Chapter 4. Analysis of Future Population and Land Use in the Study Area

4.1 Current Land Use Plan

Each of the cities/municipalities in the Study Area has prepared a comprehensive land use plan (hereinafter referred to as CLUP) for its jurisdiction. These CLUPs were combined and integrated into one map in the Study as shown in Fig. 4.1 and Table 4.1. The land uses projected in the CLUPs are further summarized in the table below.

Table R 4.1 Existing and Future Land Use Projected by City/Municipality in the Study Area

Land Use		Present (As of 2003)		Future (Projected by City/Municipality)	
		Area (ha)	Share	Area (ha)	Share
Built-up Area	Residential	8,420	20.7%	6,294	15.4%
	Industrial	914	2.2%	1,883	4.6%
	Institutional	208	0.5%	64	0.2%
	Commercial	422	1.0%	1,395	3.4%
	Built-up/Mix Use	57	0.1%	16,926	41.5%
	Sub-total	**10,021**	**24.6%**	**26,561**	**65.2%**
Non-Built-up Area	Agricultural	19,037	46.7%	12,861	31.6%
	Grassland/Open Area	6,278	15.4%	1,004	2.5%
	Tree Plantation	4,484	11.0%	249	0.6%
	Water Bodies	903	2.2%	68	0.2%
	Unclassified	21	0.1%	1	0.0%
	Sub-total	**30,722**	**75.4%**	**14,182**	**34.8%**
Total		**40,743**	**100.0%**	**40,743**	**100.0%**

As shown above, the present built-up area covers 24.6% of the entire Study Area, but it was projected to remarkably increase to 65.2%. Such dynamic increment of the built-up area is attributed to reduction of the farmland, which includes agricultural land (46.7% to 31.6%), the grassland/open area (15.4% to 2.5%) and tree plantation (11% to 0.6%).

The Housing and Land Regulatory Board (HLURB) has, however, imposed a certain restriction on conversion of the farmland through the Regulation of Land Conversion, MC No. 54 (1993). According to the regulation, the extent of farmland that could be converted to built-up area is estimated at 9,212ha, while the cities/municipalities had projected that the built-up area will expand by 16,540 ha, i.e., the present built-up area of 10,021 ha will expand to 26,561 ha.

Moreover, the built-up area of 26,561 ha projected by the cities/municipalities could accommodate the population of about 3.5 million, assuming that the standard built-up area is $75m^2$/per person (details of a standard residential area are given in Section 4.3). However, the existing population in the Study Area is only 1.1 million. Thus, the built up area in the CLUPs widely exceeds the area of convertible farmland and contains a very high expectation on the increase of future population. From these points of view, the term “Built-Up Area” in the CLUP is deemed to be unrealistic.

The CLUP also projects a large increment of mix land use (0.1% at present to 41.5% in the future). Development of mix land use is urged in Resolution No. 105, Province of Cavite, Office of Sangguniang Panlalawigan, Trece Martires City, March 25, 1988, and its addendum, dated April 8, 1988. The resolution includes the following items:

- The tracts of land in Imus and a part of Dasmariñas (along the Aguinaldo Highway) are declared as industrial-residential-institutional mix.
- The tracts of land in Carmona, Silang, Dasmariñas, Gen. Trias, Trece Martires City, Tanza and Naic extending 2 km, more or less, from each side of the road (Governor’s Drive) are declared as industrial-residential-institutional mix.
- The tracts of land in Rosario including the Cavite Export Processing Zone and the Philippine National Oil Company are declared as industrial-residential-institutional mix.

The resolution had already expired and the responsibility on the land use plan has been transferred to each city/municipality under EO No. 72 (1993). The policy on the development of mix land use is, however, still valid in the recent CLUP, but the development of mix land use is deemed to contain the following potential problems:

- Efficient public investment will hardly take place.
- The existing farmlands would be fragmented, leading to the difficulty in developing large-scale subdivisions in the remaining farmlands and, at the same time, the difficulty in effectively using the farmland and in attaining high agricultural production.
- The natural landscape would be marred.
- Serious traffic congestion would occur.

4.2 Population Projection

The CLUPs were reviewed and certain revisions were made in the Study through the following steps: (1) population projection; (2) estimation of population distribution and the required built-up area; and (3) estimation of spatial distribution of the built-up area. The first step, population projection for the Study Area, is as discussed below.

4.2.1 Population Projection in Past Studies

Population projections for the Study Area have been made by several agencies, as described below.

(1) Population Projection by the National Statistics Office (NSO)

The NSO had made a nationwide population projection by province and by sex until 2040 based on the census in 2000. The projection assumed the following conditions:

- Birthrate: The total fertility rate would reduce year by year and drop from 3.20 at present to 2.26 in 2015 to 2020.
- Death rate: The average life expectancy would increase from 64.93 to 70.13 years for men and 73.18 to 77.18 years for women.
- Net migration rate: Cavite Province is assumed to have the highest incremental rate of migration from other provinces.

The population projection was made in three cases, high, medium and low migration rates, and both projection method and assumptions for population projection were evaluated to be appropriate and persuasive.

(2) Population Projection in Cavite Provincial Physical Framework Plan (PPFP)

The Provincial Government of Cavite had assumed that the annual average population growth rate of 5.45% recorded in 1995 to 2000 would continue until 2020. The population growth rate was further assumed to be same in all cities and municipalities. This population projection takes far higher future populations than those in other population projections. However, the recorded remarkable high population growth in the recent five or ten years in Cavite Province could be attributed to the rapid urbanization, and it could be hardly verified that such high population growth would continue for more than 20 years from on the present.

(3) Population Projection by Each City/Municipality

The cities/municipalities in the Study Area had assumed, in principle, that the trend of population growth in the recent 10 years would continue in the future, although different target years were applied. As the result, all cities/municipalities had projected a remarkably high future population growth. The annual population growth projected by the municipalities of Dasmariñas and Bacoor were 13.96% and 9.03%, or 2.2 and 3.2 times the present population respectively. The future populations projected by each city/municipality are the highest among all relevant projection figures.

(4) Population Projection in the Past Studies (JICA CALA Study, JICA Busway Study and UN Water Supply Project)

The JICA CALA Study had estimated the future population for Cavite and Laguna provinces until 2030. The estimation was based on the assumption that the annual average population growth rate for 2000-2005 would be the same as the rate recorded in 1995-2000, while the growth rate after 2006 would drop below the recorded rate (refer to the "Feasibility Study and Implementation Support on the Cala East-West National Road Project" December 2006). This assumption is deemed to be rather realistic and persuasive. The JICA Busway Study had applied a similar assumption of population growth to that of JICA CALA Study and estimated the future population to be slightly higher than that of the JICA CALA Study. The future population projected by the UN Water Supply Project was the lowest among the results of relevant projections.

4.2.2 Population Projection in the Study

The population projection for the Study Area was made by referring to the results of the aforesaid past relevant studies. The basic concepts of the population projection are as described in Items (1) and (2) in the box below:

Basic Concept on Population Projection for the Study Area

(1) The past remarkably high population growth is supported by the following factors:

- The Province of Cavite is located adjacent to Metro Manila and situated as the commuting zone to Metro Manila.
- The Province is largely influenced by the policy on dispersed development of industrial estates toward outside of Metro Manila (refer to "50-km Radius Ban Policy of Metro Manila on Industries and Large-scale Residential Subdivision Development").
- The objective relocation site for "Squatter Relocation Program of Metro Manila" was placed in the Province.
- The Province has ever induced the large-scale residential subdivision development.
- The Province induced development of tourist hotel, resort and golf course.
- The several trunk road lines such as South Super Highway, Cavite Coastal Road, Aguinaldo Highway and Governor's Drive were set up in the Province.

(2) The future population growth would drop below the above past growth because of the following factors:

- Priority to full operation of the existing industrial estates over development of new industrial estates;
- Moratorium on golf course development in the highland area;
- Control of subdivision development in the highland area, recently stated by the present Provincial Governor;
- Decrease of natural population growth rate (2.2% in 2001 to 1.7% in 2006);
- Delay on planned infrastructure development such as R1 Extension, C-5 Expressway, MMS Extension Stage 2, Molino Boulevard, LRT 1 Extension to Cavite, etc.

All of the past population projections except that by the Cavite Province Physical Framework Plan (PPFP) assumed that the population growth would slow down in the future as shown in the following Table R 4.2, and such assumption is deemed to be appropriate judging from the above basic concepts.

Table R 4.2 Annual Average Population Growth Rates in the Past Projections

Past Projection	Recorded	Projected (2000-2020)			
	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020
PPFP	5.45%	5.45%	5.45%	5.45%	5.45%
NSO Long-term	5.45%	3.67%	3.11%	2.67%	2.43%
JICA CALA	5.45%	4.46 %	3.79%	2.66%	2.13%
JICA Busway	5.45%	4.43%	3.92%	3.27 %	3.27 %
UN Water Supply	5.45%	3.91%	3.91%	3.06%	2.24%

The annual average deceleration rates of population growth in every five years were further estimated from the above annual average population growth, as shown in Table R 4.3. The deceleration rates in the past projections are in a range of about 75 to 90%, and this range of rates is adopted in this Study in principal taking the following items into account:

(1) The past projections assumed that the largest deceleration rate of the population growth as estimated at 75.5% in average would break out in the period of 2000-2005 as shown in Table R.4.3. However, the Provincial Government of Cavite has recently estimated the provincial annual average population growth of 4.76% for the period of 2000 to 2007, which corresponds to the 89.8% of the annual average population growth for the period of 1995-2000. Thus, the deceleration of the population after 2000 could be recognized but the deceleration rate of 75.5 % as assumed in the previous projection is evaluated to be too much to excess. Instead of the projected rates projected by the previous Study, the Study apply 90% as the deceleration rate for 2000- 2005 taking the said results of the recent census for 2007 by the Provincial Government.

(2) The future trend of the deceleration of the population growth in the Cavite Province wild be sure judging from the factors as described in the “Basic Concept on Population Projection for the Study Area” (see the item (2) in the box above). From this standpoint, the population growth after 2006 is assumed to gradually drop and its deceleration rates to be 85.0% in 2005-2010 to 80% in 2015 to 20 with referring the results of the projections made in the previous studies.

As the results of the above evaluation, the annual average deceleration rates of the population growth are assumed as listed in the last column of Table R. 4.3

Table R 4.3 Annual Average Deceleration Rates of Population Growth in Past Studies and this Study

(The percentage of annual population growth rates to that of the former five years)

Study Cases		Projected (2000-2020)			
		2000-05	2005-10	2010-15	2015-20
Past Studies	NSO Long-term	67.3%	84.7%	85.9%	91.0%
	JICA CALA	81.9%	85.0%	70.2%	80.0%
	JICA Busway	81.3%	88.5%	83.6%	100.0%
	UN Water Supply	71.7%	100.0%	78.3%	73.2%
	Average	75.5%	89.6%	79.5%	86.1%
This Study		**90.0%**	**85.0%**	**82.5%**	**80.0%**

Based on the above annual average deceleration rates of population growth, the future population of Cavite Province in 2020 is firstly estimated at 4,364,000, as shown in Table R 4.4. The future population of the Study Area is then estimated at 2,444,000 based on the present sharing rates of population to the provincial total as shown in Table R 4.5.

Table R 4.4 Population Projection for 2000-2020

(Unit: Thousand)

Study Cases		2000	2005	2010	2015	2020
Past Studies	NSO Long-term	2,063	2,500	2,914	3,324	3,748
	JICA CALA	2,063	2,566	3,092	3,526	3,918
	JICA Busway	2,063	2,562	3,105	3,648	4,285
	UN Water Supply	2,063	2,499	3,028	3,520	3,932
	Average	2,063	2,532	3,034	3,504	3,971
This Study		**2,063**	**2,622**	**3,216**	**3,809**	**4,364**

Table R 4.5 Estimation of Future Population of the Study Area in 2020

Particulars	Cavite Province	13 Cities/ Municipalities	Study Area
Share in 2000	100%	76.9%	70.1%
Share in 2020 (rounded)	100%	80%	70%
Estimated Population in 2020 (thousand)	4,364	3,491	2,444

4.2.3 Trend of Urban Development and Population Increase for Each City or Municipality

The population of each of the 13 cities/municipalities in the Study Area had increased in the period 1990-2000, as shown in Table R 4.6. Trece Martires City and the three municipalities of Dasmariñas, Bacoor and Imus which have induced large-scale development of subdivisions show a remarkably high population growth. Moreover, Silang, Tanza, and General Trias, which are adjacent to the three municipalities, also show a rather high population growth.

Table R 4.6 Population Increase Ratios in the Past and the Ratios Applied in the CLUPs

City/ Municipality	Population Increase Ratio	
	1990-2000	CLUP Projection
Dasmariñas	10.8%	14.0%
Imus	7.8%	8.2%
Gen. Trias	7.4%	7.4%
Bacoor	6.7%	9.0%
Trece Martires City	10.3%	5.5%
Tanza	6.0%	7.3%
Silang	5.2%	5.1%
Noveleta	4.6%	5.1%
Tagaytay City	6.7%	2.9%
Rosario	5.0%	3.6%
Kawit	2.8%	3.1%
Indang	2.7%	3.7%
Amadeo	2.0%	3.2%
Cavite Province	6.0%	-.-

Source: NSO, CLUP and JICA Study Team

In contrast to the cities/municipalities mentioned above, other municipalities such as Kawit, Noveleta and Rosario in the lowland area are already densely populated and show a lower population growth rate. Kawit in particular shows the rate of 2.8%, which is almost equivalent to the population growth rate of the municipalities in the highland agricultural area, Amadeo and Indang. The above Table R 4.6 also shows the future population projected by the 13 cities/municipalities in their CLUPs. As shown in the table, the projected population growth basically follows the past trend of population growth; however, some of cities/municipalities applied a rather higher or lower ratio than the actual trend.

The future trend of regional development of the 13 cities/municipalities could be evaluated through the present built-up ratio and population density, as shown in Fig. R 4.1. Since Rosario, Bacoor and Noveleta show high figures in both built-up ratio and population density, these municipalities are judged to be currently experiencing rapid urbanization. In contrast, Silang and Indang show low figures in both indicators so that they may be in the stage of future urbanization.

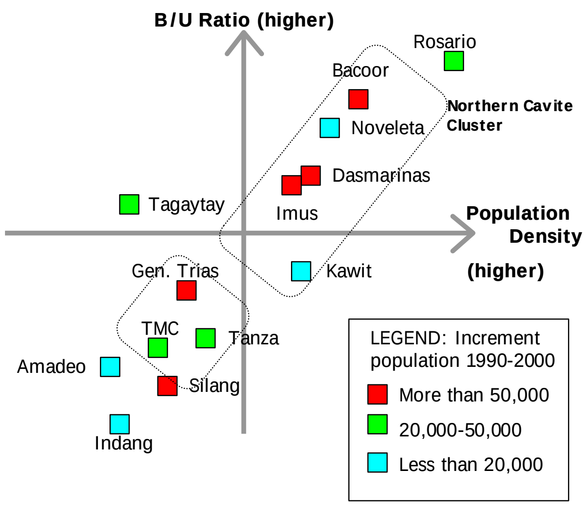


Fig. R 4.1 Built-Up Area Ratio and Population Density of 13 Cities/Municipalities

Based on the aforesaid past and projected population growth of each city/municipality, the Provincial Physical Framework Plan (PPFP) ranked the 13 cities/municipalities according to the future potential of urbanization, as shown in Table R 4.7. The JICA CALA Study also made a similar ranking of each city/municipality. According to these rankings, the following cities/ municipalities are expected to grow as urban centers:

- Dasmariñas (Small City to Middle City as Regional Growth Pole)
- Gen. Trias (Little Town to Small City as Residential Development Area)

- Tagaytay City (Middle Town to Large Town as Resort Area)
- Trece Martires City (Middle Town to Large Town as Administrative Center)

Table R 4.7 Urban Hierarchy of 13 Cities/Municipalities

City/municipality	Provincial Framework		Cala Study
	Present	Future	
Amadeo	ST	ST	AAC
Bacoor	SC	SC	UD-residential
Dasmarinas	SC	MC	Regional growth pole
Gen. Trias	LT	SC	UD-residential
Imus	SC	SC	UD-residential
Indang	ST	ST	AAC
Kawit	LT	LT	CG-residential
Noveleta	MT	MT	CG-residential
Rosario	LT	LT	CG-residential
Silang	LT	LT	AAC
Tagaytay	MT	LT	Resort
Tanza	LT	LT	UD-residential
Trece Martires	MT	LT	Administrayion

Note: ST: Small town, MT: Middle town, LT: Large town,
SC: Small city, MC: Middle city
UD: Urban Development, CG: Control Growth,
AAC: Agricultural Center

Based on the evaluation of the future trend of regional development and the potential of urbanization ranked by PPFP, the 13 cities/municipalities in the Study Area are classified into the following three groups according to the future potential population growth. Accordingly, the population of each city/municipality in the year 2020 is estimated, as shown in Table R 4.8 (refer to Table R 4.2).

- Lower Rate (2.5% to 1.1%) for Amadeo, Kawit , Indang, Rosario and Tagaytay
- Middle Rate (5.5% to 2.3%) for Noveleta, Silang, Tanza, and Trece Martires
- Higher Rate (8.0% to 3.4%) for Imus, Bacoor, Gen. Trias and Dasmariñas

Table R 4.8 Present and Projected Population by City/Municipality in the Study Area

(Unit: thousand)

District	Municipality	Present Population in 2000	Project Population in 2020	Incremental Population for 2000-2020
District I	Bacoor	137	351	214
	Kawit	63	80	17
	Noveleta	32	41	9
	Rosario	74	94	20
District II	Trece Martires	24	44	20
	Dasmarinas	352	901	550
	Gen. Trias	108	203	95
	Imus	195	513	317
	Tanza	32	59	27
District III	Amadeo	26	33	7
	Indang	7	8	2
	Silang	60	110	50
	Tagaytay	4	7	3
Total		1,112	2,444	1,331

4.3 Distribution of Population and Required Built-Up Area

The previous studies had applied the following standards for the required residential area per person: (1) 90m^2/person under the UN-FAO Standard; and (2) 60 m^2/person under the NEDA Standard. The present average residential area was further estimated to be 90 m^2/person. HLURB also prepared the land use planning standards for residential area as 240m^2/household. Taking these standards into account, the Study has provisionally assumed the required built-up area as 75 m^2/person (the average of 90 m^2 and 60 m^2).

The existing farmlands that could be converted to built-up areas (convertible land) were then estimated in accordance with Regulation of Land Conservation, MC No. 54, of HLURB. As the results of estimation, convertible lands consist of 9,212 ha, and the maximum extent of the future built-up area is limited to 19,233 ha, which is the sum of the existing built-up area (10,021 ha) and the said convertible land (9,212 ha), as shown in the table below.

Table R 4.9 Existing Built-up Area and Farmland Convertible to Built-up Area

(Unit: ha)

District	City/ Municipality	Existing Built-Up Area	Convertible Land to Built-Up Area	Area to be Preserved as Non-Built-Up Area	Total Area
District I	Bacoor	1,027	207	576	1,809
	Kawit	375	236	938	1,548
	Noveleta	247	53	284	585
	Rosario	499	54	124	677
District II	Trece Martires	412	352	1,549	2,313
	Dasmariñas	2,595	1,519	2,898	7,012
	Gen. Trias	1,725	2,321	4,436	8,482
	Imus	1,710	1,182	2,267	5,160
	Tanza	337	408	785	1,530
District III	Amadeo	257	746	3,285	4,287
	Indang	57	395	753	1,204
	Silang	607	1,548	2,952	5,108
	Tagaytay	175	191	663	1,029
Total		10,021	9,212	21,510	40,743

The farmland of 9,212 ha convertible to built-up area is estimated to accommodate the population of 1.288 million, assuming that the requirement for a residential area is 75m^2/person, as shown in Table R 4.10. On the other hand, the incremental population for 2000–2020 is estimated at 1.331 million. Thus, the future incremental population of about 103 thousand would not be accommodated in the Study Area even assuming that all convertible farmlands are converted to built-up areas.

Table R 4.10 Land Convertible to Built-Up Area and Population Absorption Capacity

District	City/ Municipality	Convertible Land (ha)	Capacity to Accommodate Population (Thousand)	Incremental population (Thousand)	Balance (Thousand)
District I	Bacoor	207	28	214	**-187**
	Kawit	236	31	17	14
	Noveleta	53	7	9	**-2**
	Rosario	54	7	20	**-13**
District II	T. Martires City	352	47	20	27
	Dasmariñas	1,519	203	550	**-347**
	Gen. Trias	2,321	309	95	214
	Imus	1,182	158	317	**-160**
	Tanza	408	54	27	28
District III	Amadeo	746	99	7	92
	Indang	395	53	2	51
	Silang	1,548	206	50	156
	Tagaytay	191	25	3	22
Total		9,212	1,228	1,331	**-103**

To cope with the above deficiency of built-up areas to accommodate the future incremental population, the following three schemes were applied to cities/municipalities in the Study Area as shown in Table R 4.11:

- Scheme 1: Increase population density by effective land use and high-rise buildings (i.e., the standard required built-up area of 75m^2/person is reduced by assuming a higher population density)
- Scheme 2: Accelerate land conversion from agricultural use to urban use (Additional Land Conversion)

- Scheme 3: Distribute population to other cities/municipalities with sufficient land for built-up area in the Study Area (Out-migration and in-migration within the Study Area)

Table R 4.11 Schemes Applied to Each City/Municipality in the Study Area

Cities/ Municipalities	Scheme 1	Scheme 2	Scheme 3	
	Higher Density	Additional Land Conversion	Out-Migration	In-Migration
Bacoor	●	●	●	–
Dasmariñas	●	●	●	–
Imus	●	●	●	–
Noveleta	●	–	–	–
Rosario	●	–	–	–
Gen. Trias	–	–	–	●
Silang	–	–	–	●
Tanza	–	–	–	●
Trece Martires	–	–	–	●
Amadeo	–	–	–	–
Indang	–	–	–	–
Tagaytay	–	–	–	–
Kawit	–	–	–	–

Legend: ● Applied - Not applied

The application of the above schemes resulted in the accommodation and distribution of future incremental population to each city/municipality, as shown in Table R 4.12. The procedures for the estimation of figures in the table are as described in Steps 1 to 4 below.

Table R 4.12 Results of the Distribution of the Incremental Population by City/Municipality

(Unit: Thousand)

Cities/ Municipalities	(1) Projected Increment of Population (2000-2020)	(2) By Conversion of Farmland within the Area	(3) By Scheme 1	(4) By Scheme 2	(5) By Scheme 3 (Out-Migration)	(6) By Scheme 3 (In-Migration	(7) Final Distribution
Bacoor	214	28	49	13	124	0	90
Kawit	17	17	0	0	0	0	17
Noveleta	9	7	2	0	0	0	9
Rosario	20	7	13	0	0	0	20
Trece Martires	20	20	0	0	0	29	49
Dasmarinas	550	203	176	86	85	0	465
Gen. Trias	95	95	0	0	0	143	238
Imus	317	158	106	13	40	0	277
Tanza	27	27	0	0	0	30	57
Amadeo	7	7	0	0	0	0	7
Indang	2	2	0	0	0	0	2
Silang	50	50	0	0	0	47	97
Tagaytay	3	3	0	0	0	0	3
Total	1,331	624	346	113	249	249	1,331

Note: Final distribution of population (7) = (2)+(3)+(4)+(6) = (1)–(5)+(6)

(1) Step 1 [Estimation for Column (2) in Table R 4.12]

The future incremental population of 624 thousand is accommodated by the following farmland conversion procedures:

- Convert farmlands in Bacoor, Dasmariñas, Imus, Noveleta and Rosario at the allowable maximum level stipulated in the existing regulation (the population to be accommodated = the allowable convertible farmland divided by the required unit residential area of 75 m^2/person).
- Convert farmlands according to the increment of population in each of the cities/municipalities of Amadeo, Gen. Trias, Indang, Kawit, Silang, Tagaytay and Trece

Martires (the population to be accommodated = the projected incremental population for 2000-2020).

(2) Step 2 [Estimation for Column (3) in Table R 4.12]

The future incremental population of 346 thousand is accommodated by the following applications of Scheme 1.

- Bacoor, Dasmarinas and Imus would induce Scheme-1, which could accommodate about 30% of the existing population (as of 2000) and the future incremental population, as presented in column (2) of Table R 4.12.
- The projected incremental population in Rosario and Noveleta slightly exceed the accommodation capacity by conversion of farmlands to built-up areas. All of the exceeding population would be accommodated with the assumption of Scheme 1.

(3) Step 3 [Estimation for Column (4) in Table R 4.12]

Some extent of the existing farmlands along Aguinaldo Highway and Governor’s Drive in the three municipalities of Bacoor, Dasmariñas and Imus are not converted to built-up areas, since the lands are designated as environmentally protected area such as the Strategic Agricultural and Fishery Development Zone (SAFDZ), the irrigated area and the agrarian reform land. Most of the farmlands are, however, currently abandoned and remain as vacant land, while the potential for urban development of the farmlands is quite high. In due consideration of the over-increment of population in the said three municipalities, it is provisionally proposed that the farmlands should be converted to built-up areas to accommodate the excessive future population increment of the municipalities. The future incremental population of 113 thousand could be accommodated by this land conversion (i.e., Scheme 2).

(4) Step 4 [Estimation for Columns (5) and (6) in Table R 4.12]

The future incremental population in three municipalities of Bacoor, Dasmariñas and Imus is still hardly accommodated by the conversion of farmlands mentioned above and the application of Schemes 1 and 2. To cope with this issue, the municipalities are assumed to take Scheme 3 (Out-Migration and In-Migration). The out-migration population from these municipalities could be accommodated in General Trias, Silang, Tanza and Trece Martires, which still have convertible farmlands. The future incremental population of 249 thousand could be accommodated by the adoption of Scheme 3.

4.4 Proposed Land Use Plan in 2020

The land use plan in 2020 is proposed, as shown in Fig. 4.2 and Tables 4.3 to 4.4, taking the aforementioned distribution of the required built-up area into account. The proposed land use plan is summarized and compared with the land use plans prepared by the cities/municipalities (CLUP), as shown in Table R 4.13 below.

Table R 4.13 Land Use Plan Proposed in the Study and Projected by City/Municipality

Land Use		Projected in the Study		Projected in CLUP	
		Area (ha)	Share	Area (ha)	Share
Built-Up Area	Residential	14,561	35.7%	6,294	15.4%
	Industrial	1,426	3.5%	1,883	4.6%
	Institutional	407	1.0%	64	0.2%
	Commercial	1,019	2.5%	1,395	3.4%
	Built-up/Mix Use	0	0.0%	16,926	41.5%
	Sub-total	**17,413**	**42.7%**	26,561	**65.2%**
Non-Built-Up Area	Agricultural	15,323	37.6%	12,861	31.6%
	Grassland/Open Area	4,149	10.2%	1,004	2.5%
	Tree Plantation	3,105	7.6%	249	0.6%
	Water Bodies	733	1.8%	68	0.2%
	Unclassified	21	0.1%	1	0.0%
	Sub-total	**23,330**	**57.3%**	14,182	**34.8%**
Total		40,743	100.0%	40,743	100.00%

As described in Section 4.1, the built up area of 26,561 ha projected in the CLUPs is based on the very high expectation on the increase of future population that could be hardly accommodated by the farmlands converted to built-up areas. From this point of view, clarifications were made as described in Sections 4.2 and 4.3, and the built-up area is revised to 17,413 ha (42.7% of the Study Area).

It is also noted that the CLUP projected a large share of built-up/mixed used. Such mixed land use is evaluated to cause several problems such as (1) decline of public investment; (2) fragmentation of farmland; (3) marring of natural landscape; and (4) serious traffic congestion, as described in Section 4.1. From this point of view, the mixed land use is not applied in the proposed land use plan in the Study.

In addition to the above conditions, other collateral conditions are applied to the proposed land use plan. The details of these collateral conditions are as described below.

(1) Method of Land Zoning

The urban growth zoning and land use plan in the Study are developed by the Area Division Method, which is applied in the Japanese City Planning System. The land use plan proposed in the Study aims at promoting and controlling urban growth into the compact city, while the CLUP is towards the huge and flexible zoning for an urbanized area. Table R. 4.14 and Fig. R 4.2 show the distinct features in the concept of land use plan of the existing CLUP and the land use plan proposed in the Study.

Table R 4.14 Comparison of Basic Concepts of Land Use Plan

Item	Existing CLUP	The Study
Future Urbanized Area	Huge and Flexible	Promoted in limited zone
Image	Fragmented or scattered	Compact
Land Use	Predominant Mixed Use	Apply Zoning as much as possible

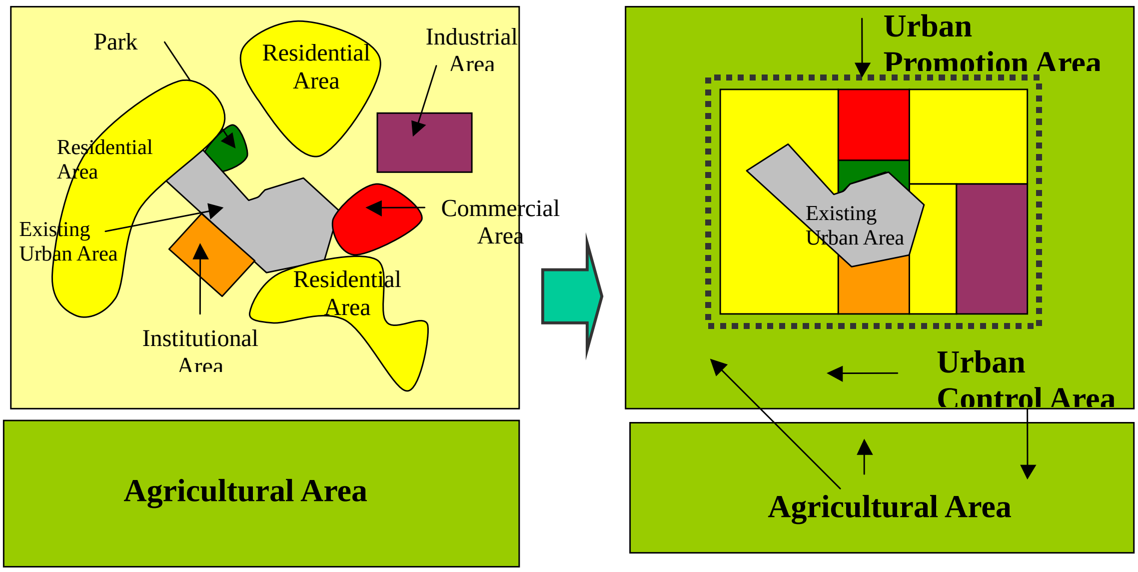


Fig. R 4.2 Difference between Existing CLUP and JICA Proposal

(2) Spatial Distribution of Built-Up Area

For the spatial distribution of built-up area, the following environmentally critical areas are assumed to be not suitable for urbanization and excluded from the proposed built-up area:

- Steep slope area (more than 15%);
- The area specified as the Strategic Agricultural and Fishery Development Zone (SAFDZ);
- The area specified in the Comprehensive Agrarian Reform Program (CARP);
- The NIA irrigated area; and
- Habitual flood inundation area (the probable flood inundation area of 2-year return

period with the probable inundation depth of more than 25cm).

The above environmentally critical areas were delineated through overlaying of the following maps (refer to Fig. 4.3):

- Soil Analysis Map (NAMRIA)
- SAFDS Map (Office of the Provincial Agriculturist)
- CARP Map (Agrarian Reform Office)
- NIA Map (National Irrigation Authority, Naic)
- Inundation Map (JICA Study Team)
- Map of Area not Suitable for Urbanization
- Base Map for Built-Up Area Distribution

(3) Regional Context of Urban Growth

Fig. 4.4 shows the urbanization concept of the Study Area in a regional context of urban growth. The main contexts are:

- Development wave from Metro Manila firstly reaches along the South Luzon Expressway.
- Laguna Urban Cluster provides workplaces for Cavite residents.
- Lowland Urban Cluster will be integrated with Muntinlupa (Alabang) Area, where a northern regional growth center is planned, as conurbation.
- Dasmariñas will be a regional growth center similar to Muntinlupa and Calamba to form a cross urban development axis along the Aguinaldo Highway and Governor's Drive
- Trece Martires and Silang will grow and become new urban centers.
- Tagaytay and the highland area will further grow as Agro-Highland Resort Area.
- The open space areas along the existing and planned major roads will be built-up due to high potential for urban use.

(4) Breakdown of Urban Growth Zone (Built-Up Area): Proposed Land Use Area in 2020

The breakdown of Land use in the proposed urban growth zone is made according to the following criteria:

The shares of areas for commercial, industry and institution land use at present are very small according to the spatial standard prepared by HLURB. The JICA Study Team has assumed the target of those areas as shown in Table R 4.15.

Table R 4.15 Applied Spatial Standards for Commercial, Industry and Institutional

Cities/ Municipalities	Existing		Year 2020		HLURB Standard	Achievement Ratio
	Area (ha)	Share	Area (ha)	Share		
Commercial	422	1.0 %	1,019	2.5 %	3% of the total area	67 %
Industry	914	2.2 %	1,426	3.5 %	8-25 m^2/pop*1)	20 %
Institution	208	0.5 %	407	1.0 %	3.3 m^2/pop	63 %

Note: *1) including light and middle industry
Source: HLURB and JICA Study Team

According to the increase of built-up area, the non-built-up areas, including agricultural area, grassland/open area, tree plantation, and water bodies, will decrease proportionately with the existing composition.

Chapter 5. Hydrological Analysis

5.1 Objectives and Process of Analysis

The Hydrological Analysis aims at clarifying the basic flood discharges which refer to flood discharges before flood control provided by dams/reservoirs or other regulating facilities, and the design flood discharges which is flood discharges after regulation by applicable flood control measures planned, for recurrence probabilities of 2 to 20-year return period. Both of the basic flood discharge and the design flood discharge are subject to the future land use in the target year of 2010, and, they were estimated based on the gauged storm rainfall data, since the gauging data of river flood discharge is not available in the Study Area.

The analysis was further made to estimate the possible flood inundation area under conditions of the with- and without alternative flood mitigation plans. In order to attain the estimation, the actual extent of the recorded maximum flood inundation caused by the Typhoon Milenyo in 2006 was firstly delineated based on the results of the interview survey and then, the hydrological simulation on it was made based on the ground elevations of the Study Area, the cross-sectional and longitudinal profiles of river channels, and various hydrological boundary conditions such as the tidal levels and the short-term rainfall intensities, which were assumed to occur during the Typhoon. As the results of simulation, it was confirmed that the simulation model could well express the actual extent of flood inundation, and the probable flood inundation areas were estimated through the simulation model, which takes the probable rainfall intensities as the input data.

The detailed flowchart of the hydrological analysis is as shown in Fig. 5.1.

5.2 Rainfall and Stream Flow Gauging Stations and Data Availability

5.2.1 Rainfall Gauging Station

(1) Rainfall Observation

The location and operational condition of seven rainfall-gauging stations operated by PAGASA in and around the Study Area as of 2007 are as indicated in Fig. 5.2 attached and Table R 5.1 respectively. Most of these stations are for daily rainfall observation and they started operation in or before the 1970's.

