8. Hydrodynamic Modeling of Drainage Pipe System

The existing drainage pipe system in Ho Chi Minh City is large and complex networks. Furthermore the outlets of the drainage pipe system are affected by the tidal time varying water levels.

Thus, for consideration of the drainage pipe network and the hydraulic condition at the outlet, MOUSE, developed by Danish Hydraulic Institute (DHI), can be applied to modeling

(1) Modeling for the Drainage Areas in the Study Area

At the Master Plan stage, there are 3 main purposes for the modeling activity.

1) Construct the main drainage pipe network database
2) Assess the flow capacity of the main drainage pipes
3) Calibration against records of inundated areas during the 1994 flood

Consequently, the modeling shall be concentrated on the main drainage pipes having an equivalent or a larger area of cross-section than that of ϕ 600 mm pipe.

a) Boundary Conditions

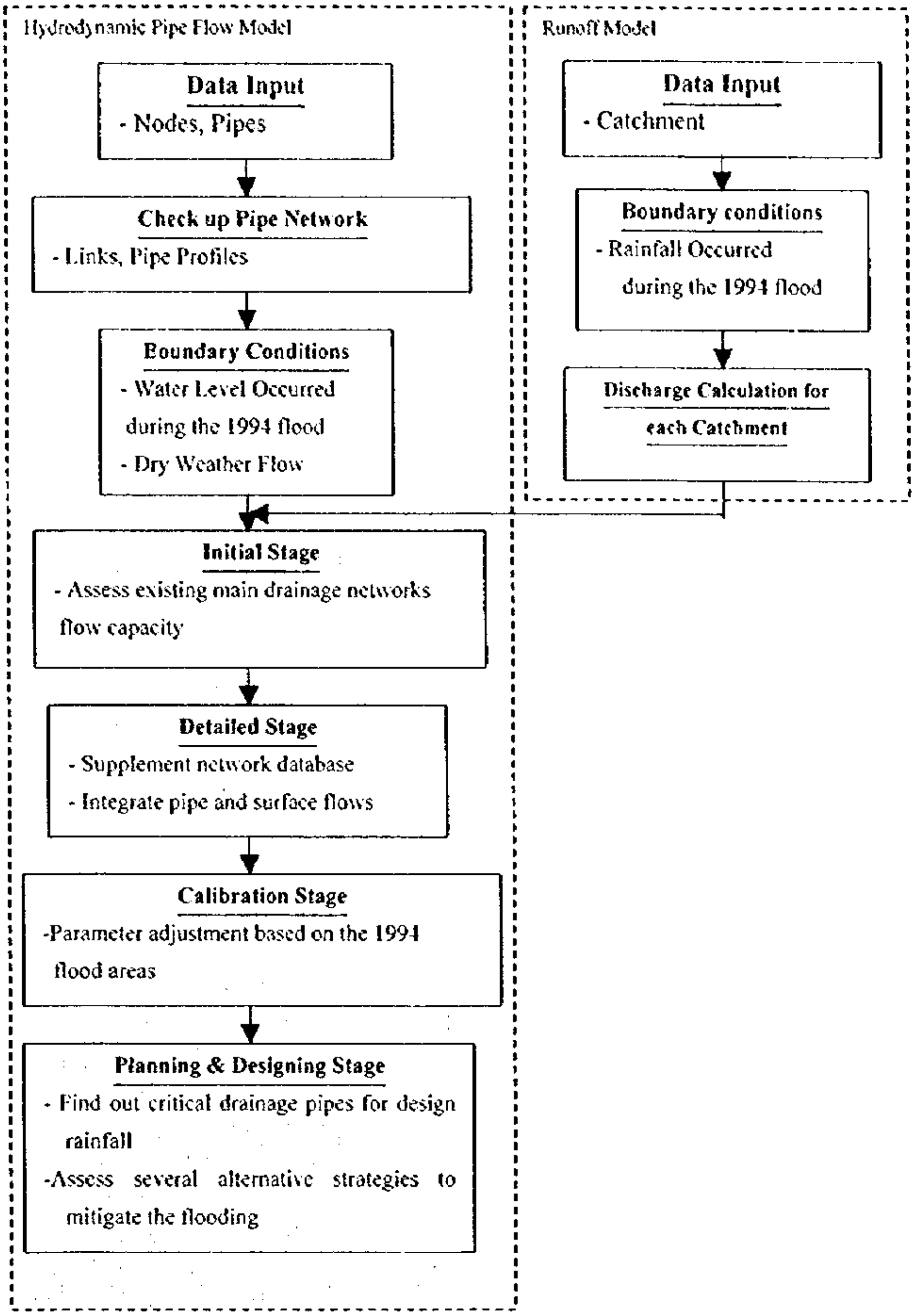
Dry-weather flow
Unit wastewater discharge, which is 170 l/day/person for urban district and 140 l/day/person for rural district, is applied to the boundary condition for the calibration.

Rainfall
The rainfall time series occurred on June 28^{th}, 1994 will be applied to the boundary condition for the calibration. The rainfall started at 7:00 on June 28, 1994 and continued for 24 hours.

Water Level at the Outlets
The water level at the Phu An station, corresponding to the rainfall time series, is applied to the boundary condition of the water level at the outlet into the Saigon River, the Tau Hu-Ben Nghe, the Doi-Te and the Nhieu Loc-Thi Nghe canals.

b) Procedure for Modeling

A general idea of modeling procedure is shown as the flow chart below.



Essentially, MOUSE consists of 2 components as shown:

* MOUSE Runoff Model : Compute surface runoff for each catchment. The Catchment is linked to the specified network node (i.e. manhole) of the Pipe Flow Model.

* MOUSE Hydrodynamic Pipe Flow Model : Compute the drainage network flows based on the runoff discharge calculated by the Runoff Model.

a) General Description of Modeling

Surface Runoff Model
The model computes the runoff discharge for each catchment. The resulting runoff from the catchment is computed on the basis of the specified time of concentration and the runoff coefficients.

Hydrodynamic Pipe Flow Model
The model is a computational tool for simulations of unsteady flows in pipe networks with alternating free surface and pressurized flow conditions. The computation is based on an implicit, finite difference numerical solution of basic 1-D, free surface flow equations (Saint Venant). The implemented algorithm provides efficient and accurate solutions in multiply connected, branched and looped pipe networks.

The computational scheme is applicable to vertically homogeneous flow conditions which occur in low-lying pipes, often pressurized main pipes, affected by the varying water level at the outlet.

Both subcritical and supercritical flows are treated by means of the numerical scheme which adopts according to the local flow conditions. Naturally, flow features such as backwater effects and surcharges are precisely simulated.

Moreover, a advanced technique using this model can simulate the street flooding when the overflow from the node surmounts the inflow capacity of the node.

b) Required Data for Modeling

Required data for modeling are shown in the table below.

Runoff Model	Hydrodynamic Pipe Flow Model	
Catchment	**Node (i.e. manhole)**	**Pipe**
- Area	- Bottom Elevation	- Linkage (upstream node and downstream node)
- Concentration Time	- Shape	- Cross-section
- Runoff Coefficient	- Dimension	- Upstream and Downstream Invert Elevation
	- Ground Elevation	- Manning Number

c) Boundary Conditions for Modeling

These models support the following time-variable boundary conditions for simulation:

Runoff Model	Hydrodynamic Pipe Flow Model
- A Rain Hydrograph	- Dry Weather Flow (wastewater from household)
	- Water Levels in the Outlets

9. CALCULATION ON STORAGE REQUIREMENT

Flood Plain Storage along Daihan Canal

Improvement plan of Daihan canal has been proposed such that the proposed canal sections can drain 5-year rain water in 24 hours. In such a case, inundation is expected to occur along the flood plain of Daihan canal. An analysis has been carried out on flood plain storage along Daihan canal for 5-year return period and is presented in Fig. C.9.1. Flood plain storage volume, V_s (m^3) along any reach is calculated as:

$$V_s = (V_i + V_f) - V_o$$

where: V_i = Inflow volume (m^3) from main channel of upper reach;
V_f = Lateral inflow volume (m^3) from contributing sub-catchment along the reach in consideration and

V_o = Outflow volume (m^3) from main channel of the reach in consideration.

Average specific storage volume and area (considering a 30 cm inundation depth) are calculated to be 29,800 m^3/km^2 and 99,300 m^2/km^2 respectively.

Specific Storage Volume due to Urbanization

According to future (2020) landuse plan prepared by Urban Planning Institute of Ho Chi Minh City, rapid urbanization is expected in the North Eastern zone. To keep future runoff (under future landuse condition) same as present runoff (under existing land use condition), storage pond (non-structural measure through landuse regulation) is proposed for the rapidly urbanizing catchments. Required specific storage volume due to increase in urbanization has been estimated. Overland flow runoff hydrographs for 5 and 10 year return periods have been constructed for five landuse conditions for a unit catchment area of 1.0 km^2 and are presented in Fig. C.9.2. Required specific storage volume ($m^3/s/km^2$) as a function of increase in runoff coefficient for four categories of urbanizations, with reference to agricultural land, have been calculated and the results are plotted as shown in Fig. C.9.3. For ease in application, two equations have been proposed for 5 and 10 year return periods :

$$V = 76852 \times (\Delta C)^{0.76112} \quad \text{5-year return period}$$
$$V = 85679 \times (\Delta C)^{0.76201} \quad \text{10-year return period}$$

where: V = required specific storage volume ($m^3/s/km^2$) and
ΔC = increase in runoff coefficient by urbanization.

10. STRENGTHENING MONITORING NETWORK ON METEO-HYDROLOGY

Proposed Rainfall Stations

In the Study area, there exists only one automatic type rainfall station at Tan Son Nhat where short duration rainfall data is available. There exist six more rainfall stations in and around the Study area which are of manual type and where, only daily rainfall data are available. This posed a great difficulty in performing a detailed analysis on rainfall distribution over the Study area that could support in carrying out a better runoff analysis and developing a better hydrodynamic model. To have a more uniform distribution with smaller representative areas, five new automatic type rainfall stations are proposed to be installed within the Study area. It is also proposed that the existing six rainfall stations shall be updated from manual to automatic type. Locations of the proposed rainfall stations are shown in Fig. C.10.1. It can be seen that areas of Thiessen polygons with the proposed rainfall stations are much smaller and more uniformly distributed than those with the existing rainfall stations.

Proposed Water Level Stations

There exists no water level station along any of the canals in the Study area. This posed a great difficulty in carrying out a detailed analysis on discharge and water level along the canals as well setting up boundary conditions and calibration for hydrodynamic model development. To overcome this difficulty, nine new automatic type water level stations are proposed to be installed along the canals that best represents the hydrologic system. Among them, six water level stations are proposed in the Western canal system and three water level stations are proposed in the Eastern canal system. Locations of the proposed water level stations are shown in Fig. C.10.2.

Table C.1.1 INVENTORY ON RAINFALL STATIONS

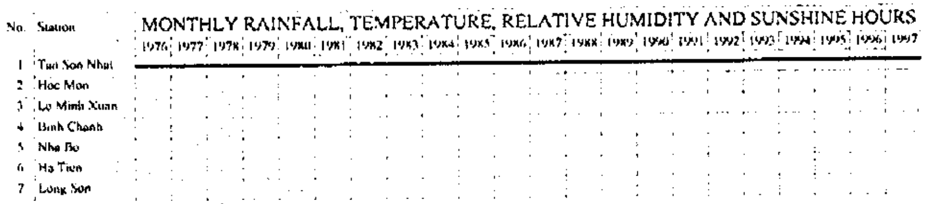
No.	Station		Date of Establishment	Elevation (EL. m)	Geographic Co-ordinates		Method of Measurement		Type of Data	
	Name	Location			Latitude	Longitude	Automatic	Manual	Short Duration	Daily
1	Tan Son Nhat (Tan Son Hoa)	Dist. Tan Binh	1915	9	10°48'	106°41'	X		X	
2	Hoc Mon	Dist. Hoc Mon	1973	10	10°53'	106°36'		X		X
3	Le Minh Xuan	Dist. Binh Chanh	1977		10°45'	106°34'		X		X
4	Binh Chanh	Dist. Binh Chanh	1977		10°40'	106°34'		X		X
5	Nha Be	Dist. Nha Be	1977	1	10°40'	106°44'		X		X
6	Ha Tien Cement Factory	Dist. 9	1963		10°50'	106°41'		X		X
7	Long Son	Dist. Thuan An	1980		10°53'	106°49'		X		X

Table C.1.2 INVENTORY ON WATER LEVEL STATIONS

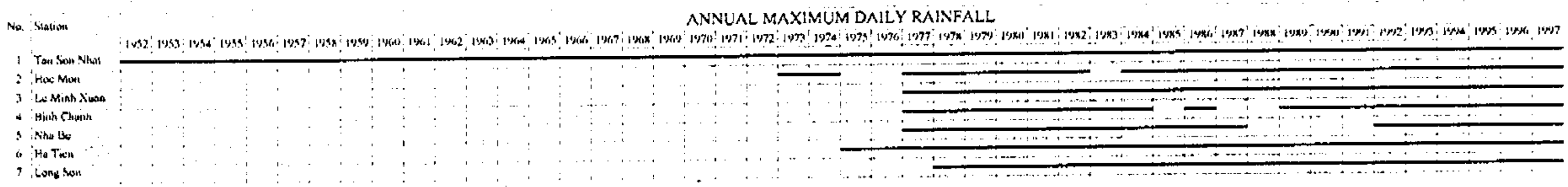
No.	Station	Location		Date of Establishment	Geographic Co-ordinates		Method of Measurement	
	Name	River Name	Chainage (km)		Latitude	Longitude	Automatic	Manual
1	Thu Dau Mot	Saigon	107.78 km from East Sea Mouth or 40.41 km from Phu An station	1966	10°58'	106°39'		X
2	Phu An	Saigon	67.36 km from East Sea Mouth or 27.22 km from Nha Be station	1912	10°47'	106°43'	X	
3	Nha Be	Nha Be	40.14 km from East Sea Mouth	1977	10°40'	106°46'	X	
4	Bien Hoa	Dong Nai	88.57 km from East Sea Mouth or 48.44 km from Nha Be station	1960	10°56'	106°49'	X	
5	Ben Luc	East Vam Co (Vam Co Dong)	67.42 km from East Sea Mouth or 42.64 km from Phu An station	1909	10°38'	106°29'		X

Implementation agency of all stations : Southern Region Hydro Meteorological Center, Ho Chi Minh City

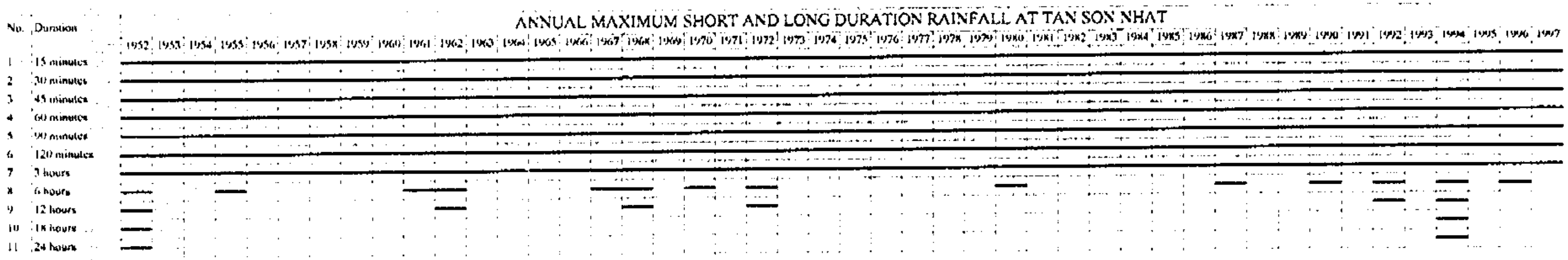
Table C.1.3 BAR CHART OF COLLECTED DATA ON RAINFALL



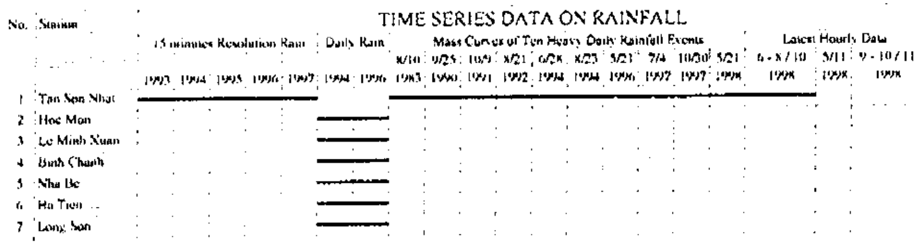
Data Source : Ho Chi Minh City Statistical Office



Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City

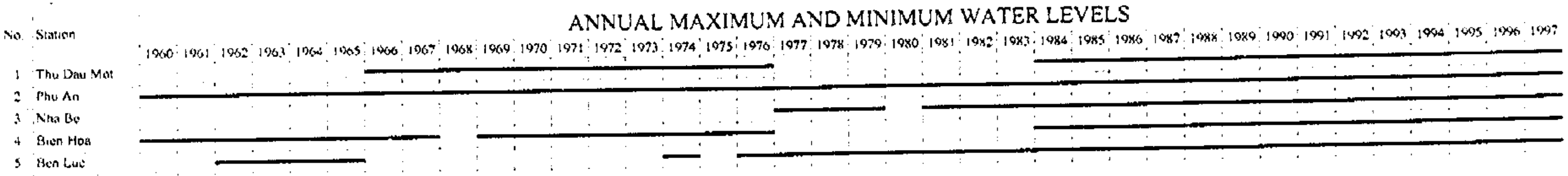


Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City

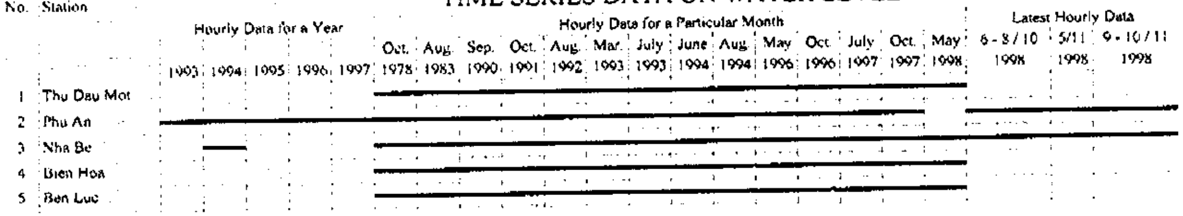


Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City

Table C.1.4 BAR CHART OF COLLECTED DATA ON WATER LEVEL



Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City



Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City

Table C.3.1 ANNUAL MAXIMUM DAILY RAINFALLS

Unit : mm

Year	Tan Son Nhat		Hoc Mon		Le Minh Xuan		Binh Chanh		Nha Be		Ha Tien Cement Factory		Long Son	
	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date
1973	89.6	11/07	30.0	11/07										
1974	75.6	27/09	20.0	20/05										
1975	83.4	20/10	-	-							95.2	21/10		
1976	81.0	29/10	-	-							116.3	16/08		
1977	86.6	07/10	99.6	13/09	83.2	17/07	109.8	29/08	89.4	07/11	95.5	27/06		
1978	176.9	10/10	134.7	22/04	130.4	06/10	144.3	15/09	90.5	11/04	158.5	09/10	170.0	09/10
1979	93.6	02/05	146.6	15/06	126.2	16/06	68.2	14/09	58.2	27/04	129.2	05/10	81.0	29/08
1980	94.5	18/05	85.5	07/05	88.0	18/05	75.0	01/08	83.5	19/05	120.5	15/05	175.0	15/05
1981	99.8	29/06	98.8	24/07	101.1	27/07	58.3	26/07	87.7	12/07	154.5	29/06	103.5	04/09
1982	110.8	08/09	88.8	07/09	82.7	07/04	52.4	04/04	46.5	14/06	168.1	08/09	114.0	21/05
1983	130.7	10/08	-	-	101.5	11/08	122.0	20/09	63.9	30/09	70.3	24/06	116.1	10/08
1984	65.7	25/07	80.6	08/10	82.0	12/07	66.3	12/10	71.4	26/07	96.0	06/09	84.0	16/10
1985	77.7	10/10	55.0	31/10	91.7	25/07	-	-	66.1	01/05	101.0	10/10	94.0	08/09
1986	92.5	23/06	83.0	08/10	84.0	24/06	100.5	17/06	90.1	11/05	100.6	13/09	146.0	18/05
1987	94.9	11/06	62.3	26/10	97.2	02/11	-	-	58.8	12/06	115.8	03/10	60.0	03/10
1988	63.6	07/11	79.9	01/11	87.6	25/11	-	-	-	-	108.0	03/10	70.0	05/11
1989	89.5	12/10	124.2	24/04	117.1	16/10	105.9	25/05	-	-	100.1	18/08	120.0	08/10
1990	84.3	29/09	70.8	25/09	99.3	08/11	74.6	17/08	-	-	46.8	20/07	115.0	04/10
1991	113.1	09/10	56.1	20/10	83.2	06/06	84.8	26/05	-	-	49.5	17/05	70.4	27/07
1992	99.9	21/08	104.7	11/06	92.9	21/06	96.7	23/05	129.3	21/08	98.8	18/07	68.0	21/08
1993	89.5	03/08	84.0	26/07	83.5	26/10	169.9	06/06	93.3	16/10	79.1	03/09	82.0	02/09
1994	162.2	28/06	137.0	04/09	62.3	18/10	184.5	28/06	196.1	28/06	124.6	28/06	159.0	28/06
1995	95.3	04/08	92.5	04/08	92.3	11/10	58.3	30/06	79.9	26/08	98.4	29/09	105.5	26/08
1996	94.6	21/05	93.5	14/10	94.0	14/10	62.3	14/10	79.3	26/09	67.4	21/05	104.5	20/08
1997	110.4	30/10	74.8	21/07	72.0	02/11	73.5	28/10	66.5	04/11	50.0	16/09	111.0	20/08
Maximum	176.9	10/10/78	146.6	15/06/79	130.4	06/10/78	184.5	28/06/94	196.1	28/06/94	168.1	08/09/82	175.0	15/05/80

Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City
Daily : From 7:00 P.M. to 7:00 P.M.

