2
a. Cement	0.8	0.6	0.53	0.3	0.2	1.0	0.21	0.5
b. Aggregate (Coarse & Fine)	3.4	2.1	0.68	1.4	1.3	1.1	1.42	2.8
c. Steel	0.9	0.2	0.24	0.0	0.7	1.1	0.73	0.8
d. Fuel & Lubricant	0.0	0.0	0.05	0.0	0.0	1.2	0.04	0.0
e. Lumber	0.0	0.0	0.80	0.0	0.0	1.0	0.00	0.0
f. Others	0.0	0.0	0.72	0.0	0.0	1.1	0.00	0.0
2. Machinery & Equipment Rent:	0.4	0.1	0.57	0.1	0.3	1.1	0.31	0.4
3. Labor	7.3	7.3	-	4.8	0.0	-	0.00	4.8
a. Skilled Workers	1.4	1.4	0.93	1.3	0.0	0.0	0.00	1.3
b. Unskilled Workers	5.9	5.9	0.60	3.5	0.0	0.0	0.00	3.5
4. Indirect Costs	3.7	3.7	-	1.9	0.0	-	0.00	1.9
a. Overhead & Miscellaneous	1.3	1.3	0.86	1.1	0.0	0.0	0.00	1.1
b. Profit	1.3	1.3	0.65	0.8	0.0	0.0	0.00	0.8
c. VAT*1	1.1	1.1	0.00	0.0	0.0	0.0	0.00	0.0
Total	16.5	13.9	-	8.6	2.5	-	2.72	11.3
Conversion Factor								**0.69**

Note: *1 Imposed on (2) Machinery & Equipment Rental and (3) Labor only.

Table A.6.5(3) Conversion Factor by Work Types

(3) Bridge and Culvert Work (Unit: Pesos)

Item	Total Construction Cost in Financial Value	Local Currency Portion			Foreign Currency Portion			Total Construction Cost in Economic Value
		Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	
Main Work								
1. Materials	20.5	7.3	-	3.9	13.2	-	13.96	17.9
a. Cement	1.2	0.4	0.53	0.2	0.9	1.0	0.89	1.1
b. Aggregate (Coarse & Fine)	2.4	1.0	0.68	0.7	1.3	1.1	1.43	2.1
c. Steel	12.4	2.5	0.24	0.6	9.9	1.1	10.52	11.1
d. Fuel & Lubricant	0.2	0.1	0.05	0.0	0.2	1.2	0.19	0.2
e. Lumber	0.0	0.0	0.80	0.0	0.0	1.0	0.00	0.0
f. Others	4.2	3.3	0.72	2.4	0.9	1.1	0.93	3.3
2. Machinery & Equipment Rent:	1.7	0.6	0.57	0.3	1.2	1.1	1.28	1.6
3. Labor	3.4	3.4	-	2.4	0.0	-	0.00	2.4
a. Skilled Workers	1.0	1.0	0.93	0.9	0.0	0.0	0.00	0.9
b. Unskilled Workers	2.4	2.4	0.60	1.4	0.0	0.0	0.00	1.4
4. Indirect Costs	6.8	6.8	-	3.9	0.0	-	0.00	3.9
a. Overhead & Miscellaneous	2.5	2.5	0.86	2.2	0.0	0.0	0.00	2.2
b. Profit	2.5	2.5	0.65	1.7	0.0	0.0	0.00	1.7
c. VAT*1	1.7	1.7	0.00	0.0	0.0	0.0	0.00	0.0
Total	32.4	18.1	-	10.4	14.3	-	15.23	25.7
Conversion Factor								**0.79**

Note: *1 Imposed on (2) Machinery & Equipment Rental and (3) Labor only.