Table R 5.1 Operational Condition of Rainfall Gauge Stations in and around the Study Area

No.	Rainfall Station	Location		Altitude (El.m)	Operation Period	Frequency of Recording	Remarks
		Latitude	Longitude				
1	Sangley Point	14°30' N	120°55' E	3.0	1974- present	Every 6 hours	Operational
2	Mabolo	14°27' N	120°56' E	N.A.	1975- present	Daily	Operational
3	Port Area	14°35' N	120°59' E	N.A.	1907- present	Hourly	Operational
4	San Pedro	14°22' N	121°02' E	N.A.	1971- 1999	Daily	Closed
5	Tagaytay	14°07' N	120°58' E	580	1994- present	Daily	Operational
6	Ambulong	14°05' N	121°03' E	10.6	1951- present	Every 6 hours	Operational
7	Amadeo	14°10' N	120°57' E	540	1985- present	Daily	Operational

Note: All rainfall stations are administered by PAGASA. "N.A." means "Data was Not Available".
Source: PAGASA

(2) Data Availability

The availability of rainfall data is shown in Table 5.1 attached. Daily rainfall data up to 2005 were collected at the Sangley Point, Mabolo, Tagaytay, Amadeo and Ambulong stations, and up to 1999 at San Pedro Station in the previous JICA study; namely, the Feasibility Study and Implementation Support on the CALA East-West National Road Project (hereinafter called as JICA CALA Study). The daily rainfall data at the Sangley Point, Mabolo, Port Area, Tagaytay, Ambulong and Amadeo stations in 2006 as well as 6-hourly rainfall records from 1978 to 2006 at the Sangley Point Station were additionally collected in the present Study (the Study).

The double mass curve analysis shows no inconsistency in the collected daily rainfall data except those at Amadeo Station. According to PAGASA, it was not advisable to use the rainfall data at Amadeo Station in the JICA CALA Study because of low reliability and hence they were not used also in the Study.

5.2.2 Stream Flow Gauging Station

(1) Water Level Observation and Discharge Measurement

There is one existing stream flow gauging station at Palubluban on the Panaysayan River, the tributary of Canas River. At the gauging station, the gauge-keeper records the water level three times a day and more frequently during floods. In addition, the personnel of DPWH carry out discharge measurements regularly. Another station was established at Alapan on the Ylang-Ylang River, but it was abandoned because of tidal affect according to the Bureau of Research and Standards (BRS), DPWH. The locations of Palubluban and Alapan water level observation stations are indicated in Fig. 5.2 attached and the conditions of observation are as summarized in the table below.

Table R 5.2 Water Level Observation Stations in the Study Area

Station (Name of River)	Catchment Area (km^2)	Location		Altitude of zero gauge (EL.m)	Observation Period	Remarks
		Latitude	Longitude			
Palubluban (Panaysayan)	29	14°22'22"N	120°52'55"E	29.970	1957-1979, 1982-present	Operational
Alapan (Ylang-Ylang)	60	14°24'30"N	120°54'20"E	5.558	1952-1979, 1982-85	Abandoned

Source: Bureau of Research and Standards, DPWH

(2) Data Availability

Daily discharge and annual peak discharge records at the two stations above were collected from BRS in the JICA CALA Study. The data were reviewed in the Study and it was found that in some years the specific discharges of the annual peak discharge records at both stations were less than 1.0 $m^3/s/km^2$. Since reliability of the recorded data was not confirmed, the discharge records were not used for the statistical analysis or calibration of runoff model in the Study.

5.3 Rainfall Analysis

Design storms were constructed for several return periods and transformed by the flood runoff model to estimate the probable discharges. The process to develop design storms is as explained below

5.3.1 Characteristics of Storm Rainfall

(1) Duration of Storm Rainfall

The duration of storm rainfall is an important factor to set up the design storm. The 6-hourly rainfall data at Sangley Point Station were utilized to estimate the representative duration of storm rainfall, because Sangley Point is the only station that observes 6-hourly rainfall in the Study Area, which is the shortest duration rainfall available in long term. The rainstorm events in which the maximum daily rainfall was recorded at more than 150 mm at Sangley Point Station were extracted as the major rainstorms. Finally, 25 major rainstorms from 1978 to 2006 were extracted.

Accumulative rainfall curves at Sangley Point Station during the past major storms are graphically illustrated in the following figure, where the accumulated rainfalls were converted as percentages of total rainfall. As seen in the figure, almost all the rainstorms ended within 48 hours. Therefore, the duration of design storm for the analysis of flash floods was set at 2 days.

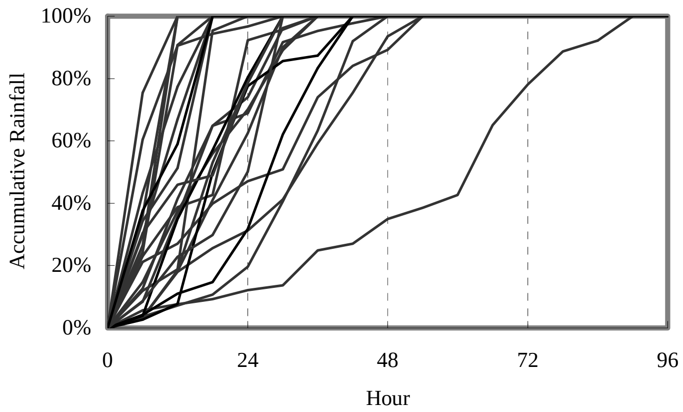


Fig. R 5.1 Accumulative Rainfall Curve of Heavy Rainstorm Events at Sangley Point Station

(2) Distribution in Time

The four recent major typhoons; namely, Typhoon Reming in October 2000, Typhoon Gloria in July 2002, Typhoon Inday in July 2002 and Typhoon Milenyo in September 2006, were selected to understand the rainfall distribution in time. Hyetographs at Sangley Point Station were drawn for the four typhoon events, as shown in Fig. 5.3 attached. The hyetographs were based on the collected 6-hourly data except those of Typhoon Milenyo in 2006 in which 3-hourly rainfall data were available. The three hydrographs are the center-concentrated type during Typhoon Reming, Typhoon Gloria and Typhoon Inday. On the other hand, the peak rainfall was almost at the end of the period during Typhoon Milenyo in 2006.

(3) Distribution in Space

Four recent rainstorms were also selected to illustrate rainfall distribution in space. Attached Fig. 5.4 shows the distribution of 2-day rainfall during each typhoon period at the four rainfall gauging stations, Sangley Point, Mabolo, Tagaytay and Ambulong. The four rainfall records show different patterns in distribution. The Typhoon Reming rainfalls seem to have a fairly uniform distribution in space from the upper basin to the lower basin. During the two typhoons in July 2002, heavier rainfall was observed in the lower basin than in the upper basin and the tendency was outstanding during Typhoon Inday in July 2002 with the 2-day rainfall of 407 mm at Sangley Point Station. On the other hand, the rainfall amount in the upper basin was larger than that in the lower basin during Typhoon Milenyo.

5.3.2 Probable Basin Mean Rainfall

The Thiessen Polygon Method was used to calculate the annual maximum basin mean 2-day rainfall. Five patterns of the Thiessen Polygon were applied to estimate basin mean rainfall based on the availability of 2-day rainfall at each rainfall station. The frequency analysis was carried out to examine the applicability of three different probability distributions, i.e. the Gumbel, Log Pearson-III and Iwai methods. The program known as Hydrological Statistics Utility (Version 1.5) developed by the Japan Institute of Construction Engineering was used for the analysis. Cunnane Plot as shown in attached Fig. 5.5 compared the computed results with the plotting positions of the annual maximum series. The figure shows that every probability distribution has validity in the Study Area and the Log Pearson-III method has the highest correlation coefficient with the samples. Therefore, the probable basin mean 2-day rainfall for each return period was estimated by the Log Pearson III method and tabulated below:

Table R 5.3 Estimated Probable Basin Mean 2-day Rainfall

Return Period (year)	Basin Mean 2-day Rainfall (mm)
2	191
3	224
5	258
10	295
20	326
30	342
50	360
100	383

Source: The JICA Study Team

5.3.3 Rainfall Intensity Curve

The number of short duration rainfall data such as hourly rainfall is very limited within the Study Area and it is difficult to set up the temporal distribution of design storm based on the actually observed rainfall pattern. Therefore, rainfall intensity duration frequency curves were utilized to set up the distribution in time for design storm.

The 6-hourly rainfall data at Sangley Point Station is the shortest duration rainfall available within the Study Area. On the other hand, annual maximum rainfall records with 5-minute to 2-day durations are available at Port Area in long term. Therefore, the annual maximum rainfall data at Port Area were used to construct the rainfall intensity curve and the curve was applied to the Study Area with the necessary adjustments.

The rainfall intensity formula at Port Area has already been developed in the Detailed Engineering Design of Pasig-Marikina River Channel Improvement Project in 2002 using the annual maximum rainfall intensity records from 1903 to 1998. Additional annual maximum rainfall intensity records from 1999 to 2006 were collected in the Study and the rainfall intensity formula was updated. The Gumbel method was applied to the frequency analysis in the Study as well as in the said detailed design for Pasig-Marikina River. To estimate the relations of rainfall intensity duration, the Kimijima Type was employed. The updated constants in the formula are given in Table R 5.4 below.

Table R 5.4 Constants of Rainfall Intensity Formula at Port Area

Return Period (year)	Constants		
	n	a	b
2	0.73	1,428	6.42
3	0.72	1,598	6.45
5	0.71	1,767	6.35
10	0.69	1,841	5.56
20	0.69	2,130	5.92
30	0.68	2,143	5.46
50	0.68	2,337	5.64
100	0.67	2,425	5.23

Source: The JICA Study Team

Note: $I=a/(T^n + b)$, where, I: Rainfall Intensity (mm/hr), T: Rainfall Duration (minute), a, b, n: Constants

5.3.4 Design Storm

Two kinds of design storm were constructed; namely, the long duration design storm for flash flood analysis and the short duration design storm for inland flood analysis.

(1) Long Duration Rainfall

To conduct the runoff analysis, the time interval was set hourly for the whole duration up to 48 hours. As for the distribution of design storm in time, the center-concentrated type of hyetograph was employed as the representative pattern, which could practically express the right scale of the flood mitigation structure according to the design scale. At first, a series of rainfall amounts for the storm durations were calculated using the rainfall intensity curve at Port Area. Then, the order of rainfall was rearranged to construct the center-concentrated type of hyetograph. Finally, the probable basin mean 2-day rainfall to adjust the total rainfall volume in order to develop design storms multiplied the model hyetograph with 1-hour interval uniformly. The design storms for each return period are as shown in Table 5.2 attached and illustrated in Fig. 5.6 attached.

(2) Short Duration Rainfall

Time intervals were set at 5 minutes for short duration design storm of up to 120 minutes. The center-concentrated type of hyetograph was applied for both the short duration rainfall and the long duration rainfall. The model hyetographs for short duration rainfall were based on the rainfall intensity formula at Port Area Station. It was judged that the model hyetograph for Port Area Station could be applied to the drainage area in the Study Area without any adjustment in intensity because the probable rainfall intensities for 12 to 48 hours at Sangley Point Station are almost the same as the probable rainfall intensities at Port Area. The developed design storms of short duration rainfall are shown in Table 5.3 attached and illustrated in Fig. 5.7 attached.

5.4 Flood Runoff Analysis

5.4.1 Model Configuration

(1) Selection of Basin Runoff Model

The whole Study Area is now being rapidly urbanized, and the rapid urbanization will have a significant effect on the flood run-off condition. It is recommended to employ the Quasi-Linear Storage Type Model as the flood runoff model for the urbanized area because this method can express differences in flood runoff due to variations in land use. The model has been utilized extensively for flood runoff analysis in small to medium scale basins to formulate the flood mitigation program considering the future urbanized conditions. Therefore, the Quasi-Linear Storage Type Model was employed for the runoff analysis in the Study as the most suitable runoff model.

(2) Model Configuration

The effective rainfall model is composed of the primary runoff coefficient (f1), saturation rainfall (Rsa) and saturation runoff coefficient (fsa). The basin model transforms the effective rainfall. The basin runoff model with the Quasi-Linear Storage Type Model generates flood discharge from each sub-basin. On the other hand, the river channel routing model expresses the recession effect on the flood discharge and the delay of the peak time due to flood travel in the river channel. Channel routing is calculated by the one-dimensional unsteady flow model using the MIKE-11 software developed by DHI. The configuration of the flood runoff model is summarized below.

Table R 5.5 Configuration of Flood Runoff Model

Item	Model
Effective Rainfall	f1-Rsa-fsa Model
Basin Runoff	Quasi-Linear Storage Type Model
River Channel Routing	One-Dimensional Unsteady Flow Model

5.4.2 Flood Runoff Model

(1) Effective Rainfall Model

In the effective rainfall model, it is assumed that rainfall loss differs for each land use item in each sub-basin. Standard runoff coefficients and saturation rainfall for each land use item are given below.

Table R 5.6 Standard Parameters of Effective Rainfall Model

Land Use Item	f1	Rsa	fsa	Remarks
Rice Field	0.00	50	1.0	
Mountainous Area/Forest	0.25	150	1.0	
Grassland/Farmland	0.15	300	0.6	
Urban Area-1	0.60	55	1.0	Many bare lands remain.
Urban Area-2	0.70	55	1.0	Roads are fairly developed.
Urban Area-3	0.80	55	1.0	The area equal to or more than 50% of total planned pavement area is paved.
Urban Area-4	0.90	55	1.0	Total planned pavement area is all paved.

Source: Japan Institute of Construction Engineering: Guideline for Improvement and Reinforcement Plan in Small-Scale Rivers (Draft), 1999

(2) River Basin Model

The concentration time of flood is estimated by Kadoya's Formula as follows:

$$T_C = C \cdot A^{0.22} \cdot r_e^{-0.35}$$

Where; Tc: Concentration time (minutes)
C: Coefficient of land use
A: Catchment area (km^2)

In the formula, concentration time is related to the land use items by coefficient C-Value. The standard C-values for each land use item are shown in Table R 5.7.

Table R 5.7 Standard C-Values of Quasi-Linear Storage Type Model

Land Use Item	C-Value
Rice Field	1,000
Mountainous Area/Forest	290
Grassland/ Farm Land	210
Urban Area-1	240
Urban Area-2	200
Urban Area-3	110
Urban Area-4	50

Source: Japan Institute of Construction Engineering: Guideline for Improvement and Reinforcement Plan in Small-Scale Rivers (Draft), 1999

(3) River Channel Model

The river channel model is composed of the one-dimensional unsteady flow model. Runoff discharge from each sub-basin is input to the channel routing model as the boundary condition.

The following river cross section data were used in the river channel model for the Imus, San Juan and Canas river basins:

- Sections from the river mouth to NIA Canal: Results of cross section survey conducted by the JICA Study Team in 2007.
- Upstream sections from NIA Canal: Assumed cross sections based on the topographic map and site investigation.

(4) Basin Subdivision

The objective basins in the Study Area are classified into two kinds; namely, the three major river basins of the Imus, San Juan and Canas rivers; and the drainage area. Based on the topographic map, ground elevation, existing flood control facilities, past flood inundations, future land development plans, etc., the Study Area was divided into sub-basins. Attached Fig. 5.8 shows the sub-basin map of the three major river basins and attached Fig. 5.9 illustrates the basin subdivision in a drainage area. The schematic diagram of sub-basins and river channels for the three major rivers is presented in Fig. 5.10 and Fig.5.11 shows the schematic diagram of drainage area.

5.4.3 Land Use Conditions

The existing land use as of 2003 and the land use in 2020 projected in the Study were analyzed as the present and future land use conditions for the runoff analysis.

(1) Classification of Land Use

For the hydrological analysis, the parameters of the effective rainfall model and the C-values for concentration time are important because they are different in each land use item. The original land use items were re-classified and finally categorized into the following four items for the runoff analysis:

- Fishpond/Rice Field
- Forest
- Farm Land/Open Area/Grassland
- Urban Area

The flood runoff characteristics of fishponds were assumed to be the same as those of rice fields based on the past studies in and around Metro Manila. The comparison of land use items in the runoff analysis and in the official land use plan is summarized in Table 5.4 attached.

(2) Present Land Use in 2003

Attached Table 5.5 shows the present land use condition as of 2003 in each sub-basin. The urban area accounts for about 26% of the whole Study Area. The Imus river basin is the most urbanized among the three major river basins with the rate of more than 40%. The rate of urban area is almost the same in the San Juan and Canas river basins with about 20%. The present land use condition in the sub-drainage areas is given in Table 5.6 attached.

(3) Future Land Use in 2020

Attached Table 5.7 shows the future land use condition as of 2020 in each sub-basin. Based on the land use in 2020 projected in the Study, the urban area is projected to increase rapidly in the Study Area. It is noted that about 70% of the Imus river basin is classified as urban area in the future land use plan, which is relatively high compared to the other basins. The rate of future urban area ranges from about 30% to 40% in the San Juan and Canas river basins. The future land use condition in the sub-drainage area is shown in Table 5.8 attached.

5.4.4 Verification of Flood Runoff Model with 2006 Flood

Standard values used for coefficients of the Quasi-Linear Storage Type Model were used as initial parameters in the basin runoff model. Then the parameters were checked with the observed records during the flood by Typhoon Milenyo in September 2006 from the viewpoints of runoff discharge in the rivers and inundation condition. The analysis on the runoff discharge in the rivers is as explained below.

(1) Input Condition

Hourly rainfall data at Tagaytay Station and 3-hourly or 6-hourly rainfall data at Sangley Point Station from 27 September to 29 September 2006 were available for the verification, as shown in Table 5.9 attached. Hourly rainfall data were only available at Tagaytay Station during Typhoon Milenyo in the Study Area. It was judged that the records at Tagaytay could represent the rainfall pattern for the whole Study Area rather than those at Sangley Point Station from the viewpoint of rainfall amount and its temporal distribution compared with the actual inundation condition. Therefore, the hourly rainfall records observed at Tagaytay Station were used as input rainfall in all sub-basins. Land use condition was assumed as the present condition in the calculation.

The estimated tidal levels at Cavite Harbor were applied as the boundary condition of water level at all of the river mouths at the Bacoor Bay and Manila Bay. The hourly tidal level records at Manila South Harbor collected from NAMRIA were used to compute the tidal level at Cavite Harbor, as shown in Table 5.10 attached.

(2) Parameter Setting

The urban area in the Study Area was assumed as Urban Area-3 in the Guideline based on the condition of pavement and drainage channel to set the parameters. In the course of verification of parameters, it was assumed that the saturation condition and runoff characteristic in farm land/open area/grassland would be similar to that in forest area in the Study Area. As the result, saturation rainfall and saturation runoff coefficient for the land use item of farm land/open area/grassland were set to be the same as those of forest area. The base flow was assumed as $1.0m^3/s/100km^2$.

Since there was no available water level or discharge record for the verification of the 2006 flood in the Study Area, the calculation result was checked by comparing the calculated water levels with the maximum water level estimated from flood marks. The reference points on the Imus, Ylang-Ylang, San Juan and Canas rivers were selected near the NIA Irrigation Canal and the flood marks were investigated by the Study Team.

Attached Fig. 5.12 shows the water levels calculated by the flood runoff model and the maximum water levels at NIA Irrigation Canal for the Imus, Ylang-Ylang, San Juan and Canas rivers during the 2006 flood. The figure indicates that the estimated maximum water levels in the four rivers are almost coincident to the flood marks. It was judged that the estimated parameters of the runoff model were reasonable. The verified parameters are as tabulated below.

Table R 5.8 Verified Parameters of Flood Runoff Model

No.	Land Use Item	f1	Rsa	fsa	C
1	Fishpond/Rice Field	0.00	50	1.0	1,000
2	Forest	0.25	150	1.0	290
3	Farm Land /Open Area/Grassland	0.15	150	1.0	210
4	Urban Area	0.80	55	1.0	110

Source: The JICA Study Team

(3) Scale of Flood by Typhoon Milenyo in 2006

The estimated peak discharges at the NIA Irrigation Canal from the Imus, Ylang-Ylang, San Juan and Canas rivers during the flood by Typhoon Milenyo in 2006 are given in the following table. It is judged that the scale of the 2006 flood is almost the same as a 100-year probable flood in each river basin from the viewpoint of peak discharge. The rainfall pattern at Tagaytay Station during the flood shows that the rainfall is intensively concentrated near the peak time, which would result in such a large-scale flood.

Table R 5.9 Comparison of Estimated Peak Discharges for Probable Floods and the 2006 Flood

River	Reference Point	Peak Discharge (m^3/s)		
		50-year Probable	100-year Probable	2006 Flood
Imus	NIA Canal	640	700	736
Ylang-Ylang	NIA Canal	690	760	735
San Juan	NIA Canal	570	640	633
Canas	NIA Canal	1,200	1,300	1,293

Source: The JICA Study Team

5.4.5 Probable Flood Discharge

The available discharge records are very limited in the Study Area. Therefore, it was judged that the probable discharges should be estimated by the flood runoff model with design storms instead of frequency analysis on historical discharge records.

(1) Thee Major River Basins

The probable peak discharges at the reference points were given for 2-year, 3-year, 5-year, 10-year, 20-year, 30-year, 50-year and 100-year return periods in the Imus, San Juan and Canas river basins as shown in Fig. 5.13 to Fig. 5.15 attached.

The estimated peak discharges were evaluated by comparing the specific discharges with those in the previous studies for rivers in Luzon Island, including those in and around Metro Manila. The comparisons of specific discharge for 5-year and 100-year return periods are presented in Fig. 5.16 and Fig. 5.17 attached. The results show that the estimated specific discharges both in the present and future land use conditions lie between the upper and the lower envelopes of the previous study results, although the specific discharges would be relatively high especially in the Imus river basin under the future land use condition. Therefore, the probable discharges were evaluated to be reasonable.

The urban area including the industrial area, built-up area/mix use area, commercial area, institutional area and residential area in the Study Area is projected to largely increase in future. Attached Fig. 5.18 indicates that the future urbanization in the Study Area will increase the flood discharge; i.e., the future condition would make the Study Area more vulnerable to floods.

(2) Drainage Area

The probable discharges for the drainage and sub-drainage areas were estimated under the present and future land use conditions. The Quasi-Linear Storage Type Model was also applied to calculate probable hydrographs for the drainage areas as well as the three major river basins. Design storm of 2-hourly rainfall was transformed to hydrograph by the model.

Attached Table 5.11 and Table 5.12 show the probable peak discharges for 2-year, 3-year, 5-year, 10-year, 20-year, 30-year, 50-year and 100-year return periods under the present and future land use conditions, respectively. As well as the probable discharges for the three major river basins, the peak discharge in the drainage area would increase in future as a result of urbanization.

5.5 Flood Inundation Analysis

5.5.1 General

(1) Purpose of Analysis

The flood inundation analysis was carried out on several scales of flood, aiming mainly as follows:

(a) To clarify the flood inundation mechanism in the Study Area, especially those in Imus, San Juan, Ylang-Ylang and Canas river basins.

(b) To define the probable flood inundation extent, inundation area, inundation depth and inundation duration that could be used as essential information for evaluation of the effect of alternative flood mitigation plans for river-overflow and inland floods in the Master Plan.

(c) To estimate flood damage based on the results of hydraulic and land use analyses.

(2) Target Area for Analysis

The Flood Inundation Analysis was carried out for the flood plain of the Cavite lowland area, which is delineated and squared off in Fig. R 5.2.

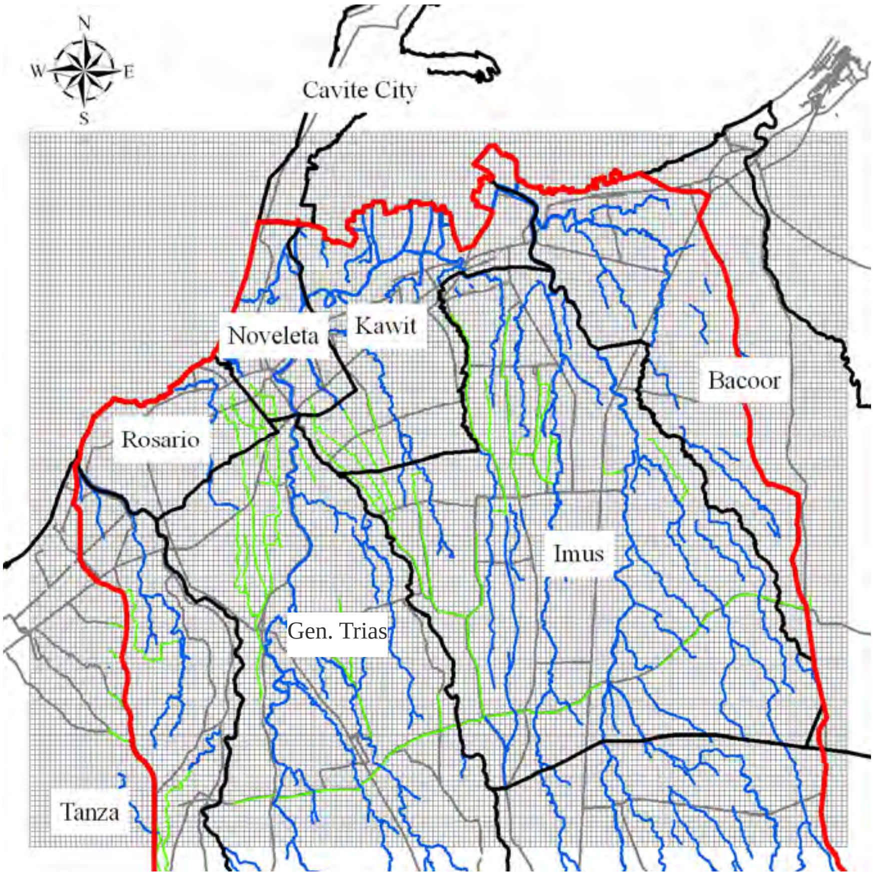


Fig. R 5.2 Target Area for Flood Inundation Analysis

(3) Concept and Outline of the Flood Inundation Model

The coastal plain and lowland area have an extremely low ground level compared with the tide level and also has a flat slope as described in Chapter 2. Moreover, the three rivers of Imus, San Juan and Canas, as well as their major tributaries, have inadequate flow capacities, which cause frequent river-overflow. Beside, the coastal area chronically suffers from inland floods due to complex factors such as high tide level, inadequate flow capacity of drainage channel and so on. Therefore, it is necessary to accurately analyze and simulate the following flood phenomena by the combination of one and two-dimensional variable flows:

- River flow affected by tide along tidal reaches in lowland area;
- Inland flood even during the time of no-rainfall due to high tide; and
- River-overflow, inland flood and their combination.

(4) Description of Software

(a) MIKE FLOOD

MIKE FLOOD is a tool that integrates the models MIKE11 and MIKE21 into a single, dynamically coupled modeling system. Using a coupled approach enables the best feature of all three models to be utilized, while at the same time avoiding some limitations that may be encountered when using the components separately.

(b) MIKE11

MIKE11 is a modeling package for the simulation of flows, water levels, flooding, water quality and sediment transport in rivers, canals, wetlands and other water bodies. MIKE11 is a user-friendly, fully dynamic, one-dimensional modeling tool for the detailed analysis, design, management and operation of both simple and complex river and channel systems.

(c) MIKE21

MIKE21 is a modeling package for 2D free-surface flow, waves, sediment transport and environmental processes. The hydrodynamic module of MIKE21 simulates water level variations and flows in response to a variety of forcing functions on surface flow, in lakes, estuaries and coastal regions.

5.5.2 Flood Inundation Model

(1) Model Set-up

The flood simulation is generally made in three steps; namely, calculation of flood runoff from the sub-basins, flood routing along the rivers and flood inundation on flood plain. For some special cases, flood inundation maps are additionally generated for the purposes of verification of the established simulation model, estimation of flood damages or just simply generation of flood risk maps.

The MIKE FLOOD software developed by DHI Water & Environment was used for the combination of MIKE11 for river channel flow and MIKE21 for flood plain two-dimensional flows, as shown in Fig. R 5.3.

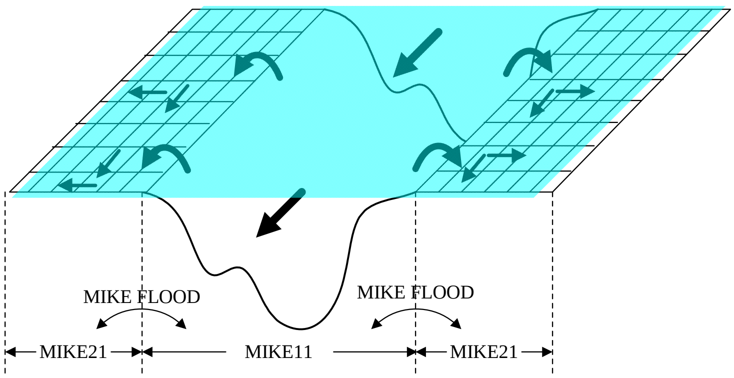


Fig. R 5.3 Structure of Model

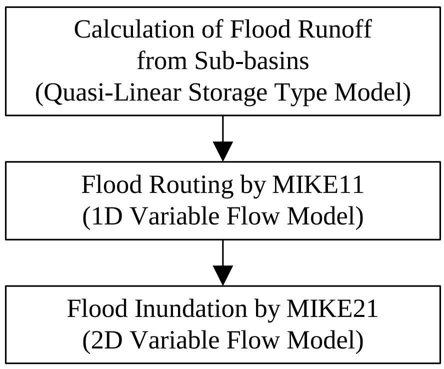


Fig. R 5.4 Flow of Flood Simulation

(2) Methodology for Flood Inundation Model

(a) One-Dimensional Variable Flow Model in MIKE11 for River Channel

The dynamic one-dimensional flow calculation module based on the Saint Venant equations is a core of MIKE11. The equations of continuity and momentum are:

$$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = q$$

$$\frac{\partial Q}{\partial t} + \frac{\partial \left(\alpha \frac{Q^2}{A} \right)}{\partial x} + gA\frac{\partial h}{\partial x} + \frac{gQ|Q|}{C^2 AR} = 0$$

where;

Q	:	discharge (m^3/s)
A	:	flow area (m)
q	:	lateral inflow (m^3/s)
h	:	water level (m)
C	:	Chezy resistance coefficient ($C=R^{1/6}/n$, $m^{1/2}/s$)
n	:	Manning’s roughness coefficient
R	:	hydraulic radius (m)
α	:	momentum distribution coefficient

Flood routing is made along the river and drainage network that consist of the three main rivers and the tributaries.

(b) Two-Dimensional Variable Flow Model in MIKE21 for Flood Plain

The hydrodynamic model in the MIKE21 Flow Model is a general numerical modeling system for the simulation of water levels and flows in estuaries, bays and coastal areas. It simulates unsteady two-dimensional flows in one layer (vertically homogeneous) fluids and has been applied in a large number of studies.

The following equations, the conservation of mass and momentum integrated over the vertical, describe the flow and water level variations:

$$\frac{\partial \zeta}{\partial t}+\frac{\partial p}{\partial x}+\frac{\partial q}{\partial y}=\frac{\partial d}{\partial t}$$

$$\frac{\partial p}{\partial t}+\frac{\partial}{\partial x}\left(\frac{p^2}{h}\right)+\frac{\partial}{\partial y}\left(\frac{pq}{h}\right)+gh\frac{\partial \zeta}{\partial x}+\frac{gp\sqrt{p^2+q^2}}{C^2\cdot h^2}-\frac{1}{\rho_w}\left[\frac{\partial}{\partial x}(h\tau_{xx})+\frac{\partial}{\partial y}(h\tau_{xy})\right]-\Omega_q$$
$$-fVV_x+\frac{h}{\rho_w}\frac{\partial}{\partial x}(p_a)=0$$

$$\frac{\partial q}{\partial t}+\frac{\partial}{\partial y}\left(\frac{q^2}{h}\right)+\frac{\partial}{\partial x}\left(\frac{pq}{h}\right)+gh\frac{\partial \zeta}{\partial y}+\frac{gq\sqrt{p^2+q^2}}{C^2\cdot h^2}-\frac{1}{\rho_w}\left[\frac{\partial}{\partial y}(h\tau_{yy})+\frac{\partial}{\partial x}(h\tau_{xy})\right]-\Omega_p$$
$$-fVV_y+\frac{h}{\rho_w}\frac{\partial}{\partial xy}(p_a)=0$$

The following symbols are used in the equations:

$h(x, y, t)$	:	water depth (=ζ-d, m)
$d(x, y, t)$	:	time varying water depth (m)
$\zeta(x, y, t)$	:	surface elevation (m)
$p,q(x, y, t)$	:	flux densities in x- and y-directions (m^3/s/m) = (uv, vh)
u, v	:	depth averaged velocities in x- and y-directions
$C(x, y)$	:	Chezy resistance ($m^{1/2}$/s)
g	:	acceleration of gravity (m/s^2)
$f(V)$	:	wind friction factor
$V, V_x, V_y(x, y, t)$	:	wind speed and components in x- and y-directions (m/s)
$\Omega(x, y)$	:	Coriolis parameter, latitude dependent (s^{-1})
$p_a(x, y, t)$	:	atmospheric pressure (kg/m/s^2)
ρ_w	:	density of water (kg/m^3)
x, y	:	apace coordinates (m)
t	:	time (s)
$\tau_{xx}, \tau_{xy}, \tau_{yy}$	:	components of effective shear stress

(c) River-Overflow with Lateral Link in MIKE FLOOD

A lateral link allows a string of MIKE21 cells/elements to be laterally linked to a given reach in MIKE11, either a section of a branch or an entire branch. Flow through the lateral link is calculated using a structure equation or a HQ table. This is particularly useful for simulating overflow from a river channel onto a flood plain.

For lateral links, flow from the river model of MIKE11 goes via a lateral boundary, which is applied into MIKE21. The lateral link varies from the standard source/sinks in the following ways:

(i) Flow through the link is dependent upon a structure equation and water levels in MIKE11 and MIKE21.

(ii) Flow through the link is distributed into several MIKE11 ***h*** points and several MIKE21 cells/elements.

(iii) The lateral links do not gurantee momentum conservation.

The latter point is not surprising since the 1D-model per definition does not consider cross channel momentum.

A structure is required to calculate the flow between MIKE11 and MIKE21. This structure is typically a weir that represents over-topping of a riverbank or levee. The geometry of the structure can be determined from cross-section bank markers, MIKE21 topographical levels, a combination of the highest of each, or from external files.

The weir equation applied to this study is the WEIR1 type which is the default of MIKE FLOOD, as follows:

$$Q = CBh_1^k \left[1-\left(\frac{h_2}{h_1}\right)^k\right]^{0.385}$$

where

C	:	weir overflow coefficient (=1.838 $m^{1/2}/s$)
B	:	width of weir (m)
k	:	exponential coefficient (=1.5)
h_1	:	depth of water above weir level upstream (m)
h_2	:	depth of water above weir level downstream (m)

(3) River and Drainage Network

The river networks were modeled in MIKE11, as illustrated in Fig. R 5.5.