Table C.3.2 ANNUAL MAXIMUM RAINFALLS AT TAN SON NHAT

Unit: mm

Year	Short Duration Rainfall								Long Duration Rainfall				Daily Rainfall (compound rain)	
	15 (min)	30 (min)	45 (min)	60 (min)	90 (min)	120 (min)	180 (min) Amount	180 (min) Date	6 (hrs)	12 (hrs)	18 (hrs)	24 (hrs)	Amount	Date
1952	26.5	27.6	29.8	31.0	31.4	32.8	44.2	06/10	54.4	70.4	76.3	113.4	113.4	20/10
1953	20.0	31.0	42.2	45.8	52.7	56.3	58.8	-					106.5	28/05
1954	30.6	42.4	62.6	82.0	93.7	94.5	95.3	-					110.6	26/09
1955	26.0	38.0	36.8	45.2	50.2	55.6	60.8	06/11	72.1				87.8	06/11
1956	25.2	37.0	45.0	45.4	45.6	45.7	45.8	15/11					70.2	06/09
1957	28.0	36.0	48.0	53.8	57.4	64.4	68.6	22/09					71.6	22/09
1958	23.2	50.3	50.8	50.8	51.8	51.8	52.4	-					52.4	30/06
1959	40.3	50.0	60.0	70.0	79.0	79.0	79.0	30/06					87.0	16/08
1960	27.6	36.6	37.6	37.9	38.2	38.3	38.5	01/04					93.0	20/06
1961	28.0	40.6	50.6	51.0	53.8	55.0	55.0	06/07	68.5				72.0	25/07
1962	22.1	31.8	48.2	53.4	68.0	71.6	74.3	12/09	86.8	116.1			154.6	30/05
1963	25.7	44.0	48.0	55.5	59.4	68.2	73.0	19/06					86.9	19/06
1964	37.5	59.0	83.7	89.3	90.8	92.8	92.8	13/06					101.5	13/06
1965	34.0	49.0	64.6	68.1	75.0	76.5	78.3	30/04					82.5	27/06
1966	28.7	47.5	73.0	85.0	95.0	112.8	116.2	17/08					116.7	17/08
1967	35.0	52.0	72.5	80.0	89.3	90.0	91.5	03/05	100.6				107.5	03/05
1968	25.0	38.7	50.0	57.5	61.0	62.0	63.0	27/04	74.6	93.4			112.9	17/09
1969	30.7	51.4	62.1	77.0	80.3	80.3	80.3	26/10					81.5	26/10
1970	41.2	50.7	70.5	72.5	72.7	73.0	73.0	30/06	84.2				87.5	17/06
1971	30.0	52.0	74.0	78.7	86.0	87.5	88.0	31/05					91.8	31/05
1972	29.0	40.0	52.0	55.0	58.0	58.5	59.5	12/05	73.0	77.8			77.8	25/06
1973	45.0	74.0	81.0	81.8	82.0	82.0	82.0	01/10					89.6	11/07
1974	30.0	36.5	58.0	66.0	72.0	72.5	73.0	27/09					75.6	27/09
1975	25.8	32.1	41.0	54.5	66.0	71.3	80.5	20/10					83.4	20/10
1976	36.5	49.5	67.0	75.0	79.0	79.9	80.9	29/10					83.4	29/10
1977	31.0	38.6	61.0	61.0	65.6	65.6	67.8	13/09					86.6	07/10
1978	31.2	48.8	67.9	75.2	106.7	137.4	144.5	09/10					176.9	10/10
1979	34.0	51.5	85.0	92.0	92.0	93.0	93.2	04/05					93.6	02/05
1980	23.4	46.7	61.2	78.6	81.7	86.7	92.0	18/05	95.4				94.5	18/05
1981	34.2	71.2	76.1	114.3	116.1	116.1	116.9	09/07					99.8	29/06
1982	32.3	57.0	62.2	62.8	64.9	65.1	66.9	19/10					110.8	08/09
1983	27.2	47.7	96.3	98.9	117.0	118.6	127.3	10/08					130.7	10/08
1984	28.8	36.4	44.5	51.7	56.6	62.0	64.2	25/07					65.7	25/07
1985	29.4	42.0	50.5	55.7	60.4	64.4	72.7	09/10					77.7	10/10
1986	34.2	41.7	46.5	46.5	47.5	51.1	51.6	24/09					92.5	23/06
1987	44.6	68.0	83.1	83.7	88.6	91.9	93.5	11/06	94.3				94.9	11/06
1988	28.8	40.3	45.1	45.1	48.8	49.5	49.5	02/10					63.6	07/11
1989	19.4	36.0	48.0	48.0	61.0	61.3	73.2	12/10					89.5	12/10
1990	50.0	69.5	76.6	78.1	78.2	78.2	84.2	03/09	97.4				84.3	29/09
1991	37.8	60.9	68.3	68.3	109.8	112.6	112.7	09/10					113.1	09/10
1992	28.7	58.1	65.7	67.7	73.7	75.9	81.7	21/08	98.1	98.7			99.9	21/08
1993	35.4	52.7	59.8	64.5	65.4	65.9	69.0	03/08					89.5	03/08
1994	37.6	84.5	94.1	102.6	106.4	106.7	108.8	23/08	116.3	154.1	188.8	205.3	162.2	28/06
1995	37.6	65.6	73.5	75.0	76.0	86.5	88.2	06/08					95.3	04/08
1996	25.6	47.5	70.5	70.5	72.0	72.5	88.2	21/05	93.7				94.6	21/05
1997	29.5	57.4	77.5	86.0	98.3	99.5	111.0	04/07					110.4	30/10
Maximum	50.0	84.5	96.3	114.3	117.0	137.4	144.5	9/10/78	116.3	154.1	188.8	205.3	176.9	10/10/78

Short and long duration rainfall : Amount represents annual maximum rainfall for a single rainfall event.
Daily rainfall : Amount represents annual maximum rainfall for compound rainfall (single or multiple rainfall events on same day).

Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City
Daily : From 7.00 P.M. to 7.00 P.M.

Table C.3.3 PROBABLE MAXIMUM RAINFALL DEPTHS AT TAN SON NHAT

Unit : mm

Time	Probable Rainfall Depths for Different Return Periods											
(minutes)	1-Yr.	1.5-Yr.	2-Yr.	3-Yr.	5-Yr.	10-Yr.	20-Yr.	25-Yr.	30-Yr.	50-Yr.	70-Yr.	100-Yr.
15	18.82	27.70	30.06	32.80	35.86	39.70	43.39	44.56	45.51	48.16	49.90	51.74
30	24.91	41.74	46.21	51.42	57.21	64.50	71.49	73.71	75.51	80.53	83.83	87.31
45	31.94	53.15	58.78	65.34	72.64	81.82	90.63	93.42	95.69	102.03	106.18	110.57
60	33.39	57.72	64.18	71.71	80.09	90.62	100.73	103.93	106.54	113.81	118.57	123.61
90	34.92	62.64	70.00	78.57	88.12	100.12	111.63	115.28	118.25	126.53	131.96	137.70
120	35.65	64.74	72.72	82.00	92.34	105.33	117.79	121.75	124.96	133.92	139.80	146.01
180	37.12	67.75	75.88	85.36	95.91	109.17	121.88	125.92	129.20	138.34	144.34	150.68
360	47.26	77.89	83.72	90.50	98.06	111.42	124.22	128.29	131.60	140.81	146.85	153.24
daily	51.09	83.58	92.22	102.27	113.47	127.54	141.03	145.31	148.80	158.50	164.86	171.59

Note: Calculated by applying Gumbel's distribution method using collected data from 1952 to 1997.

Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City.

Table C.4.1 PROBABLE MAXIMUM WATER LEVELS BY STATION

Unit: EL. m (Mui Nai)

Station	Probable Maximum Water Level for Different Return Periods											
	1.0-Yr.	1.5-Yr.	2-Yr.	3-Yr.	5-Yr.	10-Yr.	20-Yr.	25-Yr.	30-Yr.	50-Yr.	70-Yr.	100-Yr.
Thu Dau Mot	1.23	1.27	1.28	1.29	1.31	1.32	1.34	1.35	1.35	1.36	1.37	1.38
			(1.20)		(1.23)	(1.25)	(1.27)					(1.30)
Phu An	1.32	1.40	1.42	1.45	1.48	1.51	1.54	1.56	1.56	1.59	1.60	1.62
			(1.35)		(1.41)	(1.44)	(1.47)					(1.57)
			<1.35>		<1.41>	<1.44>	<1.46>			<1.49>		<1.52>
Nha Be	1.40	1.47	1.48	1.50	1.53	1.56	1.58	1.59	1.60	1.62	1.63	1.65
			(1.32)		(1.41)	(1.46)	(1.51)					(1.60)
Bien Hoa	1.30	1.55	1.62	1.69	1.78	1.89	1.99	2.02	2.05	2.12	2.17	2.22
Ben Luc	1.08	1.22	1.26	1.30	1.34	1.40	1.46	1.48	1.49	1.53	1.56	1.59

Table C.4.2 PROBABLE MINIMUM WATER LEVELS BY STATION

Unit: EL. m (Mui Nai)

Station	Probable Minimum Water Level for Different Return Periods											
	1.0-Yr.	1.5-Yr.	2-Yr.	3-Yr.	5-Yr.	10-Yr.	20-Yr.	25-Yr.	30-Yr.	50-Yr.	70-Yr.	100-Yr.
Thu Dau Mot	-1.76	-1.99	-2.05	-2.12	-2.20	-2.29	-2.39	-2.42	-2.44	-2.51	-2.56	-2.60
			(-2.18)		(-1.99)	(-1.87)	(-1.76)					(-1.53)
Phu An	-1.80	-2.03	-2.09	-2.15	-2.23	-2.33	-2.42	-2.45	-2.48	-2.54	-2.59	-2.63
			(-2.23)		(-2.04)	(-1.92)	(-1.80)					(-1.55)
			<-2.16>		<-2.27>	<-2.33>	<-2.37>			<-2.43>		<-2.45>
Nha Be	-1.98	-2.17	-2.22	-2.28	-2.35	-2.43	-2.51	-2.54	-2.56	-2.61	-2.65	-2.69
			(-2.42)		(-2.29)	(-2.15)	(-2.06)			(-1.87)		
Bien Hoa	-1.35	-1.56	-1.61	-1.67	-1.74	-1.83	-1.92	-1.94	-1.96	-2.02	-2.06	-2.11
Ben Luc	-1.47	-1.56	-1.58	-1.61	-1.64	-1.67	-1.71	-1.72	-1.73	-1.75	-1.77	-1.79

1.48 : Calculated by the Study Team applying Gumbel's distribution method using collected data from 1960 to 1997, depending upon station.
Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City.

(1.41) : The Hydrological Sub-Institute HCMC, 1990; Using Gumbel's method.
<1.41> : Asian Development Bank, 1998; Data ranges from 1960 - 1991.

Table C.4.3 REFERENCE WATER LEVELS BY STATION

Unit: EL. m (Mui Nai)

Station	Reference Water Levels					
	Recorded Historical Highest WL	High Water Level (HWL)	Design Flood Level (DFL)	Mean Water Level (MWL)	Low Water Level (LWL)	Recorded Historical Lowest WL
Thu Dau Mot	1.38	1.29	1.22	0.32	-2.08	-2.34
Phu An	1.54	1.43	1.31	0.24	-2.11	-2.41
Nha Be	1.67	1.49	1.36	0.17	-2.25	-2.57
Bien Hoa	2.02	1.65	1.50	0.66	-1.63	-1.87
Ben Luc	1.54	1.27	1.12	0.32	-1.59	-1.70

Note : Calculated by the Study Team using collected data from 1960 to 1997, depending upon station.
MWL : Data for Phua An ranges from 1993 to 1997 (hourly data) and for other stations, estimated from correlations of mean water levels.
Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City.

Criteria for Refernce Water Levels

Highest WL	: Recorded historical maximum water level
HWL = High Water Level	: Average of annual maximum water levels
DFL = Design Flood Level	: Average of monthly maximum water levels for the months August to November
MWL = Mean Water Level	: Average of daily mean water levels
LWL = Low Water Level	: Average of annual minimum water levels
Lowest WL	: Recorded historical minimum water level

Table C.4.4 PROBABLE MAXIMUM WATER LEVELS BY REACH

Unit: EL. m (Mui Nai)

Reach	Probable Maximum Water Level for Different Return Periods											
	1.0-Yr.	1.5-Yr.	2-Yr.	3-Yr.	5-Yr.	10-Yr.	20-Yr.	25-Yr.	30-Yr.	50-Yr.	70-Yr.	100-Yr.
Reach 1	1.33	1.42	1.44	1.47	1.50	1.53	1.57	1.58	1.59	1.62	1.63	1.65
Reach 2	1.38	1.48	1.51	1.55	1.58	1.63	1.67	1.69	1.70	1.73	1.75	1.77
Reach 3	1.32	1.53	1.58	1.65	1.72	1.81	1.89	1.92	1.94	2.00	2.01	2.09
Reach 4	1.33	1.42	1.44	1.47	1.50	1.53	1.57	1.58	1.59	1.62	1.63	1.65
Southern Boundaries	1.38	1.48	1.51	1.55	1.58	1.63	1.67	1.69	1.70	1.73	1.75	1.77

Table C.4.5 PROBABLE MINIMUM WATER LEVELS BY REACH

Unit: EL. m (Mui Nai)

Reach	Probable Minimum Water Level for Different Return Periods											
	1.0-Yr.	1.5-Yr.	2-Yr.	3-Yr.	5-Yr.	10-Yr.	20-Yr.	25-Yr.	30-Yr.	50-Yr.	70-Yr.	100-Yr.
Reach 1	-1.80	-2.02	-2.08	-2.15	-2.23	-2.32	-2.42	-2.45	-2.47	-2.54	-2.58	-2.63
Reach 2	-1.94	-2.14	-2.19	-2.26	-2.32	-2.41	-2.49	-2.52	-2.54	-2.60	-2.64	-2.68
Reach 3	-1.85	-2.06	-2.12	-2.19	-2.26	-2.35	-2.44	-2.47	-2.50	-2.56	-2.60	-2.65
Reach 4	-1.80	-2.02	-2.08	-2.15	-2.23	-2.32	-2.42	-2.45	-2.47	-2.54	-2.58	-2.63
Southern Boundaries	-1.94	-2.14	-2.19	-2.26	-2.32	-2.41	-2.49	-2.52	-2.54	-2.60	-2.64	-2.68

Table C.4.6 REFERENCE WATER LEVELS BY REACH

Unit: EL. m (Mui Nai)

Reach	Reference Water Levels					
	Recorded Historical Highest WL	High Water Level (HWL)	Design Flood Level (DFL)	Mean Water Level (MWL)	Low Water Level (LWL)	Recorded Historical Lowest WL
Reach 1	1.56	1.45	1.32	0.23	-2.11	-2.40
Reach 2	1.75	1.52	1.39	0.27	-2.12	-2.42
Reach 3	1.94	1.61	1.47	0.54	-1.78	-2.04
Reach 4	1.56	1.45	1.32	0.23	-2.11	-2.40
Southern Boundaries	1.75	1.52	1.39	0.27	-2.12	-2.42

Reach 1 : From confluence point of Rach Ba Hong with Song Saigon to confluence point of Kinh Te with Song Saigon (33.97 km).

Reach 2 : From confluence point of KinhTe with Song Saigon to confluence point of Song Muong Chuoi with Song Nha Be (27.83 km).

Reach 3 : From confluence point of Song Saigon with Song Nha Be to (northern) confluence point of Song Tac with Song Dong Nai (26.33 km).

Reach 4 : From confluence point of Kinh Te (and Kinh Ben Nghe) with Song Saigon to confluence point of Rach Ba Goc with Song Ben Luc (15.00 km).

Southern Boundaries : The southern boundaries of Rach Can Giuoc, Rach Ba Lao etc. flowing towards the south.

Table C.6.1 BASIN AREAS BY ZONES, CATCHMENTS AND SUB-CATCHMENTS

Zone ID	Zone Area (km2)	Catchment ID	Catchment Area (km2)	Sub-Catchment ID	Sub-Catchment Area (km2)
N	136.18	N 1	19.87	N 1 1	3.33
				N 1 2	6.60
				N 1 3	4.25
				N 1 4	5.69
		N 2	107.57	N 2 1	11.67
				N 2 2	6.43
				N 2 3	11.24
				N 2 4	5.32
				N 2 5	10.98
				N 2 6	11.19
				N 2 7	7.43
				N 2 8	13.93
				N 2 9	6.32
				N 2 10	5.54
				N 2 11	5.71
				N 2 12	4.89
				N 2 13	6.89
		N a	8.75	N a	8.75
C	106.41	C 1	31.67	C 1 1	7.54
				C 1 2	3.55
				C 1 3	5.87
				C 1 4	7.58
				C 1 5	7.13
		C 2	5.14	C 2	5.14
		C 3	20.22	C 3 1	5.86
				C 3 2	4.72
				C 3 3	3.77
				C 3 4	5.88
		C 4	41.50	C 4 1	1.84
				C 4 2	2.88
				C 4 3	3.41
				C 4 4	3.11
				C 4 5	5.24
				C 4 6	7.51
				C 4 7	6.64
				C 4 8	10.86
		C a	4.91	C a	4.91
		C b	1.28	C b	1.28
		C c	1.68	C c	1.68
W	72.91	W 1	72.91	W 1 1	9.68
				W 1 2	5.14
				W 1 3	4.73
				W 1 4	8.62
				W 1 5	8.20
				W 1 6	3.20
				W 1 7	3.70
				W 1 8	6.04
				W 1 9	0.99
				W 1 10	0.27
				W 1 11	8.55
				W 1 12	13.50

Measurement : GIS database
Scale = 1/10,000

Zone ID	Zone Area (km2)	Catchment ID	Catchment Area (km2)	Sub-Catchment ID	Sub-Catchment Area (km2)
S	81.74	S 1	14.33	S 1 1	2.68
				S 1 2	4.04
				S 1 3	4.38
				S 1 4	1.96
				S 1 5	1.27
		S 2	15.66	S 2 1	2.40
				S 2 2	1.96
				S 2 3	2.85
				S 2 4	8.45
		S 3	34.51	S 3 1	2.17
				S 3 2	2.32
				S 3 3	4.79
				S 3 4	5.75
				S 3 5	4.31
				S 3 6	4.34
				S 3 7	6.45
				S 3 8	4.38
		S 4	2.36	S 4	2.36
		S 5	2.23	S 5	2.23
		S a	3.46	S a	3.46
		S b	3.86	S b	3.86
		S c	5.33	S c	5.33
SE	119.36	SE 1	1.98	SE 1	1.98
		SE 2	2.60	SE 2	2.60
		SE 3	1.92	SE 3	1.92
		SE 4	7.80	SE 4 1	5.40
				SE 4 2	2.40
		SE 5	3.83	SE 5	3.83
		SE 6	5.10	SE 6	5.10
		SE 7	14.58	SE 7 1	8.39
				SE 7 2	6.20
		SE 8	11.33	SE 8 1	2.77
				SE 8 2	8.56
		SE 9	21.11	SE 9 1	7.46
				SE 9 2	6.26
				SE 9 3	7.38
		SE 10	24.88	SE 10 1	7.57
				SE 10 2	11.43
				SE 10 3	5.88
		SE a	3.67	SE a	3.67
		SE b	5.16	SE b	5.16
		SE c	1.82	SE c	1.82
		SE d	1.30	SE d	1.30
		SE e	2.77	SE e	2.77
		SE f	9.52	SE f	9.52
NE	64.91	NE 1	3.32	NE 1	3.32
		NE 2	9.53	NE 2 1	4.78
				NE 2 2	4.75
		NE 3	7.15	NE 3	7.15
		NE 4	2.65	NE 4	2.65
		NE 5	34.38	NE 5 1	10.12
				NE 5 2	4.72
				NE 5 3	3.16
				NE 5 4	10.17
				NE 5 5	6.21
		NE a	3.76	NE a	3.76
		NE b	2.50	NE b	2.50
		NE c	1.62	NE c	1.62
				Total	581.51

Table C.6.2 EXISTING LAND USE AREAS BY SUB-CATCHMENT (1/2)

Zone	Catchment ID	Sub-Catchment ID	Sub-Catchment Area (km2)	Landuse Area by Category (km2) Com.	Ind.	High R.	Med. R.	Low R.	Inst.	Green	Agri.	Water	Runoff Coefficient
Northern Zone	N.1	N.1.1	3.33	0.00	0.13	0.00	0.22	0.00	0.00	0.00	2.96	0.01	0.44
		N.1.2	6.60	0.00	0.16	0.00	1.79	0.00	0.00	0.00	4.60	0.05	0.50
		N.1.3	4.25	0.00	0.00	0.00	0.37	0.00	0.00	0.00	3.82	0.06	0.43
		N.1.4	5.69	0.00	0.00	0.00	0.22	0.00	0.00	0.00	5.26	0.22	0.43
	N.2	N.2.1	11.67	0.00	0.08	0.00	3.59	0.00	0.00	0.00	8.00	0.00	0.50
		N.2.2	6.43	0.00	0.00	0.00	1.93	0.00	0.00	0.00	4.50	0.00	0.49
		N.2.3	11.24	0.00	0.00	0.00	2.52	0.00	0.11	0.00	8.60	0.01	0.47
		N.2.4	5.32	0.00	0.05	0.04	1.17	0.00	0.15	0.00	3.84	0.05	0.49
		N.2.5	10.98	0.00	0.14	1.11	0.87	0.00	0.22	0.00	8.50	0.14	0.48
		N.2.6	11.19	0.00	0.56	2.59	0.29	0.00	6.67	0.00	0.83	0.25	0.66
		N.2.7	7.48	0.00	0.18	0.89	1.28	0.00	1.14	0.00	3.93	0.05	0.55
		N.2.8	13.93	0.00	0.35	3.03	2.05	0.00	0.59	0.21	7.55	0.15	0.56
		N.2.9	6.32	0.00	0.19	0.00	1.54	0.00	0.02	0.00	4.47	0.10	0.50
		N.2.10	5.54	0.00	0.20	0.00	1.18	0.00	0.00	0.00	4.06	0.11	0.49
		N.2.11	5.71	0.00	0.01	1.36	0.24	0.00	0.64	0.00	2.89	0.57	0.59
		N.2.12	4.89	0.00	0.03	0.58	0.52	0.00	0.01	0.00	3.52	0.23	0.51
		N.2.13	6.89	0.05	0.07	1.64	0.15	0.00	1.51	0.00	3.21	0.26	0.58
	N.a	N.a	8.75	0.00	0.06	0.00	2.09	0.00	0.02	0.00	6.45	0.12	0.48
Central Zone	C.1	C.1.1	7.54	0.06	0.28	5.61	0.00	0.00	1.45	0.06	0.00	0.08	0.76
		C.1.2	3.55	0.11	0.01	2.54	0.00	0.00	0.70	0.08	0.00	0.10	0.75
		C.1.3	5.87	0.36	0.09	4.13	0.00	0.00	1.12	0.12	0.00	0.05	0.76
		C.1.4	7.58	0.23	0.36	4.49	0.00	0.00	1.69	0.56	0.14	0.12	0.72
		C.1.5	7.13	0.05	0.18	5.79	0.00	0.00	0.50	0.24	0.06	0.30	0.78
	C.2	C.2	5.14	0.04	0.32	3.41	0.00	0.00	0.04	0.00	0.96	0.37	0.74
	C.3	C.3.1	5.86	0.00	0.63	4.88	0.00	0.00	0.09	0.00	0.20	0.07	0.80
		C.3.2	4.72	0.00	0.49	2.82	0.10	0.00	0.09	0.21	0.83	0.20	0.72
		C.3.3	3.77	0.00	0.15	1.98	0.00	0.00	0.07	0.00	1.24	0.33	0.69
		C.3.4	5.88	0.00	0.16	0.27	0.70	0.00	0.00	0.00	4.54	0.21	0.49
	C.4	C.4.1	1.84	0.00	0.10	0.63	0.00	0.00	0.03	0.00	0.56	0.52	0.74
		C.4.2	2.88	0.00	0.03	0.00	0.00	0.00	0.01	0.00	2.66	0.19	0.49
		C.4.3	3.41	0.00	0.00	0.00	0.81	0.00	0.00	0.00	2.50	0.11	0.48
		C.4.4	3.11	0.00	0.01	0.07	0.21	0.00	0.00	0.00	2.58	0.24	0.45
		C.4.5	5.24	0.31	0.51	3.43	0.00	0.00	0.11	0.00	0.44	0.44	0.79
		C.4.6	7.51	0.31	0.38	4.62	0.02	0.00	0.99	0.01	0.71	0.47	0.75
		C.4.7	6.64	0.14	0.16	4.28	0.03	0.00	0.72	0.01	0.62	0.69	0.76
		C.4.8	10.86	0.57	0.92	4.71	0.69	0.00	0.81	0.54	0.95	1.68	0.76
	C.a	C.a	4.91	0.00	0.01	1.06	0.00	0.00	0.06	0.00	3.62	0.15	0.51
	C.b	C.b	1.28	0.00	0.32	0.72	0.00	0.00	0.08	0.00	0.08	0.08	0.80
	C.c	C.c	1.68	0.48	0.10	0.00	0.00	0.00	0.94	0.12	0.00	0.04	0.66
Western Zone	W.1	W.1.1	9.68	0.01	0.27	3.96	0.76	0.00	0.17	0.00	4.43	0.06	0.61
		W.1.2	5.14	0.00	0.00	0.00	0.50	0.00	0.00	0.00	4.58	0.06	0.44
		W.1.3	4.73	0.00	0.00	0.00	0.12	0.00	0.00	0.00	4.52	0.09	0.42
		W.1.4	8.62	0.00	0.10	0.02	1.88	0.00	0.00	0.00	6.60	0.03	0.47
		W.1.5	8.20	0.00	0.04	0.00	0.68	0.00	0.00	0.00	7.37	0.11	0.44
		W.1.6	3.20	0.00	0.34	0.03	0.84	0.00	0.02	0.00	1.93	0.03	0.54
		W.1.7	3.70	0.00	0.12	0.60	0.04	0.00	0.00	0.00	2.84	0.10	0.50
		W.1.8	6.04	0.00	0.01	0.00	0.56	0.00	0.00	0.00	5.33	0.13	0.44
		W.1.9	0.99	0.00	0.06	0.06	0.05	0.00	0.00	0.00	0.72	0.10	0.53
		W.1.10	0.27	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.05	0.13	0.82
		W.1.11	8.85	0.00	0.00	0.46	1.35	0.00	0.00	0.00	6.75	0.30	0.49
		W.1.12	13.50	0.00	0.00	0.00	1.21	0.00	0.03	0.00	11.64	0.63	0.46
Southern Zone	S.1	S.1.1	2.68	0.00	0.00	0.00	0.39	0.00	0.00	0.00	2.09	0.20	0.49
		S.1.2	4.04	0.00	0.00	0.00	0.34	0.00	0.00	0.00	3.39	0.30	0.47
		S.1.3	4.38	0.00	0.00	0.01	0.07	0.00	0.00	0.00	3.86	0.43	0.47
		S.1.4	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81	0.15	0.45
		S.1.5	1.27	0.00	0.00	0.00	0.04	0.00	0.01	0.00	1.06	0.16	0.49
	S.2	S.2.1	2.40	0.00	0.00	0.00	0.26	0.00	0.00	0.00	1.88	0.26	0.50
		S.2.2	1.96	0.00	0.00	0.03	0.40	0.00	0.00	0.00	1.41	0.11	0.50
		S.2.3	2.85	0.00	0.00	0.00	0.14	0.00	0.00	0.00	2.33	0.38	0.49
		S.2.4	8.45	0.00	0.03	0.00	0.64	0.00	0.03	0.00	7.13	0.62	0.47