Table A.6.5(4) Conversion Factor by Work Types

(4) Other Works

(Unit: Pesos)

Item	Total Construction Cost in Financial Value	Local Currency Portion			Foreign Currency Portion			Total Construction Cost in Economic Value
		Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	Construction Cost in Financial Value	Conversion Rate	Construction Cost in Economic Value	
Main Work								
1. Materials	2.6	0.3	-	0.1	2.3	-	2.41	2.6
a. Cement	0.2	0.0	0.53	0.0	0.2	1.0	0.17	0.2
b. Aggregate (Coarse & Fine)	0.5	0.2	0.68	0.1	0.4	1.1	0.38	0.5
c. Steel	1.9	0.1	0.24	0.0	1.7	1.1	1.83	1.9
d. Fuel & Lubricant	0.0	0.0	0.05	0.0	0.0	1.2	0.03	0.0
e. Lumber	0.0	0.0	0.80	0.0	0.0	1.0	0.00	0.0
f. Others	0.0	0.0	0.72	0.0	0.0	1.1	0.00	0.0
2. Machinery & Equipment Rent:	5.3	0.5	0.57	0.3	4.8	1.1	5.34	5.6
3. Labor	1.3	1.3	-	0.8	0.0	-	0.00	0.8
a. Skilled Workers	0.3	0.3	0.93	0.2	0.0	0.0	0.00	0.2
b. Unskilled Workers	1.0	1.0	0.60	0.6	0.0	0.0	0.00	0.6
4. Indirect Costs	1.2	1.2	-	0.6	0.0	-	0.00	0.6
a. Overhead & Miscellaneous	0.4	0.4	0.86	0.4	0.0	0.0	0.00	0.4
b. Profit	0.4	0.4	0.65	0.3	0.0	0.0	0.00	0.3
c. VAT*1	0.3	0.3	0.00	0.0	0.0	0.0	0.00	0.0
Total	10.3	3.2	-	1.9	7.1	-	7.75	9.7
Conversion Factor								**0.93**

Note: *1 Imposed on (2) Machinery & Equipment Rental and (3) Labor only.

Table A.6.6 Financial and Economic Costs, and Conversion Factors by Urgent Plan

Work Item	Financial Costs (Mil. Pesos)	Conversion Factor	Economic Costs (Mil. Pesos)
1. Main Construction Works	86.0	*0.80*	68.4
1.1 Preparatory Works (10% of 1.2 &1.3)	7.8		6.2
1.2 Main Works	71.1	*0.80*	56.5
1.2.1 Earth Work *1	11.9	*0.83*	9.9
1.2.2 Revetment Work *1	16.5	*0.69*	11.3
1.2.3 Bridge and Culvert Work *1	32.4	*0.79*	25.7
1.2.4 Other Works *1	10.3	*0.93*	9.7
1.3 Miscellaneous Works (10% of 1.2)	7.1		5.7
2. Compensation Cost	4.7		0.0
2.1 Land Acquisition	4.7	0.00	0.0
2.2 House Resettlement	0.0	0.83	0.0
3. Administration Cost (3% of 1 and 2) *3	2.7	0.95	2.6
4. Engineering Services Cost (16% of 1) *4	13.8	1.10	15.1
5. Physical Contingency (10% of 1, 2, 3 and 4)	10.7	*0.80*	8.6
Total	118.0	*0.80*	94.7

Note: * Italic figures of the conversion factors are calculated as a comprehensive factor based on the results of work types.
*1 Refer to Table A.6.5.
*2 Applied the conversion factor of a housing unit
*3 Refer to the conversion factor in Table E.2.3 of Appendix E in Part 2.
*4 Refer to the conversion factor in the case of including both local and foreign portions in Table E.: Appendix E in Part 2.

Table A.6.7 Economic Cost and Benefit Stream of Flood Control Urgent Plan in Laoag City under Present Conditions

(Unit : Million Pesos)