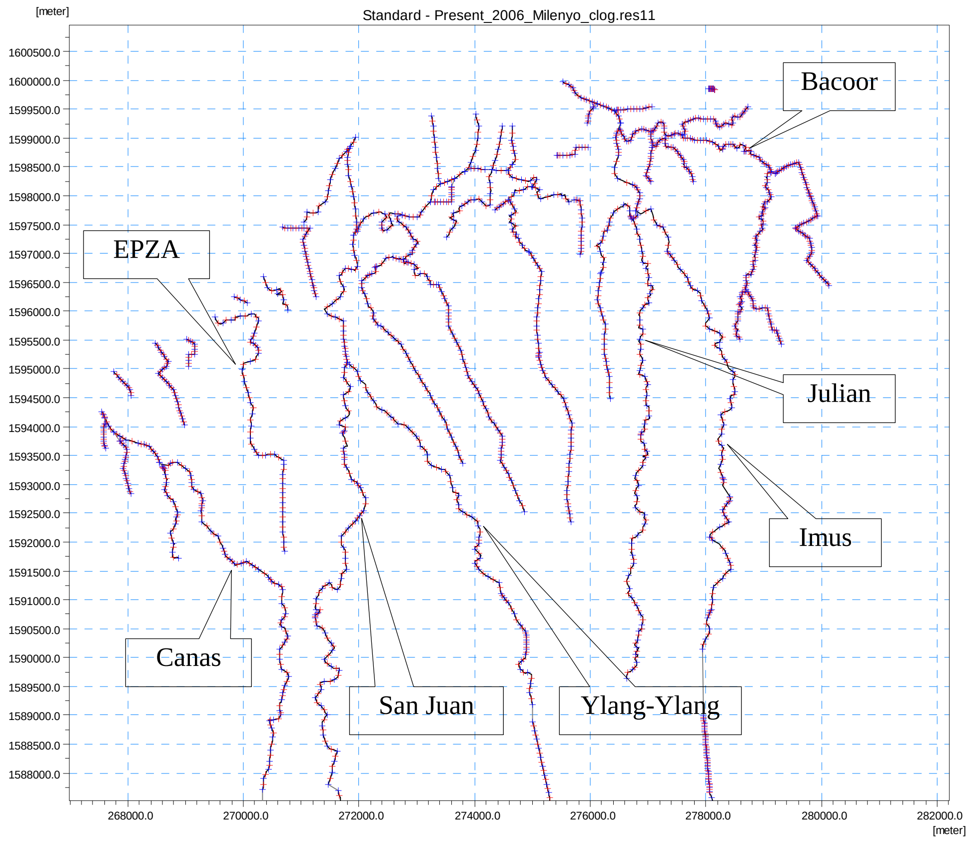


Fig. R 5.5 River Network

(4) Cross-Sectional Data

Rivers in the river network to be modeled and the cross-sectional data surveyed in this JICA Study in 2007 are listed in Table R 5.10. To express inundation in an irrigation area, especially between Imus River and Ylang-Ylang River, assumed river cross-sections were applied in this model. To consider the inland flood and drainage to the sea or river through small creeks, assumed drainage cross-section were also adopted.

Table R 5.10 River and Drainage Network and Cross Sections

Rivers	Name of MIKE11	Station	Number of Cross-Sections
Imus River	IMUS	Sta.0+000 - Sta.12+900	76
Bacoor River	BACOOR-1	Sta.0+000 - Sta.7+700	37
	BACOOR -2	Sta.0+000 - Sta.1+800	10
	BACOOR -3	Sta.0+000 - Sta.1+700	9
Julian	IT-1	Sta.0+000 - Sta.10+000	51
	IT-2	Sta.0+000 - Sta.1+850	9
San Juan	SAN JUAN	Sta.0+000 - Sta.14+400	69
Ylang-Ylang	YLANGYLANG	Sta.0+000 - Sta.7+800	41
	DR-7	Sta.0+000 - Sta.1+700	8
Canas	CANAS	Sta.0+000 - Sta.9+150	48
Tanza River	CT-1	Sta.0+000 - Sta.1+950	11
Malamok Drainage	DR-1	Sta.0+000 - Sta.2+600	13
	DR-2	Sta.0+000 - Sta.1+900	8
Tirona River	DR-3	Sta.0+000 - Sta.2+800	13
	DR-4	Sta.0+000 - Sta.4+000	20
Panamitan River	DR-5	Sta.0+000 - Sta.2+200	10
	DR-6	Sta.0+000 - Sta.2+100	10
Malimango Drainage	DR-8	Sta.0+000 - Sta.1+000	5
EPZA	DR-9	Sta.0+000 - Sta.4+100	21
Upstream of Imus River	IMUSuo		Assumed
Upstream of San Juan River	SANJUANup		Assumed
Upstream of Ylang-Ylang River	YLANup		Assumed
Upstream of Canas River	CANASup		Assumed
Tributary of Julian River	IT-2up		Assumed
Upstream of DR-1	Dr-1up		Assumed
Upstream of DR-2	Dr-2up		Assumed
Upstream of DR-5	Dr-5up		Assumed
Upstream of DR-6	Dr-6up		Assumed
Upstream of DR-9	Dr-9up		Assumed
Small Creeks	C01, 02, 03......, 11		Assumed

(5) Boundary Condition

Tide levels in Manila Bay area are as summarized below:

Table R 5.11 Tide Level of Manila Bay and Cavite Harbor

Tide Level	Height1	Height2
Maximum Tide Level	1.89	1.32
Mean Monthly Highest Tide Level	1.31	0.74
Mean Sea Level	0.48	-0.09

Height1 are in Meters above Mean Lower Low Water Level at Manila Bay.
Height2 are in Meters above Mean Sea Level at Cavite Harbor.
Source: NAMRIA

The latest "Tide and Current Tables, Philippines" published by NAMRIA as of 2007 shows that the high water level at the Cavite Harbor is 0.09m lower than the level at the Manila South Harbor. To design the river and drainage channels by the non-uniform flow calculation and flood inundation analysis, the boundary of river mouth is set at the Mean Monthly Highest Tide level of EL. 0.8m, taking into consideration the difference between the high water levels of Cavite and Manila.

(6) Digital Elevation Model (DEM)

In this two-dimensional variable flow model, the flood plain of the lowland area of 224 km^2 (14km by 16km) was divided into 22,400 cells of 100m squared, as shown in Fig. 5.19 attached.

This DEM was generated from the following three kinds of spot elevation data:

- Based on Contour line prepared by the JICA CALA Study;
- Measured by NAMRIA in 1997; and
- Measured by the JICA Study Team in 2007.

5.5.3 Reproduction of Typhoon Milenyo Flood in 2006

(1) Clogged Bridge

According to the Preliminary Study Report, three bridges; namely, the Tejero Bridge across the Canas River, the Ylang-Ylang Bridge across the San Juan River, and the Imus Bridge across the Imus River, were clogged with drift materials which was one of the causes of the flood during Typhoon Milenyo in 2006.

Fig. R 5.6 Clogged Bridge (Ylang-Ylang Bridge)

In addition to above fact, results of flood runoff analysis and flood inundation analysis in this study showed excessively high water level at the Tejero Bridge on the Canas River. Since this high water level could not be explained by effects of high tide and runoff discharge only, the Study team took clogging effect into consideration as a factor of analyses.

The clogging cross-section at the Tejero Bridge was simulated by trial and error method so as to express the flooding phenomena in the 2006 flood. The clogging cross-section at Ylang-Ylang Bridge was simulated based on the photograph shown in Fig. R 5.6, and the clogging cross section of Imus Bridge was assumed to be of the same extent as the clogging at the Ylang-Ylang Bridge.

(2) Verification of Model

The flood by Typhoon Milenyo in 2006 that could provide the richest information about floods was selected as the target flood for the model verification.

In order to define roads and to express the inundation due to road embankments, the cells located at road embankments were elevated at from 0.1 to 2.0m as the originally generated DEM elevation. These initial raising levels were determined by field inspection in this Study.

Trial runs of simulation of flood inundation were made by changing and adjusting road embankment levels and the Manning's roughness coefficient of rivers until the result reached the acceptable extent of the result of flood damage interview survey, which shows the maximum flood inundation depth in Typhoon Milenyo in September 2006.

The roughness coefficients are as shown in the following table.

Table R 5.12 Determined Roughness Coefficient of Rivers

Rivers	Section		Station		Manning's Roughness Coefficient "n"
	Sta.		MIKE11		
Imus	12+900	9+200	0	3700	0.050
	9+200	6+000	3700	6900	0.040
	0+000	6+000	6900	12900	0.030
Julian	10+000	0+000	0	10000	0.040
Bacoor					0.040
Tributaries of Bacoor					0.030
San Juan	14+400	9+100	0	5300	0.050
	9+100	4+400	5300	10000	0.040
	4+400	0+000	10000	14400	0.030
Ylang-Ylang	7+600	4+000	0	3800	0.050
	4+000	0+000	3800	7600	0.040
Canas	9+150	4+800	0	4350	0.050
	4+800	2+800	4350	6350	0.040
	2+800	0+000	6350	9150	0.030
Others					0.035

(3) Reproduction Result

As the result of flood inundation analysis, the maximum extent and depth of inundation due to Typhoon Milenyo in 2006 are summarized in the table below. Simulation results are shown in Table 5.13 and Fig. 5.20 attached.

Table R 5.13 Estimated Inundation Area of the Typhoon Milenyo Flood in 2006

Range of Inundation Depth (m)	Extent of Inundation Area (km^2)			
	Canas	Imus	San Juan & Ylang-Ylang	Total
0.01 - 0.24	2.15	12.32	12.58	27.04
0.25 - 0.49	0.28	5.03	6.21	11.52
0.50 - 0.99	0.43	4.62	5.65	10.70
1.00 - 1.99	0.37	1.71	1.88	3.96
2.00 - 2.99	0.13	0.02	0.17	0.32
>= 3.00	0.03	0.00	0.03	0.06
Total	3.38	23.71	26.51	53.60

5.5.4 Simulation of Flood Inundation under Several Scales of Flood

(1) Case of Simulation

A total of one hundred seventeen (117) cases of simulation were carried out, as shown in Table R 5.14. The countermeasures are as described in Sections 8.3 and 8.4 of Chapter 8.

(a) Reproduction of Present Condition (Without-Project)

Seven (7) cases of simulation were carried out under the present land use condition based on probable discharge to grasp the present condition of the Study Area.

(b) River-Overflow Only (Without-Project)

Fourteen (14) cases of simulation were carried out under the present and 2020 land use conditions as well as the without-project situation to estimate the damage caused by river-overflow flood only.

(c) Imus River Basin and San Juan River Basin (5-year, 10-yr and 20-year Protection)

A total of thirty (30) cases of simulation for Imus River Basin and a total of sixty (60) cases of simulation for San Juan River Basin were carried out under the present and 2020 land use conditions to estimate the effect of each countermeasure against river-overflow flood.

(d) Inland Flood Only

A total of six (6) cases of simulation were carried out under the present and 2020 land use conditions to estimate the damage and effect of each countermeasure against inland flood only.

Table R 5.14 Cases of Simulation of Flood Inundation

Case	Alternative No.	Countermeasure	Scale of Flood under Present Land Use							Scale of Flood under 2020 Land use						
			2	5	10	20	30	50	100	2	5	10	20	30	50	100
Reproduction		Without-Project	O	O	O	O	O	O	O	-	-	-	-	-	-	-
River-Overflow Only		Without-Project	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Imus River Basin	F_I.2 and F_I.3	5-yr protection	-	O	O	O	O	O	O	-	O	O	O	O	O	O
		10-yr protection	-	-	O	O	O	O	O	-	-	O	O	O	O	O
		20-yr protection	-	-	-	O	O	O	O	-	-	-	O	O	O	O
San Juan River Basin	F_S.4 and F_S.5R	Retarding Basin, 5-yr	-	O	O	O	O	O	O	-	O	O	O	O	O	O
		Retarding Basin, 10-yr	-	-	O	O	O	O	O	-	-	O	O	O	O	O
		Retarding Basin, 20-yr	-	-	-	O	O	O	O	-	-	-	O	O	O	O
	F_S.3 and F_S.5D	Diversion, 5-yr	-	O	O	O	O	O	O	-	O	O	O	O	O	O
		Diversion, 10-yr	-	-	O	O	O	O	O	-	-	O	O	O	O	O
		Diversion, 20-yr	-	-	-	O	O	O	O	-	-	-	O	O	O	O
Inland Flood Only		Without-Project	O	-	-	-	-	-	-	O	-	-	-	-	-	-
		Partial Protection	O	-	-	-	-	-	-	O	-	-	-	-	-	-
		Full Protection	O	-	-	-	-	-	-	O	-	-	-	-	-	-

Note: "O" stands for "simulated", and "-" stands for "not simulated".

(2) Simulation Results

The inundation areas estimated by the simulation are as indicated in Tables R 5.15 to R 5 19 below.

(a) Reproduction of Present Condition (Without-Project)

The results of reproduction of river-overflow and inland floods under the present land use and without-project conditions are as illustrated in Fig. 5.21 attached and shown in Table 5.14 attached.

Table R 5.15 Inundation Areas by River-Overflow and Inland Floods under Present Land Use and Without-Project Conditions

Range of Inundation Depth (m)	Extent of Inundation Area (km^2)						
	2-yr	5-yr	10-yr	20-yr	30-yr	50-yr	100-yr
0.01 - 0.24	14.09	19.47	23.07	26.25	26.44	26.88	27.22
0.25 - 0.49	2.99	5.35	6.44	7.90	8.61	9.38	10.65
0.50 - 0.99	2.07	3.79	5.14	6.81	7.36	8.19	9.25
1.00 - 1.99	0.12	0.66	1.09	1.82	2.19	2.80	3.33
2.00 - 2.99	0.00	0.01	0.03	0.05	0.07	0.11	0.25
>= 3.00	0.00	0.00	0.00	0.02	0.02	0.02	0.06
Total	19.27	29.28	35.78	42.85	44.68	47.38	50.75

(b) River Overflow Only (Without-Project)

The results of simulation of only river-overflow flood under the present and 2020 land use and the without-project conditions are as illustrated in Fig. 5.22 attached and shown in Table 5.15 attached

Table R 5.16 Inundation Areas by River-Overflow under the Present and 2020 Land Use as well as Without-Project Conditions

	Extent of Inundation Area (km^2)						
	2-yr	5-yr	10-yr	20-yr	30-yr	50-yr	100-yr
Present Land Use	9.32	16.54	22.56	29.53	31.97	34.66	38.57
2020 Land Use	13.62	20.66	26.13	33.19	34.62	37.66	40.86

(c) Imus and San Juan (5-yr, 10-yr and 20-yr Protection)

The results of simulation of river-overflow at Imus and San Juan river basins under the present and 2020 land use conditions and the without and with-protection situations are as summarized in Tables R 5.17 and R 5.18 below.

Table R 5.17 Inundation Areas by River Overflow at Imus River Basin under the Present and 2020 Land Use and the Without and With-Protection Conditions

Condition		Extent of Inundation Area of Imus River Basin (km²)						
		2-yr	5-yr	10-yr	20-yr	30-yr	50-yr	100-yr
Present Land Use	Without Protection	8.39	11.75	13.78	15.59	16.43	17.46	19.64
	Protection 5yr	0.00	0.98	2.73	6.17	8.08	10.88	13.32
	Protection 10yr	0.00	0.98	2.31	6.17	8.04	10.83	13.32
	Protection 20yr	0.00	0.98	2.31	6.17	8.04	10.83	13.32
2020 Land Use	Without Protection	11.50	14.67	16.57	18.05	18.46	19.98	20.93
	Protection 5yr	0.00	1.19	3.78	7.17	12.80	14.88	16.18
	Protection 10yr	0.00	1.19	3.78	7.17	12.80	14.87	16.17
	Protection 20yr	0.00	1.19	3.78	7.17	12.80	14.87	16.17

According to Table R 5.17 above, inundation with a 5-year return period occurs even under the condition of 5-year protection. This inundation is caused by river overflow of Bacoor River and Julian River, which are tributaries of Imus River. Their flood protection levels are less than 2-year for Bacoor River and less than 5-year for Julian River.

Table R 5.18 Inundation Areas by River Overflow at Imus River Basin under the Present and 2020 Land Use and the Without and With-Protection Conditions

Condition		Extent of Inundation Area of San Juan & Ylang-Ylang River Basins (km²)						
		2-yr	5-yr	10-yr	20-yr	30-yr	50-yr	100-yr
Present Land use	Without	0.93	4.77	8.67	13.43	14.88	16.36	17.93
	Retarding Basin 5yr	0.00	0.00	0.05	2.60	3.44	4.25	6.50
	Retarding Basin 10yr	0.00	0.00	0.00	2.35	2.99	3.64	4.86
	Retarding Basin 20yr	0.00	0.00	0.00	0.00	2.99	3.64	4.86
	Diversion 5yr	0.00	0.00	1.83	7.68	8.77	10.28	11.64
	Diversion 10yr	0.00	0.00	0.00	6.30	7.84	9.55	11.15
	Diversion 20yr	0.00	0.00	0.00	0.00	7.84	9.55	11.15
2020 Land use	Without	2.11	5.95	9.44	14.67	15.50	17.03	18.90
	Retarding Basin 5yr	0.00	0.00	0.60	3.33	4.02	4.60	7.30
	Retarding Basin 10yr	0.00	0.00	0.00	2.53	3.36	4.17	6.81
	Retarding Basin 20yr	0.00	0.00	0.00	0.00	3.36	4.17	6.81
	Diversion 5yr	0.00	0.00	2.05	7.92	9.42	10.90	12.78
	Diversion 10yr	0.00	0.00	0.00	6.56	8.49	10.19	12.23
	Diversion 20yr	0.00	0.00	0.00	0.00	8.49	10.19	12.23

(d) Inland Flood Only

The results of simulation of only inland floods under the present and 2020 land use conditions are as illustrated or shown in Fig. 5.23 and Table 5.16 attached.

Table R 5.19 Inundation Areas by Inland Flood under the Present and 2020 Land Use Conditions

Condition	Extent of Inundation Area (km²)		
	Without Protection	With Partial Protection	With Full Protection
Present Land Use	7.09	2.91	0
2020 Land Use	8.90	2.92	0

Chapter 6. Basic Survey on Current Approach to Flood Mitigation

6.1 National Policies for Flood Mitigation

The Medium-Term Philippine Development Plan for 2001-2004 (MTPDP) and the National Framework for Physical Planning for 2001-2030 have been formulated to spell-out the policy and direction for economic and infrastructure development including flood mitigation in the Philippines.

6.1.1 Medium-Term Philippine Development Plan (2001-2004)

While flood damage has been reduced in many parts of the country, there still remain complex issues associated with floods such as (1) encroachment of houses on waterways; (2) indiscriminate garbage dumping; (3) rapid urbanization, which increases peak flood runoff; (4) deforestation of watershed areas; and (5) deficiency in technical standards and regulations, organization and budget for continuous operation and maintenance (O&M), rehabilitation and improvement of existing facilities and natural channels.

Considering the above issues, the MTPDP aims at promoting economic development and poverty reduction through the implementation of several flood mitigation projects, and put up the following policies and strategies related to flood mitigation:

- The mitigation of flooding up to tolerable levels in Metro Manila and major river basins with the additional construction/installation of flood mitigation facilities in all flood prone areas that need protection as determined under the national land use plan and, to this end, the Flood Control Act, which provides for a flood control mechanism shall be pursued;
- The Flood Control and Sabo Engineering Center shall be strengthened to enable it to efficiently conduct basic and applied research and development, human resource development, feasibility studies and preliminary engineering;
- Conduct comprehensive floodplain management together with the installation of flood forecasting and warning systems in all major river basins;
- Pursue proper O&M of flood control and drainage facilities including the establishment of systems for effective garbage collection and disposal, the community-based protection for esteros/rivers ("Bantay Estero/Ilog Brigades") and the regulations/rules in coordination with other concerned government agencies and LGUs;
- Policy and strategy on the coordination of development of flood control projects together with the implementation of water resources development projects;
- Relocate informal settlers and prevent them from living along the banks of rivers/esteros/ creeks;
- Implement Sabo projects for the prevention/mitigation of sediment-related disasters, debris and lahar flow/landslide;
- Study and formulate guidelines leading to sustainable development/land use in sediment-related disaster-prone areas. (The Erosion and Sediment Movement Management Act providing for a comprehensive erosion and sediment movement management shall be promoted to address the national problems on sedimentation);
- Implement comprehensive measures consisting of construction, warning/evacuation, livelihood programs in coordination with concerned agencies and LGUs; and
- Enact a law to create the National Commission on Flood Control and Drainage Research and Development.

6.1.2 National Framework for Physical Planning (2001-2030)

The Land Use Committee had promulgated the National Framework for Physical Planning 2001-2030 (NFPP) to guide the preparation of an effective land use plan for proper infrastructure development. The NFPP includes the land use plan relevant to disaster management, as summarized below.

(1) Protection and Disaster Mitigation

The river basin management concept shall be adopted in infrastructure planning to ensure upstream and downstream compatibility. In the implementation of environmentally critical infrastructure projects, environmental rules and regulations shall be strictly complied to mitigate hazardous impacts of projects.

- In solid waste disposal projects, for example, this includes adequate protection against leachate contamination of groundwater and sources of drinking water, breeding of vermin, flies and other carriers of communicable diseases; and
- Thorough environmental impact assessments of environmentally critical projects such as fossil-fueled, nuclear-fueled, hydroelectric or geothermal power plants should also be undertaken to prevent harm to flora and fauna and other hazardous impacts to neighboring communities;

(2) Incorporation of Disaster Mitigation Principles in Infrastructure Development

In addition to avoiding unnecessary encroachment into the national integrated protected area and other protection areas, additional planning considerations are needed to incorporate disaster mitigation principles in infrastructure planning, including the following:

- Design of infrastructure facilities according to specific hazard risk assessments;
- Building of backup capabilities and alternative routes into infrastructure facilities, where appropriate, to ensure life support systems and services (fire-fighting services, access to medical services, power and water supply, transportation, and telecommunication) in the event of a disaster; and
- Intensification or introduction of disaster mitigation measures. (In road projects, for instance, designing of slope protection is required, while at the same time, emphasizing the need to adopt non-structural or non-engineering measures, such as warning system and controlled zoning. The use of non-structural measures also intends to reduce the need for large infrastructure investment. The adoption of non-traditional measures such as terracing rock sheds is also encouraged.)

(3) Local and Private Sector Participation

The following items are put up in connection with the participation of local and private sectors in infrastructure projects, as follows:

- Local and private sector participation in the planning and implementation of infrastructure projects should be encouraged. Lack of such participation has led to increased project costs, wasted resources, and protracted delays in project implementation. Sufficient participation, on the other hand, can lead to better design (through primary source identification and confirmation of project objectives), facilitate construction, and improve maintenance by fostering a degree of ownership among concerned local communities.
- Sharing of capital costs and maintenance responsibilities between the LGUs and the private sector should also be encouraged.

6.1.3 Integrated Water Resources Management

The National Water Forum 2004 was held in Manila on March 22, 2004 to present and discuss the recent water issues and to hold the signing ceremony on the *Clean Water Act* in Malacañang Palace. In the Forum, recommendations were made for water related disasters and risk management, as follows:

- Intensify reforestation, forest protection and other watershed protection activities;
- Adopt philosophy of flood management in place of flood control;
- Enhance comprehensive land use planning LGUs;
- Push for the full implementation of solid waste management plans under the Ecological Solid Waste Management Act; and
- Conduct public awareness programs and more research on disaster preparedness and mitigation.

6.2 Organizational Setup for Flood Mitigation

6.2.1 Overview

Various government agencies and/or inter-agency commissions currently undertake policy-making, formulation, coordination and execution of the programs and/or projects related to flood mitigation in the Philippines. Several new organizational setups related to flood mitigation are further proposed and/or projected.

These existing and proposed organizations could be broadly classified into three types or groups. The first group is the nationwide policy-making/coordination body. This group is represented by NEDA, NWRB-DENR and NDCC (refer to the following Subsections 6.2.2 to 6.2.4). NEDA undertakes policy-making/coordinating for the entire socio-economic development in the country, while NWRB is for the water-sector in particular including flood mitigation. The NDCC is further designated to take the role for nationwide disaster coordination works, which include those for flood as one of the disasters. All of these existing entities were established in the 1970's, and since then they have always played as principal policy/coordination bodies in the water-sector (refer to Subsection 6.2.3(2)). It is herein noted that some new organizations such as NWRB-RBCO were recently established. However, the roles and/or authorities given to these new organizations are deemed to duplicate and/or overlap, to a certain extent, with those currently in operation. As the result, it seems to be still uncertain whether the organizations currently in operation are to be replaced by the newly proposed entities.

The second group consists of the national government agencies, which could be the implementing agencies in specific fields of the water sector. The organizations such as DPWH, NIA, PAGASA and OCD could be categorized into this group (refer to Subsections 6.2.5 to 6.2.7). Among them, DPWH and NIA take the role of developing the major and/or large-scale infrastructures for flood mitigation, which are usually implemented with foreign financial assistance. On the other hand, the functions of PAGASA and OCD contribute to the non-structural flood mitigation measures such as flood forecasting, warning and evacuation. These national government agencies have their own regional offices to perform their roles and authorities over the whole country.

The third group consists of the local government units (LGUs), which are divided into three tiers; namely, the Provincial Government, the City/Municipality, and the Barangay (the smallest administrative unit in the Philippines). In spite of the enactment of the Local Government Code of 1991, which intends to strengthen the local autonomy, the development of large-scale infrastructures for flood mitigation has been hardly undertaken by the LGUs due to budgetary constraint. As the result, the roles and authorities of the LGUs on flood mitigation are limited to the construction, maintenance and rehabilitation of local drainage systems and/or non-structural measures such as the cleaning of waterways and small-scale watershed management.

6.2.2 National Economic Development Authority (NEDA)

NEDA was created in 1972 and since then, has always been the leading agency for the county's socio-economic development and planning as mandated by the Philippine Constitution. The powers and functions of NEDA reside in the NEDA Board, which is headed by the President as chairman and the Director General of NEDA as the vice-chairman. The members of the Board include all Cabinet members, the Central Bank Governor and the Secretaries of major Departments.

NEDA has the following functions and collaborative support with the afore-said DENR-RBCO in connection with water-related works including those for flood mitigation:

(a) To set the direction of socio-economic development in each region of the country;

(b) To formulate and approve the policies on development and management of water resources; and

(c) To evaluate, appraise and approve the major development projects.

6.2.3 Department of Environment and Natural Resources (DENR)

(1) National Water Resources Board (NWRB)

The National Water Resources Council (NWRC) was established through Presidential Decree No. 424 of May 1975 and renamed to the present National Water Resources Board (NWRB) in accordance with Executive Order 124-A of July 1987. The NWRB had always been the country's leading policy-making and regulatory body in the water sector, holding the following functions:

(a) Formulation and coordination of policies, programs and standards relating to the water-related programs and projects;

(b) Management and regulation for all water-related activities; and

(c) Regulation and monitoring of water utilities.

The NWRB is chaired by the Secretary of DENR and composed of five cabinet secretaries, a representative from the academe and the executive director as the member. Although the NWRB is independent in the aspects of the afore-said policy-making and regulatory functions, it is currently under the administrative supervision of the DENR as an attached agency.

(2) River Basin Control Office (RBCO)

The RBCO was established through Executive Order No. 510 dated March 05, 2006, as an agency attached to DENR. The RBCO is the core agency for the direction, control, regulation, rationalization and harmonization of all water-related programs and projects including those for flood mitigation.

The RBCO formulated the Master Plan of Nationwide Integrated River Basin Management and Development in 2007, and proposed the following items:

(a) The NWRB is to be reorganized into the Water Resources Management Bureau of DENR. Upon the reorganization, the functions of policy-making for water-related programs and projects are likely to be transferred from the aforesaid NWRB to the RBCO.

(b) The River Basin Management Office (RBMO) and the River Basin Council (RBC) are to be newly established to strengthen the functions of the RBCO. The RBMO shall be the unit of DENR to support the roles of RBCO at the river basin level. On the other hand, the RBC shall be composed of representatives from the existing water-related agencies serving as entities for policy governing and fund sourcing for the river basin program.

(c) The RBMO shall organize and facilitate the local multi-sectoral river basin committees and task forces. Hence, the Flood Mitigation Committee (FMC) is proposed as one of the level river basin committees to foster participation of communities and other stakeholders to a series of flood management works as deemed necessary. The FMC could be organized at the regional, provincial, city/municipal or barangay level depending on the extent of coverage of the river basin concerned.

(3) Other Attached Agencies related to the Water Sector

The following three bureaus attached to DENR are at present the agencies relevant to the management of water resources:

(a) Environment Management Bureau (EMB), which is responsible on matters pertinent to environmental management and conservation, pollution control and water quality management.

(b) Mines and Geo-Sciences Bureau (MGB), which is responsible for the preparation of the national geo-hazard mapping to determine the hazard prone areas.

(c) Forest Management Bureau (FMB), which is responsible on matters related to forest development and conservation.

6.2.4 National Disaster Coordination Council (NDCC)

Presidential Decree No. 1566 was issued in 1978 to organize the National Disaster Coordination Council (NDCC) on the premise that the country and its component communities shall mobilize all its available institutions to protect lives and property and ensure collective survival in the face of natural disasters.

The NDCC is the policy-making and coordinating body for disasters management at the national level. It directs all disaster preparedness planning, as well as disaster response operations and rehabilitation, both in the public as well as private sectors. The Secretary of National Defense serves as the Chairman of the NDCC. The members of the NDCC are composed of the heads of fourteen national agencies, the Chief of Staff of the Armed Forces of the Philippines, the Secretary-General of the Philippine National Red Cross, and the Administrator of the Office of Civil Defense (OCD).

In each of the administrative regions of the country, the Regional Disaster Coordinating Council (RDCC) was also established to perform similar functions as the NDCC for the regions. Equivalent officials of various agencies at regional level serve in these councils, which are headed by regional chairmen designated by the President.

There also exists the local disaster coordinating councils at the provincial, regional, city/municipal and barangay level. These local councils have the function to execute the actual disaster management works required at the local level through cooperation with civic and non-government organizations (NGOs). The chief executive of the local government such as the provincial governor or the mayor serves as chairman of the local disaster coordinating council. The members of the local disaster coordinating council include the staffs of the local government agencies as well as the private citizens and NGOs.

6.2.5 Department of Public Works and Highways (DPWH)

The DPWH has the mandate to undertake plan formulation, design, construction and operation/maintenance of public infrastructures including flood mitigation facilities. The central office of DPWH consists of ten bureau level offices and seven project management offices (PMOs). Of the seven PMOs, the PMO-Major Flood Control and Drainage Projects (MFCDP) and Mount Pinatubo Emergency mainly undertake flood control and sabo projects, which are usually subject to foreign technical and financial assistance.

The DPWH also has 16 regional offices and 176 district engineering offices under the regional offices. These regional and district offices mainly undertake the locally-funded infrastructure projects. The objective river basins of the Study; namely, Imus, San Juan and Canas are under the jurisdiction of the DPWH District Office in Tress Martires City, which belongs to Regional Office IV-A.

6.2.6 National Irrigation Administration (NIA)

The NIA was established in 1963 as a government agency responsible for development, operation and maintenance of irrigation systems all over the country. The particular function of NIA is oriented to the promotion of national food production programs and the enhancement of economic and social growth in rural areas through the development of irrigation systems. In the course of development of irrigation systems, NIA sometimes constructs flood control facilities like dike to protect the irrigation systems in case they are developed in flood prone areas.

The NIA has 13 regional irrigation offices, 67 provincial irrigation offices and 101 irrigation systems offices. The objective river basins of the Study are under the jurisdiction of the Provincial Office of NIA in Naic, Cavite. There are numerous dams and weirs for irrigation water intake in the Study Area as described in Section 5.3. These river facilities are under the administration of the Provincial Irrigation Office-Cavite.

6.2.7 Other National Agencies related to Flood Mitigation

The following agencies currently possess certain roles related to flood mitigation and/or river basin management works:

(1) Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) under the Department of Science and Technology (DOST)

PAGASA, which is under DOST, has the important function to provide atmospheric, geophysical and astronomical data including rainfall data and other climatologic data, which are essential for the formulation of a flood mitigation plan and execution of flood forecasting and warning.

(2) Office of Civil Defense under the Department of National Defense (DND)

The OCD has the function to monitor safety of dams and other water resources development facilities. At the same time, the agency has the responsibility for preparation and emergency support of the residents in case of calamities such as flood and typhoon.

(3) Environmental and Occupational Health Office (EOHO) under the Department of Health (DOF)

The EOHO is responsible for water supply and sanitation programs and strategies to forestall environmental-related diseases.

(4) National Hydraulic Research Center (NHRC-UPERDFI)

The NHRC is a research center attached to the University of the Philippines Engineering Research and Development Foundation, Inc. (UPERDFI), which was formally organized in 1972 as a private, non-stock, non-profit corporation based in the University of the Philippines. The objectives of UPERDFI are to promote and support engineering research and development in the country in the furtherance and enhancement of its economic development.

(5) Philippine Institute of Volcanology and Seismology (PHIVOLCS)

As specified in EO 128, PHIVOLCS is mandated to perform the following functions:

- Predict the occurrence of volcanic eruptions and earthquakes and their geotectonic phenomena;
- Determine how eruptions and earthquakes occur and also areas likely to be affected;
- Exploit the positive aspects of volcanoes and volcanic terrain in furtherance of the socio-economic development efforts of the government;
- Generate sufficient data for forecasting volcanic eruptions and earthquakes;
- Formulate appropriate disaster-preparedness and mitigation plans; and
- Mitigate hazards of volcanic activities through appropriate detection, forecast and warning system.

6.2.8 Local Government

The local government of Cavite is composed of three tiers of administrative units; namely, the Provincial Government, the City/Municipality, and the Barangay. The cities/municipalities and barangays located in the Study Area (i.e., the river basin of Imus, San Juan and Canas River) are under the jurisdiction of three congressional districts as listed in the table below:

Table R 6.1 Cities/Municipalities and Barangays in the Study Area

Congressional Districts	City/Municipality	Number of Barangays
District I	Bacoor	44
	Kawit	23
	Noveleta	16
	Rosario	20
District II	Trece Martires	9
	Dasmarinas	72
	Gen. Trias	33
	Imus	96
	Tanza	23
District III	Amadeo	24
	Indang	6
	Silang	31
	Tagaytay	14
Total		411

The Provincial Government of Cavite is composed of 14 offices under the Provincial Governor as the chief executive. Of these offices, the Provincial Planning and Development Office (PPDO) is the principal agency to coordinate, formulate, monitor and evaluate the economic, social and infrastructure development plans including those for flood mitigation in conformance with the provincial policies and goals. In accordance with the plans formulated by PPDO, the Provincial Engineering Office (PEO) supervises, administers and controls the construction, maintenance and repair of the infrastructure development facilities including those for flood mitigation.

In the City/Municipality Level, the Office of the Municipal/City Planning and Development Coordinator (MPDC/CDPC) takes responsibilities similar to those of PPDO, and its Engineering Section undertakes actual construction works similar to PEO.

The works related to flood mitigation at the Barangay Level headed by the Barangay Captain is oriented to non-structural flood mitigation measures including cleaning of waterways and evacuation during floods in line with the activities of the local disaster coordination committee.

The Local Government Code of 1991 was enacted in 1992 aiming at decentralization, devolution and development of the country. The Code intended to increase the financial resources available to the LGUs. However, the current financial resources of the LGUs are still unable to cover the costs for the development of major flood mitigation infrastructures. The LGUs currently undertake the following minor drainage projects and non-structural flood mitigation measures:

- Maintenance, rehabilitation and construction of open drainage channels and/or small river tributaries including embankment/slope protection and declogging or cleaning of canals;
- Community-based watershed management and/or forestry projects with an area not exceeding 50 square kilometers;
- Monitoring and control of illegal construction/modification of waterways made by land developers; and
- Disaster prevention works tasked to the local disaster coordination committee.