Table C.6.2 EXISTING LAND USE AREAS BY SUB-CATCHMENT (2/2)

Zone	Catchment	Sub-Catchment ID	Sub-Catchment Area (km2)	Landuse Area by Category (km2) Com.	Ind.	High R.	Med. R.	Low R.	Inst.	Green	Agri	Water	Runoff Coefficient
Southern Zone	S 3	S 3.1	2.17	0.00	0.00	0.00	0.67	0.00	0.00	0.00	1.35	0.15	0.53
		S 3.2	2.32	0.00	0.00	0.00	0.15	0.00	0.02	0.00	1.94	0.21	0.48
		S 3.3	4.79	0.00	0.00	0.00	0.60	0.00	0.13	0.00	3.33	0.72	0.53
		S 3.4	5.75	0.00	0.00	0.00	0.30	0.00	0.00	0.00	4.91	0.54	0.47
		S 3.5	4.31	0.00	0.00	0.00	0.08	0.00	0.01	0.00	3.76	0.45	0.47
		S 3.6	4.34	0.00	0.00	0.00	0.73	0.00	0.04	0.00	2.97	0.60	0.54
		S 3.7	6.45	0.00	0.00	0.00	0.23	0.00	0.00	0.00	5.63	0.60	0.47
		S 3.8	4.38	0.00	0.00	0.00	0.57	0.00	0.00	0.00	3.20	0.61	0.52
	S 4	S 4	2.36	0.00	0.81	0.00	0.60	0.00	0.00	0.00	0.82	0.14	0.68
	S 5	S 5	2.23	0.00	0.18	0.00	0.00	0.00	0.00	0.00	1.96	0.09	0.46
	S a	S a	3.46	0.00	2.03	0.00	0.24	0.00	0.00	0.00	1.04	0.16	0.74
	S b	S b	3.86	0.00	0.14	0.00	0.10	0.00	0.18	0.00	3.19	0.24	0.47
	S c	S c	5.33	0.00	0.14	0.00	0.92	0.00	0.12	0.00	3.89	0.26	0.50
North-Eastern Zone	NE 1	NE 1	3.32	0.00	0.01	0.00	0.53	0.00	0.00	0.00	2.73	0.05	0.46
	NE 2	NE 2.1	4.78	0.00	0.03	0.00	0.88	0.00	0.05	0.00	3.79	0.04	0.47
		NE 2.2	4.75	0.00	0.00	0.00	1.01	0.00	0.00	0.00	3.66	0.07	0.47
	NE 3	NE 3	7.15	0.00	0.02	0.00	2.02	0.00	0.35	0.00	4.69	0.06	0.50
	NE 4	NE 4	2.65	0.00	0.18	0.00	1.04	0.00	0.28	0.00	1.14	0.01	0.57
	NE 5	NE 5.1	10.12	0.00	0.08	0.00	0.34	0.00	0.00	0.00	9.68	0.02	0.42
		SE 5.2	4.72	0.00	0.16	0.00	0.58	0.00	0.00	0.00	3.94	0.03	0.46
		NE 5.3	3.16	0.00	0.55	0.00	0.27	0.00	0.03	0.00	2.26	0.04	0.52
		NE 5.4	10.17	0.00	0.23	0.00	1.24	0.00	0.47	0.00	8.20	0.03	0.46
		NE 5.5	6.21	0.00	0.00	0.00	0.70	0.00	0.48	0.00	4.87	0.17	0.47
	NE a	NE a	3.76	0.00	0.03	0.00	0.14	0.00	0.02	0.00	3.42	0.15	0.44
	NE b	NE b	2.50	0.00	0.07	0.00	0.06	0.00	0.02	0.00	2.28	0.06	0.44
	NE c	NE c	1.62	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.83	0.30	0.66
South-Eastern Zone	SE 1	SE 1	1.98	0.00	0.04	0.00	0.18	0.00	0.00	0.00	1.68	0.08	0.46
	SE 2	SE 2	2.60	0.00	0.03	0.00	0.17	0.00	0.00	0.00	2.33	0.06	0.44
	SE 3	SE 3	1.92	0.00	0.01	0.00	0.13	0.00	0.00	0.00	1.60	0.19	0.48
	SE 4	SE 4.1	5.40	0.00	0.00	0.00	1.27	0.00	0.00	0.00	3.92	0.21	0.49
		SE 4.2	2.40	0.00	0.00	0.00	0.27	0.00	0.00	0.00	1.98	0.15	0.47
	SE 5	SE 5	3.83	0.00	0.00	0.00	0.58	0.00	0.00	0.00	3.18	0.07	0.46
	SE 6	SE 6	5.10	0.00	0.03	0.00	0.64	0.00	0.08	0.00	4.24	0.13	0.46
	SE 7	SE 7.1	8.39	0.00	0.12	0.00	1.22	0.00	0.04	0.00	6.83	0.17	0.46
		SE 7.2	6.20	0.00	0.19	0.00	0.74	0.00	0.12	0.00	4.79	0.36	0.49
	SE 8	SE 8.1	2.77	0.00	0.00	0.00	0.03	0.00	0.00	0.00	2.68	0.06	0.42
		SE 8.2	8.56	0.00	0.00	0.00	1.03	0.00	0.00	0.00	7.25	0.28	0.46
	SE 9	SE 9.1	7.46	0.00	0.02	0.00	1.20	0.00	0.36	0.00	5.76	0.12	0.47
		SE 9.2	6.26	0.00	0.00	0.00	0.32	0.00	0.00	0.00	5.73	0.22	0.44
		SE 9.3	7.38	0.00	0.00	0.00	0.62	0.00	0.00	0.00	6.51	0.25	0.45
	SE 10	SE 10.1	7.57	0.00	0.00	0.00	0.00	0.00	0.08	0.00	6.68	0.81	0.47
		SE 10.2	11.43	0.00	0.00	0.00	0.62	0.00	0.00	0.00	9.85	0.96	0.47
		SE 10.3	5.88	0.00	0.00	0.00	0.28	0.00	0.00	0.00	5.17	0.43	0.46
	SE a	SE a	3.67	0.00	0.00	0.00	1.09	0.00	0.00	0.00	1.83	0.75	0.61
	SE b	SE b	5.16	0.00	0.00	0.00	1.00	0.00	0.00	0.00	3.99	0.17	0.48
	SE c	SE c	1.82	0.00	0.00	0.00	0.16	0.00	0.00	0.00	1.62	0.03	0.44
	SE d	SE d	1.30	0.00	0.07	0.00	0.00	0.00	0.37	0.00	0.69	0.17	0.56
	SE e	SE e	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.26	0.46
	SE f	SE f	9.52	0.00	0.00	0.00	0.42	0.00	0.00	0.00	8.99	0.12	0.42
		Total (km2)	581.51	2.72	14.02	71.98	60.83	0.00	24.12	2.14	380.66	25.04	
		Percent (%)	100.00	0.47	2.41	12.38	10.46	0.00	4.15	0.37	65.46	4.31	

Com. : Commercial Areas
Ind. : Industrial Areas
High R. : High Residential Areas
Med. R. : Medium Residential Areas
Low R. : Low Residential Areas
Inst. : Institutional Areas
Green : Green Spaces
Agri. : Agricultural Areas
Water : Water Bodies

Data Source : Urban Planning Institute, Ho Chi Minh City (UPI, HCMC)
Calculation : GIS database : Inner City : Scale = 1/10,000
Outer City : Scale = 1/25,000

Table C.6.3 FUTURE (2020) LAND USE AREAS BY SUB-CATCHMENT (1/2)

Zone	Catchment ID	Sub-Catchment ID	Sub-Catchment Area (km2)	Landuse Area by Category (km2) Com.	Ind.	High R.	Med. R.	Low R.	Inst.	Green	Agri.	Water	Runoff Coefficient
Northern Zone	N.1	N.1.1	3.33	0.00	0.90	0.00	0.12	0.06	0.00	1.51	0.72	0.01	0.51
		N.1.2	6.60	0.00	2.07	0.00	0.64	0.23	0.26	2.18	1.17	0.05	0.57
		N.1.3	4.25	0.00	0.00	0.00	0.88	0.09	0.07	1.94	1.20	0.06	0.43
		N.1.4	5.69	0.00	0.00	0.00	1.52	0.00	0.00	1.09	2.87	0.22	0.48
	N.2	N.2.1	11.67	0.00	0.07	0.00	2.58	1.85	0.00	2.87	4.31	0.00	0.45
		N.2.2	6.43	0.00	0.00	0.00	0.41	0.65	0.13	0.19	5.05	0.00	0.44
		N.2.3	11.24	0.00	1.83	1.54	0.67	0.40	0.08	2.03	4.68	0.01	0.54
		N.2.4	5.32	0.00	1.00	1.82	0.70	0.00	0.00	1.74	0.00	0.05	0.64
		N.2.5	10.98	0.00	0.08	4.39	2.30	0.58	0.18	2.13	1.19	0.14	0.63
		N.2.6	11.19	0.00	0.15	3.15	0.00	0.00	7.14	0.49	0.00	0.25	0.66
		N.2.7	7.48	0.00	0.00	3.74	0.29	0.65	1.70	1.04	0.00	0.05	0.66
		N.2.8	13.93	0.00	0.00	6.49	2.25	1.86	1.18	1.98	0.00	0.15	0.67
		N.2.9	6.32	0.00	0.27	0.00	1.66	0.70	0.26	3.32	0.00	0.10	0.49
		N.2.10	5.54	0.00	1.39	0.00	1.52	0.00	0.00	2.52	0.00	0.11	0.57
		N.2.11	5.71	0.00	0.00	2.29	1.70	0.00	0.25	0.91	0.00	0.57	0.70
		N.2.12	4.89	0.00	0.00	1.23	2.03	0.00	0.11	1.24	0.04	0.23	0.63
		N.2.13	6.89	0.00	0.00	5.15	0.23	0.00	0.16	1.09	0.00	0.26	0.72
	N.a	N.a	8.75	0.00	0.23	0.00	4.02	0.00	0.43	3.91	0.00	0.12	0.52
Central Zone	C.1	C.1.1	7.54	0.00	0.00	5.96	0.00	0.00	1.47	0.04	0.00	0.05	0.76
		C.1.2	3.55	0.00	0.00	3.16	0.00	0.00	0.00	0.29	0.00	0.10	0.77
		C.1.3	5.87	0.00	0.00	5.58	0.00	0.00	0.11	0.13	0.00	0.05	0.79
		C.1.4	7.58	0.00	0.00	5.61	0.00	0.00	1.09	0.76	0.00	0.12	0.72
		C.1.5	7.13	0.00	0.00	6.15	0.00	0.00	0.46	0.21	0.00	0.30	0.78
	C.2	C.2	5.14	0.00	0.00	4.47	0.00	0.00	0.00	0.30	0.00	0.37	0.78
	C.3	C.3.1	5.86	0.00	0.00	5.64	0.00	0.00	0.00	0.15	0.00	0.07	0.79
		C.3.2	4.72	0.00	0.00	3.36	0.00	0.00	0.00	1.16	0.00	0.20	0.69
		C.3.3	3.77	0.00	0.00	3.42	0.00	0.00	0.02	0.00	0.00	0.33	0.82
		C.3.4	5.88	0.00	0.05	4.18	0.00	0.00	0.00	1.40	0.04	0.21	0.69
	C.4	C.4.1	1.84	0.00	0.00	1.31	0.00	0.00	0.00	0.01	0.00	0.52	0.85
		C.4.2	2.88	0.00	0.00	1.15	0.93	0.00	0.00	0.61	0.00	0.19	0.62
		C.4.3	3.41	0.00	0.00	0.00	2.56	0.00	0.00	0.74	0.00	0.11	0.53
		C.4.4	3.11	0.00	0.00	0.04	0.62	0.00	0.71	0.96	0.53	0.24	0.67
		C.4.5	5.24	0.00	0.00	2.77	0.00	0.00	2.03	0.00	0.00	0.44	0.74
		C.4.6	7.51	0.00	0.00	3.24	0.01	0.00	3.07	0.71	0.00	0.47	0.68
		C.4.7	6.64	0.00	0.00	3.10	0.00	0.00	2.75	0.10	0.00	0.69	0.73
		C.4.8	10.86	0.00	0.36	3.67	0.55	0.29	3.28	1.03	0.00	1.68	0.72
	C.a	C.a	4.91	0.00	0.00	2.03	0.00	0.00	0.07	2.65	0.00	0.15	0.53
	C.b	C.b	1.28	0.00	0.00	0.75	0.00	0.00	0.00	0.42	0.04	0.08	0.64
	C.c	C.c	1.68	0.00	0.00	0.00	0.00	0.00	1.53	0.11	0.00	0.04	0.59
Western Zone	W.1	W.1.1	9.68	0.00	0.03	6.07	0.58	0.28	0.38	2.26	0.01	0.06	0.66
		W.1.2	5.14	0.00	0.00	0.00	0.60	0.41	0.00	0.19	3.88	0.06	0.45
		W.1.3	4.73	0.00	0.00	0.00	0.00	0.08	0.00	0.00	4.56	0.09	0.41
		W.1.4	8.62	0.00	0.08	1.93	1.61	0.62	0.15	4.13	0.07	0.03	0.52
		W.1.5	8.20	0.00	2.64	0.86	0.16	0.84	0.99	0.98	1.62	0.11	0.65
		W.1.6	3.20	0.00	0.16	1.99	0.33	0.00	0.01	0.69	0.00	0.03	0.69
		W.1.7	3.70	0.00	0.92	0.00	1.69	0.45	0.03	0.51	0.01	0.10	0.69
		W.1.8	6.04	0.00	0.00	0.00	0.49	0.21	0.00	0.00	5.20	0.13	0.44
		W.1.9	0.99	0.00	0.73	0.00	0.00	0.00	0.00	0.15	0.00	0.10	0.82
		W.1.10	0.27	0.00	0.13	0.00	0.00	0.00	0.00	0.02	0.00	0.13	0.91
		W.1.11	8.85	0.00	1.04	1.08	1.25	0.07	0.87	2.34	1.92	0.30	0.56
		W.1.12	13.50	0.00	0.96	0.39	1.48	0.69	0.37	1.75	7.24	0.63	0.51
Southern Zone	S.1	S.1.1	2.68	0.00	0.25	0.00	0.92	0.00	0.00	0.66	0.66	0.20	0.57
		S.1.2	4.04	0.00	0.00	0.00	0.99	0.06	0.00	1.06	1.62	0.30	0.50
		S.1.3	4.38	0.00	0.43	0.00	0.85	0.00	0.21	1.26	1.19	0.43	0.55
		S.1.4	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81	0.15	0.45
		S.1.5	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.06	0.16	0.47
	S.2	S.2.1	2.40	0.00	0.00	0.00	0.58	0.07	0.00	1.49	0.00	0.26	0.48
		S.2.2	1.96	0.00	0.00	0.00	0.85	0.00	0.51	0.49	0.00	0.11	0.59
		S.2.3	2.85	0.00	0.00	0.00	0.57	0.00	0.00	1.32	0.58	0.38	0.49
		S.2.4	8.45	0.00	0.92	0.00	1.55	0.07	0.00	0.61	4.67	0.62	0.55

Table C.6.3 FUTURE (2020) LAND USE AREAS BY SUB-CATCHMENT (2/2)

Zone	Catchment	Sub-Catchment ID	Sub-Catchment Area (km2)	Landuse Area by Category (km2) Com.	Ind	High R.	Med. R.	Low R.	Inst	Green	Agri.	Water	Runoff Coefficient
Southern Zone	S 3	S 3.1	2.17	0.00	0.00	0.79	0.59	0.42	0.12	0.10	0.00	0.15	0.71
		S 3.2	2.32	0.00	0.00	1.73	0.00	0.00	0.00	0.38	0.00	0.21	0.74
		S 3.3	4.79	0.00	0.00	1.77	0.62	1.56	0.00	0.11	0.00	0.72	0.74
		S 3.4	5.75	0.00	0.00	0.38	2.13	0.01	0.22	2.47	0.00	0.54	0.56
		S 3.5	4.31	0.00	0.00	1.00	1.05	0.07	0.15	1.58	0.00	0.45	0.60
		S 3.6	4.34	0.00	0.00	0.00	2.33	0.33	0.00	1.08	0.00	0.60	0.63
		S 3.7	6.45	0.00	0.00	0.00	2.75	0.00	0.05	3.05	0.00	0.60	0.54
		S 3.8	4.38	0.00	0.00	0.00	2.33	0.31	0.23	0.90	0.00	0.61	0.65
	S.4	S.4	2.36	0.00	1.04	0.26	0.00	0.00	0.09	0.84	0.00	0.14	0.67
	S 5	S.5	2.23	0.00	0.61	0.49	0.00	0.00	0.00	1.04	0.00	0.09	0.60
	S a	S a	3.46	0.00	2.75	0.00	0.00	0.00	0.00	0.55	0.00	0.16	0.81
	S b	S b	3.85	0.00	0.92	0.47	0.00	0.00	0.23	2.00	0.00	0.24	0.57
	S c	S c	5.33	0.00	1.13	0.00	0.27	1.40	0.00	2.26	0.00	0.26	0.56
North-Eastern Zone	NE.1	NE.1	3.32	0.00	0.47	0.00	1.46	0.00	0.00	1.34	0.00	0.05	0.57
	NE 2	NE 2.1	4.78	0.00	0.00	0.00	3.70	0.73	0.28	0.04	0.00	0.04	0.68
		NE 2.2	4.75	0.00	0.00	0.26	2.68	0.77	0.09	0.85	0.02	0.07	0.62
	NE 3	NE 3	7.15	0.00	0.17	1.35	1.63	0.49	2.62	0.82	0.01	0.06	0.64
	NE.4	NE.4	2.65	0.00	0.00	1.76	0.31	0.16	0.25	0.17	0.00	0.01	0.73
	NE.5	NE 5.1	10.12	0.00	1.09	0.00	0.00	0.80	4.89	3.32	0.00	0.02	0.53
		NE 5.2	4.72	0.00	1.98	0.00	0.17	0.65	0.32	1.57	0.00	0.03	0.63
		NE 5.3	3.16	0.00	1.71	0.72	0.00	0.00	0.44	0.25	0.00	0.04	0.79
		NE 5.4	10.17	0.67	0.88	0.23	1.34	1.07	1.97	3.97	0.00	0.03	0.54
		NE 5.5	6.21	0.00	1.43	0.00	0.36	0.35	0.40	3.52	0.00	0.17	0.52
	NE a	NE a	3.76	0.00	0.21	0.00	1.32	0.00	0.44	1.65	0.00	0.15	0.54
	NE b	NE b	2.50	0.00	0.00	0.00	0.81	0.00	0.21	1.41	0.00	0.06	0.47
	NE c	NE c	1.62	0.00	0.47	0.26	0.00	0.22	0.00	0.37	0.00	0.30	0.72
South-Eastern Zone	SE.1	SE.1	1.98	0.00	0.00	0.25	0.60	0.00	0.73	0.92	0.00	0.08	0.50
	SE 2	SE 2	2.60	0.00	0.00	1.71	0.00	0.00	0.00	0.82	0.00	0.06	0.65
	SE.3	SE 3	1.92	0.00	0.00	1.57	0.00	0.00	0.10	0.05	0.00	0.19	0.80
	SE.4	SE.4.1	5.40	0.00	0.00	0.00	1.12	0.09	0.29	3.70	0.00	0.21	0.43
		SE 4.2	2.40	0.00	0.00	0.41	0.00	0.00	0.32	1.52	0.00	0.15	0.47
	SE 5	SE 5	3.83	0.00	0.19	2.31	0.00	0.00	0.01	1.25	0.00	0.07	0.65
	SE 6	SE 6	5.10	0.00	3.79	0.00	0.20	0.36	0.00	0.63	0.00	0.13	0.80
	SE 7	SE 7.1	8.39	0.75	0.00	0.00	3.76	0.68	0.00	3.02	0.00	0.17	0.56
		SE 7.2	6.20	0.00	0.02	0.02	1.77	0.99	0.37	2.67	0.00	0.36	0.52
	SE 8	SE 8.1	2.77	0.00	0.00	0.00	1.01	0.00	0.00	1.70	0.00	0.06	0.46
		SE 8.2	8.56	0.00	2.28	0.00	1.00	0.40	0.08	4.52	0.00	0.28	0.55
	SE 9	SE 9.1	7.46	0.63	1.10	1.69	1.06	0.35	0.50	2.01	0.00	0.12	0.65
		SE 9.2	6.26	0.00	0.00	1.29	0.50	0.17	0.41	3.67	0.00	0.22	0.49
		SE 9.3	7.38	0.00	0.00	0.00	3.52	0.00	0.23	3.37	0.00	0.25	0.52
	SE 10	SE 10.1	7.57	0.00	0.00	0.00	0.86	0.00	0.18	5.72	0.00	0.81	0.43
		SE 10.2	11.43	0.00	0.49	2.69	1.70	0.03	0.59	4.95	0.01	0.96	0.58
		SE 10.3	5.88	0.00	0.00	0.00	0.36	0.26	0.23	4.61	0.00	0.43	0.40
	SE a	SE a	3.67	0.00	0.00	2.26	0.00	0.00	0.13	0.53	0.00	0.75	0.76
	SE b	SE b	5.16	0.00	0.00	0.55	0.00	0.00	3.45	0.98	0.00	0.17	0.58
	SE c	SE c	1.82	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.00	0.03	0.31
	SE d	SE d	1.30	0.00	0.49	0.00	0.00	0.00	0.00	0.64	0.00	0.17	0.62
	SE e	SE e	2.77	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00	0.26	0.37
	SE f	SE f	9.52	0.00	0.00	0.00	1.18	0.29	0.45	7.48	0.00	0.12	0.38
		Total (km2)	581.51	2.06	39.91	133.92	86.59	24.19	53.16	158.67	57.99	25.04	
		Percent (%)	100.00	0.35	6.86	23.03	14.89	4.16	9.14	27.29	9.97	4.31	

Com : Commercial Areas
Ind. : Industrial Areas
High R. : High Residential Areas
Med. R. : Medium Residential Areas
Low R. : Low Residential Areas
Inst : Institutional Areas
Green : Green Spaces
Agri. : Agricultural Areas
Water : Water Bodies

Data Source : Urban Planning Institute, Ho Chi Minh City (UPI, HCMC)
Calculation : GIS database : Inner City : Scale = 1/25,000
Outer City : Scale = 1/25,000