Serial Year	Year	Cost			Benefit			Balance
		Construction	O&M	Total	Flood Control	Negative	Total	
1	1999	11.06		11.06			0.00	-11.06
2	2000	62.07		62.07		0.02	-0.02	-62.07
3	2001	21.62	0.26	21.88	16.75	0.02	16.73	-5.12
4	2002		0.34	0.34	21.80	0.02	21.78	21.46
5	2003		0.34	0.34	21.80	0.02	21.78	21.46
6	2004		0.34	0.34	21.80	0.02	21.78	21.46
7	2005		0.34	0.34	21.80	0.02	21.78	21.46
8	2006		0.34	0.34	21.80	0.02	21.78	21.46
9	2007		0.34	0.34	21.80	0.02	21.78	21.46
10	2008		0.34	0.34	21.80	0.02	21.78	21.46
11	2009		0.34	0.34	21.80	0.02	21.78	21.46
12	2010		0.34	0.34	21.80	0.02	21.78	21.46
13	2011		0.34	0.34	21.80	0.02	21.78	21.46
14	2012		0.34	0.34	21.80	0.02	21.78	21.46
15	2013		0.34	0.34	21.80	0.02	21.78	21.46
16	2014		0.34	0.34	21.80	0.02	21.78	21.46
17	2015		0.34	0.34	21.80	0.02	21.78	21.46
18	2016		0.34	0.34	21.80	0.02	21.78	21.46
19	2017		0.34	0.34	21.80	0.02	21.78	21.46
20	2018		0.34	0.34	21.80	0.02	21.78	21.46
21	2019		0.34	0.34	21.80	0.02	21.78	21.46
22	2020		0.34	0.34	21.80	0.02	21.78	21.46
23	2021		0.34	0.34	21.80	0.02	21.78	21.46
24	2022		0.34	0.34	21.80	0.02	21.78	21.46
25	2023		0.34	0.34	21.80	0.02	21.78	21.46
26	2024		0.34	0.34	21.80	0.02	21.78	21.46
27	2025		0.34	0.34	21.80	0.02	21.78	21.46
28	2026		0.34	0.34	21.80	0.02	21.78	21.46
29	2027		0.34	0.34	21.80	0.02	21.78	21.46
30	2028		0.34	0.34	21.80	0.02	21.78	21.46
31	2029		0.34	0.34	21.80	0.02	21.78	21.46
32	2030		0.34	0.34	21.80	0.02	21.78	21.46
33	2031		0.34	0.34	21.80	0.02	21.78	21.46
34	2032		0.34	0.34	21.80	0.02	21.78	21.46
35	2033		0.34	0.34	21.80	0.02	21.78	21.46
36	2034		0.34	0.34	21.80	0.02	21.78	21.46
37	2035		0.34	0.34	21.80	0.02	21.78	21.46
38	2036		0.34	0.34	21.80	0.02	21.78	21.46
39	2037		0.34	0.34	21.80	0.02	21.78	21.46
40	2038		0.34	0.34	21.80	0.02	21.78	21.46
41	2039		0.34	0.34	21.80	0.02	21.78	21.46
42	2040		0.34	0.34	21.80	0.02	21.78	21.46
43	2041		0.34	0.34	21.80	0.02	21.78	21.46
44	2042		0.34	0.34	21.80	0.02	21.78	21.46
45	2043		0.34	0.34	21.80	0.02	21.78	21.46
46	2044		0.34	0.34	21.80	0.02	21.78	21.46
47	2045		0.34	0.34	21.80	0.02	21.78	21.46
48	2046		0.34	0.34	21.80	0.02	21.78	21.46
49	2047		0.34	0.34	21.80	0.02	21.78	21.46
50	2048		0.34	0.34	21.80	0.02	21.78	21.46
51	2049		0.34	0.34	21.80	0.02	21.78	21.46
52	2050		0.34	0.34	21.80	0.02	21.78	21.46
53	2051		0.34	0.34	21.80	0.02	21.78	21.46

NPV: 33.9 B/C: 1.47 EIRR : 22.0%

Table A.6.8 Economic Cost and Benefit Stream of Flood Control Urgent Plan in Laoag City under Future Conditions

(Unit : Million Pesos)