6.3 Budget for Flood Mitigation Project

6.3.1 National Budget

As described above, the DPWH is the national agency mandated to undertake construction of infrastructures for flood mitigation, and it shoulders investment costs for major flood mitigation projects in the Philippines. The actual average investment cost for infrastructure projects under the DPWH budget was about 40.3 billion pesos on average for the period from 1999 to 2006. This investment cost is divided into 21 billion pesos (53%) for national road projects, 5.1 billion pesos (13%) for flood mitigation projects, and 14 billion pesos (27%) for other locally-funded projects, as listed in Table R 6.2.

Table R 6.2 Actual Investment Cost for Infrastructure Projects from 1999 to 2006 - DPWH

(Unit of Cost: million pesos)

Year	National Road Projects		Flood Mitigation Projects		Other Local Funded Projects		Total
	Cost	Percentage to Total	Cost	Percentage to Total	Cost	Percentage to Total	
1999	21,878	60%	5,346	15%	9,513	26%	36,737
2000	22,950	51%	4,791	11%	17,146	38%	44,887
2001	21,878	60%	5,346	15%	9,512	26%	36,736
2002	13,059	33%	4,969	12%	22,115	55%	40,143
2003	18,328	45%	4,347	11%	17,668	44%	40,343
2004	18,898	51%	4,270	11%	14,220	38%	37,388
2005	24,313	63%	5,085	13%	9,391	24%	38,789
2006	28,642	60%	6,318	13%	12,754	27%	47,714
Average	21,243	53%	5,059	13%	14,040	35%	40,342

Source: DPWH

The actual investment costs listed above were disbursed based on the cost proposed in the "DPWH Medium-Term Infrastructure Development Program (DPWH-MTIDP)" and a comparison between the actual cost and proposed investment cost for 1999-2004 shows that the proposed investment cost had been almost fully disbursed as actual investment cost. However, the investment cost both for national road projects and flood mitigation projects were curtailed to less than 70% of the proposed cost, and the balance was converted to investment for other locally-funded projects, as listed below.

Table R 6.3 Proposed Investment Cost in Medium-Term Investment Program (1999-2004) and Rate of Proposed Investment Cost to Actual Cost Disbursed

(Unit of Cost: million pesos)

Year	National Road Projects		Flood Mitigation Projects		Other Locally Funded Projects		Total	
	Cost	Rate to Actual Cost	Cost	Rate to Actual Cost	Cost	Rate to Actual Cost	Cost	Rate to Actual Cost
1999	24,273	90%	4,384	122%	581	1637%	29,240	126%
2000	22,951	100%	4,791	100%	2,147	799%	29,891	150%
2001	28,161	78%	6,089	88%	458	2077%	34,710	106%
2002	29,063	45%	8,285	60%	719	3076%	38,068	106%
2003	39,983	46%	9,641	45%	905	1952%	50,530	80%
2004	41,640	45%	10,773	40%	1,950	729%	54,364	69%
Average	31,012	63%	7,327	66%	1,127	1334%	39,467	100%

Source: DPWH MTIDP for 1999-2004

The latest DPWH-MTIDP for the period 2005-2010 was proposed in May 2007, as shown in the following Table R 6.4. According to the Plan, the annual total investment cost for the period would gradually increase and the average would reach about three times of that for the period 1999-2004. The share of the investment for flood mitigation to the total cost has slightly decreased from 13% for 1999-2004 to 12% for 2005-2010.

Table R 6.4 Proposed Investment Cost in the Medium-Term Program for 2005-2010

(Unit of Cost: million pesos)

Year	National Road Projects		Flood Mitigation Projects		Other Locally Funded Projects		Total
	Cost	Percentage to Total	Cost	Percentage to Total	Cost	Percentage to Total	
2005	26,203	68%	5,285	14%	7,232	19%	38,720
2006	35,556	75%	4,784	10%	7,380	15%	47,720
2007	37,288	60%	8,032	13%	17,342	28%	62,662
2008	56,660	76%	5,515	7%	12,132	16%	74,307
2009	64,695	76%	11,866	14%	8,892	10%	85,453
2010	75,990	77%	13,641	14%	8,640	9%	98,271
Average	49,399	73%	8,187	12%	10,270	15%	67,856

Source: DPWH MTIDP for 2005-2010

In the proposed DPWH-MTIDP for the period 2005-2010, implementation of 33 foreign financial assistance projects (9 ongoing projects and 24 new projects) is included in the sector of flood mitigation. The average investment cost per project is estimated at about 2.8 billion pesos (4.3 billion pesos for the ongoing projects and 2.3 billion pesos for the proposed projects), as listed below.

Table R 6.5 Proposed Investment Cost for Ongoing and Proposed Flood Mitigation Projects in the Medium Term Program for 2005-2010 (Foreign Financial Assistance Projects)

(Unit: million pesos)

Project Status	Number of Projects	Investment Cost (million pesos)				Ave. Invest. Cost/Project (million pesos)
		Prior Years	2005 to 2010	After 2005	Total	
Ongoing	9	17,414	21,173	0	38,587	4,287
Proposed	24	0	23,050	31,785	54,835	2,285
Total	33	17,414	44,223	31,785	93,422	2,831

In addition to the above foreign financial assistance projects, the DPWH-MTIDP for 2005-2010 projected the investment cost of 4.9 billion pesos in total for locally funded projects in the sector for flood mitigation, as shown in Table R 6.6. This cost is likely to be oriented to the maintenance of flood mitigation facilities such as drainage along national roads, protection works along national roads/seawall and maintenance for river channels.

Table R 6.6 Proposed Investment Cost for Ongoing and Proposed Flood Mitigation Projects in the Medium Term Program for the Years from 2005 to 2010 (Locally Funded Project)

(Unit: million pesos)

Project	Annual Investment Cost (million pesos)						
	2005	2006	2007	2008	2009	2010	Total
Drainage along National Roads	0	0	500	500	300	350	1,650
Protection Works along National Roads/Seawall	0	0	500	500	300	350	1,650
Flood Control in Principal/Major River Basin	0	0	500	500	300	300	1,600
Total	0	0	1,500	1,500	900	1,000	4,900

DPWH has taken efforts, through its Cavite District Office, to mitigate and prevent flood damage in Cavite Province such as installation of bank protection works, dredging of deposited material on the riverbed, and drainage improvement works. DPWH has also undertaken maintenance and cleaning of drainage canals along national roads. The annual investment cost of DPWH for the flood mitigation works in Cavite Province is in the range of 16.7 to 53.8 million pesos, as listed in Table 6.1 attached.

6.3.2 Budget of Local Government Units

The Local Government Code of 1991, which was enacted in 1992, induced decentralization and/or devolution of the country. The Code increased the financial resources available to LGUs units by:

(1) Broadening their taxing powers;

(2) Providing the LGUs with a specific share from national wealth exploited in their area; e.g., mining, fishery, and forestry charges; and

(3) Increasing share from the national taxes, i.e., internal revenue allotments (IRA), from the previously low 11% to as much as 40%.

As shown in Table R 6.7, the annual income of the Provincial Government of Cavite is a little over 1 billion pesos. About 70%bof it is covered by the IRA, and more than 90% of the annual expense is allocated for office operating cost, which is mostly used for personnel expenses. Judging from this income and expense, the IRA (i.e., the share of national budget) is deemed to hardly cover the cost for devolution in spite of the increment of IRA, and budgeting for flood mitigation works by the Provincial Government is rarely affordable.

Table R 6.7 Annual Income and Expense in the General Fund of Provincial Government of Cavite

(Unit: million pesos)

Item		General Fund in 2005		General Fund in 2006	
		Amount	Share	Amount	Share
Income	Taxes and other Incomes	316	29.2%	337	28.6%
	IRA	767	70.8%	839	71.4%
	Total	1,083	100.0%	1,177	100.0%
Expense	Office Operating Cost	811	96.0%	990	92.3%
	Subsidies to LGUs	16	1.9%	37	3.4%
	Subsidies to Others	4	0.5%	5	0.5%
	Others	14	1.6%	41	3.8%
	Total	845	100.0%	1,073	100.0%

Source: Cavite Socio-Economic Profile, 2005 and 2006

The principal sources of income of the city/municipalities are the local taxes, the IRA and others (such as the senatorial funds, congressional funds and subsidies from the provincial and national government). In case of the Municipality Kawit in 1999, the income generated from taxes was 46 million pesos, while revenue from the national government in the form of internal revenue allotment (IRA) amounted to 26 million pesos.

The budgetary scales of the city/municipalities in the Study Area are less than 10% of that of the Provincial Government, and they have rather large gaps among city/municipalities. The cities and municipalities in the Philippines are classified into five groups according to their income. Of the 12 city/municipalities in the Study Area, Bacoor and other seven city/municipalities belong to the fist class, which has the annual income of more than 75 million pesos, while four municipalities belong to the third or forth class, which has the annual income of less than 30 million pesos, as listed in Table R 6.8.

The municipal fund for infrastructure development usually comes from 20% of the IRA. In spite of the increment of IRA by decentralization, the fund could hardly shoulder the necessary cost for flood mitigation. Therefore, the budget for flood mitigation works by the LGUs is rarely affordable, and the city/municipalities currently undertake minor drainage projects only.

Table R 6.8 Income Classification of City and Municipalities in the Study Area

District	City/Municipality	Income Classification	
		2001	2005
District I	Bacoor	1st	1st
	Kawit	1st	1st
	Noveleta	4th	3rd
	Rosario	1st	1st
District II	Trece Martires City	3rd	4th
	Dasmariñas	1st	1st
	General Trias	1st	1st
	Imus	1st	1st
	Tanza	1st	1st
District III	Amadeo	4th	4th
	Indang	3rd	3rd
	Silang	1st	1st

Source: Socio-Economic Profile 2006, Province of Cavite
Note: 1st Class = Average annual income of more than 75 million pesos
2nd Class = Average annual income between 50 and 75 million pesos
3rd Class = Average annual income between 30 and 50 million pesos
4thd Class = Average annual income between 20 and 30 million pesos
5th Class = Average annual income between 10 and 20 million pesos

Outside Metro Manila, flood control, urban drainage and other urban infrastructure projects of the LGUs are implemented through credit facilities provided by the Land Bank of the Philippines (LBP), the Development Bank of the Philippines (DBP), and the Municipal Finance Corporation (MFC; formerly, Municipal Development Fund Office of the Department of Finance) under such category as World Bank (WB), Asian Development Bank (ADB), and Japan Bank for International Cooperation (JBIC) assisted projects:

These credit facilities are usually called as "Two-Step Loan," where the LGUs may borrow funds for infrastructure projects through the guarantee of the national government or national funding institutions. Generally, the interest rate of 9% to 10% on the original rate of the foreign funding institution is added to the amortization and because of such high interest rate, the LGUs could hardly afford repayment of the said "Two-Step Loan."

6.4 Past and Ongoing Activities relevant to Flood Mitigation in the Study Area

6.4.1 Maintenance of River and Drainage Structures

DPWH, the municipalities and NIA undertake the following maintenance and rehabilitation works of river and drainage structures:

(1) Maintenance Work by DPWH

As described above, the DPWH-Cavite District Office undertake maintenance works of the river facilities including the installation of bank protection works, dredging of material deposited on the riverbed and drainage improvement works. DPWH also undertake maintenance and cleaning works of drainage canals along national roads (refer to Table 6.1 attached).

(2) Maintenance Work by Municipalities

The municipalities also take efforts to mitigate and prevent flood damage in the Study Area, such as installation of bank protection works, construction of parapet wall along rivers, and drainage improvement works. However, a strategic drainage and maintenance plan has hardly been formulated due to the lack of information on the existing drainage system layout. Notwithstanding such circumstances, the Municipality of Gen. Trias has prepared a Drainage Improvement Plan (Draft) by its own effort. According to the improvement plan, one diversion channel is to be constructed to connect San Juan River with Canas River at the immediate upstream of the Bayan Dam (the nearest distance between both rivers), and a drainage canal that will connect San Juan River to Canas River along the Diversion Road.

(3) Rehabilitation Works of Irrigation Dam by NIA

River water in the Study Area is used for irrigation. The irrigation facilities have been provided and are maintained by the National Irrigation Administration (NIA). According to the 2001 data from NIA, there are 13.6 thousand hectares of irrigated land, a part of which are sporadically located in the municipalities of the Study Area, such as the municipalities of Bacoor, Dasmariñas, Gen. Trias, Imus and Tanza.

In this connection, there are many irrigation facilities (dams: approx. 60) including major and small intake dams in the study area. Among them, about 10 dams are located in the low land area (downstream river reaches), while the rests are all in the central hilly area (middle river reaches). These dams are getting old and most of the dams required rehabilitation due to peeling of the concrete surface and cracks on the dam, sidewall and appurtenant facilities. NIA had repaired the dams to restore their stability and functions, and to facilitate maintenance.

Table R 6.9 Rehabilitation Works of Irrigation Facilities in the Study Area by NIA in 2007

Project Name	Main Objective	Budget (mil. Pesos)
Butas River Irrigation System Improvement	Rehabilitation of Butas Dam (temporary)	43
Quintana River Irrigation System Improvement	Rehabilitation of Quitana Dam	10
Rehabilitation of Plucena Irrigation System	Rehabilitation of Plucena Dam	3

Source: NIA Naic Office

6.4.2 Activities relevant to Cleanup of Waterway

The following activities relevant to the cleanup of waterways are currently being undertaken in Cavite Province:

(1) Projection of Provincial-wide Solid Waste Management System

The present solid waste disposal system in Cavite Province is characterized by the open dumping system administered by each city or municipality. There exist about 20 open dumping sites in the province, but some of them are going to be filled up within a few years. Moreover, the open dumping sites are causing serious environmental hazards such as odor emission and contamination of soil and groundwater by leachate. Some of the cities/municipalities in the Province have established their own Material Recovery Facility (MRF) in order to segregate biodegradable and recyclable wastes and to reduce the volume hauled to the dumping sites. MRFs, however, hardly prevail over the province because of the odor emitted, budgetary constraint and lack of human resources.

To cope with the present issues on solid waster management, the Provincial Government has programmed a new integrated provincial-wide solid waste management system. The system is composed of (1) haulers of waste from pick-up points designated in each community to the transfer stations; (2) three transfer stations; (3) haulers of wastes from transfer stations to the final disposal site; and (4) one integrated final disposal site.

Of these components, item (1) is undertaken by the respective cities/municipalities using their own dump tracks and/or contract haulers. On the other hand, items (2) to (4) are newly established and managed by a private firm, Environsave, Inc. The firm undertakes initial investment as well as operation, maintenance and management for items (2) and (3). As incentive for these undertakings, the firm is entitled to receive US$18 per ton of household wastes from the local government and further sell the composts and recyclable materials refined by the MRA.[1]

[1] The cost of 18$/ton is financed from the source of cities and municipalities. The Provincial Government firstly receives the amount from the cities/municipalities and pays it to the Environsave, Inc.

The Environmental Compliance Certificate (ECC) for the new solid management system was issued in November 2007, and operation of the system is expected to start in the third quarter of 2008. Upon commencement of operation of the new dumping site, all existing dumping sites in Cavite Province are to be closed, and the whole household wastes in the province will be disposed through this new system. Particular features of the system are as described below.

(a) Transfer Stations

All of the three transfer stations are placed in Cavite Province: one is adjacent to the final disposal site in Ternate Municipality as mentioned below, while other two are in municipalities of General Trias and Silang (refer to Fig. 6.1 attached). All of these transfer stations are equipped with new MRFs that could segregate about 80% of the household wastes into biodegradable wastes, recyclable wastes and special wastes, and another 20% as inert wastes. The biodegradable wastes and recyclable waste would be refined to composts and/or other useful recyclables. On the other hand, the special wastes (about 1% of the whole wastes) are disposed through special treatment, and the inert wastes are compacted and transported to the final disposal site.

(b) Haulers from Transfer Stations to Final Disposal Site

The Environsave, Inc. owns and operates fifteen new compactors as haulers of wastes from the transfer stations to the final disposal site. The wastes to be hauled are the afore-said inert wastes, which are segregated from the original household wastes and compacted by MRF at the transfer stations.

(c) Final Disposal Site

The new final disposal site is in Ternate Municipality, which is located at the western part of the Study Area. The underground of this site is sealed with double liners made of tough plastic films called "High Density Policy Ethylene (HDPE)", which prevents leachate from penetrating into the underground. The site is further divided into several units, and each unit is covered with soil every time the depth of the disposed material at the unit reaches 10m. Thus, the new disposal site is a sanitary landfill type, which is environmentally far advanced as compared with the existing open dumping type.

The new disposal site has an area of 85ha, which is more than three times of the whole extent of the existing open dumping sites in the Province (25ha). Moreover, the wastes dumped into the new site are substantially reduced because of segregation and compaction by the new MRFs placed at the transfer station. Thus, the disposal capacity of the new solid wastes management system is also much increased from that of the existing system.

(2) Ongoing Provincial Cleanup Drive

The Provincial Government launched a provincial-wide cleanup campaign through a Program called "Oplan Linis Cavite" in 2005. Since then, the cities and municipalities in collaboration with the residents, NGOs, the Rotary Club and other groups have undertaken the relevant information education campaign (IEC). At the same time, they have regularly conducted cleaning together with green planting in public places such as waterways, coastal area, parks and roads based on the Program. Private firms such as industrial and commercial firms have supported such field activities through the provision of manpower and materials required for the programs. The details of the activities are as described below.

(a) Information and Education Campaign (IEC)

The cities and municipalities open seminars/workshops and distribute materials for the IEC on the cleanup drive. The objectives of the IEC are broadly classified into the following two issues:

- One of the issues is concerned with the cleanup of public places including waterways. The Municipality of Imus in collaboration with the DENR, the NGO of Sagip Ilog Cavite Council Inc. (SCC) and the De La Salle University-Dasmariñas lunched out the “Save Imus River Rehabilitation Project (SIRP)” in 2005 in order to rehabilitate the environment of Imus River. The municipality intends to start the IEC with the residents on the proper utilization of the river including cleanup of the waterway. The NGO of the Kawit Sagip-Ilog and Anti-Flood Group in the Municipality of Kawit also undertake IEC on the cleanup of rivers in the Municipality of Kawit.

- Another principal target of the IEC is oriented to the reduction of household wastes by segregation and recycling. The JICA Study Team has confirmed that the municipalities of Kawit, Amadeo, Trece Martires, Indang and Silang currently undertake the relevant IECs. The Municipality of Silang in particular is currently promoting the Project “Silang Malinis, Silang Masipag” (Beautification of Silang through diligent efforts by Silang) to disseminate the necessity of waste reduction by segregation and reuse of household wastes.

(b) Practices for Segregation of Household Wastes

Some of the municipalities such as Imus and Rosario apply the rule of “No Segregation, No Collection” such that the municipality would not collect the household wastes when the wastes are not segregated. In addition to the enforcement of segregation, the community of Phase VI in Barangay Molino V, Bacoor Municipality has voluntarily started a project to reduce wastes through recycling even without support from the local government. The project has encouraged the majority of the residents to segregate wastes and to refine the compost from the wastes, leading to the harvest of fresh products from gardens.

(c) Cleanup Work in the Field

In line with Oplan Linis Cavite, some of the cities and municipalities in collaboration with the residents regularly undertake the cleaning of public spaces such as roads, parks and waterways. The Municipality of Imus in particular carries out cleanup activities in various barangays every Saturday of the week.

The Municipality of Imus in particular has programmed a comprehensive river cleaning work including dredging/cleanup of the Imus River, tree planting along the river and establishment of buffer zone to check the dumping of garbage into the waterways through the afore-said the SIRP.

(d) Capacity Development

In line with the technical assistance being provided by JICA, the International Center for Environmental Technological Transfer (ICETT), Japan, undertook technology transfer on the segregation of biodegradable wastes from household wastes and refining of them into organic fertilizers. This transfer of knowledge was a sort of pilot project and given to the officials of Barangay Gahak in Kawit Municipality. The Municipality intends to ultimately disseminate the knowledge acquired over its entire jurisdiction.

(e) Physical Enforcement

The Municipality of Tanza has a program to put up barriers/grills (a la strainers) in the rivers and waterways in each barangay to check and contain garbage flow. The Municipality of Amadeo has also assigned watchers to check the illegal garbage dumping.

6.4.3 Present Activities for Flood Warning and Evacuation in the Study Area

Presidential Decree No. 1566, which was signed on June 11, 1978, prescribes that multi-sectoral disaster coordinating councils from the national to barangay levels shall be organized to cope with disasters including flood in the Philippines. This Decree further prescribes that the councils shall formulate their respective "Calamities and Disaster Preparedness Plan" as the bases for disaster management.

Of the councils prescribed in the Decree, the Provincial Disaster Coordinating Council (PDCC), the City and Municipal Disaster Coordinating Council (CDCC and MDCC) and Barangay Disaster Coordinating Council (BDCC) could be regarded as the front body for operation and management of the objective flood forecasting and warning system. These local councils are to be headed by the elected chief executives, such as the governor, mayor and barangay captain and undertake the operation for flood warning and evacuation in collaboration with civic and non-government organizations

The local councils function to mobilize all available human resources, equipment and materials for the sake of flood warning and evacuation. The councils also facilitate dissemination of flood information. At the same time, the councils provide the knowledge and awareness on the flood warning and evacuation. Thus, the institutional setup prescribed in PD 1566 is closely related to the operation for flood warning and evacuation. In spite of the prescription, no systematic flood warning and evacuation prevail in the Study Area. The updated conditions for institutional setup of the flood warning and evacuation system for the Study Area are as described below.

(1) Setup of Local Disaster Coordinating Councils

Trece Martires City and the municipalities of Kawit, Imus, Noveleta and Tanza have recently completed reorganization of their respective MDCC/CDCC. Reorganization is also now in progress in the Provincial Government of Cavite as well as the municipalities of Rosario, Bacoor and General Trias. However, some of the municipalities in the upland of the Study Area such as Indang, Amadeo and Dasmariñas either have not organized their respective MDCCs or their MDCCs have not been fully activated. Moreover, most of barangays in the Study Area have yet to organize their BDCCs.

(2) Calamities and Disaster Preparedness Plan

Majority of the municipalities as well as most of the barangays in the Study Area have yet to formulate their Calamities and Disaster Preparedness Plan. Only the two municipalities of Kawit and Imus have completed formulation of their Plan, which presents the concept, organizational tasks, coordinating instruction procedure, and administrative and logistics support to be provided in case of disaster including flood. However, these plans do not provide detailed instructions on flood warning and evacuation for the residents. To reduce vulnerability of the communities against flood, it is important to actually "implement" the Plan to prepare against flood disasters and to execute preventive activities during floods.

The Provincial Government shall inventory available resources, which may be needed at the time of flood disaster as the bases for formulation of the Calamities and Disaster Preparedness Plan. To be checked and updated are the quantities/locations of the available resources and the list of responsible officers/trained personnel in the entire province.

(3) Disaster Operation Center

Disaster operation centers to lead the necessary activities for flood warning and evacuation have been designated only for the three municipalities of Imus, Kawit and Tanza, as follows:

- The Municipal Social Welfare Office in Kawit;
- The new building named as "Municipal Emergency and Disaster Operations Center" in Imus, which is located adjacent to the Evacuation Center and commonly used as the police station and the disaster operation center, and
- The Office of the Municipal Mayor in Tanza.

(4) Evacuation Center

The Provincial Government as well as the municipalities of Kawit and Imus has identified the following evacuation centers, which could accommodate evacuees during flood (refer to Fig. 9.3)

(a) Provincial Government of Cavite

The Provincial Disaster Coordinating Council had identified the following nine eligible flood evacuation centers within the Province through its inventory survey.

Table R 6.10 Eligible Evacuation Centers Identified by PDCC

Name of Evacuation Center	Location	Capacity (Persons)
(1) Army Reserved Command	Paradhan, Tanza	100
(2) Bahay Sanayan	Trece Martires City	45
(3) Cavite Computer Center	Imus	150
(4) Farmers/Fisherman's Hall	Trece Martires City	50
(5) Phil. Air Force, 15th Strike Wing	Sangiey Point, Cavite City	2,000
(6) Provincial Senior Citizens Office	Trece Martires City	20
(7) Public Elementary & Secondary Schools	Entire Province	To be clarified
(8) Rescue 161	Imus	100
(9) TESDA	Trece Martires City	60

Source: Provincial Government of Cavite

(b) Municipality of Imus

The existing of Municipal Sports Center Complex located near the Municipal Hall in Barangay Poblacion IV-A, has been designated as the Main Evacuation Center. The Center consists of the Municipal Health Office, a large storage room, and public toilets with evacuation-supporting equipment. The Municipal Health Office is opened during evacuation period to provide services to evacuees. The Imus Pilot Elementary School in Barangay Tanzang Luma I, which has the largest school area of 47,034 m^2, has been further designated as the Sub-Evacuation Center.

(c) Municipality of Kawit

The three elementary schools in Barangay Aguinaldo, Binakayan and Gahak-Marulas, are currently designated as the main evacuation centers in the Municipality of Kawit because of the large accommodation capacity for evacuees. These schools are, however, located in the flood prone area and the municipality plans to shift the evacuation center to the new four-story Municipal Hall, which is now being constructed in Barangay Batong Dalig. The new evacuation center will have the floor space of 3,000 m^2 for evacuees.

(5) Training/Drill

The PDCC in coordination with the National Disaster Coordinating Council is currently spearheading trainings/drills of members together with MDCCs. In response to such efforts of the PDCC, the municipalities of Kawit, Imus, Noveleta and Rosario undertake a certain extent of training and/or drill on disaster management.

The Municipality of Kawit in particular regularly conducts training for the members of MDCC. As a part of the training, the MDCC recently held a two-day workshop (called "Management Training and Contingency Planning Workshop") on natural disaster preparation/mitigation in collaboration with the Office of Civil Defense, the Regional Disaster Coordinating Council (RDCC) of Region VI-A and PAGASA. Approximately 100 personnel attended the workshop.

The MDCC of Noveleta also conducts training on emergency responses such as the methods for emergency rescue and cardio-pulmonary resuscitation twice a year with support from the provincial government. The MDCC further undertakes evacuation drills, although no specific training program for flood management is available.

(6) Coordination with Other Disaster Coordinating Bodies

The CDCC/MDCC of Kawit, Imus, Noveleta, Rosario, Bacoor and Trece Martires City keep contact and coordination with PDCC and other MDCCs, to achieve trans-municipality disaster management. The other MDCCs, however, seldom contact and/or coordinate their activities with each other. As the results, it is still virtually difficult to achieve the trans-municipality disaster management over the Study Area.

(7) Communication System

All municipalities except Imus have no exclusive emergency communication system for disaster management. Only the Municipality of Imus has a well-established UHF radio system, which connects between the MDCC and all the barangays in the municipality.

(8) Involvement of Communities

Since the activities of PDCC and CDCC/MDCC in the Study Area are not well arranged, the communities are still hardly involved in the activities of flood warning and evacuation. The residents currently rely on the weather forecast released through the mass media and/or their visual observations to determine the necessity of flood evacuation.

6.4.4 Infrastructure Development Projects relevant to the Study

The following infrastructure development projects are in progress in the Study Area:

(1) Route-1 Road Project

The coastal expressway will be extended to Kawit as the Route-1 Road Project through the build-operate-transfer scheme (BOT). The construction works have started and will be completed in 2010. However, the road alignment and appurtenant structures in the Project might affect the drainage system in the municipalities Bacoor and Kawit. In parallel with the construction of the coastal expressway, the reclamation between the present coastal line and the alignment of a new expressway is projected. The plan for flood mitigation measures and the drainage system in the eastern side of the Municipality of Kawit in particular will be formulated in the Study, considering the road project.

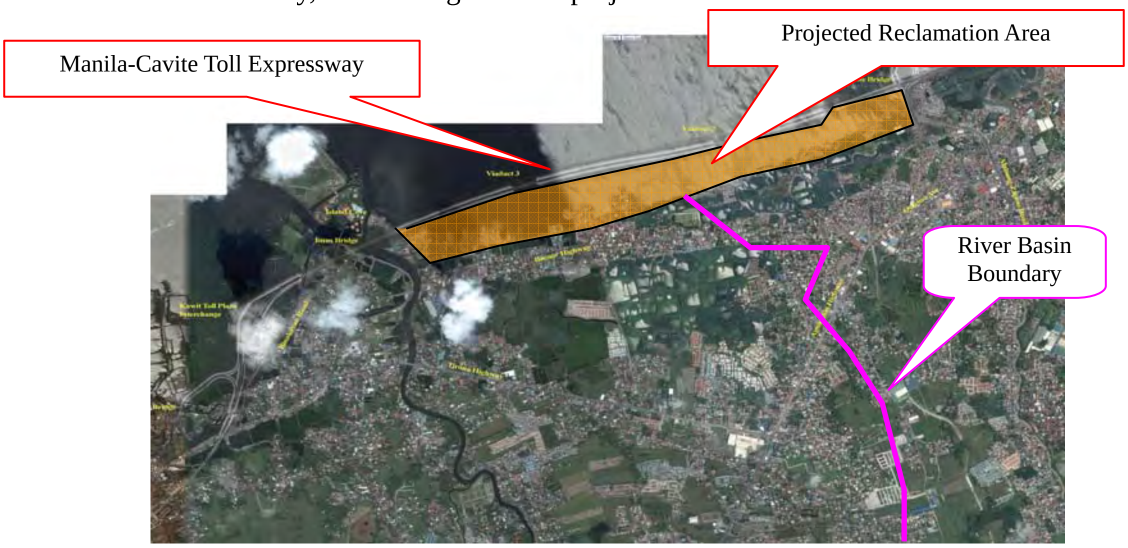


Fig. R 6.1 Alignment of Route-1 Road (Extension of Coastal Expressway) Project

(2) CALA Road Project

To improve the increasingly deteriorating traffic condition in the Cavite-Laguna (CALA) area, JICA had conducted a study (hereinafter, the "CALA study") in which the scope of the Cala Road Project covers not only the feasibility study on the road, but also a review of the regional development concept and the transport master plan. The Project aims at alleviating the traffic congestion in the CALA area which includes the Study Area, improving the living environment of local residents, promoting dispersion of the urban function of Metro Manila, and encouraging the improvement of investment environment in the area given its strategic location vis-à-vis the international port in Batangas City. Since a substantial part of the objective area of the CALA Road Project overlaps with the Study Area (see Figure below), the Study will coordinate closely with the the Project.

Fig. R 6.2 Alignment of CALA Road Project

Chapter 7. Planning Framework

7.1 Basic Concepts

As described before, the Study Area is currently undergoing intensive industrialization because of its easy accessibility from Metro Manila leading to the rapid increment of population and intensive land development. However, the Study Area suffers from habitual inundation by storm rainfall and high tide as well as occasional river overflow, which deteriorate the regional economy and the daily living condition of the residents. Under these circumstances, the Study being conducted aims at the minimization of damage caused by the said habitual inundation and/or river-overflow through the formulation of a comprehensive flood mitigation plan.

The comprehensive flood mitigation plan consists of the structural and non-structural components. Both of the structural and non-structural measures would have the functions to increase the flood flow capacity of the waterway and at the same time to control the flood runoff discharge from the river basin as listed in Table R7.1. Moreover, in order to minimize the damage cause by the flood, which exceeds the design capacity of the structural measures, the flood warning and evacuation system is highlighted as the eligible non-structural flood mitigation measure.

Table R 7.1 Functions of Structural and Non-structural Flood Mitigation Measures

Function of Flood Mitigation	By Structural Measures	By Non-structural Measures
Increase of Flood Flow Capacity of Waterway	• River channel improvement • Drainage channel improvement • Construction of flood diversion channel	• Management for removal of garbage and other drifting materials in the waterway • Prevention of encroachment to river area
Control of Flood Runoff from River Basin	• Construction of off-site flood retarding basin • Construction of on-site flood regulation pond in the new subdivisions	• Control of excessive land development in the river basin • Legal arrangement for construction of on-site flood regulation pond by land developer
Minimize the damage by the flood, which exceeds the design capacity of structural measures		• Flood Warning and Evacuation System

There are several distinct merits and demerits of the above structural and non-structural flood mitigation measures. The merit of structural measures is such that they could almost completely get rid of any damage of the flood, whenever the flood is less than the design scale adapted to them. On the other hand, the structural measure would possess the demerits such that they hardly mitigate the damage of the flood, which exceeds the design scale adapted to them, and they may cause the negative environmental impacts such as a large number of house relocation and felling of the mangrove forest. Moreover, it may take a time and a large cost to complete the construction of the structural measures, and during the time of construction, the effect of the flood mitigation is hardly expected.

As for the non-structural measures, the merits are such that they could bring about the early effect of flood mitigation with less cost of implementation as compared with the structural measures, and at the same time, they could contribute to a certain range of flood mitigation effect for every scales of flood. On the other hand, the demerit of the non-structural measures is such that the quantitative estimation on the flood mitigation by them is hardly made.

The target design level for the structural measures is, in general, determined as precondition according to recommendations in the relevant guideline and/or the design levels applied in the similar flood mitigation projects in Philippines. Moreover, the common design level is usually applied to the entire target area. These concepts on the design level are useful to avoid the regional gap in the flood safety level.

In this Study, however, the above design level as precondition is hardly applied due to the particular physical, social and financial constrains of the Study Area such as: (1) extremely small river flow capacity of existing rivers/drainage channels, (2) existing densely packed houses along the river/drainage channel, which lead to difficulties in executing a large-scale river/drainage channel improvement and (3) the budgetary constraint for construction and maintenance of the structures.

In due consideration of the particular conditions of the Study Area, the plan for structural components would be examined with assuming the various different options of design level. It is further noted that the plan for the structural flood mitigation components would be separately formulated for the following three components, and the optimum design scale for each of the components would be separately determined based on the particular physical, social and financial constrains of each target area of the components.

(1) Plan for the river-overflow flood of Imus River,

(2) Plan for river-overflow of San Juan River and

(3) Plan for the inland flood in the low-lying coastal area.

The above concepts on the design level applied in the Study could bring out the minimum negative environmental impact and the most economical and affordable structural flood mitigation plan, while they also cause the regional gap in flood safety level, which lead to the regionally different allowable extents of flood inundation. Hence, the stakeholder meetings are indispensable in order to attain the adequate understandings of the stakeholders on the proposed flood mitigation plan and the unavoidable regional gap in the flood safety level. At the same time, the importance of the non-structural components is highlighted in order to minimize such regional gap inflicted by the structural components.

7.2 Planning Framework

Planning frameworks will be set up as the bases for plan formulation taking the results of the baseline study and basic analysis into account. The objective planning frameworks will include: (1) the target project completion year; (2) the socio-economic framework; and (3) the design frameworks. The details of these items are as described in the following subsections.

7.2.1 Target Project Completion Year

The flood mitigation project containing both structural and non-structural measures is to be categorized into the short-term and long-term projects. The short-term project will consist of structural and non-structural flood mitigation works urgently required as the priority project expected to produce immediate flood mitigation effects within a short period. A part of the short-term project will be selected as the objective of the Feasibility Study.

On the other hand, the long-term project will cover the overall flood mitigation project components proposed in the Master Plan except those for the short-term project.

The target completion years of the short-term and long-term projects will be finally determined through discussion with the counterpart agencies. The Study Team preliminarily presumes that the following target years will be the basis of discussion:

(1) The target year for the short-term project was originally assumed to be 2010 as proposed in the Inception Report. It was, however, clarified through the succeeding study stages that the structural flood mitigation measures in particular will involve a large volume of work, which will lead to difficulties in completing any priority project by the year 2010. Based on the clarification, it is re-proposed that the target year for the priority non-structural flood mitigation plan should be 2010, while that for the structural plan is 2013.