Table C.6.4 CRITERIA FOR RUNOFF COEFFICIENT BY LAND USE CATEGORY

Item No.	Main Landuse Group (grouped by JICA Study Team)	Sub-Group for Landuse Category (as in original GIS database by UPI, HCMC)		Run off Coefficient		
		Existing Landuse	Future Landuse (2020)	Normal Range	Hydrological Sub-Institute, HCMC*	Applied by JICA Study Team
1	Commercial Areas	Services, Commerce	Commerce, Services	0.70 - 0.90	0.80	0.80
2	Industrial Areas	Industrial Area Ware House	Industrial Area (Existing) Industrial Area (Planned) Ware House Garbage Treatment Site (Planned)	0.70 - 0.90	0.90	0.90
3	High Residential Areas	Residential (Inner City)	Inner City Suburban Residential Town (Planned)	0.70 - 0.90	0.80	0.80
4	Medium Residential Areas	Residential (Suburban)	Suburban Residential Area (Planned)	0.50 - 0.70	0.60	0.70
5	Low Residential Areas		Existing Residential Area (Suburban)	0.30 - 0.50	0.40	0.60
6	Institutional Areas	Administrative Office Education Health Care Social Culture, Sports Military Preservative Works Religion Transportation Stations Public Works Technical Works	City Center District Center Center of an Area Culture, Education Tourism Military	0.40 - 0.60	0.50	0.60
7	Green Spaces	Green Park Cemetary	Green Park (Planned) Ecological Forestry	0.10 - 0.30	0.30	0.30
8	Agricultural Areas	Agriculture	Agriculture	0.10 - 0.60	0.15	0.40
9	Water Bodies	River, Canal	River, Canal			1.00

* : "Research the drainage capacity and measure for the inner area of Ho Chi Minh City"; Hydrological Sub-Institute of HCMC; 1989

Table C.6.5 URBANIZATION AND RUNOFF COEFFICIENTS

Zone		Catchment		Existing Landuse Area (km2)				Future (2020) Landuse Area (km2)				Runoff Coefficient			
				Urbanized		Non-Urbanized		Urbanized		Non-Urbanized		Catchment		Zone	
ID	Area (km2)	ID	Area (km2)	Catchment	Zone	Catchment	Zone	Catchment	Zone	Catchment	Zone	Existing	Future	Existing	Future
		N 1	19.87	2.88		16.98		6.85		13.01		0.46	0.51		
N	136.18	N 2	107.57	41.54	46.60	66.03	89.58	68.81	80.35	38.75	55.83	0.53	0.60	0.52	0.58
		N a	8.75	2.17		6.58		4.68		4.06		0.48	0.52		
		C 1	31.67	29.76		1.91		29.59		2.07		0.75	0.76		
		C 2	5.14	3.81		1.33		4.47		0.67		0.74	0.78		
		C 3	20.22	12.41		7.81		16.67		3.56		0.67	0.74		
C	106.41	C 4	41.50	25.61	75.38	15.89	31.03	32.45	87.56	9.05	18.85	0.70	0.70	0.70	0.72
		C a	4.91	1.14		3.77		2.10		2.81		0.51	0.53		
		C b	1.28	1.13		0.16		0.75		0.54		0.80	0.64		
		C c	1.68	1.52		0.16		1.53		0.16		0.66	0.59		
W	72.91	W 1	72.91	14.39	14.39	58.52	58.52	33.62	33.62	39.29	39.29	0.48	0.56	0.48	0.56
		S 1	14.33	0.87		13.46		3.71		10.62		0.47	0.52		
		S 2	15.66	1.53		14.13		5.12		10.54		0.48	0.53		
		S 3	34.51	3.54		30.97		20.96		13.55		0.50	0.63		
S	81.74	S 4	2.36	1.40	11.38	0.96	70.36	1.39	39.46	0.97	42.28	0.68	0.67	0.50	0.59
		S 5	2.23	0.18		2.05		1.10		1.13		0.46	0.60		
		S a	3.46	2.26		1.20		2.75		0.71		0.74	0.81		
		S b	3.86	0.42		3.44		1.62		2.24		0.47	0.57		
		S c	5.33	1.17		4.15		2.81		2.52		0.50	0.56		
		NE 1	3.32	0.54		2.78		1.93		1.39		0.46	0.57		
		NE 2	9.53	1.97		7.56		8.51		1.02		0.47	0.65		
		NE 3	7.15	2.39		4.75		6.25		0.89		0.50	0.64		
NE	64.93	NE 4	2.65	1.50	12.38	1.15	52.53	2.48	44.58	0.18	20.33	0.57	0.73	0.47	0.59
		NE 5	34.38	5.13		29.25		21.46		12.92		0.45	0.57		
		NE a	3.76	0.20		3.57		1.97		1.79		0.44	0.54		
		NE b	2.50	0.16		2.34		1.02		1.47		0.44	0.47		
		NE c	1.62	0.49		1.13		0.95		0.67		0.66	0.72		
		SE 1	1.98	0.22		1.75		0.98		1.00		0.46	0.50		
		SE 2	2.60	0.20		2.39		1.71		0.88		0.44	0.65		
		SE 3	1.92	0.13		1.78		1.68		0.24		0.48	0.80		
		SE 4	7.80	1.55		6.25		2.23		5.57		0.49	0.44		
		SE 5	3.83	0.58		3.25		2.51		1.32		0.46	0.65		
		SE 6	5.10	0.74		4.36		4.35		0.76		0.46	0.80		
		SE 7	14.58	2.43		12.15		8.36		6.22		0.48	0.55		
SE	119.36	SE 8	11.33	1.06	13.54	10.27	105.82	4.76	54.25	6.57	65.11	0.45	0.53	0.46	0.53
		SE 9	21.11	2.52		18.59		11.46		9.64		0.45	0.56		
		SE 10	24.88	0.98		23.89		7.40		17.48		0.46	0.49		
		SE a	3.67	1.09		2.57		2.39		1.28		0.61	0.76		
		SE b	5.16	1.00		4.16		4.01		1.15		0.48	0.58		
		SE c	1.82	0.16		1.66		0.00		1.82		0.44	0.31		
		SE d	1.30	0.44		0.86		0.49		0.81		0.56	0.62		
		SE e	2.77	0.00		2.77		0.00		2.77		0.46	0.37		
		SE f	9.52	0.42		9.11		1.92		7.60		0.42	0.38		
		Total Area (km2)	581.51	173.66		407.85		339.81		241.70					
		Percent (%)	100.00	29.86		70.14		58.44		41.56					

Urbanized : Sub-Total of commercial, industrial, residential and institutional areas
Non-Urbanized : Sub-Total of green spaces, agricultural areas and water bodies

Data Source : Urban Planning Institute, Ho Chi Minh City (UPI, HCMC)
Measurement : GIS database Inner City => Scale = 1/10,000 (for existing landuse) and 1/25,000 (for future landuse)
Outer City => Scale = 1/25,000 (for both existing and future landuse)

Table C.6.6 PEAK RUNOFF CALCULATION FOR OUTFLOW FROM DAIHAN CANAL (ALTERNATIVE 1)

Drainage Area	Catchment	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Point ID	Runoff Point Area (km2)	C Ex.	C Fut.	L_i (km)	T_i (min) Ex	T_i (min) Fut.	Vr (m/s) by Segment Ex.	Vr (m/s) by Segment Fut	Lr (km) Segment	Lr (km) Cumulative	Cumulative Tr (min) Ex.	Cumulative Tr (min) Fut.	Cumulative Tc (min) Ex	Cumulative Tc (min) Fut.	I for 5-yr (mm/hr) Ex	I for 5-yr (mm/hr) Fut	I for 10-yr (mm/hr) Ex.	I for 10-yr (mm/hr) Fut	f	Q_p for 5-yr (m3/s) Ex	Q_p for 5-yr (m3/s) Fut	Q_p for 10-yr (m3/s) Ex	Q_p for 10-yr (m3/s) Fut
Northern Zone	N.2	N.2.1	11.67	N.2.A	11.67		0.48	3.47		100		0.70	0.97	0.97		23		124		46.0		51.5	0.96		69		77
		N.2.2	6.43	N.2.B	18.10		0.47					0.70	1.68	2.65		63		163		35.4		39.4	0.94		78		87
		N.2.3	11.24	N.2.C	29.33		0.50					0.60	4.09	6.74		177		277		20.7		22.6	0.91		78		83
		N.2.4	5.32	N.2.D1	34.65		0.52					0.40	2.49	9.23		281		381		15.3		16.7	0.90		78		83
		N.2.5	10.98	N.2.D2	10.98		0.63	3.52		193		0.30	3.34	3.34		186		379		15.4		16.8	0.96		28		31
				N.2.D	45.63		0.55							9.23		281		381		15.3		16.7	0.88		93		101
		N.2.6	11.19	N.2.E	56.82		0.57					0.35	1.56	10.79		355		455		13.0		14.2	0.86		99		108
		N.2.7	7.48	N.2.F	64.30		0.58					0.35	2.25	13.04		462		562		10.7		11.7	0.84		99		108
		N.2.8	13.93	N.2.G1	78.22		0.59					0.35	4.37	17.41		670		770		8.1		8.9	0.83		99		108
		N.2.9	6.32	N.2.G2	6.32		0.49	2.16		123		0.30	3.10	3.10		172		295		19.5		21.3	0.98		16		18
		N.2.10	5.54	N.2.G3	11.86		0.53					0.35	2.49	5.59		291		413		14.2		15.5	0.96		24		26
				N.2.G	90.09		0.59							17.41		670		770		8.1		8.9	0.81		99		108
		N.2.11	5.71	N.2.H	95.79		0.59					0.35	1.57	18.98		745		845		7.4		8.2	0.81		99		108
		N.2.12	4.89	N.2.I	100.68		0.59					0.35	2.50	21.48		864		964		6.6		7.3	0.81		99		108
		N.2.13	6.89	N.2.J	107.57		0.60					0.35	2.61	24.09		988		1088		5.9		6.6	0.81		99		108
Western Zone	W.1	W.1.1	9.68	W.1.A	9.68		0.66	3.00		68		0.50	2.60	2.60		87		154		37.5		41.8	0.97		65		72
		W.1.2	5.14	W.1.B	14.81		0.59					0.40	2.05	4.65		172		239		23.9		26.1	0.95		65		72
		W.1.3	4.73	W.1.C1	19.55		0.55					0.40	4.11	8.76		343		411		14.3		15.6	0.94		65		72
		W.1.4	8.62	W.1.C2	8.62		0.52	3.20		88		0.30	2.20	2.20		122		211		27.2		29.7	0.97		33		36
				W.1.C	28.16		0.54							8.76		343		411		14.3		15.6	0.92		65		72
		W.1.5	8.20	W.1.D1	36.36		0.57					0.40	4.49	13.25		531		598		10.1		11.1	0.90		65		72
		W.1.6	3.20	W.1.D2	3.20		0.69	1.80		52		0.30	2.07	2.07		115		167		34.7		38.7	0.99		21		23
				W.1.D	39.56		0.58							13.25		531		598		10.1		11.1	0.89		65		72
		W.1.7	3.70	W.1.E1	43.26		0.58					0.40	2.72	15.97		644		711		8.7		9.5	0.88		65		72
		W.1.8	6.04	W.1.E2	6.04		0.44	1.22		74		0.30	4.90	4.90		272		346		16.8		18.3	0.98		12		13
		W.1.9	0.99	W.1.E3	7.02		0.50					0.40	1.36	6.26		329		402		14.5		15.9	0.98		14		15
				W.1.E	50.28		0.57							15.97		644		711		8.7		9.5	0.87		65		72
		W.1.10	0.27	W.1.F	50.55		0.57					0.40	1.18	17.15		693		760		8.2		9.0	0.87		65		72
		W.1.11	8.85	W.1.G	59.41		0.57					0.40	1.85	18.99		770		837		7.5		8.3	0.85		65		72
		W.1.12	13.50	W.1.H	72.91		0.56					0.40	1.76	20.75		843		910		7.0		7.7	0.83		65		72

Details of Runoff Calculation by Rational Formula

C = Runoff coefficient; L_i = Inlet length; T_i = Inlet time; Vr = Flow velocity; Lr = Flow length; Tr = Flow time
T_c = Time of concentration; I = Rainfall intensity; f = Areal reduction factor; Q_p = Peak runoff

Note: It is assumed that outflow from Rach Daihan will be discharged into Rach Tham Luong - Rach Ben Cat system.

Table C.6.7 PEAK RUNOFF CALCULATION FOR OUTFLOW FROM DAIHAN CANAL (ALTERNATIVE 2)

Drainage Area	Catchment	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Point ID	Runoff Point Area (km2)	C Ex	C Fut	Li (km)	Ti (min) Ex.	Ti (min) Fut.	Vr (m/s) by Segment Ex	Vr (m/s) by Segment Fut.	Lr (km) Segment	Lr (km) Cumulative	Cumulative Tr (min) Ex.	Cumulative Tr (min) Fut	Cumulative Tc (min) Ex.	Cumulative Tc (min) Fut.	I for 5-yr (mm/hr) Ex	I for 5-yr (mm/hr) Fut.	I for 10-yr (mm/hr) Ex	I for 10-yr (mm/hr) Fut.	f	Qp for 5-yr (m3/s) Ex.	Qp for 5-yr (m3/s) Fut.	Qp for 10-yr (m3/s) Ex.	Qp for 10-yr (m3/s) Fut
Northern Zone	N.2	N.2.6	11.19	N.2.E	11.19		0.66	2.10		65		1.00	3.60	3.60		60		125		45.6		51.0	0.96		90		100
		N.2.7	7.48	N.2.F	18.66		0.66					0.35	2.25	5.85		167		232		24.7		26.9	0.94		90		100
		N.2.8	13.93	N.2.G1	32.59		0.66					0.35	4.37	10.21		375		440		13.4		14.6	0.91		90		100
		N.2.9	6.32	N.2.G2	6.32		0.49	2.16		123		0.30	3.10	3.10		172		295		19.5		21.3	0.98		16		18
		N.2.10	5.54	N.2.G3	11.86		0.53					0.35	2.49	5.59		291		413		14.2		15.5	0.96		24		26
				N.2.G	44.45		0.63							10.21		375		440		13.4		14.6	0.88		90		100
		N.2.11	5.71	N.2.H	50.16		0.64					0.35	1.57	11.79		450		515		11.6		12.7	0.87		90		100
		N.2.12	4.89	N.2.I	55.05		0.64					0.35	2.50	14.28		569		633		9.6		10.5	0.86		90		100
		N.2.13	6.89	N.2.J	61.94		0.65					0.35	2.61	16.89		693		758		8.2		9.0	0.85		90		100
		N.2.1	11.67	N.2.A	11.67		0.48	3.47		100		0.70	0.97	0.97		23		124		46.0		51.5	0.96		99		77
		N.2.2	6.43	N.2.B	18.10		0.47					0.70	1.68	2.65		63		163		35.4		39.4	0.94		78		87
		N.2.3	11.24	N.2.C	29.33		0.50					0.60	4.09	6.74		177		277		20.7		22.6	0.91		78		87
		N.2.4	5.32	N.2.D1	34.65		0.52					0.40	2.49	9.23		281		381		15.3		16.7	0.90		78		87
		N.2.5	10.98	N.2.D2'	45.63		0.55					0.30	3.34	12.58		466		567		10.6		11.6	0.88		78		87
Western Zone	W.1	W.1.1	9.68	W.1.A'	9.68		0.66	3.00		68		0.30	2.60	2.60		87		154		37.5		41.8	0.97		65		72
				W.1.A	55.31		0.57					0.30	0.50	13.07		483		583		10.4		11.3	0.86		78		87
		W.1.2	5.14	W.1.B	60.45		0.56					0.40	2.05	15.12		568		668		9.2		10.1	0.85		78		87
		W.1.3	4.73	W.1.C1	65.18		0.55					0.40	4.11	19.23		740		840		7.5		8.2	0.84		78		87
		W.1.4	8.62	W.1.C2	8.62		0.52	3.20		88		0.30	2.20	2.20		122		211		27.2		29.7	0.97		33		36
				W.1.C	73.79		0.54							19.23		740		840		7.5		8.2	0.83		78		87
		W.1.5	8.20	W.1.D1	81.99		0.55					0.40	4.49	23.73		927		1027		6.3		6.9	0.82		78		87
		W.1.6	3.20	W.1.D2	3.20		0.69	1.80		52		0.30	2.07	2.07		115		167		34.7		38.7	0.99		21		23
				W.1.D	85.19		0.56							23.73		927		1027		6.3		6.9	0.82		78		87
		W.1.7	3.70	W.1.E1	88.89		0.56					0.40	2.72	26.44		1040		1140		5.7		6.3	0.82		78		87
		W.1.8	6.04	W.1.E2	6.04		0.44	1.22		74		0.30	4.90	4.90		272		346		16.8		18.3	0.98		12		13
		W.1.9	0.99	W.1.E3	7.02		0.50					0.40	1.36	6.26		329		402		14.5		15.9	0.98		14		15
				W.1.E	95.91		0.56							26.44		1040		1140		5.7		6.3	0.81		78		87
		W.1.10	0.27	W.1.F	96.19		0.56					0.40	1.18	27.62		1089		1189		5.5		6.1	0.81		78		87
		W.1.11	8.85	W.1.G	105.04		0.56					0.40	1.85	29.47		1166		1266		5.2		5.8	0.81		78		87
		W.1.12	13.50	W.1.H	118.54		0.56					0.40	1.76	31.22		1239		1339		5.0		5.5	0.81		78		87

Details of Runoff Calculation by Rational Formula

C = Runoff coefficient; Li = Inlet length; Ti = Inlet time; Vr = Flow velocity; Lr = Flow length; Tr = Flow time
Tc = Time of concentration; I = Rainfall intensity; f = Areal reduction factor; Qp = Peak runoff

Note : It is assumed that outflow from Rach Daihan will be discharged into Rach Tham Luong - Rach Ben Cat system.

Table C.6.8 PEAK RUNOFF CALCULATION BY RATIONAL METHOD (1/2)

Drainage Area	Catchment ID	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Point ID	Runoff Point Area (km2)	C Ex.	C Fut.	Li (km)	Ti (min) Ex	Ti (min) Fut.	Vf (m/s) by Segment Ex.	Vf (m/s) by Segment Fut.	Lf (km) Segment	Lf (km) Cumulative	Cumulative Tf (min) Ex	Cumulative Tf (min) Fut.	Cumulative Tc (min) Ex	Cumulative Tc (min) Fut.	I for 5-yr (mm/hr) Ex.	I for 5-yr (mm/hr) Fut.	I for 10-yr (mm/hr) Ex	I for 10-yr (mm/hr) Fut.	f	Qp for 5-yr (m3/s) Ex	Qp for 5-yr (m3/s) Fut.	Qp for 10-yr (m3/s) Ex.	Qp for 10-yr (m3/s) Fut.
Northern Zone	N.1*	N.1.1	3.33	N.1.A	3.33	0.44	0.51	1.53	56	50	0.31	0.35	1.07	1.07	58	51	114	101	49.3	54.9	55.2	61.5	0.99	20	25	22	29
		N.1.2	6.60	N.1.B	9.93	0.48	0.55				0.30	0.35	2.78	3.85	211	183	266	233	21.5	24.5	23.5	26.8	0.97	28	36	30	39
		N.1.3	4.25	N.1.C	14.17	0.47	0.52				0.45	0.50	2.04	5.89	266	251	341	301	17.0	19.1	18.5	20.8	0.96	30	37	32	40
		N.1.4	5.69	N.1.D	19.87	0.46	0.51				0.45	0.50	3.61	9.50	419	372	475	421	12.5	13.9	13.6	15.2	0.94	30	37	32	40
	N.2**	N.2.1	11.67	N.2.A	11.67	0.50	0.48	3.47	100	100	0.70	0.70	0.97	0.97	23	23	124	124	46.0	46.0	51.5	51.5	0.96	69	69	77	77
		N.2.2	6.43	N.2.B	18.10	0.50	0.47				0.70	0.70	1.68	2.65	63	63	163	163	35.4	35.4	39.4	39.4	0.94	78	78	87	87
		N.2.3	11.24	N.2.C	29.33	0.49	0.50				0.59	0.60	4.09	6.74	179	177	279	277	20.6	20.7	22.4	22.6	0.91	78	78	87	83
		N.2.4	5.32	N.2.D1	34.65	0.49	0.52				0.37	0.40	2.49	9.23	290	281	390	381	15.0	15.3	16.3	16.7	0.90	78	78	87	83
		N.2.5	10.98	N.2.D2	10.98	0.48	0.63	3.52	249	193	0.23	0.30	3.34	3.34	242	186	491	379	12.1	15.4	13.2	16.8	0.96	17	28	19	31
				N.2.D	45.63	0.49	0.55							9.23	290	281	491	381	12.1	15.3	13.2	16.7	0.88	65	93	71	101
		N.2.6	11.19	N.2.E	56.82	0.52	0.57				0.32	0.35	1.56	10.79	371	355	471	455	12.6	13.0	13.7	14.2	0.86	88	99	96	108
		N.2.7	7.48	N.2.F	64.30	0.52	0.58				0.32	0.35	2.25	13.04	490	462	590	562	10.2	10.7	11.2	11.7	0.84	88	99	96	108
		N.2.8	13.93	N.2.G1	78.22	0.53	0.59				0.31	0.35	4.37	17.41	724	670	824	770	7.6	8.1	8.4	8.9	0.83	88	99	96	108
		N.2.9	6.32	N.2.G2	6.32	0.50	0.49	2.16	123	123	0.30	0.30	3.10	3.10	172	172	295	295	19.5	19.5	21.3	21.3	0.98	16	16	18	18
		N.2.10	5.54	N.2.G3	11.86	0.50	0.53				0.33	0.35	2.49	5.59	298	291	421	413	13.9	14.2	15.2	15.5	0.96	22	24	24	26
				N.2.G	90.09	0.52	0.59							17.41	724	670	824	770	7.6	8.1	8.4	8.9	0.81	88	99	96	108
		N.2.11	5.71	N.2.H	95.79	0.53	0.59				0.31	0.35	1.57	18.98	808	745	908	845	7.0	7.4	7.7	8.2	0.81	88	99	96	108
		N.2.12	4.89	N.2.I	100.68	0.53	0.59				0.31	0.35	2.50	21.48	942	864	1042	964	6.2	6.6	6.9	7.3	0.81	88	99	96	108
		N.2.13	6.89	N.2.J	107.57	0.53	0.60				0.31	0.35	2.61	24.09	1083	988	1183	1088	5.5	5.9	6.1	6.6	0.81	88	99	96	108
Central Zone	C.1	C.1.1	7.54	C.1.A	7.54	0.76	0.76	4.00	72	72	1.50	1.50	0.55	0.55	6	6	78	78	67.2	67.2	75.4	75.4	0.98	104	104	117	117
		C.1.2	3.55	C.1.B	11.09	0.76	0.76				0.70	0.70	2.14	2.69	57	57	129	129	44.2	44.2	49.4	49.4	0.96	104	104	117	117
		C.1.3	5.87	C.1.C	16.96	0.76	0.77				0.69	0.70	1.77	4.46	100	99	172	171	33.6	33.8	37.4	37.6	0.95	114	116	127	129
		C.1.4	7.58	C.1.D	24.54	0.75	0.76				0.69	0.70	2.32	6.78	156	155	228	227	25.1	25.2	27.3	27.5	0.93	118	121	129	131
		C.1.5	7.13	C.1.E	31.67	0.75	0.76				0.69	0.70	2.15	8.94	208	206	280	278	20.5	20.7	22.3	22.5	0.91	123	126	134	137
	C.2	C.2	5.14	C.2.A	5.14	0.74	0.78	1.43	31	29	0.38	0.40	2.09	2.09	92	87	122	116	46.4	48.5	51.9	54.3	0.98	49	53	54	60
	C.3	C.3.1	5.86	C.3.A	5.86	0.80	0.79	1.80	45	45	1.40	1.40	2.26	2.26	27	27	72	72	71.1	71.1	79.8	79.8	0.98	90	90	101	101
		C.3.2	4.72	C.3.B	10.58	0.76	0.74				1.20	1.20	1.97	4.23	54	54	100	100	55.4	55.4	62.1	62.1	0.97	117	117	131	131
		C.3.3	3.77	C.3.C1	14.35	0.74	0.76				0.58	0.60	2.84	7.07	135	133	181	179	31.8	32.5	34.9	36.1	0.95	117	117	131	131
		C.3.4	5.88	C.3.C2	5.88	0.49	0.69	2.00	99	72	0.29	0.40	1.50	1.50	88	63	187	135	30.7	42.6	33.7	47.6	0.98	24	47	26	52
	C.4	C.4.1	1.84	C.4.A1	1.84	0.74	0.85	0.59	17	15	0.35	0.40	3.34	3.34	161	139	178	154	32.6	37.4	36.2	41.7	0.99	12	16	14	18
		C.4.2	2.88	C.4.A2	2.88	0.45	0.67	1.60	131	88	0.26	0.40	3.33	3.33	210	139	342	227	17.0	25.2	18.5	27.5	0.99	6	13	7	15
		C.4.3	3.41	C.4.A3	3.41	0.49	0.62	1.51	105	84	0.31	0.40	2.56	2.56	136	107	241	190	23.8	30.1	25.9	33.0	0.99	11	18	12	19
		C.4.4	3.11	C.4.A4	6.52	0.48	0.58				0.34	0.40	3.18	5.75	294	239	399	344	14.7	16.8	16.0	18.3	0.98	13	18	14	19
				C.4.A	31.46	0.61	0.71							7.07	294	239	399	344	14.7	16.8	16.0	18.3	0.91	117	117	131	131
		C.4.5	5.24	C.4.B	36.71	0.64	0.71				0.36	0.40	2.02	9.09	387	323	433	369	13.6	15.8	14.8	17.2	0.90	117	117	131	131
		C.4.6	7.51	C.4.C	44.22	0.66	0.71				0.37	0.40	1.40	10.49	450	382	496	427	12.0	13.8	13.1	15.0	0.88	117	117	131	131
		C.4.7	6.64	C.4.D	50.86	0.67	0.71				0.38	0.40	1.97	12.46	537	464	582	509	10.4	11.7	11.4	12.8	0.87	117	117	131	131
		C.4.8	10.86	C.4.E	61.73	0.69	0.71				0.39	0.40	4.25	16.71	720	641	765	687	8.1	8.9	8.9	9.8	0.85	117	117	131	131
Western Zone	W.1	W.1.1	9.68	W.1.A	9.68	0.61	0.66	3.00	73	68	0.46	0.50	2.60	2.60	95	87	168	154	34.5	37.5	38.4	41.8	0.97	55	65	61	72
		W.1.2	5.14	W.1.B	14.81	0.55	0.59				0.37	0.40	2.05	4.65	186	172	260	239	22.1	23.9	24.0	26.1	0.95	55	65	61	72
		W.1.3	4.73	W.1.C1	19.55	0.52	0.55				0.38	0.40	4.11	8.76	368	343	441	411	13.4	14.3	14.6	15.6	0.94	55	65	61	72
		W.1.4	8.62	W.1.C2	8.62	0.47	0.52	3.20	97	88	0.27	0.30	2.20	2.20	135	122	231	211	24.7	27.2	27.0	29.7	0.97	27	33	30	36
				W.1.C	28.16	0.50	0.54							8.76	368	343	441	411	13.4	14.3	14.6	15.6	0.92	55	65	61	72
		W.1.5	8.20	W.1.D1	36.36	0.49	0.57				0.35	0.40	4.49	13.25	585	531	658	598	9.3	10.1	10.2	11.1	0.90	55	65	61	72
		W.1.6	3.20	W.1.D2	3.20	0.54	0.69	1.80	64	52	0.24	0.30	2.07	2.07	146	115	210	167	27.3	34.7	29.8	38.7	0.99	13	21	14	23
				W.1.D	39.56	0.49	0.58							13.25	585	531	658	598	9.3	10.1	10.2	11.1	0.89	55	65	61	72
		W.1.7	3.70	W.1.E1	43.26	0.49	0.58				0.34	0.40	2.72	15.97	719	644	792	711	7.9	8.7	8.7	9.5	0.88	55	65	61	72
		W.1.8	6.04	W.1.E2	6.04	0.44	0.44	1.22	74	74	0.30	0.30	4.90	4.90	274	272	348	346	16.7	16.8	18.2	18.3	0.98	12	12	13	13
		W.1.9	0.99	W.1.E3	7.02	0.45	0.50				0.37	0.40	1.36	6.26	335	329	410	402	14.3	14.5	15.6	15.9	0.98	12	14	14	15
				W.1.E	50.28	0.49	0.57							15.97	719	644	792	711	7.9	8.7	8.7	9.5	0.87	55	65	61	72
		W.1.10	0.27	W.1.F	50.55	0.49	0.57				0.34	0.40	1.18	17.15	776	693	849	760	7.4	8.2	8.2	9.0	0.87	55	65	61	72
		W.1.11	8.85	W.1.G	59.41	0.49	0.57				0.34	0.40	1.85	18.99	866	770	939	837	6.8	7.5	7.5	8.3	0.85	55	65	61	72
		W.1.12	13.50	W.1.H	72.91	0.48	0.56				0.34	0.40	1.76	20.75	951	843	1024	910	6.3	7.0	7.0	7.7	0.83	55	65	61	72