Serial Year	Year	Cost			Benefit			Balance
		Construction	O&M	Total	Flood Control	Negative	Total	
1	1999	11.06		11.06			0.00	-11.06
2	2000	62.07		62.07		0.03	-0.03	-62.07
3	2001	21.62	0.26	21.88	20.92	0.03	20.89	-0.96
4	2002		0.34	0.34	28.47	0.03	28.45	28.13
5	2003		0.34	0.34	29.78	0.03	29.76	29.44
6	2004		0.34	0.34	31.15	0.03	31.13	30.81
7	2005		0.34	0.34	32.59	0.03	32.56	32.25
8	2006		0.34	0.34	34.09	0.03	34.06	33.75
9	2007		0.34	0.34	35.66	0.03	35.62	35.31
10	2008		0.34	0.34	37.30	0.03	37.26	36.95
11	2009		0.34	0.34	39.01	0.03	38.98	38.67
12	2010		0.34	0.34	40.81	0.04	40.77	40.46
13	2011		0.34	0.34	42.06	0.04	42.03	41.72
14	2012		0.34	0.34	43.36	0.04	43.32	43.02
15	2013		0.34	0.34	44.70	0.04	44.66	44.36
16	2014		0.34	0.34	46.08	0.04	46.03	45.73
17	2015		0.34	0.34	47.50	0.04	47.45	47.15
18	2016		0.34	0.34	48.96	0.04	48.92	48.62
19	2017		0.34	0.34	50.47	0.04	50.42	50.13
20	2018		0.34	0.34	52.02	0.05	51.98	51.68
21	2019		0.34	0.34	53.63	0.05	53.58	53.29
22	2020		0.34	0.34	55.28	0.05	55.23	54.94
23	2021		0.34	0.34	55.28	0.05	55.23	54.94
24	2022		0.34	0.34	55.28	0.05	55.23	54.94
25	2023		0.34	0.34	55.28	0.05	55.23	54.94
26	2024		0.34	0.34	55.28	0.05	55.23	54.94
27	2025		0.34	0.34	55.28	0.05	55.23	54.94
28	2026		0.34	0.34	55.28	0.05	55.23	54.94
29	2027		0.34	0.34	55.28	0.05	55.23	54.94
30	2028		0.34	0.34	55.28	0.05	55.23	54.94
31	2029		0.34	0.34	55.28	0.05	55.23	54.94
32	2030		0.34	0.34	55.28	0.05	55.23	54.94
33	2031		0.34	0.34	55.28	0.05	55.23	54.94
34	2032		0.34	0.34	55.28	0.05	55.23	54.94
35	2033		0.34	0.34	55.28	0.05	55.23	54.94
36	2034		0.34	0.34	55.28	0.05	55.23	54.94
37	2035		0.34	0.34	55.28	0.05	55.23	54.94
38	2036		0.34	0.34	55.28	0.05	55.23	54.94
39	2037		0.34	0.34	55.28	0.05	55.23	54.94
40	2038		0.34	0.34	55.28	0.05	55.23	54.94
41	2039		0.34	0.34	55.28	0.05	55.23	54.94
42	2040		0.34	0.34	55.28	0.05	55.23	54.94
43	2041		0.34	0.34	55.28	0.05	55.23	54.94
44	2042		0.34	0.34	55.28	0.05	55.23	54.94
45	2043		0.34	0.34	55.28	0.05	55.23	54.94
46	2044		0.34	0.34	55.28	0.05	55.23	54.94
47	2045		0.34	0.34	55.28	0.05	55.23	54.94
48	2046		0.34	0.34	55.28	0.05	55.23	54.94
49	2047		0.34	0.34	55.28	0.05	55.23	54.94
50	2048		0.34	0.34	55.28	0.05	55.23	54.94
51	2049		0.34	0.34	55.28	0.05	55.23	54.94
52	2050		0.34	0.34	55.28	0.05	55.23	54.94
53	2051		0.34	0.34	55.28	0.05	55.23	54.94