(2) The target year for the long-term project was assumed to be 2020 on the premise that the project is included in the first “Mid-Term Philippine Development Plan (MTPDP)” and could be completed within the second MTPDP.

7.2.2 Social Framework

The different municipalities in Cavite Province have prepared their own land use plans with 2010 as the target year. The Study Team will delineate the overall land use plan for the Study Area based on these plans, and further estimate the population as well as land use conditions of the Study Area for the target year 2020 based on the factors mentioned below.

(1) Zoning plans projected by the municipal governments;

(2) Past trend of regional economy and population;

(3) Existing land use and economic conditions; and

(4) Ongoing and projected large-scale land development plans.

The basin flood runoff conditions will be seriously influenced by the basin land use conditions. Moreover, the flood damage potential could increase as the basin population and assets increase. From this point of view, the flood mitigation plan is formulated on the premise of social conditions in the years 2010 and 2020.

7.2.3 Design Framework

The design framework shall include the target design level and its corresponding standard discharge. Of these items, the target design level is expressed in terms of return period, and the standard discharge means probable peak discharge in natural basin runoff conditions without any control by basin flood storage facilities such as flood regulation pond and other off-site flood detention facilities.

The target design scale is determined taking the following items into account:

(1) The design flood levels adopted and/or recommended in the DPWH Design Guidelines or in previous and similar flood mitigation projects in Philippines;

(2) The scale of recorded maximum floods; and

(3) The design flood level, which could be realized with appropriate structural and non-structural measures for the study area in due consideration of financial capacity, allowable extent of land acquisition and other restrictions to project implementation.

The DPWH Guidelines specify a 50-year return period flood as the design level for river channel improvement (refer to "Design Guidelines, Criteria and Standards for Public Works and Highways"). In spite of this specification, most flood mitigation projects for middle-scale river basins in the Philippines (hereinafter referred to as "Urban Center Projects") have employed the design level of 10 to 20-year return period (refer to "The Flood Control For Rivers in Selected Urban Centers, 1995, JICA"). Hence, the design scale of 10 to 20-year return period will be the standard for Item (1) above.

The recorded maximum flood in the Study Area was determined to be the flood triggered by Typhoon Milenyo in 2006, which had the recurrence probability of almost 100-year return period as clarified through the hydrological analysis in the Study. Accordingly, it is concluded that Items (1) and (2) would require the design scale of more than 20-year return period.

On the other hand, the existing structural flood mitigation capacity in the Study Area was evaluated to be extremely small and could hardly cope with even the probable flood discharge of 2-year return period, as described in the following Chapters. Moreover, the area along the downstream river channel is densely packed with houses and the river channel improvement with the design scales set up under the above Items (1) and (2) would cause serious conflicts in house evacuation in particular. Due to these points of view, the above Item (3) is applied as the base for determination of target design scale or structural flood mitigation measures in the Study. The flood over the design scale would be dealt with by non-structural measures such as the flood warning and evacuation system and the dissemination of flood risk maps to the residents.

Chapter 8. Structural Flood Mitigation Plan

The structural flood mitigation plan would include components against river-overflow and inland floods caused by storm rainfall and high tide. These structural plan components against both types of flood are examined in this Chapter based on the results of the flood simulation analysis described in Section 4 of Chapter 5.

8.1 Structural Flood Mitigation Plan against River-Overflow Flood

8.1.1 Maximum Design Scale Examined in the Study

As described in Subsection 7.2.3 of Chapter 7, most flood mitigation projects for middle-scale river basins in the Philippines employ the design scale of 10 to 20-year return periods for structural measures against river-overflow floods (refer to "The Study on Flood Control for Rivers in the Selected Urban Centers, 1995, JICA"). Considering these precedents, the design scale of 20-year return period is provisionally assumed as the maximum design scale to be examined in the Study.

The potential flood mitigation measures and the alternative flood mitigation plans consisting of combinations of potential measures are firstly examined within the scope of the above maximum design scale. Then, the optimum design scale as well as the optimum combination of flood mitigation measures will be selected based on the synthetic evaluation of socio-economic impacts, natural environmental impacts, financial affordability and technical viability.

8.1.2 Potential Measures

River-overflow flood is herein defined as the flood runoff from a large catchment area that spills over the inland due to the overflow of riverbanks and inflicts significant damage over a wide area. In accordance with this definition, the objective rivers for which measures against river-overflow flood will be proposed are provisionally assumed as the Imus River, the San Juan River and the Canas River, each of which have a catchment area of more than 100 km^2 including the catchment area of their major tributaries such as Bacoor River, Julian River including left tributary and Ylang-Ylang River. However, among the said three objective rivers, Canas River has been proven through the hydraulic simulation that it possesses a large channel flow capacity of more than 20-year return period. Therefore, Canas River is excluded from the objective rivers of plan formulation (refer to Subsection 2.3.3 of Chapter 2).

According to the field reconnaissance and the interview survey with the residents, the flood overflow of the objective three rivers has the following particular characteristics:

(1) Flood overflow occurred along some sections of the objective rivers more than four times in the recent seven years from 2000 to 2007 (refer to Subsection 5.1.2 of Chapter 5).

(2) Flood overflow occurred along a rather extensive river stretch not only in the lower reaches but also in the middle reaches.

(3) Areas along the river channels in the lower reaches in particular are densely packed with houses. In spite of such dense houses along the river and the extensive area of flood overflow, the number of casualties was small. This could be attributed to the condition that most of the existing river bank elevations are almost the same as the hinterland ground level, so that a large volume of the river overflow discharge hardly rushes out within a short duration.

(4) As described in Sections 2.4 and 5.4, Canas River is evaluated to have a large channel flow capacity, which could cope with the probable flood of 20-year return period. During the Typhoon Milenyo in 2006, about 3.4 km^2 was inundated by overflow flood. Essentially, however, the overflow flood was not due to the inadequate channel flow capacity but to the clogging of the river channel at Tejero Bridge by driftwood entangled around the bridge piers.

(5) A flood control dam would have a large effect on the mitigation of river-overflow, should the natural and socio-economic conditions allow its construction. However, the dam is excluded in

the selection of potential flood mitigation measures due to the identified difficulties in constructing a flood control dam, as follows:

- Most of the mountainous areas in the Study Area have been developed as agro-industry and/or housing subdivisions;
- The mountainous area in the Study Area forms a terrace descending from south to north, which leads to a less suitable dam pocket; and
- No suitable quarry site for obtaining construction materials for the dam was detected.

Taking the above items into consideration, the following four measures are contemplated as the eligible potential measures against river-overflow flood in the Study Area: (1) Full-scale river channel improvement; (2) Construction of off-site flood retarding basin; (3) Construction of flood diversion channel; and (4) Construction of on-site flood regulation pond. The details of these potential measures are as described below.

(1) Full-Scale River Channel Improvement

The downstream sections of the Imus and San Juan rivers possess extremely small channel flow capacities judging from the afore-said frequent occurrence of river-overflow and the results of hydraulic analysis on channel flow capacity. Accordingly, river channel improvement is firstly conceived as the eligible measure to increase the channel flow capacity.

The method of increment of channel flow capacity shall be, basically, oriented to the widening of river channel instead of elevating the river dike to minimize the flood damage potential in case of river overflow inflicted by extraordinary floods of over the design scale. The major works for the widening of river channel are excavation and dredging of the river channel. Elevating the river dike is to be applied only to the coastal/estuary section, which is affected by the high tide, and the sections whose hinterland has an extremely low ground elevation.

The present longitudinal profile and channel width of the river channels have been clarified through the channel survey, as shown in Fig. 8.1 to Fig. 8.6 attached. The present channel flow capacities were further estimated, as described in Subsections 2.3 and 5.4. Based on these river features and calculated probable discharges, the maximum extent of channel improvement for each river was estimated assuming the design scale of 20-year return period, as shown in Table R 8.1 and Fig. 8.7 attached.

Table R 8.1 Maximum Extent of Channel Improvement of Imus and San Juan River Basins (Design Scale: 20-Year Return Period)

River Basin	River	Code of Stretch*	Extent	Distance (km)
Imus	Imus	IA	From river mouth to Confluence Point with Julian River (Sta. 3+400)	3.4km
	Imus	IB	From confluence point with Julian River (Sta. 3+400) to Imus Bridge passing under Aguinaldo H.W. (Sta. 6+000)	2.6km
	Imus	IB	From Imus Bridge (Sta. 6+000) to NIA Cala Canal (Sta. 13+000)	7.0km
	Bacoor	BA	From confluence with Imus River to upstream end of fishpond (Sta. 3+000)	3.0km
	Bacoor	BB	From upstream end of fishpond (Sta. 3+000) to Sta. 7+000	4.0km
	Julian	JA	Whole river stretch	10.0km
	Left Tributary	LJ	Whole river stretch	4.5km
San Juan	San Juan	SA	From river mouth to Sta. 1+700 upstream	1.7km
	San Juan	SB	From Sta. 1+700 to merging point of San Juan and Ylang-Ylang (Sta. 4+800)	3.1km
	San Juan	SC	From Sta. 4+800 to upstream of Bayan Dam (Sta. 11+000)	6.2km
	Ylang-Ylang	YA	From Sta. 4+800 to Sta. 8+000	3.2km

Note: Codes of stretch correspond to those shown in Fig. 8.7 attached.

(2) Construction of Off-Site Flood Retarding Basin

There still remains a rather extensive non-built up area (i.e., agricultural land and/or grassland) in the lower and middle reaches of all of the objective river basins. Taking such land use conditions into consideration, the off-site flood retarding basin in the present non-built up area is conceived as one of the potential flood mitigation measures to temporarily store the basin runoff discharge and reduce the flood flow discharge of the downstream river channel.

This measure has the advantage of minimizing house relocation, but may require a large extent of land acquisition. The possible sites and required extents of the off-site flood retarding basins were identified based on the results of field reconnaissance, interpretation of existing topographic maps/aerial photos for available area and hydrological simulation of each protection level. As the result, the areas shown in Table R 8.2 and Fig. 8.8 attached are preliminarily identified as the eligible sites for off-site flood retarding basin for the mitigation of river-overflow as well as off-site flood retention pond for inland flood (Refer to 8.2.2 (5)).

Table R 8.2 Potential Site for Off-site Flood Retarding Basin

River Basin	River	Code of Retarding Basin*1	Available Area	Approximate Available Depth for Retarding*2
Imus	Imus	I1	70 ha	5 m
	Bacoor	B1~B3	62 ha	1 m
	Bacoor	B4	12 ha	5 m
	Julian (Left Tributary)	J1	35 ha	5 m
	Julian	J2	11 ha	5 m
San Juan	San Juan	S1	110 ha	5 m
	Ylang-Ylang	Y1	13 ha	5 m
	Ylang-Ylang	Y2	35 ha	5 m

Note: *1: Codes of off-site flood retarding basin and off-site flood retention pond correspond to those given in Fig. 8.8 attached.
*2: Available depth shall be determined in terms of difference between riverbed and ground surface. Values enumerated in table above are rough values for maximum storage volume capacity for each site.

(3) Construction of Flood Diversion Channel

The flood diversion channel aims at diverting a part of the river flood discharge into the sea or to a new waterway so as to reduce the necessary scale of the aforesaid river improvement works and the off-site flood-retarding basin. Significant advantages of the flood diversion channel are as follows:

- Less number of house relocation is required as compared with the full-scale river channel improvement, when its alignment could be placed along less populated areas.
- Less land acquisition is required as compared with the off-site flood-retarding basin, when the objective diversion point could be placed relatively near to the sea and/or another river channel, which are proposed as the outlet of the diversion channel.

Taking the above advantages into account, the following two potential routes of the flood diversion channel for San Juan River have been preliminarily identified:

Table R 8.3 Probable Routes of Flood Diversion Channel for San Juan River in the First Screening

Route	Location	Channel Extent	Number of House Relocations*	Number of River Structures Crossing
Route A	From the downstream of confluence with Ylang-Ylang River to the river mouth of Dr-8 at the left bank side	About 2.3 km	100~320	Bridge: 3 Canal: 3
Route B	From the upstream left bank of Bayan Dam to Canas River	About 0.8 km	30~100	Bridge: 1 Canal: 1

* The number of house relocations varies according to the assumed design scale.

Of the above two routes of flood diversion channel, Route B aims at diverting the floodwater from San Juan River to Canas River. However, such flood diversion plan will increase the flood damage potential to residents along the downstream of Canas River and unavoidably causes social conflict between the residents along Canas River and the beneficiaries along San Juan River. From this point of view, Route B is abandoned, and only Route A (hereinafter, San Juan Diversion Channel) is applied as the eligible measure in the Study. The approximate alignment of the San Juan Diversion Channel is delineated taking the minimum number of house relocations and location of the ongoing MRF into account (refer to Fig. 8.9 attached).

(4) On-Site Flood Mitigation Facilities

The on-site flood mitigation facilities function to offset the increment of peak flood runoff discharge caused by covering road pavements, roofs of houses and other impermeable structures over the site of the new industrial/housing subdivision. From this point of view, the Study is made on a regulatory approach to oblige land developers to install a certain scale of on-site flood mitigation facilities in their land development sites for new subdivisions.

There are various types of on-site flood mitigation facilities such as: (a) on-site flood regulation pond; (b) rainfall tank installed at each of residential houses; (c) temporary flood retention pond at public open spaces such parks, sports ground and car parking areas in the subdivision; and (d) permeable pavement on new roads in each subdivision.

However, all of the above types except the on-site flood regulation pond have never been introduced in the Philippines, and difficulties are anticipated in their implementation due to regulatory constraints and the high cost required. From this point of view, the on-site flood regulation pond is assumed as the most eligible on-site flood mitigation facility. The detailed background of selection of the on-site regulation pond is as given below.

(a) On-Site Flood Regulation Pond

The On-site Flood Regulation Pond is to be installed at the downstream end of new industrial and/or housing subdivisions. The pond could have a larger capacity than the other on-site flood mitigation facilities installed for the control of peak runoff discharge from new subdivisions.

In addition to the increment of peak flood runoff discharge, a new subdivision usually produces a large volume of sediment runoff during the period of land development, which would aggravate the flow capacity as well as the environment of the rivers and drainage channels located in the lower reaches of the land development site (refer to Subsection 2.7). In this connection, the on-site flood regulation pond is also expected to minimize the sediment runoff from the subdivision with the allocation of a storage capacity for sediment deposits.

There exist on-site flood regulation ponds at the existing industrial complexes and golf courses in Philippines, however, technical difficulties in constructing and maintaining this facility are unforeseeable. Besides, the major issue would be the establishment of an ordinance (Provincial Ordinance, as pilot legislation) to obligate land developers to construct an on-site flood regulation pond and to organize an administrative unit in each new subdivision to be in charge of maintenance of the flood regulation pond. The major works for maintenance of the pond would include control of garbage dumping and disposal of wastewaters into the pond. These issues on legal arrangement and maintenance are discussed further in Subsections 9.4.2 and 11.1.

The standard structural features of the on-site flood regulation ponds have been estimated through the hydrological simulation with reference to the technical standards for ponds developed in Japan. Based on the results of simulation, the structural features listed in Table R 8.4 are preliminarily proposed.

Table R 8.4 Standard Structural Features of Proposed On-Site Flood Regulation Pond

Description	Specifications	Structural Dimensions	
		Subdivision (5ha)	Subdivision (100ha)
Pond Area	Pond Area: 3% of Subdivision area Amenity Area: 1% of Subdivision area	1,500m^2 500m^2	30,000m^2 10,000m^2
Effective Storage Volume	(Area of Pond Site) x 80% x 3m	3,600m^3	72,000m^3
Storage Capacity for Sediment	150m^3/ha/year* x $\sum_{i=0}^{N-1}(1/2)^i \times A$ Where; N: period of land development; and A: the whole extent of Subdivision	1,125m^3 (Assuming N=2years)	22,500m^3 (Assuming N=2years)
Height of Outlet	30cm	30cm	30cm
Total Width of Outlet	4cm/ha x [The whole extent of Subdivision (ha)]	20cm	400cm
Location of Outlet	30cm below the bottom of effective storage	30cm	30cm

* The standard in Japan

On the premise of the above structural features of the on-site flood regulation pond, the hydrological effects of the ponds have been simulated. As the result, it was confirmed that the on-site flood regulation pond will possibly offset the increment of peak flood runoff discharge caused by pavements in new industrial/housing subdivisions in the case of less than 20-year return period flood, as listed in Table R 8.5. On the other hand, the pond will cause spill-overflow and can hardly control the peak runoff discharge in the case of a more than 50-year return period flood.

Table R 8.5 Hydraulic Effects of Proposed On-Site Flood Regulation Ponds

Size of Land Development	Flood Return Period	Runoff Discharge from Subdivision (m^3/sec)		
		Before Land Development	After Land Development	
			Without Regulation Pond	With Regulation Pond
100 ha	5-year	5.83	17.63	5.38
	10-year	10.46	18.92	7.05
	20-year	15.69	20.62	10.81
	50-year	19.52	22.01	22.01*
	100-year	20.81	22.71	22.71*
5 ha	5-year	0.32	0.93	0.35
	10-year	0.77	1.00	0.35
	20-year	0.99	1.10	0.39
	50-year	1.09	1.18	1.10*
	100-year	1.13	1.23	1.14*

* Runoff discharge spills out of the on-site flood regulation pond

(b) Rainfall Tank Installed at Residential House/Business Building

A rainfall tank is to be installed at individual house lots for the purpose of reducing the peak runoff discharge from the subdivision by temporarily storing rainfall from the rooftop of houses. However, only about 42% of the whole subdivision could be assumed as the net space for house roofs, as listed in Table R 8.6. The other parts are for private open spaces such as private gardens and car parks, and public open spaces such as roads and public car spaces.

Due to the limited space of house roofs, the rainfall tank could hardly mitigate the increment of peak runoff discharge caused by land development for housing subdivisions. Moreover, the rainfall tank is not effective, unless it is installed at most of the houses in the new subdivision; besides, difficulties are foreseeable in obligating all private house owners in particular to install them.

Table R 8.6 Classification of Land-use in a Housing Subdivision

Classification of Land Use in Housing Subdivision	Rate of Occupancy	
1. Area not covered with House Roof		58%
1.1 Public Space (Road, etc)	30% /1	
1.2 Private Space (Private garden, Car park, etc.)	28% /2	
2. Area covered by House Roof		42%
Total		100%

Note /1: Land developers are obliged to allocate 30% of the subdivision area for public space in accordance with Presidential Degree No. 957.

/2: Area of private space (28%) is assumed on the premise of floor-area-plot ratio of 60% [i.e., 28% = ratio of private house lot (70%) x non-floor area (40%)].

(c) Temporary Flood Retention Pond

Temporary flood retention pond is to be installed in public open spaces such as parks, sports ground and car parking areas. The allowable depth of the pond is, however, limited to about 30cm because of the safety required for such public open spaces. Moreover, the extent of public open spaces would not be much because road spaces are not included among the objective areas for a temporary flood retention pond. From these points of view, the temporary flood retention pond is evaluated not to possess an eligible flood mitigation effect.

(d) Permeable Pavement

New roads and large parking spaces in new subdivisions shall have permeable pavement to reduce the peak runoff discharge from such spaces. The construction and maintenance cost of the permeable pavement is, however, more than two times the cost of concrete and/or asphalt pavement based on precedents in Japan. Moreover, the permeable pavement has never been introduced in Philippines so that it will be necessary to introduce new asphalt plants and the know-how from other countries for the production of permeable pavement, which will lead to the further increment of construction cost. The permeable pavement is also easily clogged due to sediment deposits resulting in the difficulty of maintenance. From these points of view, the permeable pavement is evaluated to be not applicable as an on-site flood mitigation facility.

8.1.3 Alternative Flood Mitigation Plans against River-overflow

The combination of potential flood mitigation measures is proposed as alternative flood mitigation measures against river-overflow flood, as examined in the preceding Subsection 8.1.2. The alternative measures thus proposed are as listed below.

Table R 8.7 Alternative Flood Mitigation Plans against River-Overflow

Objective River Basin	Alternative No.	Component of Flood Mitigation Measures				
		Full-Scale River Improvement	Partial River Improvement(*1)	Off-site Flood Retarding Basin	Flood Diversion Channel	On-site Flood Regulation Pond
Imus River	F_I.1	●	-	-	-	-
	F_I.2	-	●	●	-	-
	F_I.3	-	●	●	-	●
San Juan River	F_S.1	●	-	-	-	-
	F_S.2	-	●	●	-	-
	F_S.3	-	●	-	●	-
	F_S.4	-	●	●	●	-
	F_S.5(*2)	-	(●)	(●)	(●)	●
			Minimum cost combination among F_S.2, 3 and 4			

Note (*1) Details of the "Partial River Improvement" is described after this table.
(*2) Alternative No. F_S.5 shall be the combination of on-site flood regulation pond and the alternative with minimum cost among F_S.2, F_S.3 and F_S.4 in each design scale.

Partial River Improvement [Note (*1) in Table R 8.7]

The down streams of the Imus and San Juan rivers have several bottleneck sections with extremely small flow capacities and hardly protected by any flood mitigation measure except river channel improvement. To secure the minimum channel flow capacity, partial river channel improvement is indispensable and commonly proposed in all the alternatives given in Table R 8.7 above, except the full-scale river improvement.

In case of combination of partial river improvement and off-site flood retarding basin, the features of the partial river improvement are as listed in the following Table R 8.8.

The combination of partial river improvement and flood diversion channel in Alternative No. F_S.3 would require another scale of improvement, as described later in this subsection.

Table R 8.8 Partial River Improvement Incidental to Construction of Off-Site Flood Retarding Basin (Alternative No. F_I.2, F_I.3, F_S.2 and F_S.4)

River Basin	River	Code of Stretch*	Required Improvement Measure	Minimum Flow Capacity**	Number of House Relocations
Imus	Imus	IA	Dredging / Coastal dike construction	500 m^3/s	90
	Bacoor	BA	Channel widening / Coastal dike construction	100 m^3/s	20
	Bacoor	BB	Channel widening / Coastal dike construction	30~50 m^3/s	40
	Julian	JA	Channel widening / Minimum dike construction	120 m^3/s	50
	Left Tributary	LJ	Channel widening / Minimum dike construction	20 m^3/s	30
	Sub-Total				230
San Juan	San Juan	SA	Channel widening/Coastal dike construction	500 m^3/s	60
Total					290

* Code of Stretch corresponds to that shown in Fig. 8.7 attached.
** Minimum flow capacity to be secured by partial river Improvement

The details of the above alternative combinations are as described in items (1) to (6) below.

(1) Principal Features of Alternative Nos. F_I.1 and F_S.1 (Full-Scale River Improvement)

This alternative aims at coping with floods solely by river channel improvement. The applicable channel improvement measures were clarified based on the longitudinal profiles and cross-section of the existing river channels, as shown in Table R 8.9 (refer to Fig. 8.7 attached).

Table R 8.9 Applicable Measures for Channel Improvement
with Design Scales of 2 to 20-Year Return Periods

River Basin	River	Code of Stretch	Applicable Improvement Measures			
			2-year	5-year	10-year	20-year
Imus (F_I.1)	Imus	IA	Dredging / Coastal dike construction			
	Imus	IB	Channel widening / Partial dike construction			
	Imus	IC	Not required	Not required	Not required	Partial dike construction
	Bacoor	BA	Channel widening / Coastal dike construction			
	Bacoor	BB	Channel widening / Partial dike construction			
	Julian	JA	Channel widening / Partial dike construction			
	Left Tributary	LJ	Channel widening / Partial dike construction			
San Juan (F_S.1)	San Juan	SA	Channel widening and Dredging / Coastal dike construction			
	San Juan	SB	Partial dike construction		Channel widening / Partial dike construction	
	San Juan	SC	Not required	Not required	Partial dike construction	
	Ylang-Ylang	YA	Not required	Not required	Partial dike construction	

Note (1) Coastal dike construction with the structural type of concrete dike, earth dike or concrete parapet wall is applied to sections with low hinterland ground elevation.
(2) Applicable channel improvement measures are proposed on the premise of future land use condition in 2020 (Built-up Area: 43.7%).
(3) Code of Stretch corresponds to that shown in Fig. 8.7 attached.

The total number of house relocations required for the above river channel improvement was estimated based on the results of field reconnaissance, interview survey and interpretation of the existing topographic maps/aerial photos, as listed in the table below.

Table R 8.10 Number of House Relocations Required for Each Design Scale of
Full-Scale River Channel Improvement

River Basin	Objective River	Number of House Relocations for each Design Scale (return period)			
		2-year	5-year	10-year	20-year
Imus (F_I.1)	Imus	400	520	650	780
	Bacoor	330	330	330	330
	Julian	250	350	350	350
	Left Tributary	100	150	150	150
San Juan (F_S.1)	San Juan	250	330	460	650
Total		1,330	1,680	1,940	2,260

Note: The estimation is based on probable flood discharge on the premise of future land use condition in 2020.

Only the Full-Scale River Channel Improvement alternative is able to make the Bacoor river and Julian river sub-basins safe against river-overflow flood at any design scale.

(2) Principal Features of Alternative Nos. F_I.2 and F_S.2 (Off-Site Flood Retarding Basin plus Partial River Improvement)

As listed in Table R 8.10 above, the full-scale river improvement requires a large number of house evacuations. To reduce the number of house relocations, the off-site flood retarding basin is proposed as the major flood mitigation measure taking the aforesaid partial river improvement as the subsidiary measure.

Details of the required partial river improvements are given in Table R 8.8. The structural size of partial river improvement is common to all the applied target design scales.

The required extent of land acquisition and storage capacities of the proposed off-site retarding basin were estimated, as listed in the table below.

Table R 8.11 Required Extent of Land Acquisition and Storage Volume of Off-Site Flood Retarding Basin in Alternative Nos. F_I.2 and F_S.2

River Basin	River	Code of Basin	Extent of Land Acquisition (ha)				Storage Volume (x 10^6 m^3)			
			2-year	5-year	10-year	20-year	2-year	5-year	10-year	20-year
Imus (F_I.2)	Imus	I1	25	36	45	62	1.15	1.76	1.97	3.03
	Bacoor	B1~B3	62	N/A-2	N/A-2	N/A-2	0.61	N/A-2	N/A-2	N/A-2
	Bacoor	B4	15	N/A-1	N/A-1	N/A-1	0.51	N/A-1	N/A-1	N/A-1
	Julian (Left Tributary)	J1	7	16	N/A-1	N/A-1	0.26	0.34	N/A-1	N/A-1
	Julian	J2	11	13	N/A-1	N/A-1	0.45	0.50	N/A-1	N/A-1
San Juan (F_S.2)	San Juan	S1	19	24	45	58	1.00	1.31	2.18	2.32
	Ylang-Ylang	Y1	5	13	13	13	0.28	0.60	0.66	0.72
	Ylang-Ylang	Y2	9	16	26	32	0.50	0.83	1.28	1.74

Note:
N/A-1: The retarding basin is not applicable, because the available area for retarding basin is smaller than the extent of the required retarding basin.
N/A-2: The retarding basin is not applicable, because river-overflow flood will occur upstream of the proposed retarding basin.

The number of house relocations for the above off-site flood retarding basin is further estimated through overlaying the above extent of land acquisition with the aerial photograph taken by JICA CALA Study in 2003, as listed below.

Table R 8.12 Required Number of House Relocations for Off-Site Flood Retarding Basin in Alternative Nos. F_I.2 and F_S.2

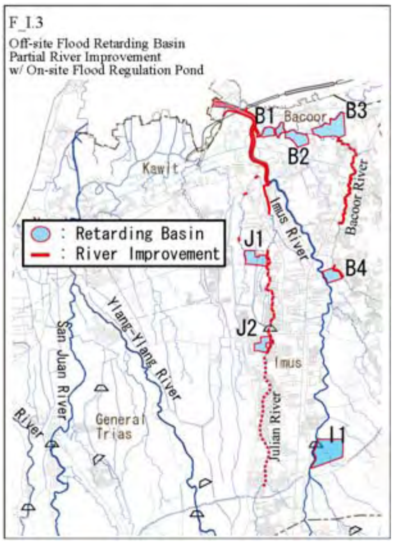
River Basin	River	Code of Basin	No. of House Relocations for Each of Design Scales				Partial River Improvement(*)
			2-year	5-year	10-year	20-year	
Imus (F_I.2)	Imus	I1	7	10	10	10	230
	Bacoor	B1~B3	30	N/A-2	N/A-2	N/A-2	
	Bacoor	B4	0	N/A-1	N/A-1	N/A-1	
	Julian (Left Tributary)	J1	1	2	N/A-1	N/A-1	
	Julian	J2	2	3	N/A-1	N/A-1	
San Juan (F_S.2)	San Juan	S1	3	3	4	4	60
	Ylang-Ylang	Y1	8	8	8	8	
	Ylang-Ylang	Y2	0	2	2	4	

Note (*): Number of house relocations for partial river improvement is common to all target design scales, as shown in Table R 8.8.
N/A-1: The retarding basin is not applicable, because the available area for the retarding basin is smaller than the extent of the required retarding basin.
N/A-2: The retarding basin is not applicable, because river-overflow flood will occur upstream of the proposed retarding basin.

Due to lack of flow capacity, alternative No. F_I.2 cannot protect Bacoor river sub-basin from river-overflow flood at the design scale of 5-year return period or above, and Julian river sub-basin at the design scale of 10-year return period or above.

Unless the “Full-Scale River Improvement” is otherwise implemented, the Bacoor and Julian river sub-basins could not be protected against river-overflow flood solely by a large-scale off-site retarding basin with the design scales given above.

(3) Principal Features of Alternative No. F_I.3 with On-Site Regulation Pond (Off-Site Flood Retarding Basin + Partial River Improvement + On-Site Flood Regulation Pond)



To reduce the number of land acquisitions and the structural size of the off-site flood retarding basin in item (2) above, the flood mitigation effect of the on-site flood regulation pond could also be taken into account. The combination of off-site flood retarding basin and on-site flood regulation pond, together with partial river improvement, is assumed as another alternative (Alternative No. F_I.3).

Partial river improvements of Stretch-IA, BA, BB and JA in Imus River Basin, as shown in Table R 8.8, are required for Alternative No. F_I.3. The structural size of partial river improvement is common to all the applied target design scales.

The features of on-site flood regulation ponds and the off-site flood retarding basin are as given in the following tables.

Table R 8.13 Required Number and Storage Capacity of On-Site Flood Regulation Pond

Description	Estimated Figures
Total area of subdivisions to be provided with on-site flood regulation pond	3,969 ha
Number of ponds required	497
Total area of the pond	119 ha
Total storage capacity of the pond required	3.57×10^6 m^3

Note: The structural size of on-site regulation pond is common to all target design scales. The pond functions to offset the increment of peak flood runoff discharge of less than 20-year return period caused by the development of new subdivision [refer to Subsection 8.1.2-(4)].
The estimated figures above include the estimated values for Imus River Basin and San Juan River Basin, but does not include the estimated values for Canas River Basin.

Table R 8.14 Required Extent of Land Acquisition and Storage Volume of Off-site Flood Retarding Basin in Alternative No. F_I.3

River Basin	River	Code of Basin	Extent of Land Acquisition (ha)				Storage Volume (x 10^6 m^3)			
			2-year	5-year	10-year	20-year	2-year	5-year	10-year	20-year
Imus (F_I.3)	Imus	I1	-	34	40	56	-	1.54	1.72	1.92
	Bacoor	B1~B3	62	N/A-2	N/A-2	N/A-2	0.39	N/A-2	N/A-2	N/A-2
	Bacoor	B4	12	N/A-1	N/A-1	N/A-1	0.45	N/A-1	N/A-1	N/A-1
	Julian (Left Tributary)	J1	-	9	N/A-1	N/A-1	-	0.31	N/A-1	N/A-1
	Julian	J2	-	12	N/A-1	N/A-1	-	0.48	N/A-1	N/A-1

Note:
N/A-1: The retarding basin is not applicable, because the available area is smaller than the extent of the required retarding basin.
N/A-2: The retarding basin is not applicable, because river-overflow flood will occur upstream of the proposed retarding basin

The number of house relocations for the above off-site flood retarding basin is further estimated by overlaying the above extent of land acquisition with the aerial photograph taken by the JICA CALA Study in 2003, as listed below.

Table R 8.15 Required Number of House Relocations for Off-Site Flood Retarding Basin in Alternative No. F_I.3

River Basin	River	Code of Basin	No. of House Relocation for Each Design Scale				Partial River Improvement(*)
			2-year	5-year	10-year	20-year	
Imus (F_I.3)	Imus	I1	-	10	10	10	230
	Bacoor	B1~B3	30	N/A-2	N/A-2	N/A-2	
	Bacoor	B4	0	N/A-1	N/A-1	N/A-1	
	Julian (Left Tributary)	J1	-	2	N/A-1	N/A-1	
	Julian	J2	-	3	N/A-1	N/A-1	

Note (*): Number of house relocations of partial river improvement is common to all target design scales, as shown in Table R 8.8.

N/A-1: The retarding basin is not applicable, because the available area is smaller than the extent of the required retarding basin.

N/A-2: The retarding basin is not applicable, because river-overflow flood will occur upstream of the proposed retarding basin.

Due to lack of flow capacity, alternative No. F_I.3 cannot protect Bacoor river sub-basin from river-overflow flood at the design scale of 5-year return period or above, and Julian river sub-basin at the design scale of 10-year return period or above.

Unless the “Full-Scale River Improvement” is otherwise implemented, the Bacoor river sub-basin and the Julian river sub-basin could not be protected against river-overflow flood solely by large-scale off-site retarding basins at the design scales shown above.

(4) Principal Features of Alternative No. F_S.3
(Flood Diversion Channel + Partial River Improvement)

Instead of the off-site flood retarding basin, the San Juan Diversion Channel is assumed as the major flood mitigation measure for the San Juan river basin.

Partial river improvement of stretch-SA in San Juan River Basin, as described in Table R 8.8, is required for Alternative No. F_S.3. The structural size of partial river improvement for Stretch-SA is common to all target design scales.

In case of this alternative, additional partial river improvement is also required in the upstream section of the diversion point (Sta. 4+800), as shown in Fig. R.8.1. Structural size of the additional upstream partial river improvement varies with the applied target design scale.