C = Runoff coefficient; Li = Inlet length; Ti = Inlet time; Vf = Flow velocity; Lf = Flow length; Tf = Flow time; Tc = Time of concentration
I = Rainfall intensity; f = Areal reduction factor; Qp = Peak runoff
* = Considering inundation along the upstream reaches of Rach Ben Da - Rach Ba Hong, reduced flow velocities due to flood plain storage have been applied.
** = Considering inundation, reduced velocities due to flood plain storage have been applied for flow through Rach Daihan. Outflow from Rach Daihan is assumed to be discharged into Rach Tham Luong - Rach Ben Cat system, not to Kinh 19 Thang 5

Table C.6.8 PEAK RUNOFF CALCULATION BY RATIONAL METHOD (2/2)

Drainage Area	Catchment ID	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Point ID	Runoff Point Area (km2)	C Ex	C Fut	Li (km)	Ti (min) Ex	Ti (min) Fut	Vr (m/s) by Segment Ex	Vr (m/s) by Segment Fut	Lr (km) Segment	Lr (km) Cumulative	Cumulative Tr (min) Ex	Cumulative Tr (min) Fut	Cumulative Tc (min) Ex	Cumulative Tc (min) Fut	I for 5-yr (mm/hr) Ex	I for 5-yr (mm/hr) Fut	I for 10-yr (mm/hr) Ex	I for 10-yr (mm/hr) Fut	f	Qp for 5-yr (m3/s) Ex	Qp for 5-yr (m3/s) Fut	Qp for 10-yr (m3/s) Ex	Qp for 10-yr (m3/s) Fut
Southern Zone	S.1	S.1.1	2.68	S.1.A	2.68	0.49	0.57	0.41	35	31	0.34	0.40	2.54	2.54	124	106	158	137	36.5	41.8	40.7	46.7	0.99	13	18	15	20
		S.1.2	4.04	S.1.B1	6.72	0.48	0.53				0.36	0.40	2.51	5.06	239	211	274	242	21.0	23.7	22.8	25.8	0.98	18	23	20	25
		S.1.3	4.38	S.1.B2	4.38	0.47	0.55	0.78	58	50	0.34	0.40	4.00	4.00	196	167	254	217	22.6	26.3	24.6	28.7	0.99	13	17	14	19
		S.1.4	1.96	S.1.B3	6.33	0.46	0.52				0.36	0.40	2.06	6.07	293	253	350	303	16.6	19.0	18.0	20.7	0.98	13	17	14	19
				S.1.B	13.05	0.47	0.52							6.07	293	253	350	303	16.6	19.0	18.0	20.7	0.96	27	34	29	37
		S.1.5	1.27	S.1.C	14.33	0.47	0.52				0.36	0.40	1.39	7.46	357	311	391	342	14.9	16.9	16.3	18.4	0.95	27	34	29	37
	S.2	S.2.1	2.40	S.2.A1	2.40	0.50	0.48	1.22	74	74	0.40	0.40	2.02	2.02	84	84	158	158	36.6	36.6	40.8	40.8	0.99	12	12	13	13
		S.2.2	1.96	S.2.A2	1.96	0.50	0.59	1.17	82	71	0.34	0.40	1.90	1.90	93	79	175	150	33.1	38.4	36.8	42.9	0.99	9	12	10	14
				S.2.A	4.36	0.50	0.53							2.02	93	84	175	158	33.1	36.6	36.8	40.8	0.99	20	23	22	26
		S.2.3	2.85	S.2.B	7.21	0.50	0.52				0.39	0.40	1.51	3.53	158	147	240	218	23.8	26.2	26.0	28.6	0.98	23	26	25	29
		S.2.4	8.45	S.2.C	15.66	0.48	0.53				0.36	0.40	3.39	6.92	314	288	396	359	14.8	16.2	16.1	17.6	0.95	29	36	32	39
	S.3	S.3.1	2.17	S.3.A	2.17	0.53	0.71	1.02	76	58	0.30	0.40	1.57	1.57	87	65	163	123	35.4	46.1	39.5	51.5	0.99	11	20	13	22
		S.3.2	2.32	S.3.B1	4.49	0.50	0.73				0.28	0.40	2.43	3.99	233	166	309	225	18.7	25.5	20.3	27.8	0.99	12	23	13	25
		S.3.3	4.79	S.3.B2	4.79	0.53	0.74	1.20	92	68	0.29	0.40	3.12	3.12	181	130	272	198	21.1	29.0	23.0	31.7	0.98	15	28	16	31
		S.3.4	5.75	S.3.B3	5.75	0.47	0.56	2.55	167	143	0.34	0.40	3.58	3.58	176	149	344	292	16.9	19.7	18.4	21.5	0.98	12	17	14	19
				S.3.B	15.03	0.50	0.67							3.99	233	166	344	292	16.9	19.7	18.4	21.5	0.95	34	52	37	57
		S.3.5	4.31	S.3.C	19.33	0.49	0.65				0.30	0.40	2.60	6.59	376	275	452	333	13.1	17.4	14.3	18.9	0.94	34	57	37	62
		S.3.6	4.34	S.3.D1	23.68	0.50	0.65				0.31	0.40	2.63	9.22	517	384	594	442	10.2	13.3	11.2	14.5	0.93	34	57	37	62
		S.3.7	6.45	S.3.D2	6.45	0.47	0.54	2.04	133	116	0.35	0.40	3.41	3.41	164	142	297	259	19.4	22.2	21.1	24.1	0.98	16	21	17	23
				S.3.D	30.13	0.49	0.63							9.22	517	384	594	442	10.2	13.3	11.2	14.5	0.91	38	64	42	69
		S.3.8	4.38	S.3.E	34.51	0.50	0.63				0.32	0.40	2.41	11.63	644	485	720	543	8.6	11.1	9.4	12.1	0.90	38	64	42	69
	S.4	S.4	2.36	S.4.A	2.36	0.68	0.67	0.92	53	53	0.40	0.40	1.92	1.92	80	80	133	133	43.1	43.1	48.2	48.2	0.99	19	19	21	21
	S.5	S.5	2.23	S.5.A	2.23	0.46	0.60	0.65	49	39	0.31	0.40	1.86	1.86	101	77	150	116	38.5	48.5	43.0	54.3	0.99	11	18	12	20
North-Eastern Zone	NE.1	NE.1	3.32	NE.1.A	3.32	0.46	0.57	0.31	25	21	0.32	0.40	3.58	3.58	186	149	211	170	27.1	34.0	29.6	37.9	0.99	11	18	12	20
	NE.2	NE.2.1	4.78	NE.2.A	4.78	0.47	0.68	2.90	93	65	0.27	0.40	2.57	2.57	156	107	249	172	23.0	33.6	25.1	37.4	0.98	14	30	15	33
		NE.2.2	4.75	NE.2.B	9.53	0.47	0.65				0.29	0.40	2.20	4.76	282	198	376	264	15.5	21.7	16.9	23.7	0.97	19	36	20	39
	NE.3	NE.3	7.15	NE.3.A	7.15	0.50	0.64	2.70	76	61	0.32	0.40	3.14	3.14	166	100	242	161	23.6	35.8	25.7	39.9	0.98	23	44	25	49
	NE.4	NE.4	2.65	NE.4.A	2.65	0.57	0.73	2.29	65	55	0.32	0.40	2.17	2.17	114	91	180	143	32.3	40.2	35.9	44.9	0.99	14	21	15	24
	NE.5	NE.5.1	10.12	NE.5.A1	10.12	0.42	0.53	1.50	45	36	2.33	3.00	3.35	3.35	24	19	69	55	73.4	85.6	82.4	96.0	0.97	83	124	93	140
		NE.5.2	4.72	NE.5.A2	4.72	0.46	0.63	1.50	48	36	2.90	4.00	2.34	2.34	13	10	62	46	79.5	95.0	89.2	106.4	0.98	47	77	53	87
				NE.5.A	14.84	0.43	0.57							3.35	24	19	69	55	73.4	85.6	82.4	96.0	0.95	124	190	139	213
		NE.5.3	3.16	NE.5.B	17.99	0.45	0.60				1.84	2.50	1.70	5.05	39	30	85	66	63.2	75.7	71.0	85.0	0.94	133	216	149	243
		NE.5.4	10.17	NE.5.C	28.17	0.45	0.58				0.77	1.00	2.83	7.88	100	77	146	113	39.5	49.6	44.1	55.6	0.92	133	216	149	243
		NE.5.5	6.21	NE.5.D1	34.38	0.45	0.57				0.32	0.40	4.44	12.32	333	262	378	298	15.4	19.3	16.8	21.0	0.90	133	216	149	243
South-Eastern Zone	SE.10	SE.10.1	7.57	SE.10.A	7.57	0.47	0.43	2.00	114	114	0.40	0.40	3.62	3.62	151	151	265	265	21.6	21.6	23.6	23.6	0.98	19	19	21	21
		SE.10.2	11.43	SE.10.B	19.00	0.47	0.52				0.36	0.40	4.08	7.71	340	321	454	435	13.0	13.5	14.2	14.7	0.94	30	35	33	38
				NE.5.D	53.38	0.46	0.55							12.32	340	321	454	435	13.0	13.5	14.2	14.7	0.86	133	216	149	243
		SE.10.3	5.88	SE.10.C	59.26	0.46	0.54				0.34	0.40	2.41	14.73	458	422	503	458	11.8	12.9	12.9	14.1	0.85	133	216	149	243
	SE.1	SE.1	1.98	SE.1.A	1.98	0.46	0.50	0.50	33	31	0.37	0.40	2.32	2.32	105	96	138	128	41.6	44.7	46.4	50.0	0.99	10	12	12	14
	SE.2	SE.2	2.60	SE.2.A	2.60	0.44	0.65	0.50	43	31	0.27	0.40	2.08	2.08	127	86	170	118	34.1	48.1	37.9	53.8	0.99	11	22	12	25
	SE.3	SE.3	1.92	SE.3.A	1.92	0.48	0.80	1.85	164	101	0.24	0.40	2.50	2.50	172	104	336	205	17.2	27.9	18.7	30.5	0.99	4	12	5	13
	SE.4	SE.4.1	5.40	SE.4.A	5.40	0.49	0.43	0.92	58	58	0.40	0.40	3.41	3.41	142	142	200	200	28.6	28.6	31.3	31.3	0.98	18	18	20	20
		SE.4.2	2.40	SE.4.B	7.80	0.49	0.44				0.40	0.40	2.05	5.45	227	227	285	285	20.2	20.2	21.9	21.9	0.97	19	19	21	21
	SE.5	SE.5	3.83	SE.5.A	3.83	0.46	0.65	2.34	177	127	0.28	0.40	1.11	1.11	65	46	242	173	23.7	33.6	25.8	37.3	0.99	11	23	12	25
	SE.6	SE.6	5.10	SE.6.A	5.10	0.46	0.80	1.45	137	81	0.23	0.40	4.39	4.39	319	183	456	263	13.0	21.8	14.1	23.7	0.98	8	24	9	26
	SE.7	SE.7.1	8.39	SE.7.A	8.39	0.46	0.56	5.55	180	150	0.49	0.60	1.50	1.50	51	42	231	191	24.8	30.0	27.0	32.8	0.97	26	38	28	42
		SE.7.2	6.20	SE.7.B	14.58	0.48	0.55				0.35	0.40	3.20	4.70	204	175	384	325	15.2	17.8	16.5	19.4	0.95	28	38	30	42
	SE.8	SE.8.1	2.77	SE.8.A	2.77	0.42	0.46	1.40	91	83	0.36	0.40	1.95	1.95	90	81	180	164	31.8	35.3	34.9	39.3	0.99	10	12	11	14
		SE.8.2	8.56	SE.8.B	11.33	0.45	0.53				0.34	0.40	4.12	6.07	292	253	383	336	15.2	17.2	16.6	18.8	0.96	21	27	22	30
	SE.9	SE.9.1	7.46	SE.9.A	7.46	0.47	0.65	1.90	60	45	0.29	0.40	2.47	2.47	142	103	201	147	28.5	39.1	31.1	43.6	0.98	27	51	30	57
		SE.9.2	6.26	SE.9.B	13.73	0.45	0.57				0.32	0.40	4.24	6.70	365	279	424	324	13.9	17.8	15.1	19.4	0.96	27	51	30	57
		SE.9.3	7.38	SE.9.C	21.11	0.45	0.56				0.32	0.40	2.83	9.53	510	397	570	442	10.6	13.3	11.6	14.6	0.94	27	51	30	57
Total			221.24										123.43														

C = Runoff coefficient; Li = Inlet length; Ti = Inlet time; Vr = Flow velocity; Lr = Flow length; Tr = Flow time; Tc = Time of concentration
I = Rainfall intensity; f = Areal reduction factor; Qp = Peak runoff

Table C.6.9 PEAK RUNOFF ALONG BEN DA-BA HONG AND THAM LUONG-BEN CAT CANALS WITHOUT INUNDATION

Drainage Area	Catchment ID	Sub-Catchment		Runoff Point		Details of Runoff Calculation by Rational Method																					
		ID	Area (km2)	ID	Area (km2)	C		Li (km)	Ti (min)		Vr (m/s) by Segment		Lr (km)		Cumulative Tr (min)		Cumulative Tc (min)		I for 5-yr (mm/hr)		I for 10-yr (mm/hr)		f	Qp for 5-yr (m3/s)		Qp for 10-yr (m3/s)	
						Ex.	Fut.		Ex.	Fut.	Ex.	Fut.	Segment	Cumulative	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.		Ex.	Fut.	Ex.	Fut.
Northern Zone	N.1	N.1.1	3.33	N.1.A	3.33	0.44	0.51	1.53	56	50	1.31	1.50	1.07	1.07	14	12	69	62	73.3	79.3	82.2	89.0	0.99	30	37	33	41
		N.1.2	6.60	N.1.B	9.93	0.48	0.55				0.70	0.80	2.78	3.85	80	70	136	120	42.2	47.4	47.1	53.0	0.97	54	70	60	78
		N.1.3	4.25	N.1.C	14.17	0.47	0.52				0.45	0.50	2.04	5.89	155	138	211	188	27.1	30.6	29.6	33.5	0.96	54	70	60	78
		N.1.4	5.69	N.1.D	19.87	0.46	0.51				0.45	0.50	3.61	9.50	289	258	345	308	16.8	18.7	18.3	20.4	0.94	54	70	60	78
	N.2	N.2.1	11.67	N.2.A	11.67	0.50	0.48	3.47	100	100	1.50	1.50	0.97	0.97	11	11	111	111	50.5	50.5	56.6	56.6	0.96	76	76	85	85
		N.2.2	6.43	N.2.B	18.10	0.50	0.47				1.50	1.50	1.68	2.65	29	29	130	130	44.0	44.0	49.2	49.2	0.94	97	97	109	109
		N.2.3	11.24	N.2.C	29.33	0.49	0.50				1.18	1.20	4.09	6.74	87	86	188	187	30.5	30.7	33.4	33.7	0.91	111	114	121	124
		N.2.4	5.32	N.2.D1	34.65	0.49	0.52				0.37	0.40	2.49	9.23	198	190	299	290	19.3	19.8	21.0	21.6	0.90	111	114	121	124
		N.2.5	10.98	N.2.D2	10.98	0.48	0.63	3.52	249	193	0.23	0.30	3.34	3.34	242	186	491	379	12.1	15.4	13.2	16.8	0.96	17	28	19	31
				N.2.D	45.63	0.49	0.55							9.23	242	190	491	379	12.1	15.4	13.2	16.8	0.88	65	93	71	102
		N.2.6	11.19	N.2.E	56.82	0.52	0.57				0.32	0.35	1.56	10.79	323	264	423	365	13.9	15.9	15.1	17.4	0.86	97	122	106	133
		N.2.7	7.48	N.2.F	64.30	0.52	0.58				0.32	0.35	2.25	13.04	442	371	542	472	11.1	12.6	12.1	13.7	0.84	97	122	106	133
		N.2.8	13.93	N.2.G1	78.22	0.53	0.59				0.31	0.35	4.37	17.41	676	579	776	680	8.0	9.0	8.8	9.9	0.83	97	122	106	133
		N.2.9	6.32	N.2.G2	6.32	0.50	0.49	2.16	123	123	0.30	0.30	3.10	3.10	172	172	295	295	19.5	19.5	21.3	21.3	0.98	16	16	18	18
		N.2.10	5.54	N.2.G3	11.86	0.50	0.53				0.33	0.35	2.49	5.59	298	291	421	413	13.9	14.2	15.2	15.5	0.96	22	24	24	26
				N.2.G	90.09	0.52	0.59							17.41	676	579	776	680	8.0	9.0	8.8	9.9	0.81	97	122	106	133
		N.2.11	5.71	N.2.H	95.79	0.53	0.59				0.31	0.35	1.57	18.98	760	654	860	755	7.3	8.2	8.1	9.0	0.81	97	122	106	133
		N.2.12	4.89	N.2.I	100.68	0.53	0.59				0.31	0.35	2.50	21.48	894	773	994	874	6.4	7.2	7.1	8.0	0.81	97	122	106	133
		N.2.13	6.89	N.2.J	107.57	0.53	0.60				0.31	0.35	2.61	24.09	1035	897	1135	998	5.7	6.4	6.4	7.1	0.81	97	122	106	133

C = Runoff coefficient; L_i = Inlet length; T_i = Inlet time; V_r = Flow velocity; L_r = Flow length; T_r = Flow time; T_c = Time of concentration; I = Rainfall intensity; f = Areal reduction factor; Q_p = Peak runoff

Table C.6.10 DESIGN DISCHARGES OF THE CANALS BY RATIONAL METHOD (1/2)