NPV: 105.1 B/C: 2.45 EIRR : 31.9%

Table A.7.1 Flora And Fauna Along The Daorao-Tupec Creek Drainage System

Scientific Name	Common Name			Scientific Name	Common Name		
	English	Ilocano	Tagalog		English	Ilocano	Tagalog
Non-Dipterocarps				**Bamboo**			
Samunea saman	Acacia	Acacia	Akasya	*Schizostachyum lumanycao*	Bamboo	Boho	Boho
Aotocarpus beterophylla Lmk.	Jack Fruit	Anangka	Langka	*Dendrocalamus merillionos*	Bamboo	Bayog	Bayog
Persea ameicana Mill.	Avocado	Avocado	Abokado	*Bambusa vulgaris schrad*	Bamboo	Kawayan	Kawayan
Psidium guajava Linn.	Guava	Bayawas	Bayabas				
Bougainvilla sp.	Bougainvillea	Isparlatina	Bongemvila	**Grasses**			
Nephelium sp.	Bulala	Bulala	Bulala		Reed		
Chrysophyllum cainito Linn	Star apple	Caimito	Kaimito	*Antigonon leptotus Hook & Arn*	Cadena de amor	Cadena de amor	Cadena de amor
Anacardium occidentale	Cashew	Casoy	Kasuy	*Imperata cylindrica Linn*	Cogon	Kogon	Kogon
Pithecolobium dulce (Roxb.) Benth	Camachile	Damortis	Kamatsile	*Lantana camara*	Wild sugar cane	Lidda	Talahib
Syzygium cumini (Linn)Skeels	Jambolan plum	Duhat (Lumboy)	Duhat			Parparitooc	
Leucaena Glauca (L.) Benth	Ipil-ipil	Ipil-ipil	Ipil-ipil				
Delonix regia (png) paf.	Fire Tree			**Water Plant (aquatic flora)**			
	Aroma	Kandaruma	Aroma	*Ipomoea aquatica*		Balangeg	Kangkong
ceiba pentandra	Kapok	Kapasagra	Kapok	*Eichornia crassipes (Mart) Cslus*	Water Hyacinth		
Sesbania grandiflora	Katurai	Katuday	Katuray				
Diospyros discolor	Camagon	Mabolo	Mabolo	**Fauna**			
Gliricidia sepium	Madre Cacao	Kakauate	Madre de Cacao		Frog	Tukak	Palaka
Mangifera indica	Mango	Mangga	Mangga		Goby	Birot / Birut	
Moringa oleifera	Horse radish	Marunggay	Malunggay	*Polinices powisianus*	Black snail	Bisukol	Kuhol
Pterocarpus indicus	Narra	Narra	Narra		Snail	Bocasit	Suso
Cocos Nucifera	Coconut	Niyog	Niyog	*Cyprinus carpio*	Carp	Carpa	Karpa
Artocarpus sp.		Pakak	Kamansi	*Ophicephalus striatus*	Mudfish	Dalag	Dalag
Cacarica papaya	Papaya	Papaya	Papaya		Yellow snail	Golden Kuhol	Kuhol
Averhoa balimbi Linn.	Kamias	Piyas	Kamias	*Trichogaster tricoptherus*	Climbing perch	Gouramy	Guramı
Veitchia merriliu	Palm Tree	Labig		*Anguila pacifica*	Eel	Igat	Igat
Musa sapientum	Banana	Saba	Saging	*Potamon Anomalus*	Native Crab	Kappi	Alimango
Tamarindous indica L.	Tamarind	Salamagi	Sampalok	*Clorias batrachus*	Catfish	Paltat	Hito
Terminalia catappa	Umbrella Tree	Salaysay	Talisay	*Tilapia mossambica*	Tilapia	Tilapia	Tilapia
Ficus nota (Blanco) Merr.		Tib beg	Tib beg	*Glycymeres reevei*	clam	Tukmem	Tulya
				Penacus setiferus	Shrimp	Udang	Hipon

Table A.7.2 Scaling Checklist for Environmental Impacts

(Construction Phase)

Impact Area	Direct Impact	Nature	Magnitude
Water Quality/Air Quality/ Noise	Water Pollution	Negative	Moderate
	Air Pollution	Negative	Minimal
	Noise Generation	Negative	Minimal
Geology	Soil Erosion	Negative	Minimal
Ecology	Fish/Wildlife Disturbance	Negative	Minimal
	Vegetation Loss	Negative	Minimal
Socio-Economy	Land Aquisition/House Relocation	Negative	Minimal
	Archaeological/Historical Asset Loss	Negative	No Effect
	Traffic Disturbance	Negative	Minimal
	Local Labor Employment	Positive	Significant

(Operation Phase)

Impact Area	Direct Impact	Nature	Magnitude
Hydrology/River Morphology	Hydrological/River Morphological Change	Negative	Minimal
Water Quality/Air Quality/ Noise	Generation of Water Pollutants	Negative	No Effect
	Generation of Air Pollutants	Negative	No Effect
	Generation of Noise	Negative	No Effect
Geology	Geological Destruction	Negative	No Effect
Ecology	Loss of Wildlife Habitat	Negative	No Effect
	Disruption of Fish Spawning Grounds	Negative	No Effect
Aesthetics	Aesthetic Impairment of Landscape	Negative	No Effect
	Visual Impairment of Historical/ Cultural Resources	Negative	No Effect
Natural Resources Use	Loss of Fishing Area	Negative	No Effect
	Impairment of Navigation	Negative	No Effect
	Damage to Economically Valuable Natural Resources	Negative	No Effect
Socio-Economy	Reduction of Economical Loss	Positive	Significant
	Reduction of Health Risk	Positive	Significant
	Increase of Available Residential Land	Positive	Significant