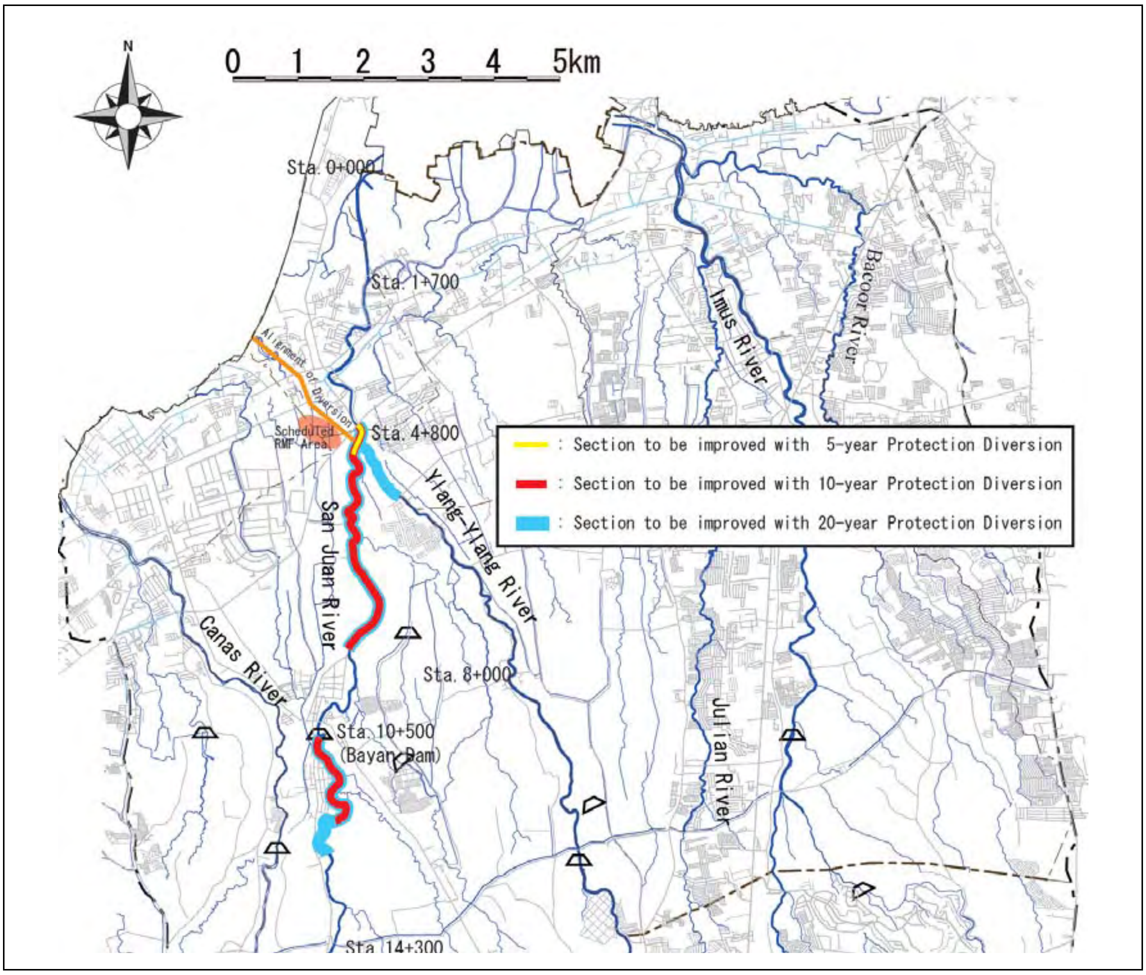


Fig. R 8.1 Partial River Improvement Section and San Juan Flood Diversion Channel

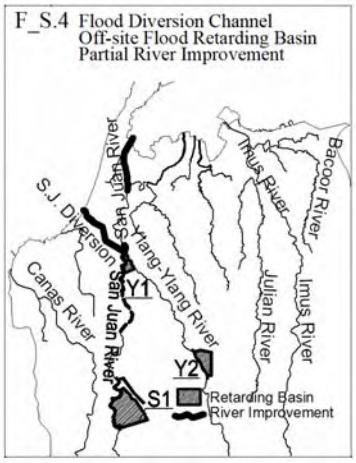
The features of the diversion channels and partial river improvement, as well as the required number of house evacuations for this alternative have been estimated, as listed in the following table.

Table R 8.16 Design Features and Number of House Relocation Required in Alternative No. F_S.3 (Flood Diversion Channel + Partial River Improvement)

Design Scale (Return Period)	Flood Diversion Channel		Design Discharge of Partial River Improvement			Number of House Relocations			
	Design Discharge	Width	San Juan River: Upstream	San Juan River: Stretch SA	Ylang-Ylang River	Diversion Channel	River Improvement: Upstream	River Improvement: Stretch SA	Total
5-year	270 m^3/s	70 m	340 m^3/s		-	105	27		192
10-year	480 m^3/s	80 m	460 m^3/s	400 m^3/s	-	135	90	60(*)	285
20-year	700 m^3/s	110 m	600 m^3/s		640 m^3/s	253	200		513

Note (*): Number of house relocations of partial river improvement for Stretch SA is common to all target design scales, as shown in Table R 8.8.

(5) **Principal Features of Alternative No. F_S.4 (Flood Diversion Channel + Off-site Flood Retarding Basin + Partial River Improvement)**



The combination of flood diversion channel and off-site flood retarding basin, together with partial river improvement is assumed as one of the major flood mitigation measures.

Partial river improvement of Stretch-SA and the upstream section in San Juan River Basin is required for Alternative No. F_S.4. Structural size of the partial river improvement is common to all target design scales applied and varies for the upstream section at the applied target design scales.

In this alternative, the most economical combination was selected through the trial calculation of least project cost, as listed below.

Table R 8.17 Proposed Combination of San Juan Diversion Channel, Off-Site Flood Regulation Pond and Partial River Improvement

Design Scale (Return Period)	Design Discharge of Partial River Improvement of San Juan River		Diversion Channel		Off-Site Flood Retarding Basin	
	Stretch-SA	Upstream	Design Discharge	Width	Required Land Acquisition	Storage Capacity
5-year	460 m^3/s	335 m^3/s	200 m^3/s	60 m	44 ha	1.50 x 10^6 m^3
10-year	460 m^3/s	460 m^3/s	250 m^3/s	70 m	63 ha	2.75 x 10^6 m^3
20-year	460 m^3/s	590 m^3/s	300 m^3/s	75 m	87 ha	4.10 x 10^6 m^3

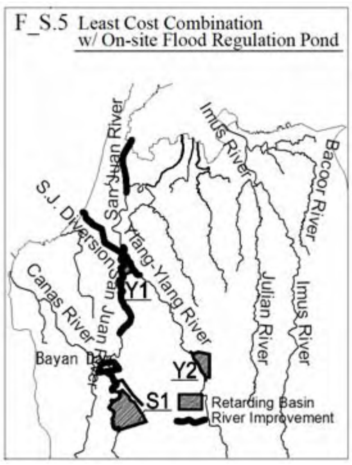
The number of house evacuations for Alternative No. F_S.4, which consists of the combination of San Juan Diversion Channel, three off-site flood retarding basins and partial river improvements of Stretch-SA, are as estimated below.

Table R 8.18 Required Number of House Relocations for Alternative No. F_S.4 (Flood Diversion Channel + Off-site Flood Retarding Basin + Partial River Improvement)

Design Scale (Return Period)	Partial River Improvement		Flood Diversion Channel	Off-site Flood Retarding Basin	Total
	Stretch-SA	Upstream			
5-year	60(*)	17	101	11	189
10-year		27	105	12	204
20-year		40	110	14	224

Note (*): Number of house relocations for partial river improvement of Stretch SA is common to all target design scales, as shown in Table R 8.8.

(6) **Principal Features of Alternative No. F_S.5 with On-Site Regulation Pond (Flood Diversion Channel + Off-Site Flood Retarding Basin + Partial River Improvement + On-Site Flood Regulation Pond)**



To reduce the land acquisition and structural sizes for the above off-site flood retarding basin and diversion channel, the flood mitigation effect of on-site flood regulation pond can also be taken into account.

The combination of on-site flood regulation pond and alternatives with minimum cost among F_S.2, F_S.3 or F_S.4 at each design scale is assumed as Alternative No. F_S.5.

In this alternative, the most economical combination was selected through trial calculation of least project cost.

The features of on-site flood regulation ponds are as listed in Table R 8.13. The other features of Alternative No. F_S.5 are listed in the following tables.

Table R 8.19 Proposed Combination of Alternatives of Flood Mitigation Measures with On-Site Regulation Pond in Alternative No. F_S.5

Design Scale (Return Period)	Alternative No.	Partial River Improvement		Flood Diversion Channel		Off-Site Flood Retarding Basin	
		Stretch	Design Discharge	Design Discharge	Width	Required Land Acquisition	Storage Capacity
5-year	F_S.2	SA	460 m^3/s	-	-	46 ha	2.37 x 10^6 m^3
	F_S.3	SA SB,SC	460 m^3/s 315 m^3/s	200 m^3/s	60 m	-	-
	F_S.4	SA	460 m^3/s	150 m^3/s	55 m	27 ha	1.42 x 10^6 m^3
10-year	F_S.2	SA	460 m^3/s	-	-	80 ha	4.20 x 10^6 m^3
	F_S.3	SA SB,SC	500 m^3/s 435 m^3/s	430 m^3/s	75 m	-	-
	F_S.4	SA	460 m^3/s	250 m^3/s	70m	44 ha	2.33 x 10^6 m^3
20-year	F_S.2	SA	460 m^3/s	-	-	100 ha	5.28 x 10^6 m^3
	F_S.3	SA SB,SC Ylang	460 m^3/s 580 m^3/s 580 m^3/s	670 m^3/s	100m	-	-
	F_S.4	SA	460 m^3/s	300 m^3/s	75m	72 ha	3.83 x 10^6 m^3

Table R 8.20 Required Number of House Relocations for Alternative No. F_S.5 (Least Cost Alternative + On-Site Regulation Pond)

Design Scale	Alternative	Partial River Improvement	Flood Diversion Channel	Off-site Flood Retarding Basin	Total Number of House Relocation
5-year	F_S.2	60	-	11	71
	F_S.3	85 (60+25)	100	-	185
	F_S.4	66 (60+6)	100	11	177
10-year	F_S.2	60	-	14	74
	F_S.3	145 (60+85)	135	-	280
	F_S.4	87 (60+27)	105	11	203
20-year	F_S.2	60	-	15	75
	F_S.3	260 (60+200)	250	-	510
	F_S.4	100 (60+40)	110	13	223

8.2 Structural Flood Mitigation Plan against Inland Flood

8.2.1 Maximum Design Scale Examined in the Study

The design scale of 2-year return period was set as the maximum design scale to be examined in the Study.

The objective areas of such inland flood mitigation were preliminarily placed in the low land areas, including the municipalities of Bacoor, Kawit, Noveleta and Rosario, and the northern part of General Trias and Imus and part of Tanza along the Canas River, where the residential houses/commercial houses are clustered remarkably close together. On the other hand, the existing drainage channels run in such densely populated areas and have the extremely small channel flow capacity, which could hardly cope with the probable rainfall intensity of even a 2-year return period. Accordingly, the critical issue on the structural flood mitigation plan against inland flood is to secure the available space for the improvement of the existing drainage channels and/or the construction of new drainage channels.

The house relocations required for the improvement of existing drainage mains at the design scale of 2 and 5-year return periods were provisionally estimated at 185 and 475, as described in the Subsection 8.2.2(2). Such remarkable increment of house evacuation at the design scale of 5-year return period is attributed to the condition that the required drainage network would require relocation of almost all houses along the existing streets, as illustrated in Fig. R 8.2. Thus, it is deemed to be virtually difficult to apply the design scale of 5-year return period to the proposed drainage network.

Moreover, the full-scale drainage improvement plan for even a 2-year return period require the project cost of more than 4,362 million pesos, which would lead to difficulties in project implementation from the viewpoint of financial affordability (refer to the Subsection 8.2.3).

Due to the above background, the design scale of 2-year return period was provisionally assumed as the maximum design scale to be examined in the Study. The various potential flood mitigation measures against inland flood were examined within the said maximum design scale. Then, the priority combination of measures was selected with particular attention to the affordability of project cost and the effectiveness of flood mitigation. In this connection, another option that acceptable inundation depth in 2-year flood is allowed has been considered taking cost affordability into consideration as "Partial Protection" for a counteroffer.

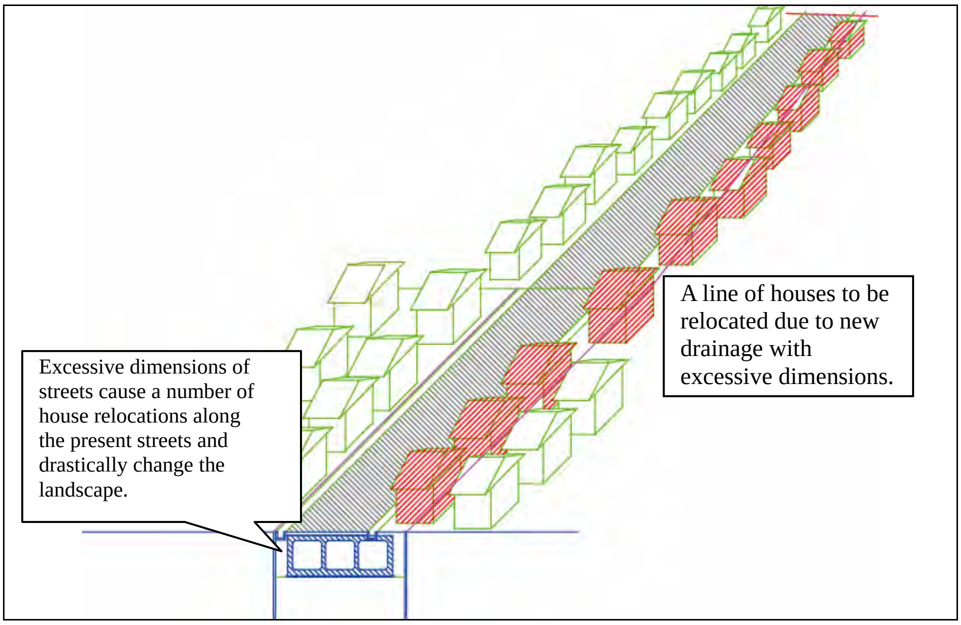


Fig. R 8.2 Drainage Improvement induced by Huge Number of House Relocation

8.2.2 Potential Measures

The inland flood mitigation plan aims at reducing the duration, extent and depth of inundation caused by stagnant storm rainfall and/or high tide. The potential measures for targeted areas were conceived based on the results of flood simulation analysis as well as the field reconnaissance, interview survey with the residents/relevant government agencies, and the interpretation of existing topographic maps/aerial photos, as described below.

(1) Coastal Dike

A certain part of the coastal area has the ground level below the tidal level during high tide. Due to such low ground level, tidal floods occur even during the time of no rainfall. The tidal flood is further aggravated when intensive rainfall occurs during the high tide. To mitigate such tidal floods, the coastal dike is proposed to shut out the high tide from the areas where ground level is lower than the high tide level along the shoreline of the said areas with tidal gates, as shown in the following table and Fig. 8.10 attached.

Table R 8.21 Proposed Coastal Dike in Lowland Area

Alignment No.	Code of Coastal Dike	Protected Area	Length	Structural Type
Coastal Dike-1	CD-1	Kawit	0.5 km	Earth Dike
Coastal Dike-2	CD-2	Kawit	1.5 km	Earth Dike
Coastal Dike-3	CD-3	Kawit	2.1 km	Earth Dike
Coastal Dike-4	CD-4	Noveleta	3.2 km	Earth Dike
Coastal Dike-5	CD-5	Rosario	4.2 km	Concrete Dike
Coastal Dike-6	CD-6	Rosario	0.5 km	Concrete Parapet Wall
Coastal Dike-7	CD-7	Tanza	0.5 km	Concrete Dike
Total			12.5 km	-

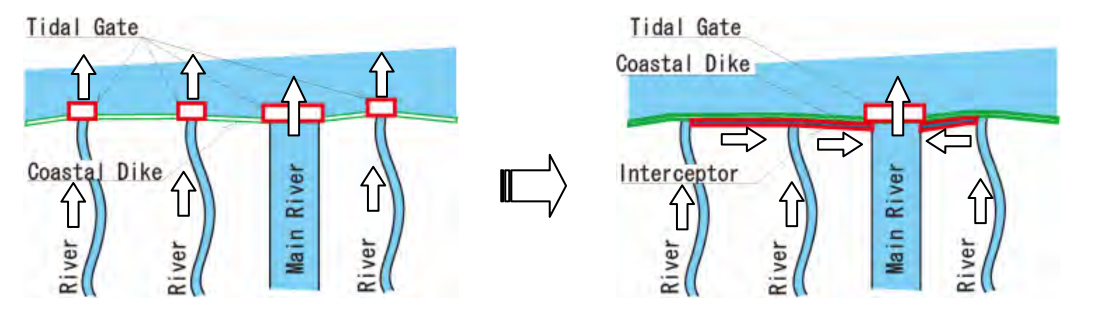
The crown level of the coastal dike was assumed to be the highest observed tidal level (EL+1.41m above Mean Sea Level) at the Manila South Harbor recorded in October 2006 from the following reasons:

- The difference between mean highest high tide (EL+0.80m) and the said recorded level (EL+1.41m) is not so large. Therefore, the types, dimensions and impacts among estimated elevations for each probability (return period) and the highest recorded elevation are not different from each other.
- There still remains the available non-residential land to install the rather high coastal dike.
- Concerning sub-soil settlement due to soil consolidation and sea level rising due to global warming, coastal dikes would swell themselves in the future. In this connection, the initial crown level of dike should be high within the economical and social applicability.
- According to the interview survey, residents have recommended a high coastal dike.

(2) Tidal Gate with Options of Existing Drainage Channel Improvement, New Drainage Main and Interceptor

A certain part of the coastal area hardly drains the storm rainfall during the time of high tide due to the tidal backwater effect. To resolve such hindrance, the tidal gate is proposed at the outlet of the representative drainage channel to be improved. The tidal gate is closed during high tide, and opened when the tidal level becomes lower.

New drainage mains are also required at suitable locations and alignment where the objective drainage area does not have a drainage channel to collect and drain storm rainfall into the sea through a tidal gate. At the same time, when the storm rainfall is hardly collected into the drainage main, an interceptor is proposed along the coastal line or the national diversion road to collect the storm rainfall and discharge it into the drainage main, as illustrated in the following figure.



Drainage System **without Interceptor** Drainage System **with Interceptor**

Fig. R 8.3 Concept of Interceptor for Inland Drainage System

Tidal gate, improvement of existing drainage channel, and construction of new drainage mains/interceptors are provisionally proposed, as shown in Fig. 8.11~13 and Table 8.1 attached.

Attached Table 8.1 also gives the number of house relocations required for the design scales of 2-year and 5-year return periods. As shown in the table, the number of house relocations for the 5-year return period (475 houses) far exceeds that for the 2-year return period (185 houses). In case that the design scale of 5-year return period is adopted, the improvement of existing drainage mains in particular require relocation of almost all houses along the existing streets, which will lead to serious social conflicts. Due to such large scale of house relocations, the design scale of 5-year return period is hardly justified, and that of 2-year return period is assumed as the standard design scale.

(3) Ring Dike

The ring dike has been proposed by DPWH and supported by the community to wall in the low land area in the eastern part of the Municipality of Kawit (including Barangays Kaingen, Poblacion, Wakas 1 & 2, Gahak-Maruas). The ground level of these areas is extremely low (EL.0m to EL.1m) and the intrusion of sea water as well as overflow from Tirona Drainage Channel often occurs in this area. A certain flood retention pond would also be required to temporarily store the storm rainfall together with the ring dike.

The proposed alignment of ring dike is shown in Fig. 8.11 attached. When this scheme is applied, the aforesaid tidal gates for the objective area of ring dike are not required. On the other hand, the ring dike would require the longer length of dike construction as compared with that for the aforesaid coastal dike, which requires additional number of house relocations as listed in the table below. Thus, the ring dike could be an alternative in the tidal gate and coastal dike combination for the objective area of the ring dike.

Table R 8.22 Comparison of Number of House Relocation between Coastal Dike Aone and Combination of Coastal Dike and Ring Dike

Protected Area (Municipality)	Number of House Relocations	
	Coastal Dike Alone	Coastal Dike and Ring Dike
Kawit	80	300
Noveleta	20	20
Rosario	40	40
Tanza	0	0
Total	140	360

(4) Flap Gate along River

Some of the existing drainage channels are connected to the estuary sections of Imus, San Juan and Canas rivers. These drainage channels could hardly fulfill the function to drain storm rainfall due to the backwater effect of the rivers during high tide. To resolve such backwater effect, flap gates are proposed, as shown in the following table and Fig. 8.13 attached.

Table R 8.23 Proposed Flap Gate along Estuary Section of River

Objective Drainage Area	Number of Gate and Location
Rosario	• Four flap gates at right bank of Canas River • One flap gate at left bank of Dr-9 (Malimango drainage channel)
Noveleta	• One flap gate at left bank of San Juan River
Kawit (Alt.1: Coastal Dike)	• One flap gate along a tributary of San Juan River
Kawit (Alt. 2: Ring Dike)	• Two flap gates along tributaries of San Juan River (w/ flap gates of Alt. 1)
Bacoor	• Four flap gates along Imus River and four flap gates along Bacoor River
Tanza	• One flap gate at left bank of Canas River

The conceptual figure of the effect of flap gate is further illustrated in the following figure.

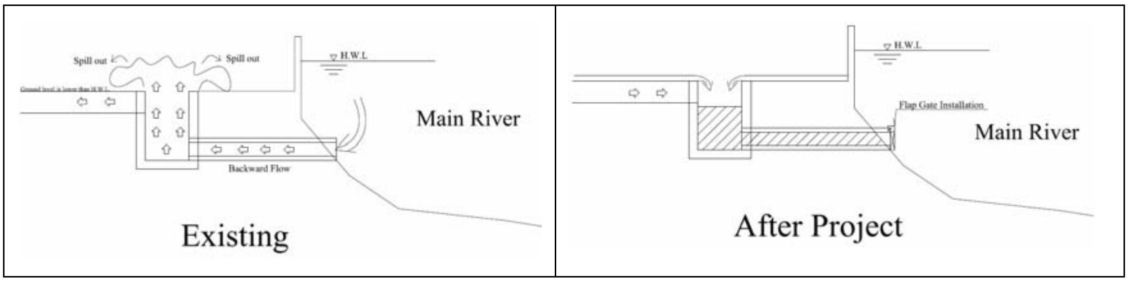


Fig. R 8.4 Effect of Flap Gate during High Water Level of River

(5) Off-Site Flood Retention Pond

The off-site flood retention pond aims at temporarily storing the storm rainfall in the objective drainage area so as to reduce the burden of channel flow on the drainage channel and/or reduce the flood inundation area/depth in the objective area. To attain such objectives, six potential off-site flood retention ponds are proposed. (see Table R 8.24)

Table R 8.24 Potential Sites for Off-Site Flood Retention Pond

Drainage Channel Connected to the Pond	Municipality	Code No. of Off-Site Flood Retention Pond*	Possible Area as ROW for the Pond	Available Depth for Retention
Tirona	Kawit	K1	10 ha	2.0m
Panamitan	Imus	P1	25 ha	2.0m
Malamok	Imus	M1	11 ha	1.0m
Malamok	Imus	M2	33 ha	1.0m
EPZA	Rosario	E1	5 ha	2.0m
EPZA	General Trias	E2	19 ha	1.5m

Note*: The Code No. corresponds to those in the location map of off-site flood regulation ponds shown in Fig. 8.8.

The following two-types of off-site flood retention pond are provisionally proposed:

(a) Off-Site Flood Retention Pond in Southern Part of Rosario-Noveleta-Kawit Diversion Road

There is a national road called “Rosario-Noveleta-Kawit Diversion Road” (hereinafter referred to as the “Diversion Road”), which stretchs east to west in the low land area of the Project Area. The Diversion Road currently works as buffer to check the flow of storm rainfall in the southern part of the Diversion Road and lead it into the northern coastal lowland area. Thus, the Diversion Road functions to mitigate the inland inundation damage in the coastal low land area. At the same time, however, inundation occurs along the southern side of the Diversion Channel. To resolve this issue, four off-site flood retention ponds are provisionally proposed along the southern side of the Diversion Road in the municipalities of Kawit and General Trias.

(b) Off-Site Flood Retention Pond in Northern Part of Rosario-Noveleta-Kawit Diversion Road

The northern part of the Diversion Road is a low-lying area sandwiched between the coastal line and the Diversion Road, and easily inundated by storm rainfall. To reduce the inundation area/depth, two off-site flood retention ponds are proposed to collect storm rainfall.

8.2.3 Alternative Plans for Inland Flood Mitigation

Alternative flood mitigation measures against inland floods, which involve some combinations of the aforesaid potential flood mitigation measures, are proposed. The alternative measures thus proposed are as listed in the following table.

Table R 8.25 Combination of Potential Flood Mitigation Measures against Inland Flood

Alt. No.	Objective Drainage Area (Municipality)	Component of Flood Mitigation Measures against Inland Flood						
		Coastal Dike	Tidal Gate	Interceptor	New Drainage Main	Flap Gate along River	Ring Dike	Off-Site Flood Retention Pond
D-1	Tanza	●	●	-	-	●	-	-
	Rosario	●	●	●	●	●	-	-
	Noveleta	●	●	-	-	●	-	-
	Kawit	●	●	-	-	●	-	●
	General Trias	-	-	-	-	-	-	●
	Bacoor	-	●	-	-	●	-	●
D-2	Tanza	●	●	-	-	●	-	-
	Rosario	●	●	●	●	●	-	-
	Noveleta	●	●	-	-	●	-	-
	Kawit	-	-	-	-	●	●	●
	General Trias	-	-	-	-	-	-	●
	Bacoor	-	●	-	-	●	-	●

Note: The difference of Alternative D-1 and D-2 is only in the measures applied to Kawit Municipality.

As noted above, the major difference alternatives D-1 and D-2 is only in the option of constructing a ring dike or a tidal dike for the Municipality of Kawit.

The two alternative flood mitigation measures against inland flood (D-1 and D-2) were studied under the condition of “With On-Site Flood Regulation Pond” or “Without On-Site Flood Regulation Pond,” in two protection levels: “Full Protection” and Partial Protection.” The study cases are as summarized in the table below.

Table R 8.26 Study Cases of Alternative Plans for Inland Flood Protection

Protection Level	Alternative Flood Mitigation Measures against Inland Flood			
	With On-Site Flood Regulation Pond		Without On-Site Flood Regulation Pond	
Full Protection	D-1	D-2	D-1	D-2
Partial Protection	D-1	D-2	D-1	D-2

Major structural features for each of the alternatives are illustrated in Fig 8.10 and Fig 8.11 for full protection and Fig 8.12 and Fig 8.13 for partial protection attached and shown in detail in Table 8.2 to Table 8.5 attached.

(1) Inland Flood Mitigation with On-Site Flood Regulation Pond

The required number of house relocation and land acquisition for the inland flood mitigation plan with on-site flood regulation pond was estimated, as summarized in the table below.

Table R 8.27 Required Number of House Relocation and Land Acquisition for Inland Flood Mitigation Measures with On-Site Flood Regulation Pond

Items	Alternatives of Inland Flood Mitigation **with** On-Site Flood Regulation Pond							
Protection Level	Full Protection (2-Year Return Period)				Partial Protection (2-Year Return Period)			
Compensation Items	House Relocation		Land Acquisition		House Relocation		Land Acquisition	
Alternative No.	D-1	D-2	D-1	D-2	D-1	D-2	D-1	D-2
Existing Drainage Improvement	156	156	1.6 ha	1.6 ha	30	30	1.8 ha	1.8 ha
New Drainage Main	14	14	1.0 ha	1.0 ha	2	2	0.8 ha	0.8 ha
Interceptor	14	14	1.5 ha	1.5 ha	10	10	1.0 ha	1.0 ha
Off-Site Retention Pond	1	1	52.0 ha	52.0 ha	1	1	52.0 ha	52.0 ha
Coastal Dike	138	138	19.5 ha	19.5 ha	78	78	7.7 ha	7.7 ha
Ring Dike	0	220	0.0 ha	8.6 ha	0	220	0.0 ha	8.6 ha
Flap Gate & Others	-	-	-	-	-	-	-	-
Total	323	543	75.6 ha	84.2 ha	121	341	63.3ha	71.9ha

(2) Inland Flood Mitigation without On-site Flood Regulation Pond

The required number of house relocation and land acquisition for the inland flood mitigation plan without on-site flood regulation pond was estimated, as summarized in the table below.

Table R 8.28 Required Number of House Relocation and Land Acquisition for Inland Flood Mitigation Measures without On-Site Flood Regulation Pond

Items	Alternatives of Inland Flood Mitigation **without** On-Site Flood Regulation Pond							
Protection Level	Full Protection (2-Year Return Period)				Partial Protection (2-Year Return Period)			
Compensation Items	House Relocation		Land Acquisition		House Relocation		Land Acquisition	
Alternative No.	D-1	D-2	D-1	D-2	D-1	D-2	D-1	D-2
Existing Drainage Improvement	156	156	1.6 ha	1.6 ha	30	30	1.8 ha	1.8 ha
New Drainage Main	14	14	1.0 ha	1.0 ha	2	2	0.8 ha	0.8 ha
Interceptor	14	14	1.5 ha	1.5 ha	10	10	1.0 ha	1.0 ha
Off-Site Retention Pond	1	1	61.0 ha	61.0 ha	1	1	61.0 ha	61.0 ha
Coastal Dike	138	138	19.5 ha	19.5 ha	78	78	7.7 ha	7.7 ha
Ring Dike	0	220	0.0 ha	8.6 ha	0	220	0.0 ha	8.6 ha
Flap Gate & Others	-	-	-	-	-	-	-	-
Total	323	543	84.6 ha	93.2 ha	121	341	72.3ha	80.9ha

8.3 Preliminary Design

Based on the results of the study on alternative measures for the structural flood mitigation plan, the following structures are preliminarily designed as the conceived structural flood mitigation measures for each alternative in accordance with the design discharge distribution shown in Fig.5.12 to 5.13, Fig. 8.14 to 8.17 and Fig.8.18 attached. Provisions for the differently-abled and gender-responsive design should preferably be considered for these structures to be designed such as design of railings and steps in Detailed Design Stage.

(1) River Channel Improvement (Full / Partial)

(2) Off-Site Flood Retarding Basin, Off-Site Flood Retention Pond and On-Site Flood Regulation Pond

(3) Diversion Channel

(4) Drainage Channel Improvement

(5) Tidal Gate and Coastal Dike

(6) New Drainage Main and Interceptor

(7) Other Appurtenant Facilities (such as Flap Gate, etc.)

8.3.1 River Channel Improvement

Design conditions for river channel improvement are given in the following table.

Table R 8.29 General Features of Design for River Channel Improvement

Item	Design Value				
	River	Drainage (Open)	Drainage (Box or Con)	Diversion	Coastal Dike/ Tidal Gate
Roughness Coefficient	0.030	0.030	0.025	0.025	-
Design Sea Level*1	EL+0.80m				EL+1.41
Freeboard (m)					
High Water lower than hinterland*	0~0.6m	0~0.3m	0~0.2m	0.6m	1.0m
High Water higher than hinterland*	Complying to Guidelines*2			1.0m	

Note *1: See Fig. R.8.5 below.
*2: Guidelines, Criteria and Standards for Department Public Works and Highways, Volumes I and II

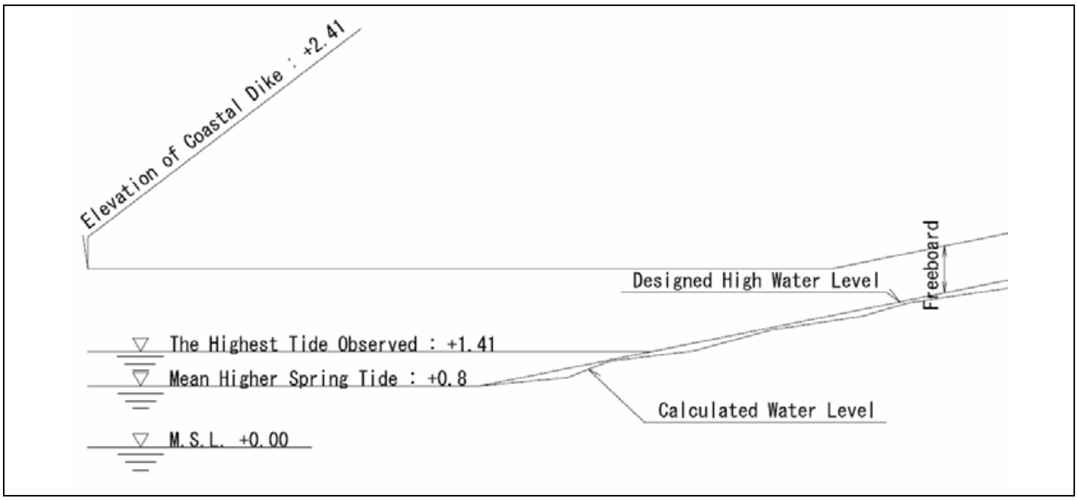


Fig. R 8.5 Sea Level for Design of River Improvement

(1) Imus River Basin

The works for the targeted stretches of river channel improvement in the Imus River Basin depending on the selected alternative and design scale (year return period) consist of the widening, deepening and dredging of existing channels together with the construction of off-site retarding basins. The design longitudinal profile and typical channel improvement for Imus River are shown in attached Fig. 8.20 and 8.21 respectively, as well as in attached Fig. 8.22 for Bacoor River and attached Fig. 8.23 for Julian River and the Left tributary.

Tentative bills of quantities for the works in the Imus River Basin for partial river improvement and river improvement targeting 5-year return period flood are given in Table R 8.30.

Table R 8.30 Tentative Bill of Quantities for Imus River Channel Improvement

Item	Unit	Partial River Improvement			Full-scaled River Improvement[*1]		
		Imus River	Bacoor River	Julian River	Imus R. (5-year)	Bacoor R. (2-year)	Julian R. (5-year)
Preparatory & Temporary Works	L.S.	1	1	1	1	1	1
Earth Works							
Dredging	m^3	120,000	121,000		150,000	121,000	
Embankment	m^3	95,000	310,000	50,000	95,000	310,000	73,800
Excavation	m^3	16,000	73,000	150,000	20,000	215,000	223,200
Hauling Earth Material (2-5km)	m^3	25,000	116,000		25,000	26,000	
Revetment							
Concrete Block on Slope	m^3	10,000			10,000		
Geotextile Sheet	m^2	42,000			42,000		
Wet Stone Masonry(1:0.5)-1	m^3		3,450	9,667		3,450	21,708
Wet Stone Masonry(1:2.0)	m^3		1,350			1,350	
Road Works							
Coastal Road (B=12m)	m	1,350			1,350		
Maintenance Road (B=3m)	m	2,000	8,000		2,000	24,000	
Sheet Pile Works							
Coping Concrete with P. Wall	m^3		1,800	350		12,000	3,360
Re-bar for Concrete	kg		180,000			1,200,000	336,000
Steel sheet piles Type III	m		24,688	14,496		180,000	85,200
Parapet Wall (L=3,200m in total)							
Excavation					50,000		
Concrete for Wall	m^3	2,720		1,650	8,160		
Re-bar for Wall	kg	272,000			816,000		
Leveling Concrete	m^3	384			1,152		
Pile Furnishing	m	11,200		5,000	33,600		
Pile Driving	m	11,200		5,000	33,600		
Bridge Replacement	m^2		900		3,600	6,620	640
House Relocation	Nos	90	60	50	400	250	250
Land Acquisition							
Fishpond	m^2	0	30,000		0	30,000	
Along River	m^2	9,000	9,600	5,000	60,000	46,000	25,000

Note: The quantities for full-scaled protection are subject to protection level, such as 2-year to 20-year.
The indicated quantities above are reference values for them.

(2) San Juan River Basin

The works of targeted stretches of river channel to be improved in San Juan River Basin depending on the selected alternative and scale (return period), consist of widening and dredging of existing channel together with the construction of off-site retarding basin or a diversion channel. Design longitudinal profile and typical channel improvement for San Juan River are shown in attached Fig. 8.23 and 8.24 respectively. The tentative bill of quantities is shown below.