Drainage Area	Catchment ID	Catchment Area (km2)	Canal ID	Canal Name	Canal Area (km2)	Runoff Point ID	Runoff Point Area (km2)	Runoff Coefficient	Segment's Flow Length (km)	Segment's Flow Velocity (m/s)	Time of Concentration (minutes)	Rainfall Intensity 5-Yr. R.P. (mm/hr)	Rainfall Intensity 10-Yr. R.P. (mm/hr)	Areal Reduction Factor	Design Discharge 5-Yr. R.P. (m3/s)	Design Discharge 10-Yr. R.P. (m3/s)
Northern Zone	N.1	19.87	C-N.1	Rach Ben Da - Rach Ba Hong *	19.87	N.1.A	3.33	0.51	1.07	0.35	101	54.9	61.5	0.99	25	
						N.1.B	9.93	0.55	2.78	0.35	233	24.5	26.8	0.97	36	
						N.1.C	14.17	0.52	2.04	0.50	301	19.1	20.8	0.96	37	
						N.1.D	19.87	0.51	3.61	0.50	421	13.9	15.2	0.94	37	
	N.2	107.57	C-N.2	Rach Dai Han **	34.65	N.2.A	11.67	0.48	0.97	0.70	124	46.0	51.5	0.96	69	
						N.2.B	18.10	0.47	1.68	0.70	163	35.4	39.4	0.94	78	
						N.2.C	29.33	0.50	4.09	0.60	277	20.7	22.6	0.91	78	
						N.2.D1	34.65	0.52	2.49	0.40	381	15.3	16.7	0.90	78	
			C-N.4	Kinh 19 Thang 5	10.98	N.2.D2	10.98	0.63	3.34	0.30	379	15.4	16.8	0.96	28	
			C-N.3	Kinh Tham Luong	107.57	N.2.E	56.82	0.57	1.56	0.35	455	13.0	14.2	0.86	99	108
						N.2.F	64.30	0.58	2.25	0.35	562	10.7	11.7	0.84	99	108
						N.2.G1	78.22	0.59	4.37	0.35	770	8.1	8.9	0.83	99	108
			C-N.5	Rach Ben Cat	11.86	N.2.G2	6.32	0.49	3.10	0.30	295	19.5	21.3	0.98	16	
						N.2.G3	11.86	0.53	2.49	0.35	413	14.2	15.5	0.96	24	
			C-N.3	Kinh Tham Luong	107.57	N.2.H	95.79	0.59	1.57	0.35	845	7.4	8.2	0.81	99	108
						N.2.I	100.68	0.59	2.50	0.35	964	6.6	7.3	0.81	99	108
						N.2.J	107.57	0.60	2.61	0.35	1088	5.9	6.6	0.81	99	108
Central Zone	C.1	31.67	C-C.1	Rach Nhieu Loc - Rach Thi Nghe	31.67	C.1.A	7.54	0.76	0.55	1.50	78	67.2	75.4	0.98	104	117
						C.1.B	11.09	0.76	2.14	0.70	129	44.2	49.4	0.96	104	117
						C.1.C	16.96	0.77	1.77	0.70	171	33.8	37.6	0.95	116	129
						C.1.D	24.54	0.76	2.32	0.70	227	25.2	27.5	0.93	121	131
						C.1.E	31.67	0.76	2.15	0.70	278	20.7	22.5	0.91	126	137
	C.2	5.14	C-C.2	Rach Cau Son - Rach Tau Vam Tat	5.14	C.2.A	5.14	0.78	2.09	0.40	116	48.5	54.3	0.98	53	
	C.3	20.22	C-C.3	Rach Tan Hoa - Rach Lo Gom	14.35	C.3.A	5.86	0.79	2.26	1.40	72	71.1	79.8	0.98	90	
						C.3.B	10.58	0.74	1.97	1.20	100	55.4	62.1	0.97	117	
						C.3.C1	14.35	0.76	2.84	0.60	179	32.5	36.1	0.95	117	
				Rach Ruoi Ngua	5.88	C.3.C2	5.88	0.69	1.50	0.40	135	42.6	47.6	0.98	47	
	C.4	41.50	C-C.5	Kinh Doi - Kinh Te	61.73	C.4.A1	1.84	0.85	3.34	0.40	154	37.4	41.7	0.99	16	18
			C-C.6	Kch Ba Tang	2.88	C.4.A2	2.88	0.67	3.33	0.40	227	25.2	27.5	0.99	13	
			C-C.7	Rach Ba Lon	6.52	C.4.A3	3.41	0.62	2.56	0.40	190	30.1	33.0	0.99	18	
						C.4.A4	6.52	0.58	3.18	0.40	344	16.8	18.3	0.98	18	
			C-C.5	Kinh Doi - Kinh Te	61.73	C.4.B	36.71	0.71	2.02	0.40	369	15.8	17.2	0.90	117	131
						C.4.C	44.22	0.71	1.40	0.40	427	13.8	15.0	0.88	117	131
						C.4.D	50.86	0.71	1.97	0.40	509	11.7	12.8	0.87	117	131
						C.4.E	61.73	0.71	4.25	0.40	687	8.9	9.8	0.85	117	131
Western Zone	W.1	72.91		Rach Tan Phu	9.68	W.1.A	9.68	0.66	2.60	0.50	154	37.5	41.8	0.97	65	
			C-W.1	Kinh Chua - Rach Nuoc Len ***	43.26	W.1.B	14.81	0.59	2.05	0.40	239	23.9	26.1	0.95	65	72
						W.1.C1	19.55	0.55	4.11	0.40	411	14.3	15.6	0.94	65	72
						W.1.C2	8.62	0.52	2.20	0.30	211	27.2	29.7	0.97	33	
						W.1.D1	36.36	0.57	4.49	0.40	598	10.1	11.1	0.90	65	72
			C-W.2	Rach Nhanh	3.20	W.1.D2	3.20	0.69	2.07	0.30	167	34.7	38.7	0.99	21	
			C-W.1	Rach Chua - Rach Nuoc Len	43.26	W.1.E1	43.26	0.58	2.72	0.40	711	8.7	9.5	0.88	65	72
			C-W.3	Rach Cai Truong - Rach Ba Goc	6.04	W.1.E2	6.04	0.44	4.90	0.30	346	16.8	18.3	0.98	12	
			C-W.4	Song Ben Luc	50.55	W.1.E3	7.02	0.50	1.36	0.40	402	14.5	15.9	0.98	14	15
						W.1.F	50.55	0.57	1.18	0.40	760	8.2	9.0	0.87	65	72
			C-W.5	Song Can Giuoc	72.91	W.1.G	59.41	0.57	1.85	0.40	837	7.5	8.3	0.85	65	72
						W.1.H	72.91	0.56	1.76	0.40	910	7.0	7.7	0.83	65	72

* : Canal improvement plan for Rach Ben Da - Ba Hong has been proposed considering inundation in the upper two reaches. The design discharges shown in this table represent discharges under inundation condition.

** : Canal improvement plan for Rach Daihan has been proposed considering inundation. Design (5-year) discharges through main channel at runoff points N.2.A, N.2.B, N.2.C and N.2.D1 are 7, 11, 19 and 24 m3/s respectively.
The design discharges along Rach Daihan, as shown in this table represent total discharges through main channel and flood plain at different runoff points, under inundation condition.

*** : Canal improvement plan for Kinh Chua has been proposed considering inundation. Design (5-year) discharges through main channel for lengths of 0.35 and 3.11 km along reaches W.1.B and W.1.C1 are 12 and 14 m3/s respectively.
The design discharges along Kinh Chua (runoff points W.1.B and W.1.C1), as shown in this table represent total discharges through main channel and flood plain, under inundation condition.

Table C.6.10 DESIGN DISCHARGES OF THE CANALS BY RATIONAL METHOD (2/2)

Drainage Area	Catchment ID	Catchment Area (km2)	Canal ID	Canal Name	Canal Area (km2)	Runoff Point ID	Runoff Point Area (km2)	Runoff Coefficient	Segment's Flow Length (km)	Segment's Flow Velocity (m/s)	Time of Concentration (minutes)	Rainfall Intensity 5-Yr. R.P. (mm/hr)	Rainfall Intensity 10-Yr. R.P. (mm/hr)	Areal Reduction Factor	Design Discharge 5-Yr. R.P. (m3/s)	Design Discharge 10-Yr. R.P. (m3/s)
Southern Zone	S.1	14.33	C-S.1	Rach Ba Lao	14.33	S.1.A	2.68	0.57	2.54	0.40	137	41.8	46.7	0.99	18	
						S.1.B1	6.72	0.53	2.51	0.40	242	23.7	25.8	0.98	23	
			C-S.2	Rach Xom Cui	6.33	S.1.B2	4.38	0.55	4.00	0.40	217	26.3	28.7	0.99	17	
						S.1.B3	6.33	0.52	2.06	0.40	303	19.0	20.7	0.98	17	
			C-S.1	Rach Ba Lao	14.33	S.1.C	14.33	0.52	1.39	0.40	342	16.9	18.4	0.95	34	
	S.2	15.66	C-S.3	Rach Ong Lon - Kinh Cay Kho	13.70	S.2.A1	2.40	0.48	2.02	0.40	158	36.6	40.8	0.99	12	
			C-S.4	Rach Ong Bay	1.96	S.2.A2	1.96	0.59	1.90	0.40	150	38.4	42.9	0.99	12	
			C-S.3	Rach Ong Lon - Kinh Cay Kho	13.70	S.2.B	7.21	0.52	1.51	0.40	218	26.2	28.6	0.98	26	
						S.2.C	15.66	0.53	3.39	0.40	359	16.2	17.6	0.95	36	
	S.3	34.51	C-S.5	Rach Roi - Rach Tom - Song Muong Chuoi	34.51	S.3.A	2.17	0.71	1.57	0.40	123	46.1	51.5	0.99	20	22
						S.3.B1	4.49	0.73	2.43	0.40	225	25.5	27.8	0.99	23	25
			C-S.6	Rach Thay Tieu	4.79	S.3.B2	4.79	0.74	3.12	0.40	198	29.0	31.7	0.98	28	
			C-S.7	Rach Dia	5.75	S.3.B3	5.75	0.56	3.58	0.40	292	19.7	21.5	0.98	17	
			C-S.5	Rach Roi - Rach Tom - Song Muong Chuoi	34.51	S.3.C	19.33	0.65	2.60	0.40	333	17.4	18.9	0.94	57	62
						S.3.D1	23.68	0.65	2.63	0.40	442	13.3	14.5	0.93	57	62
			C-S.8	Phuoc Khien River	6.45	S.3.D2	6.45	0.54	3.41	0.40	259	22.2	24.1	0.98	21	
			C-S.5	Rach Roi - Rach Tom - Song Muong Chuoi	34.51	S.3.E	34.51	0.63	2.41	0.40	543	11.1	12.1	0.90	64	69
	S.4	2.36	C-S.9	Rach Cau Kinh	2.36	S.4.A	2.36	0.67	1.92	0.40	133	43.1	48.2	0.99	19	
	S.5	2.23	C-S.10	Rach AP3 Phu My	2.23	S.5.A	2.23	0.60	1.86	0.40	116	48.5	54.3	0.99	18	
North-Eastern Zone	NE.1	3.32	C-NE.1	Rach Ong Dau	3.32	NE.1.A	3.32	0.57	3.58	0.40	170	34.0	37.9	0.99	18	
	NE.2	9.53	C-NE.2	Rach Go Dua	9.53	NE.2.A	4.78	0.68	2.57	0.40	172	33.6	37.4	0.98	30	
						NE.2.B	9.53	0.65	2.20	0.40	264	21.7	23.7	0.97	36	
	NE.3	7.15	C-NE.3	Rach Thu Duc	7.15	NE.3.A	7.15	0.64	3.14	0.40	161	35.8	39.9	0.98	44	
	NE.4	2.65	C-NE.4	Rach Truong Tho	2.65	NE.4.A	2.65	0.73	2.17	0.40	143	40.2	44.9	0.99	21	
	NE.5	34.38	C-NE.5	Rach Nhum - Rach Cau - Rach Go Cong *	34.38	NE.5.A1	10.12	0.42	3.35	2.33	69	0.0	82.4	0.97	83	93
						NE.5.A2	4.72	0.46	2.34	2.90	62	0.0	89.2	0.98	47	53
						NE.5.B	17.99	0.45	1.70	1.84	85	63.2	71.0	0.94	133	149
						NE.5.C	28.17	0.45	2.83	0.77	146	39.5	44.1	0.92	133	149
						NE.5.D1	34.38	0.45	4.44	0.32	378	15.4	16.8	0.90	133	149
South-Eastern Zone	SE.1	1.98	C-SE.1	Rach Binh Khanh	1.98	SE.1.A	1.98	0.50	2.32	0.40	128	44.7	50.0	0.99	12	
	SE.2	2.60	C-SE.2	Rach Ca Tre Nho	2.60	SE.2.A	2.60	0.65	2.08	0.40	118	48.1	53.8	0.99	22	
	SE.3	1.92	C-SE.3	Rach Da Do	1.92	SE.3.A	1.92	0.80	2.50	0.40	205	27.9	30.5	0.99	12	
	SE.4	7.80	C-SE.4	Rach Giong Ong To	7.80	SE.4.A	5.40	0.43	3.41	0.40	200	28.6	31.3	0.98	18	
						SE.4.B	7.80	0.44	2.05	0.40	285	20.2	21.9	0.97	19	
	SE.5	3.83	C-SE.5	Rach Muong	3.83	SE.5.A	3.83	0.65	1.11	0.40	173	33.6	37.3	0.99	23	
	SE.6	5.10	C-SE.6	Rach Ky Ha	5.10	SE.6.A	5.10	0.80	4.39	0.40	263	21.8	23.7	0.98	24	
	SE.7	14.58	C-SE.7	Rach Chiec - Rach Kinh Ong Hong	14.58	SE.7.A	8.39	0.56	1.50	0.60	191	30.0	32.8	0.97	38	
						SE.7.B	14.58	0.55	3.20	0.40	325	17.8	19.4	0.95	38	
	SE.8	11.33	C-SE.8	Rach Ong Cay - Rach Ba Cua - Rach Ong Kieu	11.33	SE.8.A	2.77	0.46	1.95	0.40	164	35.3	39.3	0.99	12	
						SE.8.B	11.33	0.53	4.12	0.40	336	17.2	18.8	0.96	27	
	SE.9	21.11	C-SE.9	Rach Tan - Rach Ong Nhieu	21.11	SE.9.A	7.46	0.65	2.47	0.40	147	39.1	43.6	0.98	51	
						SE.9.B	13.73	0.57	4.24	0.40	324	17.8	19.4	0.96	51	
						SE.9.C	21.11	0.56	2.83	0.40	442	13.3	14.6	0.94	51	
	SE.10	24.88	C-SE.11	Tac River	59.26	SE.10.A	7.57	0.45	3.62	0.40	265	21.6	23.6	0.98	19	21
						SE.10.B	19.00	0.52	4.08	0.00	435	13.5	14.7	0.94	35	38
						SE.10.C	59.26	0.54	2.41	0.40	458	12.9	14.1	0.85	133	149

* : Canal improvement plan for Rach Go Cong has been proposed considering construction of on-site storage ponds to reduce peak runoff due to rapid urbanization such that discharges under existing landuse condition can be kept.
The design discharges along Rach Go Cong shown in this table represent discharges under existing landuse condition.

Table C.7.1 SPECIFICATION OF SUB-CATCHMENTS FOR RUNOFF HYDROGRAPH GENERATION

Canal System	Inflow Hydrograph ID	Inflow Hydrograph Type	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Coefficient	Flow Length (km)	Lag Time (minutes)	Areal Reduction Factor
Western Canal System	A1	Distributed	N.2.13	6.89	0.72	2.61	232.20	0.98
	A2	Distributed	N.2.12	4.89	0.63	2.50	212.38	0.98
	A3	Distributed	N.2.11	5.71	0.70	1.00	206.58	0.98
	A4	Distributed	N.2.10	5.54	0.57	2.49	216.07	0.98
	A5	Distributed	N.2.9	6.32	0.49	3.10	294.72	0.98
	A6	Distributed	N.2.8	13.93	0.67	4.37	303.93	0.96
	A7	Distributed	N.2.7	7.48	0.66	2.25	215.06	0.98
	A8	Point	N.2.6	11.19	0.66	3.60	124.67	0.96
	Durban (A9 to A12)	Point	N.2.4 to N.2.1	34.66	Runoff hydrograph with a peak runoff of 24 m3/s (please refer to Fig. C.44)			
	A13	Distributed	N.2.5	10.98	0.63	3.34	378.89	0.96
	A14-1	Point	W.1.1-1	2.74	0.66	0.00	83.13	0.99
	A14-2	Distributed	W.1.1-2	6.94	0.66	2.60	150.00	0.98
	A15	Distributed	W.1.2	5.14	0.45	2.05	230.83	0.98
	A16	Distributed	W.1.3	4.73	0.41	4.11	266.67	0.98
	A17	Point	W.1.4	8.62	0.52	2.20	210.56	0.97
	A18	Distributed	W.1.5	8.20	0.65	4.49	285.63	0.97
	A19	Point	W.1.6	3.20	0.69	2.07	166.88	0.99
	A20	Distributed	W.1.7	3.70	0.69	2.72	147.81	0.99
	A21	Point	W.1.8	6.04	0.44	4.90	345.76	0.98
	A22+23	Distributed	W.1.9+10	1.26	0.84	2.54	127.50	1.00
	A24	Point	W.1.11	8.85	0.56	3.82	294.17	0.97
	A25	Distributed	W.1.12	13.50	0.51	1.76	312.50	0.96
	A26-1	Point	C.3.1-1	1.77	0.79	0.00	45.42	0.99
	A26-2	Distributed	C.3.1-2	4.10	0.79	1.90	54.86	0.99
	A27	Distributed	C.3.2	4.72	0.69	1.97	75.00	0.98
	A28	Distributed	C.3.3	3.77	0.82	2.84	110.97	0.99
	A29	Distributed	C.3.4	5.88	0.69	1.50	112.36	0.98
	A30	Distributed	C.4.1	1.84	0.85	3.34	154.42	0.99
	A31	Distributed	C.4.5	5.24	0.74	2.00	149.03	0.98
	A32	Distributed	C.4.6	7.51	0.68	0.79	129.44	0.98
	A33	Distributed	C.4.7	6.64	0.73	1.00	113.75	0.98
	A34	Distributed	C.4.8	10.86	0.72	4.25	226.94	0.97
	A35	Distributed	C.4.2	2.88	0.67	3.33	227.08	0.99
	A36	Distributed	C.4.3	3.41	0.62	2.56	190.31	0.99
	A37	Distributed	C.4.4	3.11	0.53	3.18	194.79	0.99
	A38	Distributed	S.1.1	2.68	0.57	2.54	137.19	0.99
	A39	Distributed	S.1.2	4.04	0.50	2.51	166.67	0.99
	A40	Distributed	S.1.5	1.27	0.47	1.39	120.00	1.00
	A41	Distributed	S.1.3	4.38	0.55	4.00	217.29	0.99
	A42	Distributed	S.1.4	1.96	0.45	2.06	140.63	0.99
	A43	Distributed	S.2.1	2.40	0.48	2.02	157.71	0.99
	A44	Distributed	S.2.2	1.96	0.59	1.90	158.10	0.99
	A45	Distributed	S.2.3	2.85	0.49	1.51	125.00	0.99
	A46	Distributed	S.2.4	8.45	0.55	3.39	218.96	0.97
	A47	Distributed	S.3.4	5.75	0.56	3.58	291.98	0.98
	A48	Distributed	S.3.3	4.79	0.74	3.12	197.30	0.98
	A49	Distributed	S.3.1	2.17	0.71	1.57	123.54	0.99
	A50	Distributed	S.3.2	2.32	0.74	2.43	150.00	0.99
	A51	Distributed	S.3.5	4.31	0.60	2.60	170.63	0.99
	A52	Distributed	S.3.6	4.34	0.63	2.63	171.88	0.99
	A53	Distributed	S.3.7	6.45	0.54	3.41	258.33	0.98
	A54	Distributed	S.3.8	4.38	0.65	2.41	204.38	0.99
	Total			366.73		130.51		

Canal System	Inflow Hydrograph ID	Inflow Hydrograph Type	Sub-Catchment ID	Sub-Catchment Area (km2)	Runoff Coefficient	Flow Length (km)	Lag Time (minutes)	Areal Reduction Factor
Eastern Canal System	B1	Distributed	SE.4.1	5.40	0.43	3.41	260.00	0.98
	B2	Distributed	SE.4.2	2.40	0.47	1.60	113.13	0.99
	B3	Distributed	SE.7.1	8.39	0.56	1.50	191.20	0.97
	B4	Distributed	SE.7.2	6.20	0.52	1.10	168.02	0.98
	B5	Distributed	SE.8.1	2.77	0.46	1.95	164.17	0.99
	B6	Distributed	SE.8.2	8.56	0.55	3.00	189.90	0.97
	B7	Point	SE.9.1	7.46	0.65	2.47	147.50	0.98
	B8	Distributed	SE.9.2	6.26	0.49	4.24	228.33	0.98
	B9	Distributed	SE.9.3	7.38	0.52	2.83	193.02	0.98
	B10	Distributed	SE.10.1	7.57	0.43	3.62	265.00	0.98
	B11	Distributed	SE.10.2	11.43	0.58	4.08	258.13	0.96
	B12	Distributed	SE.10.3	5.88	0.40	2.41	230.21	0.98
	B13-1	Point	NE.5.1	10.12	0.42	3.35	67.92	0.97
	B13-2	Point	NE.5.2	4.72	0.46	2.34	61.15	0.98
	B13-3	Point	NE.5.3	3.16	0.45	1.70	64.56	0.99
	B14	Distributed	NE.5.4	10.17	0.46	2.83	123.96	0.97
	B15	Distributed	NE.5.5	6.21	0.47	4.44	241.95	0.98
	Total			114.08		39.48		

Table C.7.2 RESULTS OF HYDRODYNAMIC MODELING (1/2)

Canal System	Drainage Area	Catchment ID	Runoff Point ID	Runoff Point Area (km2)	Design Discharge by Rational Formula 5-Year (m3/s)	Design Discharge by Rational Formula 10-Year (m3/s)	Proposed Bank Level (EL m)	Scenario 1: Constant Water Level Boundary Condition, 5-Year Return Period W.L. (EL m)	Free Board (m)	Discharge (m3/s) +	Discharge (m3/s) -	Scenario 1, 10-Year Return Period W.L. (EL m)	Free Board (m)	Discharge (m3/s) +	Discharge (m3/s) -	Scenario 2: Dynamic Water Level Boundary Condition, 5-Year Return Period W.L. (EL m)	Free Board (m)	Discharge (m3/s) +	Discharge (m3/s) -	Scenario 2, 10-Year Return Period W.L. (EL m)	Free Board (m)	Discharge (m3/s) +	Discharge (m3/s) -
Western Canal System	Northern Zone	N.2	N.2.D2	10.98	28	31	2.02	1.65	0.37	27	-8	1.63	0.39	29	-5	1.52	0.50	57	-31	1.52	0.50	62	-35
			N.2.E	56.82	99	108	1.99	1.64	0.35	70		1.63	0.36	80		1.52	0.47	82	-42	1.51	0.48	90	-50
			N.2.F	64.30	99	108	1.94	1.63	0.31	80		1.61	0.33	92		1.52	0.42	94	-62	1.51	0.43	106	-72
			N.2.G1	78.22	99	108	1.85	1.58	0.27	85		1.56	0.29	98		1.48	0.37	134	-95	1.47	0.38	150	-109
			N.2.G2	6.32	16	18	1.90	1.60	0.30	11		1.59	0.31	12	-1	1.51	0.39	15	-19	1.51	0.39	17	-21
			N.2.G3	11.86	24	26	1.85	1.58	0.27	23	-1	1.56	0.29	26	-1	1.48	0.37	29	-32	1.47	0.38	32	-34
			N.2.H	95.79	99	108	1.82	1.53	0.29	124		1.52	0.31	141		1.46	0.36	168	-127	1.45	0.38	190	-146
			N.2.I	100.68	99	108	1.77	1.44	0.33	137		1.43	0.34	155		1.40	0.37	184	-147	1.39	0.38	208	-166
			N.2.J	107.57	99	108	1.72	1.32	0.40	156		1.32	0.40	177		1.32	0.40	209	-168	1.32	0.40	236	-186
	Central Zone	C.3	C.3.A	5.86	90	101	2.76	2.05	0.71	73		2.17	0.59	81		1.62	1.14	69	-15	1.77	0.99	77	-15
			C.3.B	10.58	117	131	1.97	1.58	0.39	112		1.62	0.35	125		1.40	0.57	104	-27	1.41	0.56	117	-27
			C.3.C1	14.35	117	131	1.83	1.43	0.40	134		1.44	0.39	150		1.38	0.45	113	-63	1.38	0.45	129	-62
			C.3.C2	5.88	47	52	1.83	1.43	0.40	35		1.44	0.39	40		1.38	0.45	35	-18	1.38	0.45	39	-18
		C.4	C.4.A1	1.84	16	18	1.83	1.42	0.41	66		1.42	0.41	65		1.38	0.45	45	-56	1.38	0.45	45	-61
				Kinh Tau Hu			1.83	1.43	0.40	39	-29	1.44	0.39	39	-37	1.38	0.45	34	-52	1.38	0.45	34	-59
			C.4.A2	2.88	13	15	1.83	1.42	0.41	18	-3	1.42	0.41	18	-5	1.38	0.45	17	-39	1.38	0.45	18	-40
			C.4.A3	3.41	18	19	1.89	1.42	0.47	12		1.43	0.46	13		1.40	0.49	20	-24	1.41	0.48	20	-24
			C.4.A4	6.52	18	19	1.83	1.42	0.41	21	-1	1.42	0.41	24		1.38	0.45	44	-56	1.38	0.45	44	-56
			C.4.B	36.71	117	131	1.80	1.40	0.40	148		1.40	0.40	151		1.35	0.45	173	-253	1.36	0.44	181	-254
				Kinh Tau Hu			1.80	1.42	0.38	51		1.43	0.38	54		1.37	0.43	40	-45	1.37	0.43	41	-46
			C.4.C	44.22	117	131	1.79	1.39	0.41	176		1.39	0.40	181		1.34	0.45	208	-301	1.34	0.45	216	-302
				Kinh Tau Hu			1.78	1.39	0.40	45		1.39	0.39	47		1.35	0.43	44	-60	1.35	0.43	45	-60
			C.4.D	50.86	117	131	1.77	1.36	0.41	217		1.37	0.41	226		1.34	0.43	238	-346	1.34	0.43	246	-347
				Kinh Tau Hu			1.76	1.36	0.40	56		1.36	0.40	58		1.34	0.42	59	-45	1.34	0.42	59	-45
			C.4.E	61.73	117	131	1.72	1.32	0.40	383		1.32	0.40	394		1.32	0.40	491	-587	1.32	0.40	499	-585
				Kinh Tau Hu			1.72	1.32	0.40	56		1.32	0.40	58		1.32	0.40	76	-86	1.32	0.40	76	-86
	Western Zone	W.1	W.1.A	9.68	65	72	2.08	1.63	0.45	46		1.62	0.46	51		1.47	0.61	43	-10	1.48	0.60	49	-12
			W.1.B	14.81	65	72	1.00	1.61	-0.61	60	-14	1.61	-0.61	64	-16	1.46	-0.46	73	-29	1.48	-0.48	82	-33
			W.1.C1	19.55	65	72	1.98	1.53	0.45	40	-15	1.53	0.45	46	-17	1.40	0.58	85	-65	1.42	0.56	98	-79
			W.1.D1	36.36	65	72	1.91	1.46	0.45	67	-15	1.46	0.45	77	-17	1.38	0.53	116	-98	1.39	0.53	133	-107
			W.1.E1	43.26	65	72	1.87	1.41	0.46	80	-15	1.42	0.45	93	-16	1.38	0.50	133	-119	1.38	0.49	151	-129
			W.1.E3	7.02	14	15	1.87	1.41	0.46	8	-1	1.42	0.45	9	-1	1.38	0.50	27	-34	1.38	0.49	27	-35
			W.1.F	50.55	65	72	1.87	1.41	0.46	89	-22	1.42	0.46	102	-20	1.37	0.50	175	-185	1.38	0.50	194	-194
			W.1.G	59.41	65	72	1.83	1.40	0.43	104	-128	1.41	0.42	130	-130	1.38	0.46	279	-450	1.38	0.46	292	-453
			W.1.H	72.91	65	72	1.79	1.39	0.40	112	-130	1.39	0.40	139	-131	1.39	0.40	324	-492	1.39	0.40	339	-494

Note: A +ve discharge indicates flow direction from HD simulation is the same as assumed flow direction, as shown in Fig. C.37 and vice versa.
A -ve free board at point W.1.B represents depth of inundation along the flod plain of Kinh Chua.
The discharges at runoff points NE.5.B, NE.5.C, NE.5.D1 and SE.10.C are for existing landuse condition.
The shaded portion represents designed condition.

Table C.7.2 RESULTS OF HYDRODYNAMIC MODELING (2/2)

Canal System	Drainage Area	Catchment ID	Runoff Point		Design Discharge by Rational Formula		Proposed Bank Level	Scenario 1: Constant Water Level Boundary Condition								Scenario 2: Dynamic Water Level Boundary Condition							
								5-Year Return Period				10-Year Return Period				5-Year Return Period				10-Year Return Period			
			ID	Area	5-Year	10-Year	Level	W.L.	Free Board	Discharge (m3/s)		W.L.	Free Board	Discharge (m3/s)		W.L.	Free Board	Discharge (m3/s)		W.L.	Free Board	Discharge (m3/s)	
				(km2)	(m3/s)	(m3/s)	(EL. m)	(EL. m)	(m)	+	-	(EL. m)	(m)	+	-	(EL. m)	(m)	+	-	(EL. m)	(m)	+	-
Western Canal System	Southern Zone	S.1	S.1.A	2.68	18	20	1.85	1.40	0.45	11		1.40	0.45	12		1.39	0.46	18	-27	1.40	0.46	19	-27
			S.1.B1	6.72	23	25	1.81	1.39	0.42	23		1.39	0.42	26	-1	1.39	0.42	55	-85	1.39	0.42	55	-85
			S.1.B2	4.38	17	19	1.84	1.40	0.44		-21	1.40	0.44	1	-21	1.38	0.46	22	-35	1.38	0.46	23	-35
			S.1.B3	6.33	17	19	1.81	1.39	0.42	4	-21	1.39	0.42	9	-21	1.39	0.42	40	-59	1.39	0.42	42	-59
			S.1.C	14.33	34	37	1.79	1.39	0.40	24	-73	1.39	0.40	26	-73	1.39	0.40	210	-325	1.39	0.40	213	-325
		S.2	S.2.A1	2.40	12	13	1.87	1.39	0.48		-171	1.39	0.48		-171	1.37	0.50	57	-160	1.37	0.50	57	-159
			S.2.A2	1.96	12	14	1.87	1.39	0.48		-8	1.39	0.48	1	-8	1.37	0.50	9	-19	1.37	0.50	9	-19
			S.2.B	7.21	26	29	1.84	1.39	0.45		-74	1.39	0.45		-74	1.37	0.47	37	-99	1.37	0.47	38	-99
			S.2.C	15.66	36	39	1.79	1.39	0.40		-52	1.39	0.40		-52	1.39	0.40	109	-173	1.39	0.40	111	-173
		S.3	S.3.A	2.17	20	22	1.95	1.42	0.54	13		1.42	0.53	14		1.40	0.55	13	-17	1.40	0.55	15	-17
			S.3.B1	4.49	23	25	1.91	1.40	0.51	23		1.41	0.51	26		1.38	0.53	38	-56	1.38	0.53	39	-56
			S.3.B2	4.79	28	31	1.91	1.40	0.51	20		1.41	0.51	22		1.38	0.53	42	-55	1.38	0.53	43	-55
			S.3.B3	5.75	17	19	1.91	1.40	0.51		-103	1.41	0.51		-103	1.38	0.53	102	-181	1.38	0.53	103	-181
			S.3.C	19.33	57	62	1.87	1.40	0.47		-103	1.40	0.47		-103	1.38	0.49	188	-336	1.38	0.49	189	-334
			S.3.D1	23.68	57	62	1.83	1.39	0.44		-103	1.40	0.44		-103	1.38	0.45	238	-426	1.38	0.45	240	-426
			S.3.D2	6.45	21	23	1.83	1.39	0.44		-23	1.40	0.44		-23	1.38	0.45	77	-137	1.38	0.45	79	-137
			S.3.E	34.51	64	69	1.79	1.39	0.40		-125	1.39	0.40	9	-125	1.39	0.40	383	-651	1.39	0.40	391	-648
Eastern Canal System	NE Zone	NE.5	NE.5.B	17.99	133	149	2.05	1.60	0.45	114		1.62	0.43	127		1.50	0.55	114		1.52	0.53	127	
			NE.5.C	28.17	133	149	1.98	1.56	0.42	145	-1	1.58	0.40	162	-2	1.48	0.50	121	-67	1.48	0.50	136	-147
			NE.5.D1	34.38	133	149	1.90	1.48	0.42	153	-2	1.48	0.42	170	-3	1.47	0.43	132	-153	1.47	0.43	135	-196
	South-Eastern Zone	SE.4	SE.4.A	5.40	18	20	1.92	1.39	0.53	2	-13	1.39	0.53	4	-13	1.38	0.54	31	-49	1.38	0.54	32	-49
			SE.4.B	7.80	19	21	1.87	1.39	0.48	9	-13	1.39	0.48	11	-13	1.39	0.48	48	-73	1.39	0.48	48	-72
		SE.7	SE.7.A	8.39	38	42	1.93	1.39	0.54	63		1.39	0.54	63		1.38	0.55	77	-35	1.38	0.55	77	-46
			SE.7.B	14.58	38	42	1.87	1.32	0.55	123		1.32	0.55	126		1.32	0.55	168	-136	1.32	0.55	169	-145
		SE.8	SE.8.A	2.77	12	14	1.95	1.46	0.49		-24	1.46	0.49		-24	1.44	0.51	28	-25	1.44	0.51	27	-24
			SE.8.B	11.33	27	30	1.87	1.47	0.40	3	-22	1.47	0.40	6	-22	1.47	0.40	21	-31	1.47	0.40	22	-31
		SE.9	SE.9.A	7.46	51	57	1.96	1.48	0.48	33		1.48	0.48	33		1.48	0.48	35	-7	1.48	0.48	39	-14
			SE.9.B	13.73	51	57	1.91	1.47	0.44		-32	1.48	0.44	2	-32	1.47	0.44	47	-69	1.47	0.44	48	-76
			SE.9.C	21.11	51	57	1.87	1.47	0.40	19	-31	1.47	0.40	25	-31	1.47	0.40	106	-142	1.47	0.40	108	-159
		SE.10	SE.10.A	7.57	19	21	1.96	1.48	0.48	8	-48	1.48	0.48	8	-54	1.48	0.48	204	-134	1.46	0.48	275	-130
			SE.10.B	19.00	35	38	1.90	1.48	0.42	1	-53	1.48	0.42	3	-57	1.47	0.43	104	-119	1.47	0.43	114	-153
			SE.10.C	59.26	133	149	1.87	1.47	0.40	105	-25	1.47	0.40	120	-25	1.47	0.40	249	-333	1.47	0.40	262	-494

Note: A +ve discharge indicates flow direction from HD simulation is the same as assumed flow direction, as shown in Fig. C.37 and vice versa.
A -ve free board at point W.1.B represents depth of inundation along the flod plain of Kinh Chua.
The discharges at runoff points NE.5.B, NE.5.C, NE.5.D1 and SE.10.C are for existing landuse condition.
The shaded portion represents designed condition.

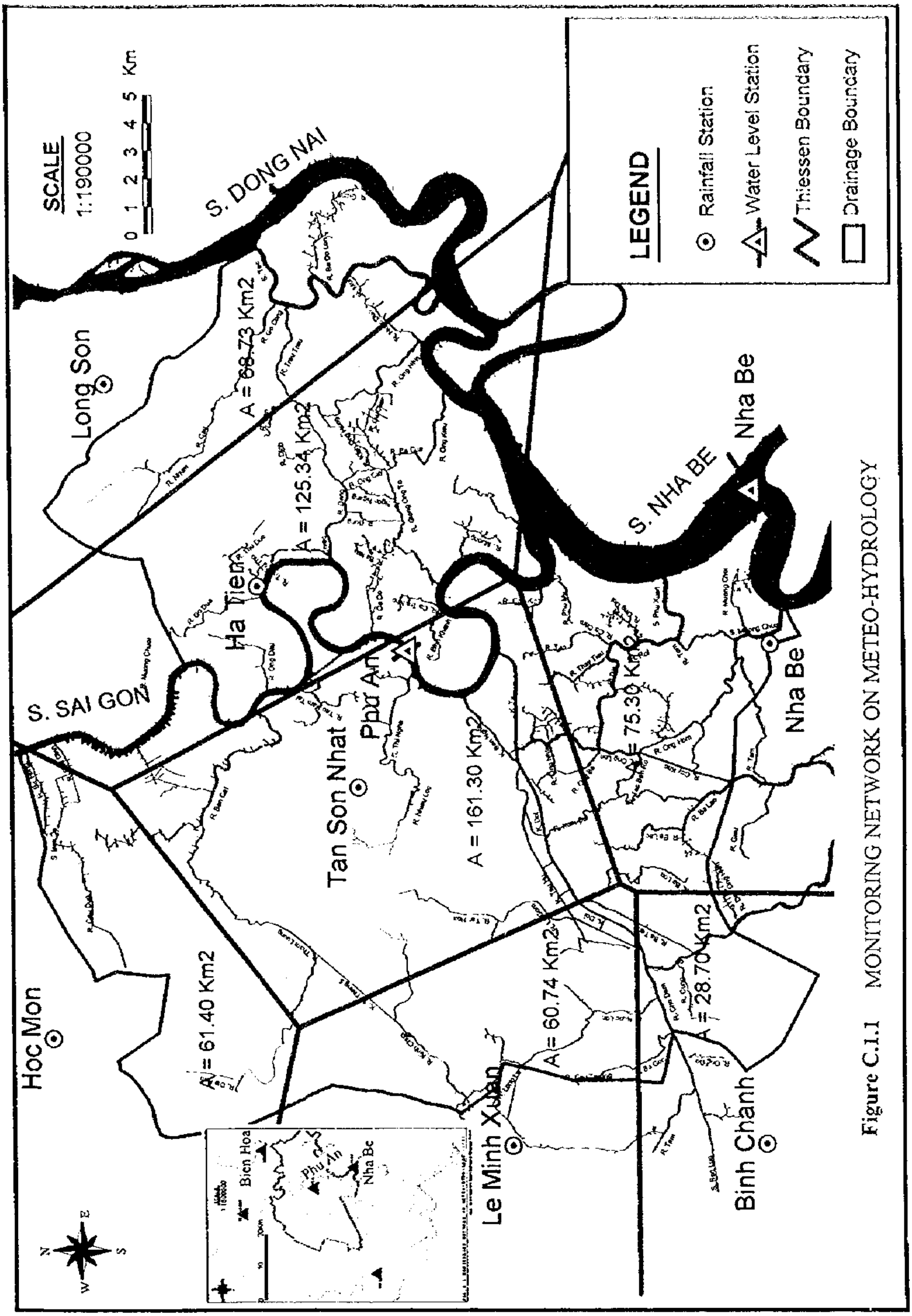
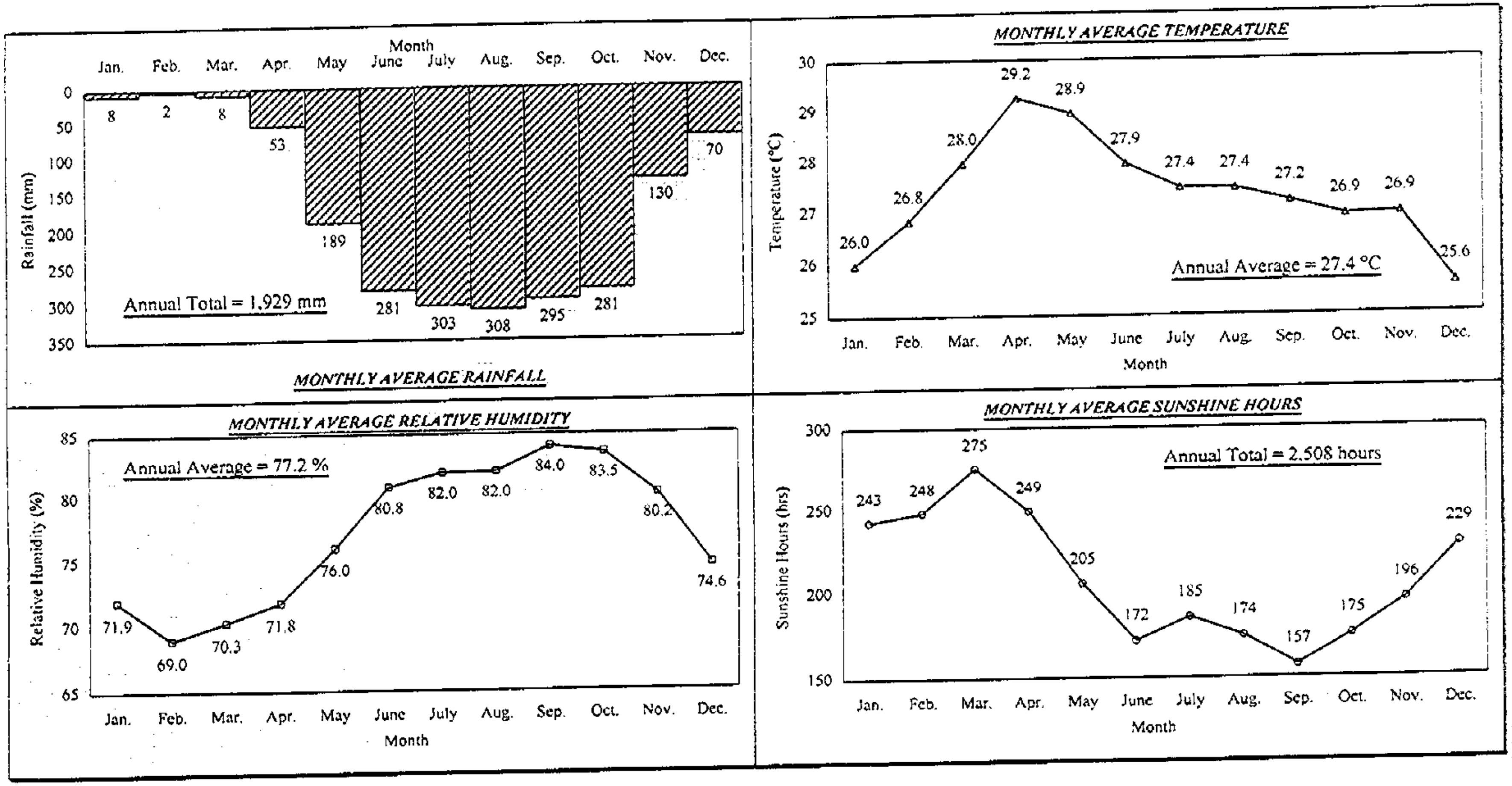


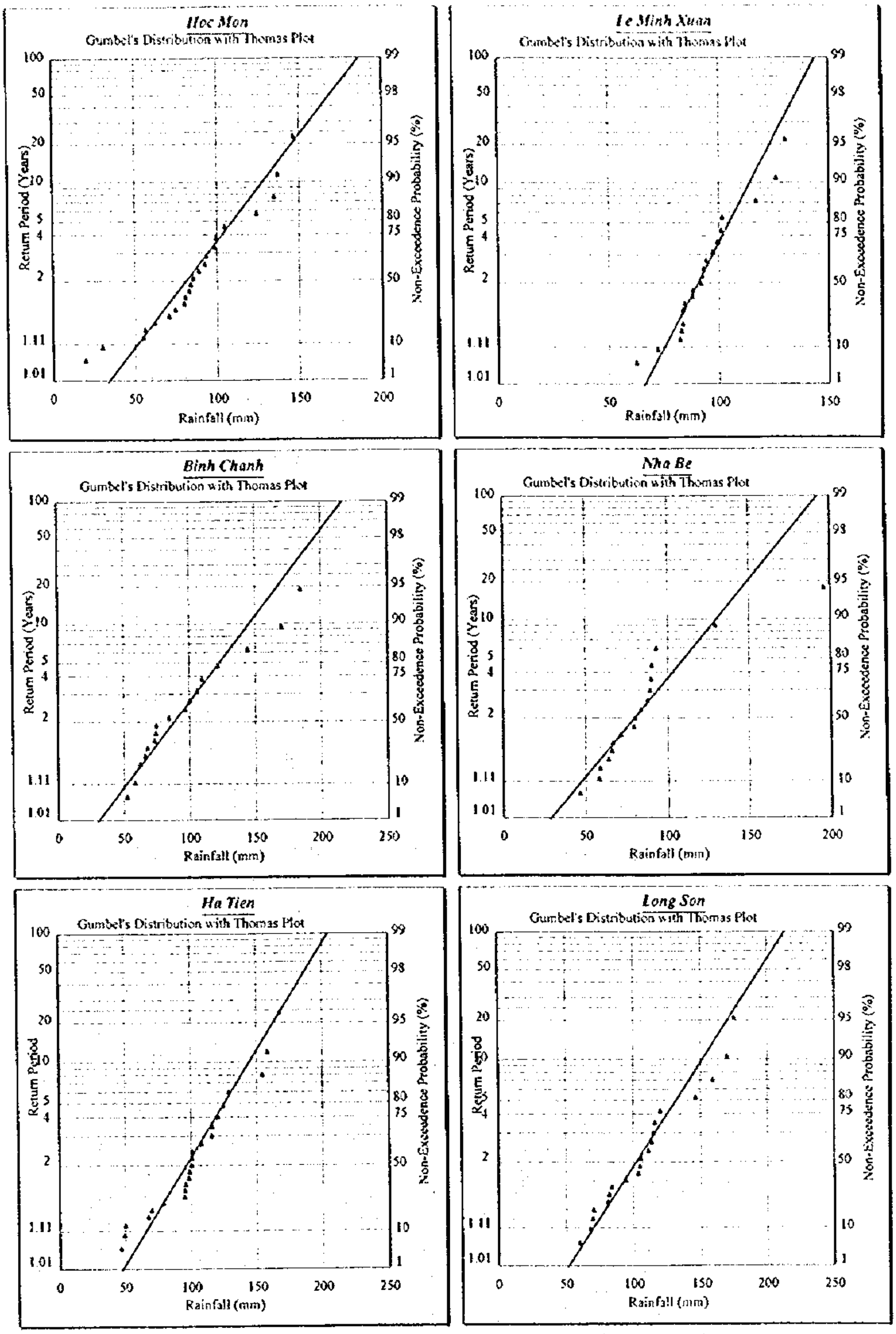
Figure C.1.1 MONITORING NETWORK ON METEO-HYDROLOGY



Data : From 1976 to 1997 at Tan Son Nhat

Data Source : Ho Chi Minh City Statistical Office

Figure C.2.1 GENERAL METEOROLOGICAL CONDITION AT TAN SON NHAT STATION



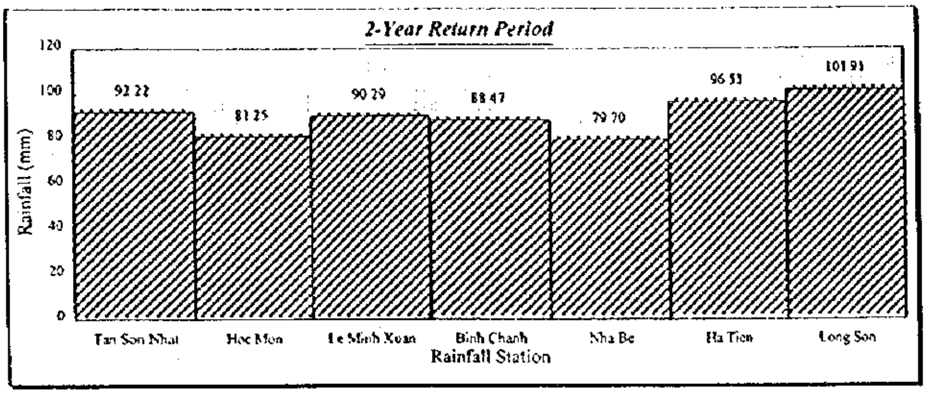
Data : 1973 - 1997

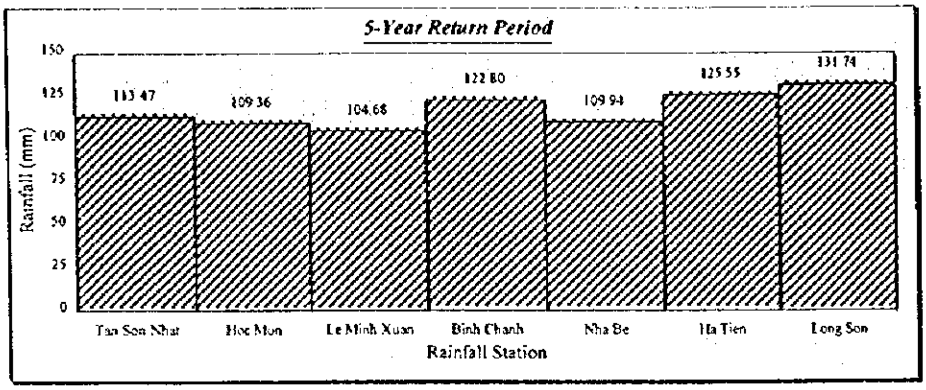
Figure C.3.1 PROBABILITY PLOTS OF DAILY RAINFALLS AT SIX STATIONS