Table R 8.31 Tentative Bill of Quantities for San Juan River Channel Improvement

Item		Unit	Partial	Full-scaled River Improvement (5-year)
Preparatory & Temporary Works		L.S.	1	1
Earth Works				
	Dredging	m^3	191,000	191,000
	Embankment	m^3	64,000	64,000
	Excavation	m^3		345,000
	Hauling Earth Material (2~5km)	m^3	127,000	127,000
Revetment				
	Concrete Block on Slope	m^3	19,700	19,700
	Geotextile Sheet	m^2	100,000	100,000
	Wet Stone Masonry (1:0.5)-1	m^3	1,000	13,020
Road Works: Maintenance Road (B=3m)		m	4,000	4,000
Bridge Replacement		m^2	420	2,356
House Relocation		No.	60	250
Land Acquisition				
	Along River	m^2		30,000
	Others (Floodplain & Mangrove)		85,000	85,000

Note: The quantities for full-scaled protection are subject to protection level, such as 2-year to 20-year.
The indicated quantities above are reference values for them.

8.3.2 Off-Site Flood Retarding Basin and Off-Site Retention Pond

Off-site flood retarding basin and off-site flood retention pond are proposed as flood mitigation facilities which have the function of temporarily storing runoff discharge and flattening the peak runoff discharge.

(1) Common Design Criteria

Design criteria common to the off-site flood retarding basin and the off-site flood retention pond are as follows:

- Facilities are designed hydraulically to ensure fulfillment of their flood control functions.
- Locations of facilities are limited to vacant areas adjacent to the river where river-overflow flood and inland flood frequently occur.
- Basin/pond is surrounded by a surrounding dike. Surrounding dike crown elevation is set higher than the original ground elevation and higher than the crown elevation of river bank so as not to cause overflow from the suurounding dike of basin/pond.
- Minimum freeboard of surrounding dike against maximum water level in the facility is set at 0.6m.
- Three meters of crown width of surrounding dike or more is adopted considering proper construction procedure and width of crest road for maintenance. Dike crown shall be paved as maintenance road.
- Both sides of slope of surrounding dike are designed at more than 1.0 vertical to 2.0 horizontal to secure the stability of both slopes.
- Side overflow and non-gated type of overflow weir is adopted to avoid mis-operation and to secure easy maintenance.
- Overflow weir is located parallel to the river alignment, and flow on the overflow weir is free in two-way, i.e., from river to facility and from facility to river.
- Overflow volume is calculated by the following formula:

$$Q = CBh_1^k \left[1 - \left(\frac{h_2}{h_1} \right)^k \right]^{0.385}$$

Where;

C	:	weir overflow coefficient (=1.838 $m^{1/2}$/s)
B	:	width of weir (m)
k	:	exponential coefficient (=1.5)
h_1	:	depth of water above weir level upstream (m)
h_2	:	depth of water above weir level downstream (m)

- Each facility has an outlet sluiceway at downstream end. Bottom elevation of outlet sluiceway has to be higher than channel bottom elevation of river.

Layout plans of the off-site retarding basin and the off-site retention pond are shown in the attached Fig. 8.25 to Fig. 8.28 attached.

Typical plan of overflow weir and cross sections of inlet and outlet of off-site retarding basin and off-site retention pond are shown in the following figures.

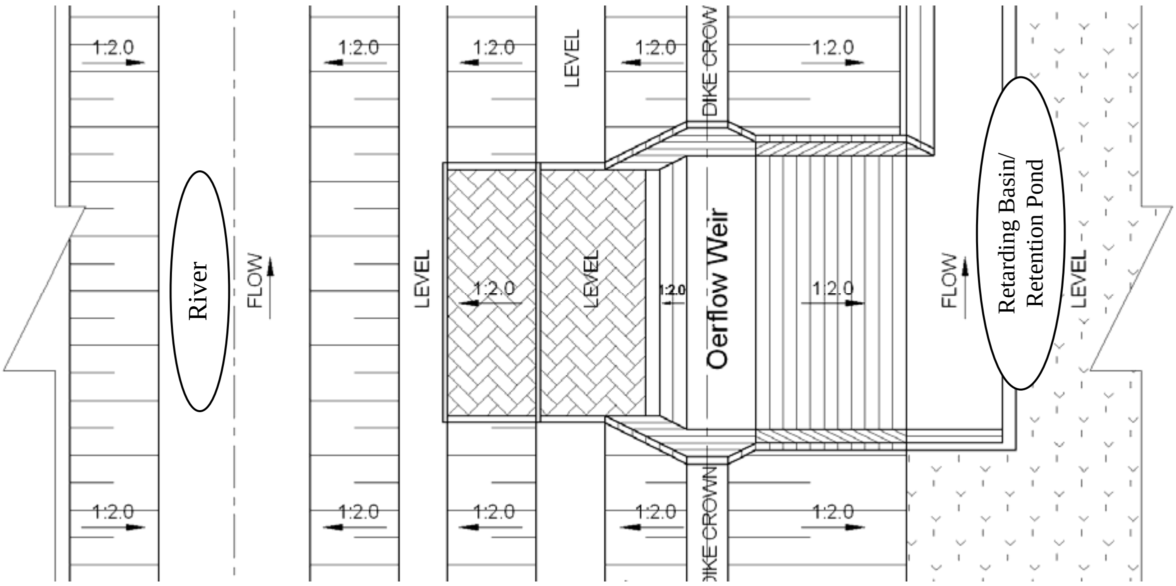


Fig. R 8.6 Typical Plan of Overflow Weir of Off-Site Flood Mitigation Facilities

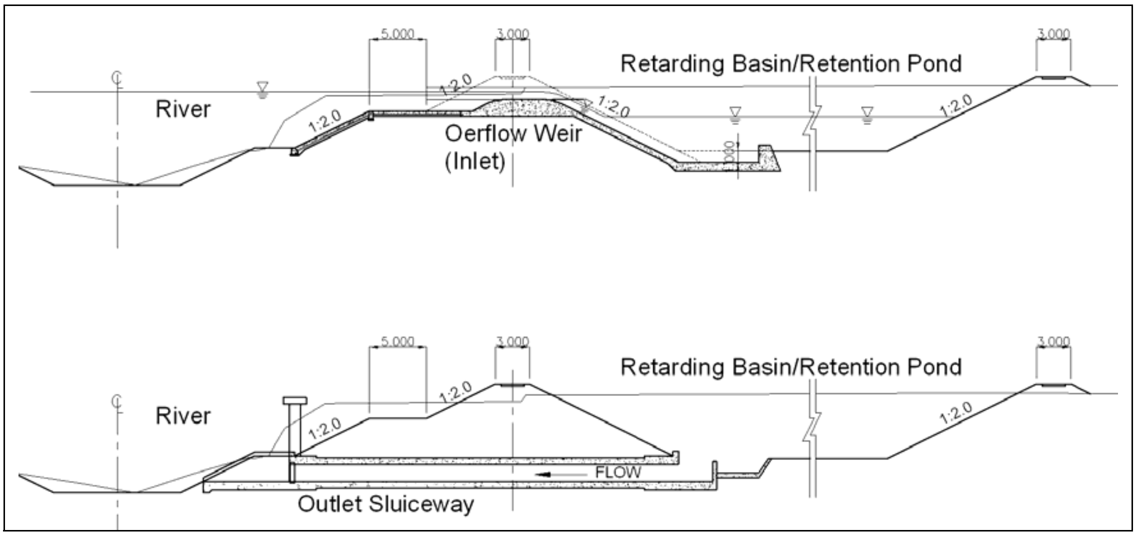


Fig. R 8.7 Typical Cross Sections of Inlet and Outlet of Off-Site Flood Mitigation Facilities

(2) Off-Site Flood Retarding Basin

Gross storage capacity of retarding basin and parameters of overflow weir are obtained as follows:

i) Available area and depth of each retarding basin is set as given in table R 8.2,

ii) The crest level and length of overflow weir which can reduce the peak runoff discharge by design discharge are set by trial-and-error method in MIKE11,

iii) The amount of storing water volume is the gross storage capacity of the retarding basin,

iv) The minimum area where the gross capacity of the retarding basin can be secured is set again as the extent land acquisition.

Major features of the off-site flood retarding basin at each site selected are as follows:

Table R 8.32 Major Features of Off-site Flood Retarding Basin

Basin	River	Retarding Basin				Dike	Overflow Weir	
		Code No.	Lowest Bottom Elevation (EL. m)	Gross Storage Capacity ($x10^6$ m^3)	Target Return Period	Crown Elevation (EL. m)	Crest Elevation (EL. m)	Crest Length (m)
Imus	Imus	RB-I1	24.5	1.7	10year	32.0	27.8	100
	Bacoor	RB-B1	0.0	0.05	2 year	2.7	1.0	40
		RB-B2	0.0	0.1	2 year	2.7	1.0	40
		RB-B3	0.0	0.2	2 year	2.7	1.0	40
		RB-B4	5.5	0.4	2 year	9.5	7.45	25
	Julian	RB-J1L	3.5	0.2	5 year	7.5	5.0	50
		RB-J1R	3.5	0.1	5 year	7.5	5.5	50
	IT-2	RB-J2	12.25	0.5	5 year	16.75	14.25	50
San	San Juan	RB-S1	21.5	2.8	20 year	27.5	23.2	200
Juan	Ylang-	RB-Y1	1.5	0.8	20 year	6.6	4.7	60
	Ylang	RB-Y2	17.5	1.5	20 year	23.5	20.4	150

Note; With On-site Flood Regulation Pond

(3) Off-Site Flood Retention Pond

Major features of off-site flood retention pond at each selected site are as follows:

Table R 8.33 Major Features of Off-site Flood Retention Pond

Municipality	River/ Drainage	Retention Pond				Dike	Overflow Weir	
		Code No.	Bottom Surface Area (ha)	Bottom Elevation (EL. m)	Gross Storage Capacity ($x10^6$ m^3)	Crown Elevation (EL. m)	Crest Elevation (EL. m)	Crest Length (m)
Kawit	Panamitan	RB-P1	25	0.6	0.7	4.0	1.6	25
Tanza	Tanza	RB-T1	5	8.0	0.2	12.0	10.0	30
Kawit & Imus	Malamok	RB-M1	11	0.0	0.2	2.7	1.0	40
Imus	Malamok	RB-M2	33	10.0	0.8	13.0	11.0	50
Kawit	Tirona	RB-K1	4	0.0	0.03	2.7	1.0	20
Rosario	Malimango	RB-E1	5	0.0	0.1	2.7	1.0	50
General Trias	Malimango	RB-E2	15	7.5	0.6	12.0	9.0	50

Note; 2-year flood with On-site Flood Regulation Pond

8.3.3 On-Site Flood Regulation Pond

On-site Flood Regulation Pond is installed at the downstream end of new industrial and/or housing subdivisions. On-site flood regulation pond has the function of temporarily storing runoff discharge and flattening the peak runoff discharge.

According to the structural standard of on-site flood regulation ponds described in Table R 8.8, structural features of ponds are as shown in the table below.

Table R 8.34 Structural Standard of On-site Flood Regulation Pond

Description	Specification	Structural Dimensions of Each Area of Subdivision			
		Area=5ha	Area= 20ha	Area=50ha	Area=100ha
Area of the Pond	3% of subdivision area	1,500m^2	6,000m^2	15,000m^2	30,000m^2
Effective Storage Volume	Area of the pond x 80% x 3m	3,600m^3	14,400m^3	36,000m^3	72,000m^3
Sediment Capacity	150m^3/ha/year	1,125m^3	4,500m^3	11,250m^3	22,500m^3

8.3.4 San Juan Diversion Channel

Instead of the off-site flood retarding basin, the San Juan Diversion Channel is assumed as the major flood mitigation measure for San Juan river basin. Proposed longitudinal profile and standard cross section of the diversion channel are shown in Fig. 8.29 attached. (Refer to Fig. 8.9 attached for alignment.)

8.3.5 Drainage Channel Improvement

Drainage channel improvement consists of widening, heightening and rehabilitation of existing bank protection. Major features of improvement works are shown below and illustrated in Fig.8.18. Improved cross-sections for these existing drainage channels are shown in Fig. 8.31 attached.

Table R 8.35 Major Features of Drainage Channel Improvement

Drainage	Standard Design Discharge (m^3/s) *1 (2-year return period)		Remarks
	With On-Site	Without On-Site	
Dr-1	75.8	97.4	Channel improvement is considered together with M-1, M-2
Dr-2	31.3	42.4	Channel improvement is considered together with M-2
Dr-3	15.0	22.1	Channel improvement is considered together with K-1
Dr-5 & 6	39.6	51.3	Channel improvement is considered together with P-1
Dr-7	6.5	6.5	No improvement is needed.
Dr-8	16.0	16.0	In parallel with the proposed San Juan Diversion Channel
Dr-9	62.6	64.1	Channel improvement is considered together with E-1, E-2
Bacoor-2	10.5	10.5	Channel improvement is considered together with B-1, 2, 3
Bacoor-3	22.4	28.7	Channel improvement is considered together with B-1, 2, 3
CT-1	26.9	41.1	No improvement is needed.

Note *1: At the lowest section
*2: See Fig.8.18 for design discharge with off-site retention pond and on-site regulation pond

8.3.6 Coastal Dike

Coastal dike is divided into 7 sections and consists of three types of dike as shown in the table below.

Table R 8.36 Proposed Coastal Dike in Lowland Area

Alternative *1	Alignment No.	Protected Area	Length	Crown Elevation*1	Structural Type
Full/Partial	Coastal Dike-1	Kawit	0.6 km	EL. 2.41 m+0.1m =2.51m	Type C: Earth Dike
Full/Partial	Coastal Dike-2	Kawit	1.6 km	EL. 2.41 m+0.1m =2.51m	Type C: Earth Dike
Full/Partial	Coastal Dike-3	Kawit	1.7 km	EL. 2.41 m+0.1m =2.51m	Type C: Earth Dike
Full	Coastal Dike-4	Noveleta	3.1 km	EL. 2.41 m+0.1m =2.51m	Type C: Earth Dike
Full	Coastal Dike-5	Rosario	4.6 km	EL. 2.41 m+0.1m =2.51m	Type A: Concrete Dike
Full	Coastal Dike-6	Rosario	0.5 km	EL. 2.41 m+0.1m =2.51m	Type B: Concrete Parapet Wall
Full	Coastal Dike-7	Tanza	0.7 km	EL. 2.41 m+0.1m =2.51m	Type A: Concrete Dike
	Total	Lowland Area	12.8km		

Note *1: Full/Partial: Alignment to be constructed in both alternatives, Full; Constructed in only Full Protection
*2: 0.1m for the sea level rise due to sub-soil consolidation and global warming (refer to Subsection 8.3.9).

Crown elevation of coastal dike is set at EL. 2.51m, considering 1m for common freeboard and 0.1m for sub-soil consolidation and global warming against the maximum tide level as per past records.

Layout and typical cross sections of coastal dike are shown in the attached Fig. 8.31 attached.

(1) Coastal Dike Type A: Concrete Dike

Coastal dike Type A is made of massive concrete or mortar plastered wet stone masonry. It is proposed along the seashore line where strong waves always strike dike directly. Dike must be strong against erosion caused by wave, and safe against overtopping of wave.

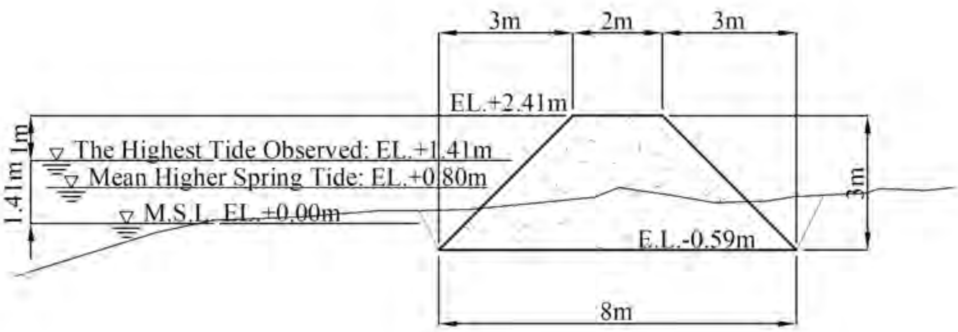


Fig. R 8.8 Typical Cross Section of Coastal Dike Type A: Concrete Dike

(2) Coastal Dike Type B: Parapet Wall

Coastal dike Type B is the parapet wall type made of massive concrete or mortar plastered wet stone masonry. It is proposed along the river mouth stretch of Canas River where the site is limited and very narrow. Dike must be strong against erosion caused by wave, and safe against overtopping of wave.

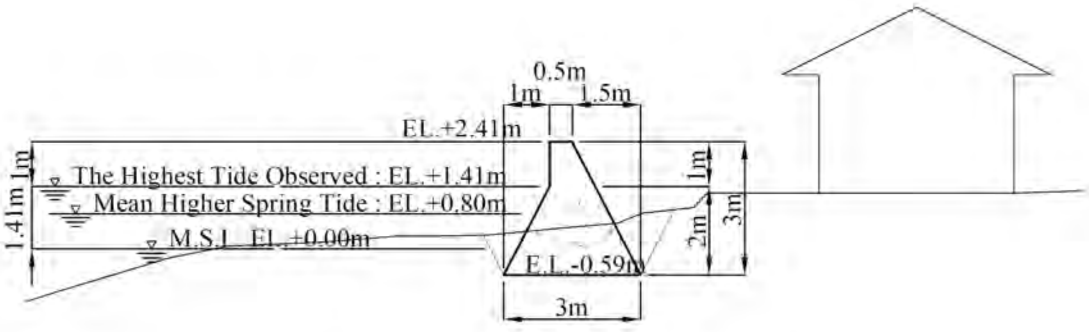


Fig. R 8.9 Typical Cross Section of Coastal Dike Type B: Parapet Wall

(3) Coastal Dike Type C: Earth Dike

Coastal dike Type C is a dike made of earth embankment. It is proposed at inland area, such as lowland area and fishpond, where wave strikes the dike only during high tide. Seaside of dike slope is protected with concrete or wet stone masonry revetment to make the dike strong against erosion caused by wave.

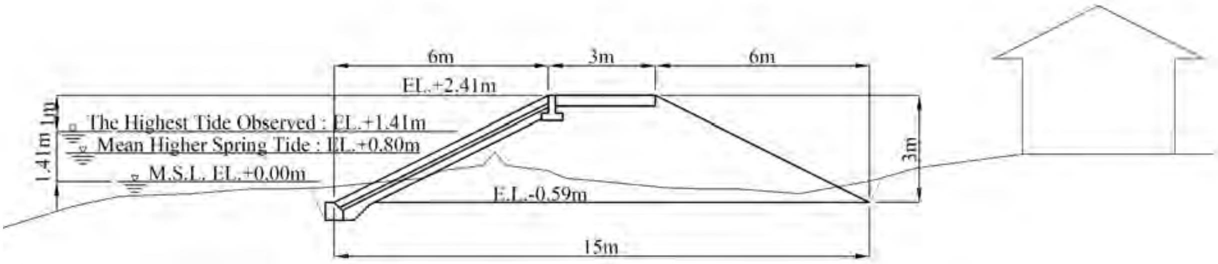


Fig. R 8.10 Typical Cross Section of Coastal Dike Type C: Earth Dike

8.3.7 Tidal Gate and Flap Gate

Tidal Gates are placed at each outlet of main drainage channel of the new drainage main to mitigate the tidal effect, as shown in Fig. 8.32 attached. In addition, flap gate at outlets of some of the existing drainage channels are connected to the estuary section of Imus, San Juan and Canas rivers. Typical tidal gate structures and flap gates are illustrated in Fig. 8.33 attached.

8.3.8 New Drainage Main and Interceptor

Some new drainages mains are proposed to traverse the northern part of Bacoor, the western and central parts of Kawit, the central part of Noveleta, and the eastern part of Rosario. Interceptors along the diversion road and some lateral roads are proposed to collect the discharge of the existing laterals running in parallel toward the sea into the drainage channel and drainage mains. The proposed structural types are the box-culvert type or open channel protected by perpendicular sidewalls. Typical cross-sections of these channels are shown in Fig. 8.34 attached.

The alignments and locations of proposed structures for inland drainage at each drainage area are shown in Fig. 8.10 to Fig. 8.13 attached for each alternatives respectively.

8.3.9 Consideration for Global Warming

As described in Subsection 2.2.3, some certain/uncertain adverse effects due to global warming would need to be incorporated into the objective flood mitigation plan, although all adverse effects would not still be pronounced in 2020 of the target year of the study in all experiments/scenarios as reported by the IPCC. In this connection, the policy and strategy against such global warming has been described in Appendix-8 in detail. Therefore, some different techniques regarding proposed structures to be adopted for the master plan have been specifically introduced and discussed below.

(1) Coastal Dike/River Dike/Parapet Wall

Dike and flood protection wall along the coast, river and new diversion channel shall be designed at the design flood level against the proposed flood scale and high tidal level. In connection with the adverse effects of global warming, as well as the consolidation of base soil and the storm-surge phenomena, the gradual decrease of protection level of structures in the future and the frequent extreme flash floods against the structures shall be considered in the design of coastal and river dikes including the flood protection wall. Therefore, it is required that: (1) dikes and walls shall have certain functions against overflow or overtopping of water; and (2) dikes and walls shall have the structural stability to withstand any swelling or uplift, as shown in Fig. 8.31 attached.

(2) Tidal Gate

Tidal gates are opened when the inland water level is higher than the sea level (ebb tide) and closed when inland water level is lower than the sea level (high tide). Therefore, the structural members of the main tidal gates such as dimension of gate columns, sill and beam of hoist machine shall be designed, subject to the replacement of gates into pump gates, to drain inland water anytime as a countermeasure for global warming.

(3) Off-Site Flood Retarding Basin / Off-Site Flood Retention Pond

Off-site flood retarding basin and off-site flood retention pond shall be designed with adequate retention capacity and extent. There are two measures to increase storage capacity, effective utilization for slope and bottom of retarding basin, for such retarding basins as shown in Fig. R 8.11 below besides new retarding basin construction in unused areas.

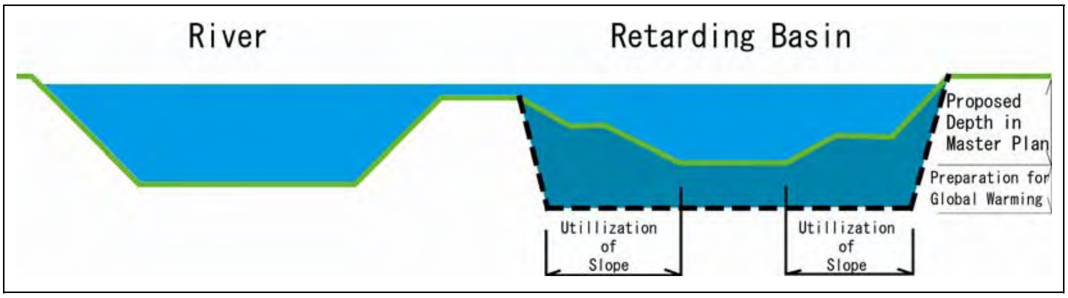


Fig. R 8.11 Additional Retention Capacity of Retarding Basin/Retention Pond in Preparation for Global Warming

8.4 Cost Estimate

8.4.1 Conditions of Cost Estimation

Project cost has been estimated under the following conditions:

(1) Price Level

Price level is as of October 2007.

(2) Contingencies

Price escalation and physical contingencies are assumed as follows:

Annual Price Escalation	:	5.07% for Local Currency Portion; 1.95% for Foreign Currency Portion
Physical Contingency	:	5% of the sum of construction base cost, compensation cost and engineering service cost

(3) Currency Conversion Rate

Currency conversion rates are assumed at USD1.00 = JPY114.67 = PHP43.95 as of the end of October 2007.

(4) Compensation Cost

Compensation cost consists of the costs of house evacuation and land acquisition. These costs are estimated on the basis of data (Zonal Valuation) obtained from the Provincial Government of Cavite and the municipalities concerned such as the fair market value of land and properties assessed for taxation purposes in the locality and the actual cost of past or ongoing house evacuation activities, as well as the ongoing projects of similar nature under JBIC and DPWH such as the Kamanava Flood Control and Drainage Improvement Project (Inland Drainage Flood Mitigation Project) and the Pasig-Marikina River Channel Improvement Project (River-Overflow Flood Mitigation Project).

(5) Administration Cost

Administration Cost (Project Owner's Expense for management) of the Project is estimated at 1% of the total sum of construction cost and compensation cost.

(6) Engineering Service Cost

Engineering service cost is prepared for the detailed engineering design and construction supervision services at 6% and 10% respectively of construction base cost.

(7) Tax, etc.

12% of the sum of construction base cost and engineering service cost is added to project cost for VAT, etc.

Project cost in the proposed master plan is as described below. The disbursement schedule of all analyzed alternative measures and the cost estimates for comparison and evaluation are as tabulated in Appendix 5.

8.4.2 Particular Description of Proposed Structures

(1) Construction Base Cost for each Alternative Measure

Construction Base Costs for each alternative described in Section 8.2 and 8.3 have been estimated as shown in Table A.5.C in Appendix 5.

(2) Cost of On-Site Regulation Pond and the Collateral Cost

As shown in attached Table 8.6 and 8.7, the construction costs of 5 and 20 hectares of on site regulation pond are 7 million pesos and 16 million pesos respectively. According to the Land Use Control described in Chapter 4, the average area of the new subdivision applied is estimated at 8 hectares. Hence, the unit cost of an 8-hectare subdivision is 8.8 million pesos.

On the other hand, the predicted expansion of the built-up area in the Study Area has been also estimated from 29.49% for the existing condition (2007) which corresponds to 120.15 km^2 to 42.7% for the future condition (2020) which corresponds to 173.97 km^2. Therefore, the new development area expected between 2007 and 2020 is also calculated as follows:

Expected Development Area in 2007-2020 $= (173.97\ km^2 – 120.15\ km^2) = 53.82\ km^2$

Based on the conditions mentioned above, the total cost of on-site regulation pond is estimated as follows:

$53.82(km^2)$ *x* $100(ha/km^2)$ */ [8 hectares/area) x 8.8 million Php/area] = 5,920 million Php*

Consequently, the cost of 5,920 million pesos is added to the costs of alternatives including the on-site regulation pond, such as F_I.3 and F_S.5.

On the other hand, some additional costs are needed for alternatives without on-site regulation pond, such as alternative F_I.1, F_I.2, and F_S.1 to 4.

Items of additional construction base costs for alternatives without on-site regulation pond are as follows:

Table R 8.37 Additional Construction Base Cost for Alternatives without On-site Regulation Pond

<table>
<tr><th>Alternative Concept</th><th colspan="2">Additional Cost Items to be Considered</th></tr>
<tr><td>Full scale River improvement</td><td>Cost due to direct increment of Peak Discharge</td><td rowspan="3">As local flow treatment due to increment of drainage discharge by new subdivision construction, it is assumed that existing drainage discharges (100m long) are improved by wet stone masonry (H=3m on both sides) at every new subdivision, to wit:
272 mil. Php for Imus Basin
147 mil. Php for San Juan Basin
38 mil. Php for Inland Drainage Basin</td></tr>
<tr><td>Partial + Retarding Basin</td><td>Cost due to increment of discharge to be regulated [*1]</td></tr>
<tr><td>Partial + Diversion</td><td>Cost due to increment of discharge to be diverted.</td></tr>
</table>

Note *1: The increment volume is 10% of base volume which corresponds to the regulating volume in alternatives with on-site regulating pond.

Costs associated to the construction of on-site regulating pond shall be shouldered by the private land development firm or the residents who purchased the subdivision lots. The said costs are summarized, as follows:

Table R 8.38 Costs to be shouldered for Construction of On-site Regulating Pond

Description	Amount (Php)	Remarks
Cost for one new subdivision	8,800,000	8 hectares/subdivision on average
Cost per 1.0m^2 of salable lot	157	8,800,000 / (8ha x 70%)
Cost per resident	15,700	100m^2/lot

(3) Optimum Combination of Diversion Channel and Retarding Basin (F_S.4 and F_S.5)

The costs of diversion channel and retarding basin are maximized based on the respective inflation rates due to their effective volumes or extents. Attached Fig. 8.35 shows the cost of a retarding basin alone (F_S.2), diversion channel alone (F_S.3) and the combination of both measures (F_S.4). The costs of combination of measures are calculated as summarized in Table R 8.39.

8.4.3 Results of Cost Estimation

(1) Construction Base Cost and Compensation Cost

The construction base costs of each alternative mitigation plan are summarized in the following tables, and calculated in detail in Table A.5.C attached in Appendix 5.

Table R 8.39 Summary of Construction Base Cost and Compensation Cost of Alternative Flood Mitigation Plans against River-Overflow Flood

No. of Alt.	Objective River	Construction Base Cost + Compensation Cost (mil. Php)*1			
		2-year return Period	5-year return Period	10-year return Period	20-year return Period
F_I.1	Imus River	3158 + 573 + 157 (3889)	3412 + 671 +157 (4240)	3717 + 849 + 177 (4743)	3777 + 958 + 200 (4935)
F_I.2		1,521 + 729 + 157 (2406)	1590 + 791 +157 (2538)	1606 + 804 +177 (2587)	1676 + 868 +200 (2745)
F_I.3		1,090+ 400 + 2404 (3,894)	1528 + 675 + 2404 (4607)	1543 + 693 +2404 (4641)	1604+ 741 + 2404 (4749)
F_S.1	San Juan River	465 + 183 + 52 (700)	558 + 241 + 52 (851)	798 + 478 + 86 (1362)	1278 + 765 + 109 (2152)
F_S.2		549 +174 + 52 (775)	668 + 239 + 52 (959)	806 +352 + 86 (1244)	876 + 422 + 109 (1408)
F_S.3		432 + 173 + 52 (658)	553 +229 + 52 (833)	776 +328 + 86 (1189)	1193 + 520 + 109 (1822)
F_S.4		775 + 238 + 52 (1064)	891 + 316 + 52 (1259)	1029 + 400 + 86 (1515)	1216 + 518 + 109 (1843)
F_S.5		178 + 55 +1282 (1515)	455 + 223 + 1282 (1960) (D)*2	789 + 339 + 1282 (2410) (RB)*1	866 + 412 + 1282 (2560) (RB)*1

*1: Construction Base Cost + Compensation Cost + Collateral Cost for On-site Regulation Pond; Amount in parentheses is Total Cost but excluding engineering service cost, contingencies, administration cost and taxes.

(D)*2: As the least cost, F_S.3 with On-site Regulation Pond is adopted as F_S.5.

(RB)*1: As the least cost, F_S.2 with On-site Regulation Pond is adopted as F_S.5.

Table R 8.40 Summary of Construction Base Cost and Compensation Cost of Alternative Flood Mitigation Plans against Inland Flood

No. of Alt.	Construction Base Cost + Compensation Cost (mil. Php)*1	
	2-Year Return Period (Partial)	2-Year Return Period (Full)
D-1 without On-site	1691 + 479 + 55 (2225)	4074 + 603 + 55 (4732)
D-2 without On-site	1853 + 667 + 55 (2575)	4210 + 791 + 55 (5056)
D-1 with On-site	1520 + 444 + 321 (2285)	3875 +568 + 321 (4764)
D-2 with On-site	1676 + 632 + 321 (2629)	4039 + 756 + 321 (5116)

*1: Construction Base Cost + Compensation Cost + Collateral Cost for On-site Regulation Pond; Amount in parentheses is Total Cost but excluding engineering service cost, contingencies, administration cost and taxes.

(2) Summary of Project Cost and Disbursement Schedule

Project costs are estimated based on the construction base cost and compensation cost for the project evaluation. Some alternatives evaluated in terms of economical aspect are selected in the comparison of costs. The project costs of selected alternatives are summarized in Table R 8.41 below, and calculated in detail in attached Table 8.8 and 8.9 in accordance with the proposed implementation schedule described in Chapter 9. The detailed calculation results together with the disbursement schedule of each alternative are given in Table A.5.D and Table A.5.DE in Appendix 5.

Table R 8.41 Summary of Project Cost including Contingencies of Alternative Flood Mitigation Plans against River-Overflow Flood

No. of Alternative	Protected Scale	Objective	Project Cost (mil. P)	
			*1	*2
F_I.2	5-year return period	Imus River	3,208	4,049
	10-year return period		3,267	4,111
	20-year return period		3,458	4,323
F_I.3	5-year return period		2,815 (5,642)	3,566 (7,161)
	10-year return period		2,855 (5,682)	3,619 (7,212)
	20-year return period		2,990 (5,817)	3,870 (7,465)
F_S.2	5-year return period	San Juan River	1,232	1,613
	10-year return period		1,582	2,063
	20-year return period		1,779	2,417
F_S.3	5-year return period		1,064	1,390
	10-year return period		1,515	2,026
	20-year return period		2,319	3,063
F_S.5R	5-year return period		1,096 (2,604)	1,425 (3,342)
	10-year return period		1,444 (2,951)	1,863 (3,781)
	20-year return period		1,627 (3,134)	2,135 (4,052)
F_S.5D	5-year return period		862 (2,369)	1,114 (3,031)
	10-year return period		1,270 (2,778)	1,574 (3,491)
	20-year return period		1,934 (3,442)	2,505 (4,423)
D-1 without On-site	2-year return period	Partial Inland Drainage Area	2,896	3,883
	2-year return period	Full Inland Drainage Area	6,302	8,069
D-1 with On-site	2-year return period	Partial Inland Drainage Area	2,560 (2,938)	3,393 (3,873)
	2-year return period	Full Inland Drainage Area	5,927 (6,304)	7,868 (8,358)

Note *1: Project Cost excluding Price Contingency; Amount is parentheses include cost of on-site
*2: Project Cost including all items to be concerned; Amount is parentheses include cost of on-site

(3) Maintenance Cost

Maintenance cost varies with scale of facilities. Annual maintenance cost has been calculated based on the following assumptions. As a result, annual maintenance cost was almost equal to 0.9 % of the construction base cost.

Therefore, annual maintenance cost of each alternative mitigation plan is estimated on the basis of the rate involved in the construction base cost. The rate is assumed at 0.9% of construction base cost.

(a) River Improvement

- Dredging work shall be done in whole length of gentle slope section of improved river stretch within 10 years. Therefore, 10% of gentle slope section shall be dredged in a year.
- Repairing work for 50% of whole part of river improvement shall be done within 50 years. Therefore, 1% of whole river facility shall be repaired in a year.

(b) Off-Site Retarding Basin / Off-Site Retention Pond

- Assuming that 1% of whole area of off-site retarding basin/off-site retention pond would be inundated every year, this part shall be cleaned.
- Assuming that 10% of overflow weir of off-site retarding basin/off-site retention pond would be partially damaged in a year, this part shall be repaired.
- Repairing work for 30% of all outlet sluiceways shall be done within 30 years. Therefore, 1% of all outlet sluiceways shall be repaired in a year.

(c) Drainage Improvement / Tidal Gate / Flap Gate

- Dredging work shall be done in whole length of drainage facilities within 10 years. Therefore, 10% of drainage facilities shall be dredged in a year.
- Repairing work for 50% of whole part of drainage facilities shall be done within 50 years. Therefore, 1% of whole drainage facilities shall be repaired in a year.

- Repairing work for 30% of all tidal gates and flap gates shall be done within 30 years. Therefore, 1% of all tidal gates and flap gates shall be repaired in a year.

(d) Coastal Dike

- Cleaning and maintenance work of dike slope shall be done in whole section of earth dike within 10 years. Therefore, 10% of dike slope of earth dike shall be cleaned and simply maintained in a year.
- Repairing work for 50% of whole part of coastal dike shall be done within 50 years. Therefore, 1% of whole part of coastal dike shall be repaired in a year.

8.5 Economic Evaluation of Project

8.5.1 Methodology

In this kind of project, economic evaluation is made according to the following steps:

(1) Identify the most likely damage item.

(2) Estimate the basic unit value per unit and/or unit area (amount/unit, or amount/ha) for each damage item.

(3) Evaluate the damages of existing floods to be the basis of evaluation.

(4) Estimate the annual average flood damages by means of probability analysis for each return period under the "With-" and "Without-Project" concept.

(5) Identify the economic benefit as differences of damages in the "With-" and "Without-Project" conditions.

(6) Compare the economic benefit with the economic cost of project, and evaluate project feasibility by means of some indices such as the economic internal rate of return (EIRR), the net present value (B – C), and the B/C Ratio.

The Economic Internal Rate of Return (EIRR) is calculated using the cash flow of economic cost and economic benefit during the project life. This EIRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_t}{(1+R_e)^t} = \sum_{t=1}^{t=T} \frac{B_t}{(1+R_e)^t}$$

Where, T = the last year of the project life;
Ct = an annual economic cost flow of the project under study in year t;
Bt = annual benefit flow derived from the project in year t; and
Re = the EIRR (a discount rate to be used for costs resulting in the same amount of benefit in terms of present value).

When the resulting EIRR is of the same rate as or higher than the discount rate applied for the calculation of present value of both the benefit and cost, the project has the feasibility for execution.

Generally, the economic cost of a project is defined as opportunity cost of capital. In this case, if goods and services would be invested in the project under study, they could no longer be utilized for other projects. This implies that the benefits the other projects could have created would be sacrificed. These sacrificed benefits of the other projects are called opportunity cost of the project. The applied discount rate is generally considered as the same rate of the said opportunity cost of capital. Therefore, in a case that the resulting EIRR is higher than the applied discount rate[1], it means that the economic reliability of the project is higher than the rate of opportunity cost of capital as the sacrificed benefit of the other project.

[1] The World Bank says that "the discount rate reflects the rate of fall of the value of consumption over time. (William

The NPV is expressed as “B-C” and defined by the following formula:

$$NPV = B - C = \sum_{t=1}^{t=T} \frac{B_t}{(1+R_e)^t} - \sum_{t=1}^{t=T} \frac{C_t}{(1+R_e)^t}$$

If “B-C” (subtract present value of cost from present value of the benefit) would become positive, it means that the project under the Study will have a reliability to execute.

The B/C Ratio is defined by the following formula:

$$B/C = \sum_{t=1}^{t=T} \frac{B_t}{(1+R_e)^t} \Bigg/ \sum_{t=1}^{t=T} \frac{C_t}{(1+R_e)^t}$$

It means that, if the rate of the present value of the benefit divided by the present value of the cost would become more than “1.00”, then the project under study will have a reliability to execute.

Project life is assumed at 50 years after completion of river channel improvement works and 30 years after completion of inland drainage works for the Project. Cash flow of the economic cost and economic benefit should be made from the first year of the construction works to the end of each project life.

In this case, annual operation and maintenance cost (O&M Cost) should be taken into account, and some amount of replacement cost, if any, should also be taken into consideration since some parts of the initial works for the facilities may not be durable during the project life.

8.5.2 Estimation of Damages Caused by Current Flood

(1) Damages to Buildings, Household Effects, Durable Assets and Inventory Stocks in Built-Up Area

First of all, the number of inundated buildings due to the 2006 flood is counted by the GIS method according to the type of building, i.e., (1) Residential/Housing units; (2) Manufacturing; (3) Wholesale and Retail Trade (Shops); (4) Hotels and Restaurants; (5) Real Estate and Business Activities (Offices); (6) Education Facilities; and (7) Buildings for Health and Social Works, because property values vary according to the type of building. In this case, the share rate of each type of building to the total number of buildings is assumed based on similar projects in the Philippines[2] modified by the field investigation in the Study.

The following table shows the share rates of each type of building per unit area:

A. Ward and Barry J. Deren, Ed. “***The Economics of Project Analysis -A Practitioner's Guide-***” IBRD Technical Paper).

Regarding the EIRR, the Asian Development Bank (the ADB) states that “the projects have viability when the resulted EIRR exceeds the Opportunity Cost of Capital (the OCC). In almost the developing countries, the most likely EIRR is ranging from 8 % to 12 %. Therefore, there will be no any issues if the resulted EIRR exceeds the 12 % to execute the projects, but if the resulted EIRR is less than the rate of 12 %, it is required some specified explanation concerning the benefits that could not be converted into monetary terms.” (“Occasional Papers -Economic and Financial Appraisal of Bank Assisted Project” ADB Appraisal Paper No.11, January 1978).

Also regarding the EIRR, the World Bank states that “if the OCC (in other words, “the EIRR”) is resulted at 5% except the non-commercial projects, it is too low. But if it resulted at 20%, it is too much. Usually, the World Bank adopts the rate of 10%.” (Warren C. Baum and Stokes M. Tolubert, Ed. “Investing in Development -Lessons of World Bank Experiences-” IBRD, June 1985).

Anyway, unless the amount of cost and benefit are not changed in the same project, a certain EIRR will always result even if no discount rate is applied. In other words, the EIRR has a meaning to avoid arbitrariness of the B/C ratio.

In this connection, 15% of EIRR is required for the projects in the Philippines, if the project is to be adopted for implementation.

2 Pasig-Marikina River Channel Improvement Project, 2001, JICA.

Table R 8.42 Share Rate of Buildings by Type

Kind of Building	Share Rate
Total	100.00%
1. Housing Units	92.27%
2. Manufacturing	0.03%
3. Wholesale & Retail Trade	0.95%
4. Hotels & Restaurants	5.42%
5. Real Estate & Offices	1.02%
6. Education Facilities	0.12%
7. Health/Medical Facilities	0.19%

Source: "Socio-Economic Profile 2006, Province of Cavite" as modified by the field investigation in the Study

On the other hand, the following table shows the results of counting according to the depth of inundation caused by the 2006 flood (locally called as "Typhoon Milenyo") by means of GIS Database under the 2003 land-use status with 26% of built-up ratio:

Table R 8.43 Number of Buildings Inundated by the 2006 Flood

Type of Building	Less than 0.5 m	0.5~0.99 m	1.0~1.99 m	2.0~2.99 m	More than 3.0 m	Total
Residential Unit	32,498	12,361	4,301	163	58	49,380
Manufacturing	291	111	38	1	1	442
Wholesale and Retail Trade (Shops)	1,370	521	181	7	2	2,082
Hotels and Restaurants	256	98	34	1	0	390
Reral Estate and Business Activities (Offices)	206	78	27	1	0	312
Education Facilities	33	13	4	0	0	50
Buildings for Health and Social Works	137	52	18	1	0	208
Total	34,791	13,233	4,605	174	62	52,865

As basic units for the estimation of damages, the figures shown in the following table are to be applied. These figures are based on the said similar projects in the Philippines modified by results of site investigation and interview with the officials concerned in the flood affected municipalities in Cavite.

Table R 8.44 Economic Basic Units for the Estimation of Flood Damage

(Unit: Pesos/unit)

Assets	Building (Pesos/ unit)	Durable Assets (Pesos/unit)	H. Effects/ Inv. Stock (Pesos/unit)	Value Added*1 (Pesos/day)	Damageable Value (Pesos/ha)	Daily Amount*2 (Pesos/day)
1. Residence						
a. Residential Unit	370,383		248,807			693
2. Industrial, Educational and Medical Facilities						
a. Manufacturing	3,914,337	13,433,664	16,357,154	77,829		
b. Wholesale & Retail Trade	186,397	454,547	5,549,398	15,075		
c. Hotels & Restaurants	4,372,154	2,649	336,823	11,642		
d. Real Estate & Business Activities	5,336,840	3,630	2,841,737	57,554		
e. Education	40,222,509	9,653,402	1,206,675	0		
f. Health & Social Work	24,937,956	6,435,601	3,754,101	0		
3. Crop Production						
a. Irrigated Farm Land (ha)					36,648	
b. Rain-fed Paddy Field (ha)					12,569	
c. Rain-fed Corn Field (ha)					2,646	

Note: *1 VA is calculated based on not actual business days of 250 days but 365 calendar days.

*2 In residence, the daily amount for cleaning damaged house is equivalent to daily income of an average family because they should stop working for cleaning.

Furthermore, the following table shows the damage rates for the estimation of damages according to inundation depth. In this case, inundation duration is already taken into consideration assuming it to be 2 days on average for agricultural crops.

Table R 8.45 Damage Rate by Inundation Depth

Item		Inundation Depth					
		Below Floor/Ground Level	Over Floor/Ground Level				
			Less than 0.5m	0.5-0.9m	1.0-1.9m	2.0-2.9m	More than 3.0m
1	Building						
a	Building*[1]	0.000	0.092	0.119	0.266	0.380	0.834
2	Residence						
a.	Household Effects	0.000	0.145	0.326	0.508	0.928	0.991
3	Industrial, Educational and Medical Facilities						
a.	Depreciable Assets	-	0.232	0.453	0.789	0.966	0.995
b.	Inventory Stock	-	0.128	0.267	0.586	0.897	0.982
4	Crop Production *[2]						
a.	Lowland Crop	-	0.210	0.240	0.370	0.370	0.370
b.	Upland Crop	-	0.200	0.310	0.440	0.440	0.440

Note: *1 In case of all buildings, floor level is 15cm higher than the ground level, because t almost all buildings have the threshold of around 15cm in height in front of their entrances according to the field investigation.
*2 Assuming that inundation duration is 2 days on average.

The attached Table 8.10 shows the result of damages estimated on the basis of the said basic data on buildings and their household effects, durable assets and inventory stocks due to the 2006 Flood. Damages amounted to 7,013 million pesos in total.

(2) Income Losses due to Cleaning of Building and/or Houses and Business Suspension

Once flood occurs and houses are inundated, several days will be needed for cleaning the houses. In case of business activities, they should be suspended for several days. During these days, people's income is decreased because they stop working or businesses are suspended.

Average daily income per household (HH) is estimated at 693 pesos/day as of 2007 (estimated based on CPI) in Region IV-A (CALABARZON Region) according to the "Philippine Yearbook 2006" and as shown in Table R 8.44 above together with the average daily amount of value-added tax for business activities. The average number of days needed for cleaning and business suspension are estimated, as shown in the following table.

Table R 8.46 Estimated Days for Cleaning and Business Suspension by Inundation Depth

Item		Inundation Depth					
		Below Floor Level	Above Floor Level				
			Less than 0.5m	0.5-0.99m	1.0-1.99m	2.0-2.99m	More than 3.0m
1.	Residence						
	Cleaning (days)	-	7.5	13.3	26.1	42.4	50.1
2.	Business Facilities						
	Suspension of Business (days)	-	4.4	6.3	10.3	16.8	22.6
	Stagnant Days of Business after Suspension*[1]		2.2	3.2	5.2	8.4	11.3
	Total		6.6	9.5	15.5	25.2	33.9

Note: *1 Businesses shall be suspended during the stagnant days.

The following table shows the result of estimation of losses:

Table R 8.47 Income Losses due to Cleaning of Buildings and Business Suspension

(million Pesos)

River Basin	Residence	Stoppage of Business and Stagnant Days of Business	Total
A. Imus River Basin	172	271	443
B. San-Juan - Ylang-Ylang River Basins	99	160	259
C. Canas River Basin	13	19	32
Total	284	449	734

(3) Damage to Social Infrastructures (Roads, Bridges, Drainage Ditches)

Once flood occurs, social infrastructures such as roads, bridges, drainages sustain heavy damages. In this case, the Municipal Social Welfare and Development Offices (MSWDO) in each municipality report the situation and request the Provincial Social Welfare and Development Office (PSWDO) for "post-disaster reconstruction." The following table shows the total amount for such post-disaster reconstruction. This is the other kind of damage to be checked.

Table R 8.48 Damage to Social Infrastructures

(million Pesos)

	According to Provincial Report on Disaster* as of 2006	Converted into 2007 Price
Post Disaster Reconstruction	44	45

* "Summary of Cost of Damages Brought About by Typhoon Milenyo, Province of Cavite," Provincial Social Welfare and Development Office, Oct. 2006.

(4) Losses due to Interruption of Transport Service and/or Detour Losses

According to the JICA CALA Report[3], traffic volume and 24hour-persons in Cavite Province were surveyed, as shown in the attached Table 8.11 attached.

In case of interruption of transportation because of flooded roads, losses due to detours may influence the whole Cavite Province. The losses due to interruption of transportation are estimated based on all the traffic volumes and 24 hour-persons shown in the Table 8.11 attached.

Losses of time-cost of cars, stock losses of goods and supplies for transportation, and income losses of 24hour-persons differ according to the occupancy of cars. The following table gives the summary of share rates of occupancy of cars surveyed in the National Center of Transportation Study (NCTS) of the University of the Philippines[4] in 1996 in and around Manila.

Table R 8.49 Share Rates of Car-Occupancy

Government Officials	Professionals	Technicians	Clerical Workers	Services Workers	Total
36.33%	34.24%	7.03%	7.31%	15.08%	100.00%

Based on the above, Losses of Interruption of Transport Service and/or Detour Losses together with the income losses are estimated by total traffic volume and total 24hour-persons as multipliers and congestion cost of cars and updated income level per hour-person surveyed by the said NCTS by car-occupancy as basic unit of economic benefit and multiplied by duration of inundation (days). The following table gives a summary of the estimation results.

3 The Feasibility Study and Implementation Support on the Cavite-Laguna (CALA) East-West National Road Project, JICA, 2006.

4 The National Center of Transportation Study (NCTS) of the University of the Philippines.

Table R 8.50 Basic Unit of Losses due to Interruption/Detour of Transport and Income Losses of Workers per Day

(As of 2007)

Occupation Group	Congestion Cost				Income Loss		
	Average Delay*	Average Congestion Cost per Day* (Pesos)	Total Number of Trips per Day**	Total Time Cost by Occupation Group (Pesos/Day)	Average Hourly Income* (Pesos)	Estimated 24 Hours-Workers	Total Amount of 24-hours Income Loss (Pesos/day)
Government Officials	0.63	52.75	150,304	7,928,499	168.32	746,834	125,707,979
Professionals	0.69	116.70	64,032	7,472,730	336.64	318,164	107,107,426
Technicians	0.73	41.04	37,405	1,535,230	112.21	185,858	20,855,933
Clerical Workers	0.72	32.10	49,727	1,596,351	89.77	247,085	22,181,113
Services Workers	0.61	34.20	96,221	3,291,040	112.21	478,105	53,650,113
Total			397,690	21,823,851		1,976,046	329,502,564

Note: * Estimated based on study results of National Center of Transportation Study of the University of Philippines (UP-NCTS).
** Based on JICA CALA Report (refer to attached Table 8.11).

As a result of interview survey with the officials concerned, the interruption of traffic ranges from a few hours to 3 days in maximum. Based on this, it is assumed that spatial average duration of interruption of traffic was 1.5 days in the 2006 Flood. Losses due to interruption of traffic and detours amounted to 33 million pesos and income losses of 24 hour-persons was 494 million pesos, as indicated in the following table.

Table R 8.51 Estimated Losses due to Interruption of Traffic and Detours and Income Losses of 24 Hour-Persons caused by the 2006 Flood

(million Pesos)

Losses due to Interruption of Traffic	Income Losses of 24 Hour-Persons
33	494

(5) Damage to Industrial Estates

There are several industrial estates in Cavite Province. Damages due to floods also extend over these industrial areas. The damages are estimated as the statistical decrease in “value added” corporate income and the amount of value-added income which is estimated for small-scale and micro-scale industries in the built-up areas. The following table gives a summary of the basic unit for estimation of damages. In this case, the industrial area is estimated by means of GIS.

Table R 8.52 Basic Unit for the Estimation of Damages to Industrial Estates

Unit Value Added of All Commercial Sectors in Built-Up Area (Pesos/ha./day)	Unit Value Added in Large-Scale Industries in Industrial Estate (Pesos/ha./day)
12,042 Pesos/ha./day (*1)	7,347,319 Pesos/ha./day (*2)

Remarks: (*1) [Unit value added of all commercial sectors in built-up area]
= [162,100 (*3) Pesos/day/unit (total of “value added” of all commercial sectors, 2.a~d in Table R 8.44)]
x [0.0743 unit/ha (total number of unit of all commercial sectors per area, b~e in Table R 8.42)]

(*2) [Unit value added in large-scale industries in industrial estate]
= [12,042 Pesos/ha./day (Unit value added of all commercial sectors in built-up area)]
x [610 = (value added of industries in industrial estate) / (value added of small/micro scale industries in built-up area)]

Note: Inundation Area in Industrial Estate by river basin:

Imus	8.5	ha
San Juan – Ylang-Ylang	12.9	ha
Canas	4.8	ha
Total	26.2	ha

Source: (*3) "Philippine Yearbook 2006".

The following table gives a summary of the estimation of damages to industrial estates caused by the 2006 Flood.

Table R 8.53 Damage to Industrial Estates caused by the 2006-Flood

(million Pesos)

River Basin	Amount of Damages
1. Imus River Basin	269
2. San-Juan - Ylang-Ylang River Basins	2,041
3. Canas River Basin	624
Total	2,934

As indicated in the table above, the damage to industrial estates due to the 2006 Flood amounted to 2,934 million pesos.

(6) Damage to Agricultural Crops

It is assumed that the damaged agricultural crops in irrigated areas are mainly “palay” (paddy or rice) based on statistical records and the results of field investigation, while the damaged upland crops are mainly corn.

Fig. 8.36 shows the cropping pattern of palay for 2nd crop according to information from the National Irrigation Administration (NIA).

Farm gate prices of palay and corn are already mentioned in Table R 8.44 as 36,648 pesos/ha and 2,646 pesos/ha respectively, and their damage rates are already indicated according to inundation depth in Table R 8.45.

The following table gives a summary of the damages estimated for agricultural crops caused by the 2006 Flood.

Table R 8.54 Damages to Agricultural Crops Caused by 2006-Flood

(million Pesos)

River Basin	Damages to Palay	Damages to Upland Crops	Total
1. Imus River Basin	3	0	3
2. San-Juan - Ylang-Ylang River Basins	5	0	6
3. Canas River Basin	0	0	0
Total	9	0	9

(7) Saving of Expenses for the Support of Evacuees

When floods occur, some houses are washed out and inundated as mentioned above. In these cases, many people evacuate to designated evacuation centers and/or evacuation places such as open spaces, schools, and/or some buildings like the barangay and municipal halls.

When evacuation is made, a large amount is needed to support the evacuated people including expenses for the distribution of goods and materials such as food, water, medicines, tents, blankets, dishes, etc, and also expenses for wages/salaries of relief workers together with traffic/transportation cost. Telecommunication cost is also needed to pay out communication between the evacuation sites and headquarters of evacuation activities. For preparation of evacuation sites, some expenses are also inevitable.

According to information from officials of the municipalities concerned, every municipalities have a budget called “Calamity Fund” ranging from 2% to 10% of their municipal budgets (2,000,000 to 4,000,000 pesos), which may not be enough to support all evacuees. Volunteers may then be requested to assist without any remuneration, but these volunteers need to suspend their work so that their income is sacrificed during the period of their activities.

In case no floods occur, no amount is spent and the income of volunteers does not need to be sacrificed. From this point of view, the expenses for supporting evacuees are to be a kind of damages caused by floods.

The following table gives a summary of the evacuation situation during the 2006 flood.

Table R 8.55 Evacuation Situation during the 2006 Flood

Municipalities Affected by 2006-Flood Subject of Measures by the Project under Study	Number of Affected Families	Number of Affected Persons	Evacuation Situation Just after Flood Occurred		
			Number of Evacuation Centers and/or Barangay Halls	Number of Evacuated Families	Number of Evacuated Persons
Bacoor	96,864	484,325	17	6,752	33,760
Kawit	4,374	21,872	6	105	527
Noveleta	4,543	22,536	16	531	2,124
Rosario	5,604	22,416	15	1,050	4,200
Gen. Trias*	3,750	18,750	1	90	452
Imus	7,579	30,316	1	52	205
Total	122,714	600,215	56	8,580	41,268

Note: * Number of evacuated families and persons are estimated based on the data in other Municipalities because of lack of data

Source: "Summary on Cost of Damages Brought About by Typhoon Milenyo," Provincial Social Welfare and Development Office (PSWDO), Province of Cavite, October 2006, and the interview of officials in each municipality concerned.

The following table shows the results of estimation of amounts saved from the budget for the support of evacuees, including wages/salaries during the 2006 Flood.

Table R 8.56 Estimated Savings from the Budget for the Support of Evacuees during the 2006 Flood

(Pesos)

Number of Evacuated Persons	Expenses for Food Support	Expenses for Emergency Shelter Assistance	Expenses for Traffic/ Transportation, etc.	Amount of Wages/Salaries to Be Saved Due to Execution of Flood Mitigation Measures incl. Official Staff	Total
41,268	17,332,466	31,651,959	17,682,659	1,444,372	68,152,724

Note:

Amount of expenses for food support:	20	pesos/meal/person
Duration of Evacuation:	1	week
Share rate of emergency shelter assistance:	47.48%	According to information from
Share rate of support foods:	26.00%	official staffs of MSWDO.
Share rate of traffic/transportation, etc:	26.52%	Excl. wages/salaries to be saved.
Number of Necessary Volunteers for Evacuation:	1	person/100 evacuees
Average wages/salaries per volunteer:	500	pesos/day

Actually, almost all residents including the public officials failed to perceive the above amounts except the cash payments as expenses during the disaster so that the amount reported was only 21.6 million pesos. However, the actual amount of expenses for supporting the evacuees was 68 million pesos as shown in the table above. This 68 million pesos may be considered as the amount to have been saved in the 2006-Flood if the proposed flood mitigation measures have already been installed.

(8) Total Damages Caused by 2006-Flood

The following table shows a summary of the total damage caused by the 2006-Flood on each damage item based on the damages mentioned above, together with the proportion of indirect damages to the direct damages.

Table R 8.57 Summary of Total Damages Caused 2006-Flood

(million Pesos)

Direct Damage Items	Damage	Indirect Damage Items	Damage
Damage to Buildings together with HH Effects, Durable Assets and Inventory Goods	7,013	Income Losses due to Cleaning of Buildings and Business Suspension	734
Damage to Industrial Estate	2,934	Damages to Social Infrastructures (Roads, Bridges, Drainage Ditches)	45
Damage to Agricultural Crops	9	Losses due to Interruption of Transport Service and/or Detour Losses	494
Sub-Total	9,956	Savings on Expenses for Supporting Evacuees	68
		Sub-Total	1,341
Total of Direct and Indirect Damages			11,297
Note: 1. Proportion of indirect damages in total against direct damages:			13.47%
2. Proportion of indirect damages excluding Income Losses Due to Cleaning of Buildings and of Business Suspension against direct damages:			6.10%

In the above table, Note 1 is the proportion of total indirect damages to the total direct damages. However, among them, "Income Losses Due to Cleaning of Buildings and Business Suspension" can be estimated by means of GIS database. Therefore, in the process of estimation of "annual average expected damages to be mitigated," 6.10% is to be applied to estimate the indirect damages other than the above indirect damages.

8.5.3 Identification of Economic Benefit

For the comparison of cost and benefit, the "annual average expected damage to be mitigated" has to be estimated. For this purpose, annual average damages "with-project" and "without-project" should be estimated and the target year is set at the year 2020.

In this connection, therefore, the said annual average damage is estimated in both cases of "2003 Land Use Status" (hereinafter referred to as "Present Land Use Status") and "2020 Land Use Status" (hereinafter referred to as "Future Land Use Status") in: (1) each river basin per measure against the mitigation of flood damage in case of 5-Year Flood, 10-Year Flood and 20-Year Flood for river improvement works; and (2) the works in full-scale and partial improvement cases of inland drainage improvement works for the mitigation of inland flood damage by a 2-Year Flood.

The economic benefit is given as the difference between annual average damages in cases of "with-project" and "without-project," i.e., the economic benefit is to be the value of "average expected damage to be mitigated."

Necessary cases needed to estimate the annual average damages are summarized below as a precaution:

Measures	For mitigation of flood damages in case of:	Remarks
(1) River Improvement		
1. Imus River	5-Year flood 10-Year flood 20-Year flood	Annual average flood damages to be estimated for the case of (1) Present Land Use Status, and (2) Future Land Use Status in each measure.
2. San Juan & Ylang-Ylang Rivers 2 cases each of "Diversion Plan" and "Retarding Basin Plan"	5-Year flood 10-Year flood 20-Year flood	
(2) Inland Drainage Improvement		
Full Scale Case	2-Year flood	Under Present and Future status as the same with the river improvement.
Partial Improvement Case	2-Year flood	

(1) River Improvement Works

<u>Economic Benefit Due to Execution of Imus River Channel Improvement</u>

Total damage at each scale of flood in the Imus river basin is estimated on the basis of the GIS data (see Table 8.12 attached), probability of floods and land use status.

Then, the annual damage caused by each scale of flood and the annual damage to be mitigated by the river channel improvement at each scale of flood are estimated as shown in Table 8.13 attached.

The following table gives a summary of the results of estimation for annual average expected damages to be mitigated due to execution of measures in each flood scale.

Table R 8.58 Annual Average Mitigated Damage to be Expected
by Imus River Channel Improvement

(million Pesos)

Flood Damage Mitigation Measures	Present Land Use Status	Future land Use Status
Measures for 5-Year Flood	874	2,696
Measures for 10-Year Flood	1,145	3,423
Measures for 20-Year Flood	1,305	3,808

If the project is executed, these figures will be the economic benefit in each project scale corresponding to flood return period.

In the future, namely in 2020, the land use status will have drastically changed as clarified by the Study, and urbanization will have greatly increased. In case none of the measures for the mitigation of flood damage as indicated in the above table has been executed, flood damage will greatly exceed the damage under the present land use status. In this connection, the flood control measures should be executed to keep with the changes under the future land use status

<u>Economic Benefit due to Execution of San Juan and Ylang-Ylang River Channel Improvement</u>

The total damage by return period in the San-Juan and Ylang-Ylang river basins was estimated by the GIS database, as shown in the attached Table 8.14 and Table 8.16, according to the probability of floods and the land use status. Then, the annual average damages under each probability of flood and the annual average mitigated damages to be expected were estimated according to the river channel improvement measure in each flood probability as shown in Table 8.15 and Table 8.17 attached.

The following table gives a summary of results of estimation for the annual average expected damages to be mitigated due to the execution of measures in each flood scale.

Table R 8.59 Annual Average Mitigated Damages to Be Expected
by San-Juan and Ylang-Ylang Rivers Channel Improvement

(million Pesos)

Flood Damage Mitigation Measures	Present Land Use Status		Future land Use Status	
	Diversion Plan	Retarding Basin Plan	Diversion Plan	Retarding Basin Plan
Measures for 5-Year Flood	96	96	225	225
Measures for 10-Year Flood	175	175	364	364
Measures for 20-Year Flood	238	238	479	479

If the project is executed, these figures will be the economic benefit in each project scale corresponding to the flood return period.

In the future, namely in 2020, the land use status will have drastically changed as clarified by the Study, and urbanization will have greatly increased. In case none of the measures for the mitigation of flood damage as indicated in the above table has been executed, flood damage will greatly exceed the damage under the present land use status by a little more than 2 times.

In this connection, the flood control measures should be executed to keep with the changes under the future land use status.

(2) Inland Drainage Improvement Works

Total damage by the 2-year return period flood due to mal-function of inland drainage systems are estimated by GIS database as shown in attached Table 8.18 and by land use status. Then, the annual average damage by the 2-year flood and the annual average mitigated damages to be expected were estimated as shown in Table 8.19 attached.

The following table gives a summary of results of estimation for the annual average expected damages to be mitigated due to the execution of measures corresponding to each flood scale.

Table R 8.60 Annual Average Mitigated Damages to be Expected from Inland Drainage Improvement

(million Pesos)

Flood Damage Mitigation Measures	Full Scale		Partial Scale	
	Present Land Use Status	Future Land Use Status	Present Land Use Status	Future Land Use Status
Measures for 2-Year Flood	221	417	140	261

If the project is executed, these figures will be the economic benefit. In the future, namely in 2020, the land use status will have drastically changed as clarified by the Study, and urbanization will have greatly increased. In case none of the measures for the mitigation of flood damage as indicated in the above table has been executed, flood damage will greatly exceed the damage under the present land use status by slightly less than 2 times. In this connection, the flood control measures should be executed to keep with the changes under the future land use status.

(3) Economic Benefit due to Construction of On-Site Flood Regulation Pond

The term “On-Site Flood Regulation Pond” has already been defined in the preceding chapter together with its function and status. Anyway, a great benefit is expected to be derived due to the construction of the said On-Site Flood Regulation Pond. The other economic benefit due to the On-Site Flood Regulation Pond is estimated as described below. The economic benefit due to the On-Site Flood Regulation Pond also depends on the return periods of flood.

The two tables attached, namely, attached Table 8.20 and Table 8.21, show the estimation process for the annual average of expected flood damages to be mitigated due to the construction of the On-Site Flood Regulation Pond.

On-Site Flood Regulation Ponds have expanded widely all over Cavite Province and the trend may continue in the future. Therefore, the indicated annual average mitigated damage to be expected (namely, the economic benefit) has to be distributed to each flood control measure. Under this concept, it is assumed that the said benefit is to be distributed based on the proportion of each cost of work

The following table shows the distribution results.

Table R 8.61 Total Annual Average Mitigated Damages to be Expected in and their Distribution due to On-Site Flood Regulation Pond in Each Flood Control Measure

(million Pesos)

Return Period	Annual Average Mitigated Damages to Be Expected in Total (Economic Benefit)	Allocation		
		Imus River Basin	**San Juan River** Basin	**Inland Drainage** Improvement
		60.00%	32.00%	8.00%
2-year	288	-	-	23
5-year	728	437	233	-
10-year	898	539	287	-
20-year	967	580	310	-

8.5.4 Estimation of Economic Cost

(1) Standard Conversion Factor (SCF)

The Standard Conversion Factor (SCF) has been estimated as 0.97166 based on the international trade statistics, as shown in the table below.

Here, SCF is calculated by the following formula.

$$SCF = \frac{\sum I + \sum E}{(\sum I + \sum I_{customs}) + (\sum E - \sum E_{tax} + \sum E_{subsidy})}$$

Where,

SCF	=	Standard Conversion Factor
I	=	Import Amount
E	=	Export Amount
$I_{customs}$	=	Import Duties (Custom Duties)
E_{tax}	=	Export Tax
$E_{subsidy}$	=	Export Subsidy

The following table shows the calculation of the Standard Conversion Factor (SCF).

Table R 8.62 Calculation of Standard Conversion Factor

(million Pesos)

Year	Export in Mil Pesos	Import in Mil Pesos	Import Duties (Customs Duties)	Export Tax	Export Subsidies
2002	1,803,362	2,045,007	96,835	0	0
2003	1,948,514	2,214,951	100,694	0	0
2004	2,215,363	2,501,868	122,715	0	0
2005	2,255,393	2,637,873	151,474	0	0
2006	2,414,597	2,680,841	190,797	0	0
Total	10,637,231	12,080,540	662,515	0	0
				SCF =	0.97166

(2) Personal Income Tax

Usually, project cost consists of cost for equipment and materials, and cost for manpower as personnel expenses and labor cost. For the cost of manpower, personal income tax is one of the transfer items. Therefore, the amount of personal income tax should be deducted from the project cost. Of course, personal income tax may consist of several levels in percentage. In this Project, the rate of 5% is applied for labor and 12% for consulting (engineering) services as the minimum rates according to the Tax Code of the Philippines[5]..

(3) Shadow Wage Rate

Based on similar projects in the Philippines, the shadow wage rate of 0.60 is applied to unskilled labor employed for the Project.

(4) Shadow Price of Land

Also based on the said similar project in the Philippines, the rate of 0.50 is applied as the conversion factor for making clear the shadow price of land needed to be acquired for the Project.

[5] “Republic Act No. 8424 or the Tax Reform Act of 1997” otherwise known as the “National Internal Revenue Code of the Philippines”

(5) Taxes

All kinds of taxes are transfer items. Therefore, the taxes, if any, should be deducted from the financial cost for the conversion into economic cost.

In the Project, the value-added-tax (VAT) of 12% is applied according to the said Tax Code of the Philippines.

(6) Corporate Profit Tax

In the Philippines, the net profit of corporations as contractors is estimated as 10% to 20% or more of the contract price. In this Project, the net profit is assumed at 15% as the reasonable level.

Corporate income tax is levied against the said net profit, and this corporate income tax is also one of the transfer items. Therefore, this tax should be deducted from the financial cost of the Project. There should be several levels of rates of the corporate income tax, but for the Project, 32% is applied based on the said Tax Code of the Philippines.

(7) Economic Cost

Under the conditions and assumptions, the economic cost is converted from the financial cost, as shown in the attached Table 8.22. Details of the Financial Cost are as described in the preceding subsection.

8.5.5 Results of Economic Evaluation for the Project and Conclusion

The economic evaluation for the Project has been made by using a cash stream as indicated in Appendix-5 taking certain conditions and assumption into account. In this case, project life is set at 50 years after completion of the works for river channel improvement, and 30 years for inland drainage improvement. The attached Table 8.23 gives a summary of the results of economic evaluation.

As indicated in the above-said table, the Imus River Flood Control Project and the San Juan and Ylang-Ylang River Flood Control Project are viable for execution without any problem based on the Economic Internal Rate of Return (EIRR), except for three measures i.e., the cases of San Juan and Ylang-Ylang River Flood Control Project; namely, the “5-Year Flood” in the River Channel Diversion Plan (EIRR: 14.15 %) and the “20-Year Flood” both in the River Channel Diversion Plan and the Retarding Basin Plan which were based on only the regulations in the Philippines of EIRR 14.47% and 14.74% respectively. Nevertheless, those cases also have the viability for execution according to recommendations of the Asian Development Bank (ADB) and the World Bank (WB) as mentioned in Subsection 8.5.1 above (refer to Footnote No. 1).

The World Bank recommends that, even in the case of public works based on basic human needs, the EIRR should at least be higher than 5% in developing countries. From this viewpoint of basic human needs, the resulting EIRRs in both the cases of “With Inland Drainage Improvement Project” and “With On-Site Flood Regulation Pond” are slightly higher at 5.43% and 5.16% even in the full-scale case, and the resulting EIRRs in the partial scale cases of “With” and “Without On-Site Flood Regulation Pond” are also much higher at 8.13% and 7.98%. Therefore, the “Inland Drainage Improvement Project” in all the cases has viability on the basis of the said basic human needs.

In the Study, the economic evaluation for cases consisting of combinations of optimum work components has also been made on the cases of: (1) Imus River Channel Improvement against a 10-Year Flood with On-Site Flood Regulation Pond; (2) San Juan and Ylang-Ylang River Channel Improvement against a 10-Year Flood in case of the Retarding Basin Plan; and (3) Partial Inland Drainage Improvement against a 2-Year Flood with On-Site Flood Regulation Pond.

The “Optimum Flood Mitigation Plan” is as described in Chapter 11 of this report. The evaluation process is shown in the attached Table 8.24. The following table shows the results of the economic evaluation.

Table R 8.63 Evaluation Results on the Combination of Optimum Flood Mitigation Plans in Case of "With On-Site Flood Regulation Pond"

Indices	
NPV	12,193
EIRR	22.19%
B/C	3.53

As indicated in the table above, the project proposed in this master plan study has a high viability for execution