Unit: mm

Station	Probable Maximum Daily Rainfall for Different Return Periods											
	1-Yr	1.5-Yr	2-Yr	3-Yr	5-Yr	10-Yr	20-Yr	25-Yr	30-Yr	50-Yr	70-Yr	100-Yr
Tan Son Nhat	51.09	83.58	92.22	102.27	113.47	127.54	141.03	145.31	148.80	158.50	164.66	171.59
Hoc Mon	26.84	69.82	81.25	94.55	109.36	127.97	145.82	151.49	156.09	168.93	177.35	186.25
Le Minh Xuan	62.42	84.44	90.29	97.10	104.68	114.22	123.36	126.26	128.62	135.19	139.50	144.06
Binh Chanh	22.03	74.52	88.47	104.71	122.80	145.53	167.33	174.24	179.87	195.55	205.83	216.70
Nha Be	24.18	67.42	79.70	94.01	109.94	129.96	149.17	155.26	160.21	174.02	183.08	192.65
Ha Tien	40.35	84.73	96.53	110.26	125.55	144.77	163.20	169.05	173.80	187.06	195.75	204.94
Long Son	44.16	89.78	101.91	116.02	131.74	151.49	170.44	176.45	181.34	193.96	203.90	213.34
Basin Mean	41.27	80.66	91.13	103.31	116.88	133.94	150.30	155.49	159.71	171.47	179.18	187.34

Probable Rainfalls : Calculated applying Gumbel's distribution method
Basin Mean : Estimated applying Thiessen Polygon method
Data : 1952 - 1997 for Tan Son Nhat and 1973 - 1997 for other stations





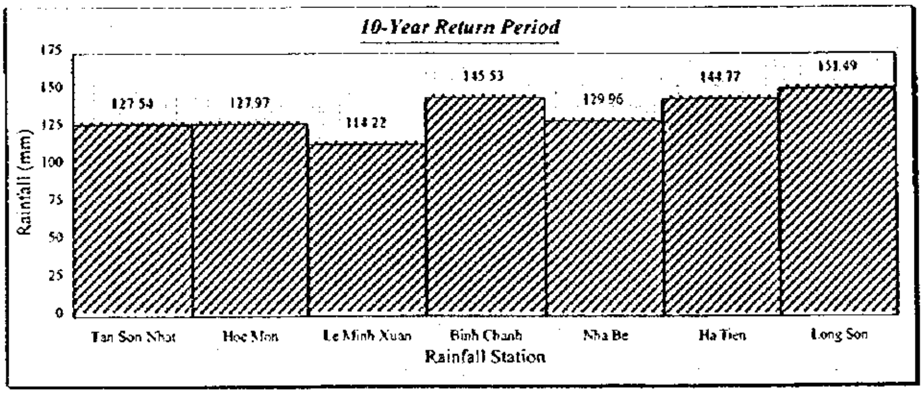
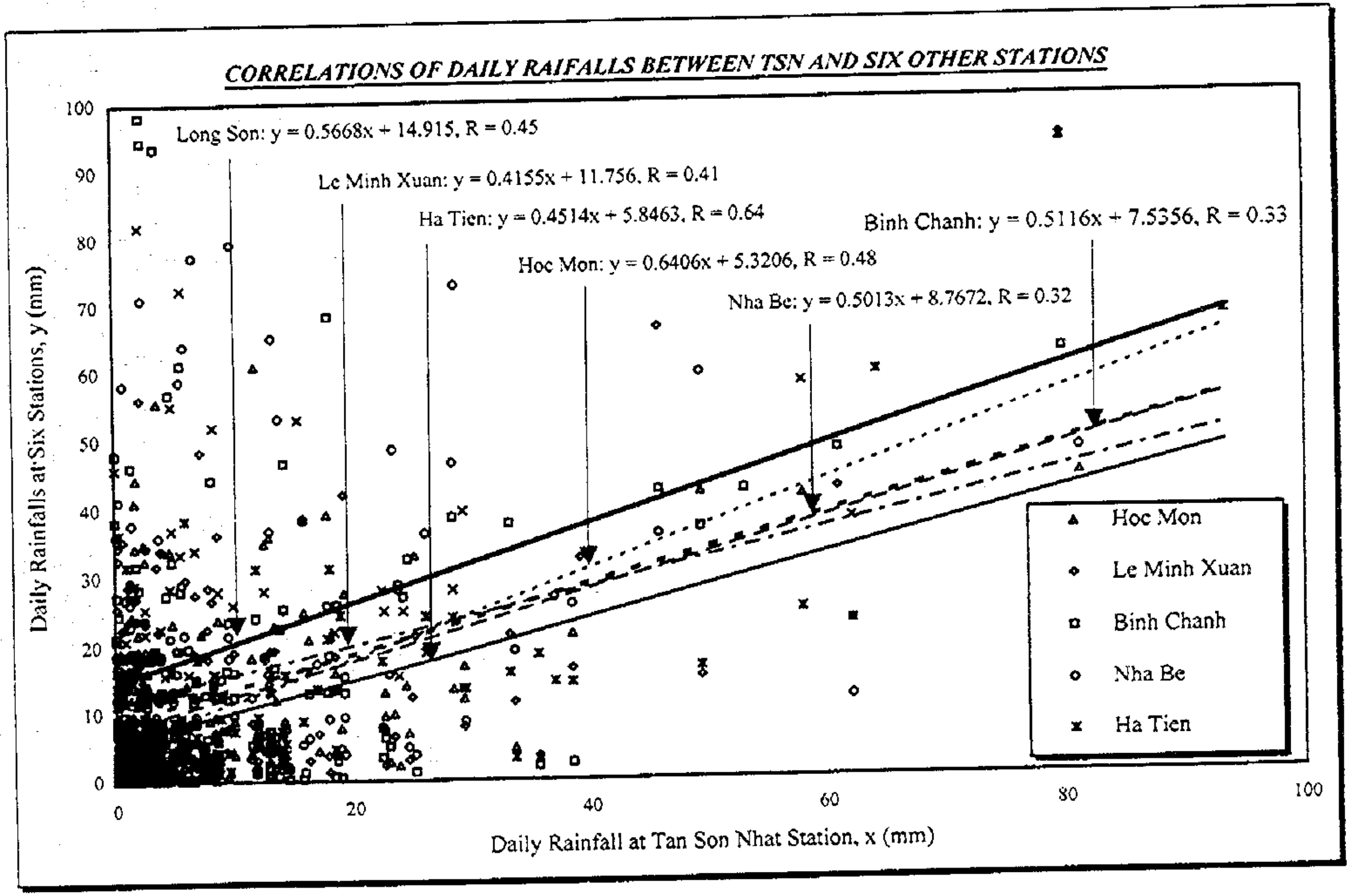
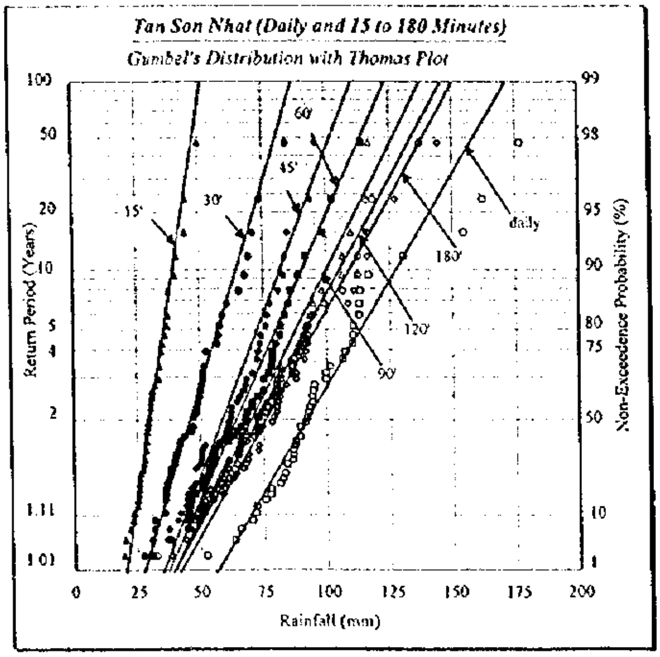


Figure C.3.2 PROBABLE MAXIMUM DAILY RAINFALLS

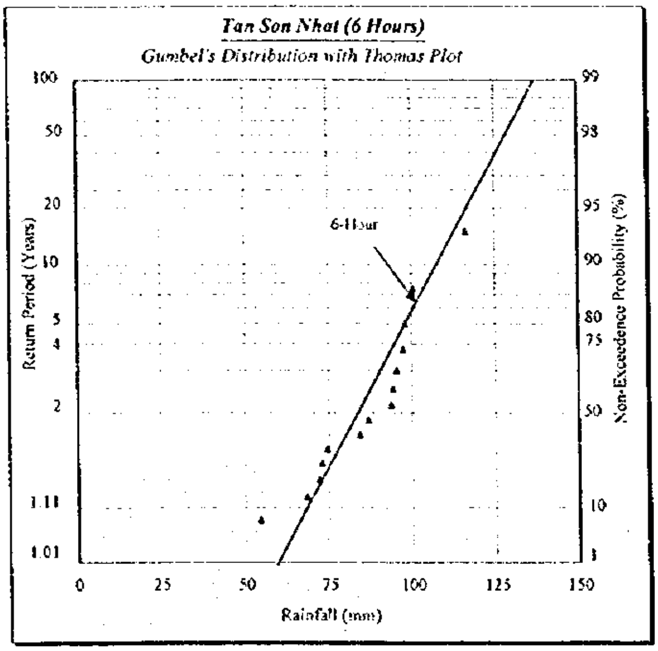


Data : Daily rainfalls for two years - 1994 and 1996.

Figure C.3.3 CORRELATIONS ON DAILY RAIFALLS BETWEEN TAN SON NHAT AND SIX OTHER STATIONS



Data : 1952 - 1997 = 46 years



Data : 1952, 1955, 1961-1962, 1967-1968, 1970, 1972, 1980, 1987, 1990, 1992, 1994 and 1996 = 14 years

Figure C.3.4 PROBABILITY PLOTS OF MAXIMUM RAINFALLS AT TAN SON NHAT

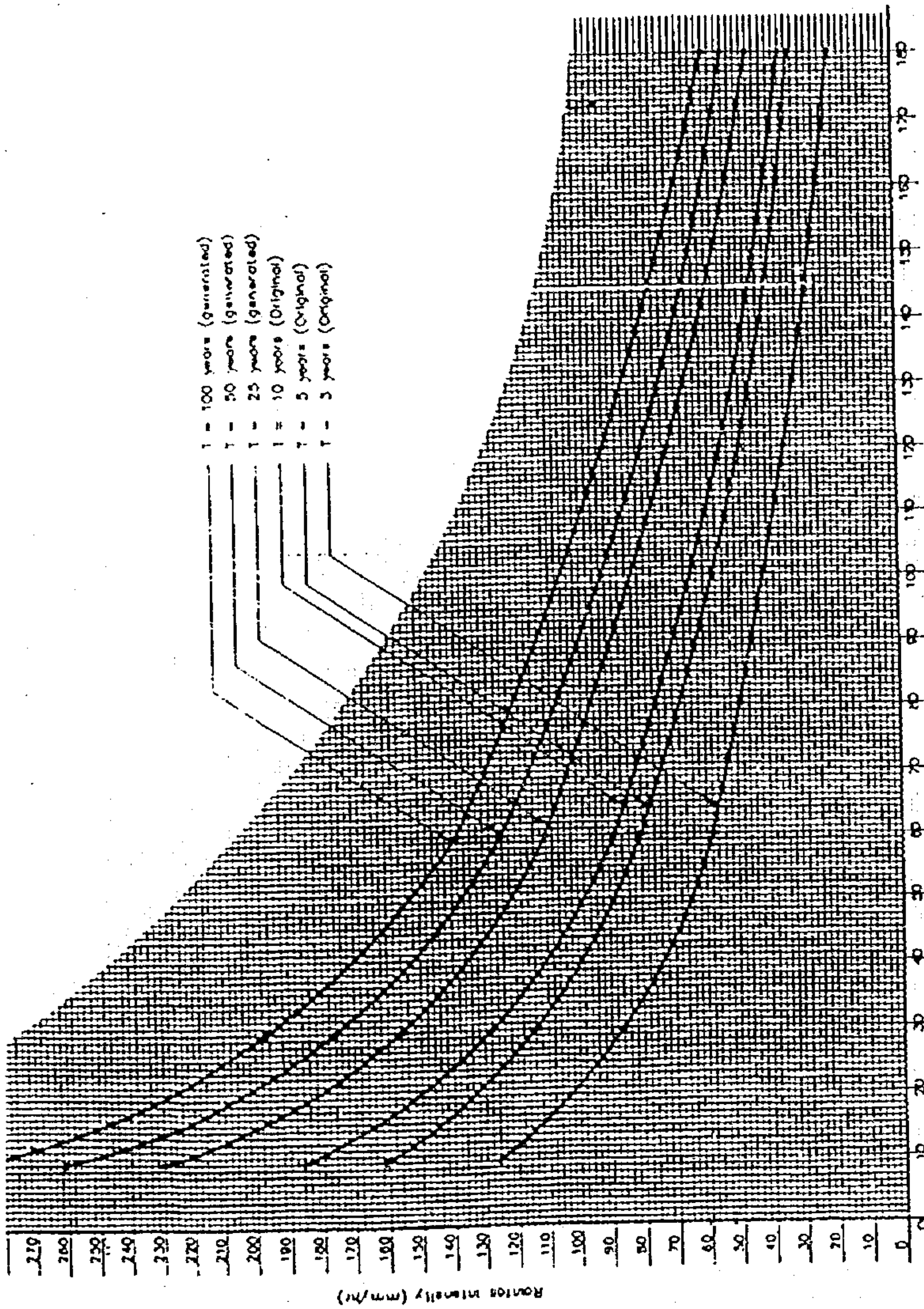


Figure C.3.5 IDF CURVES PREPARED BY HYDROLOGICAL SUB-NSTITUTE, HCMC (KTTV, 1933 – 1989)

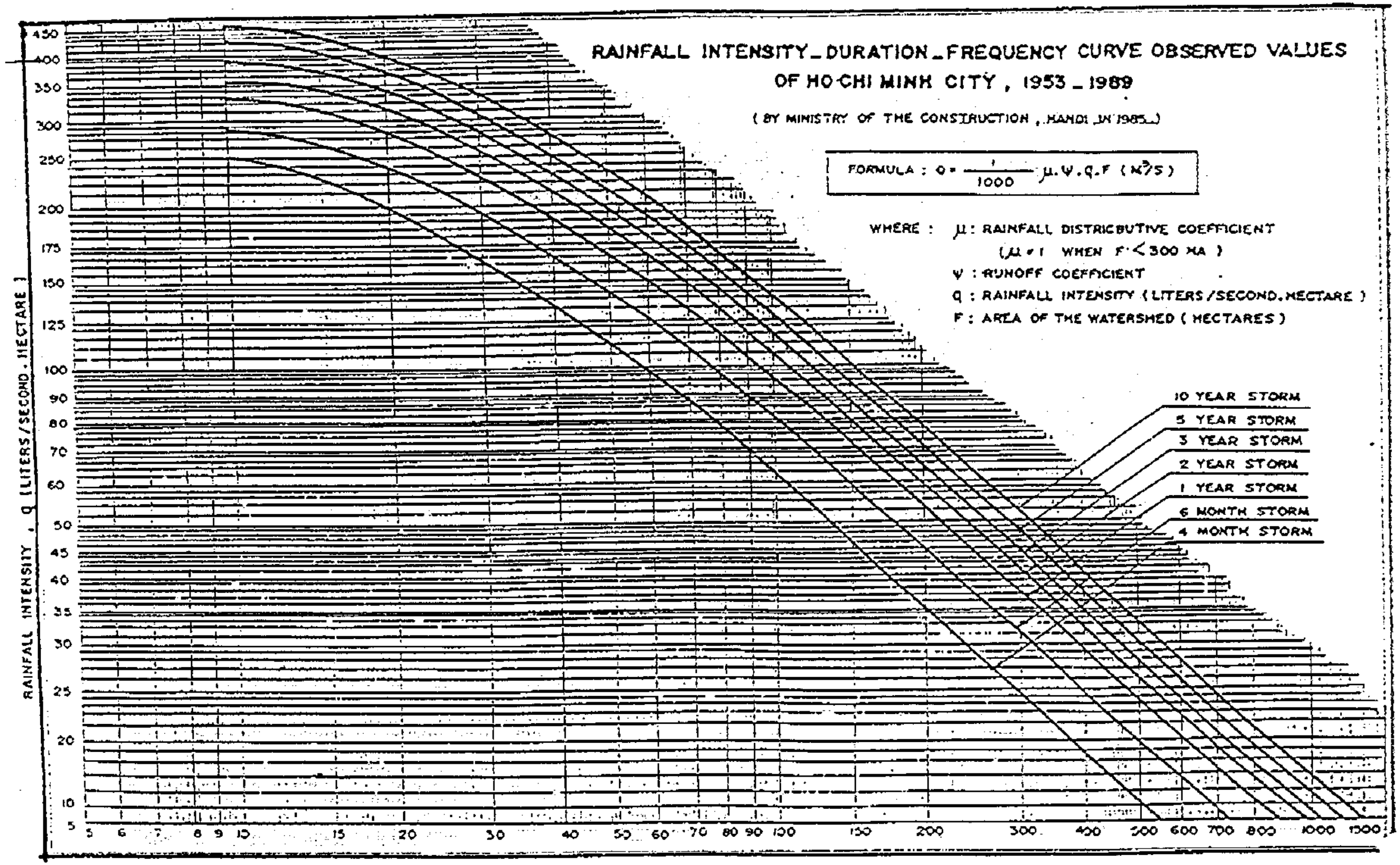
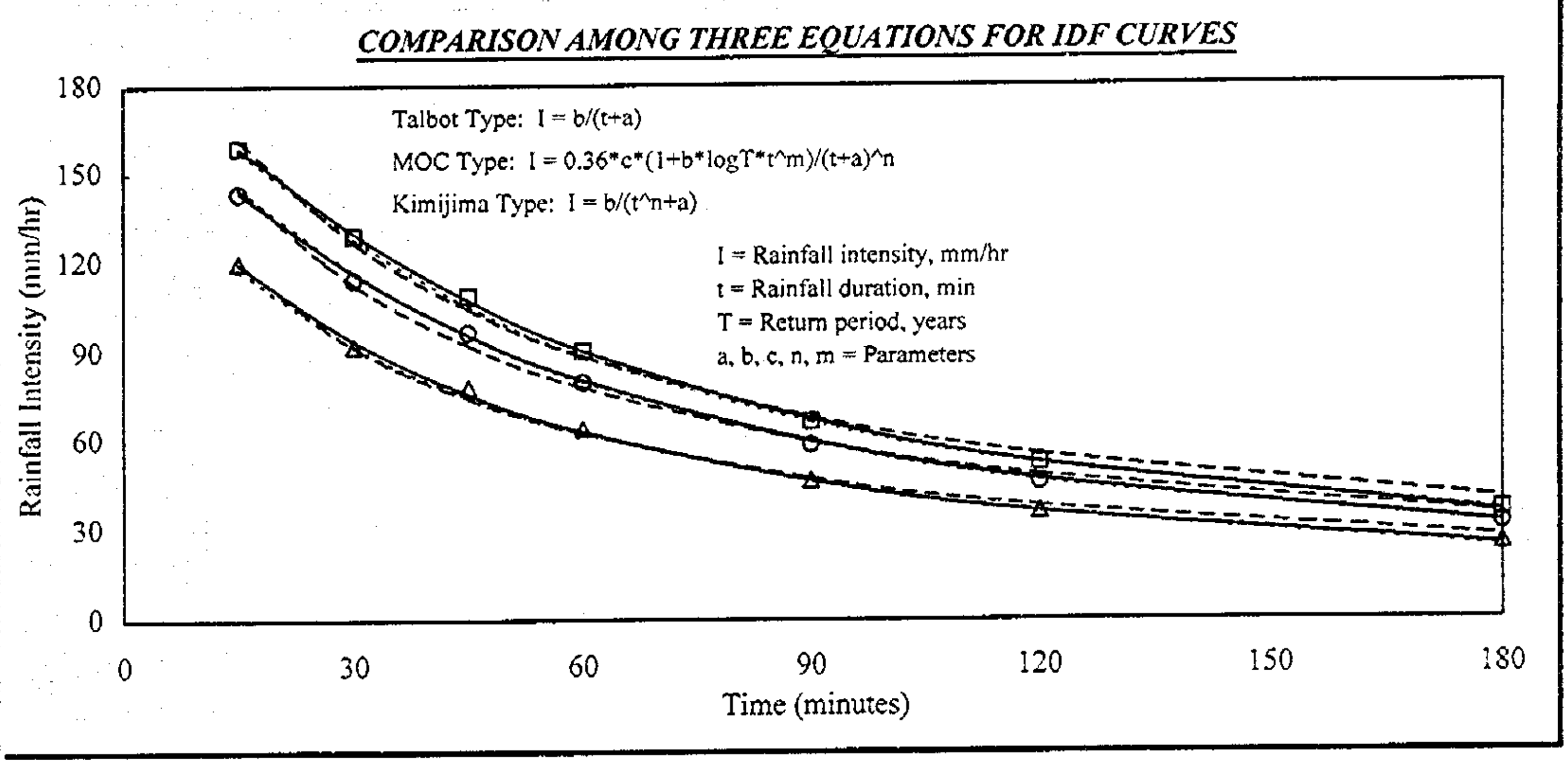


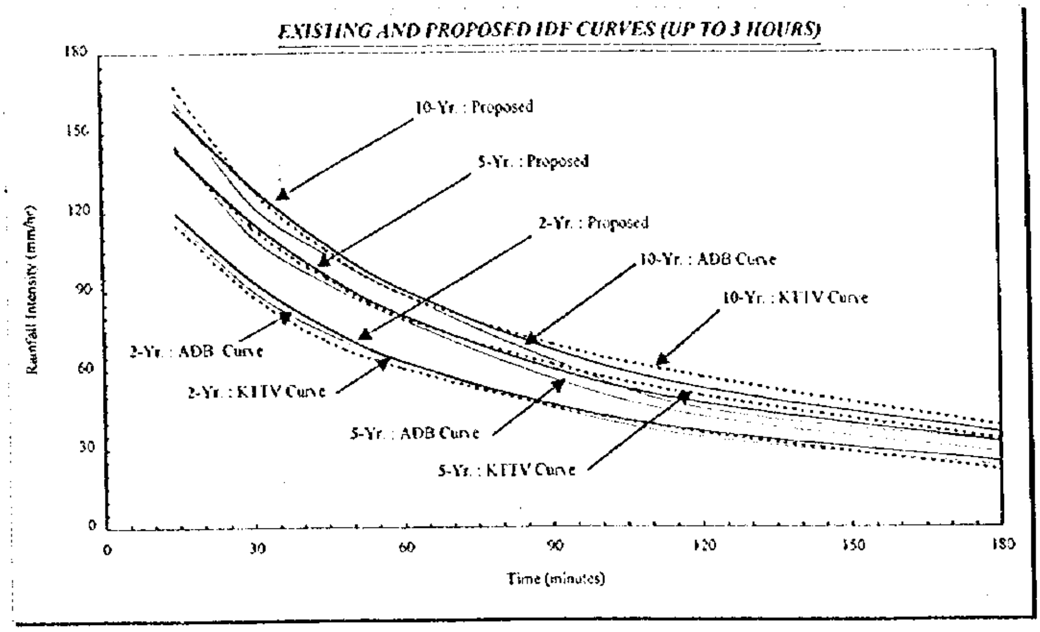
Figure C.3.6 IDF CURVES PREPARED BY MINISTRY OF CONSTRUCTION, HANOI (MOC 1953 – 1983)



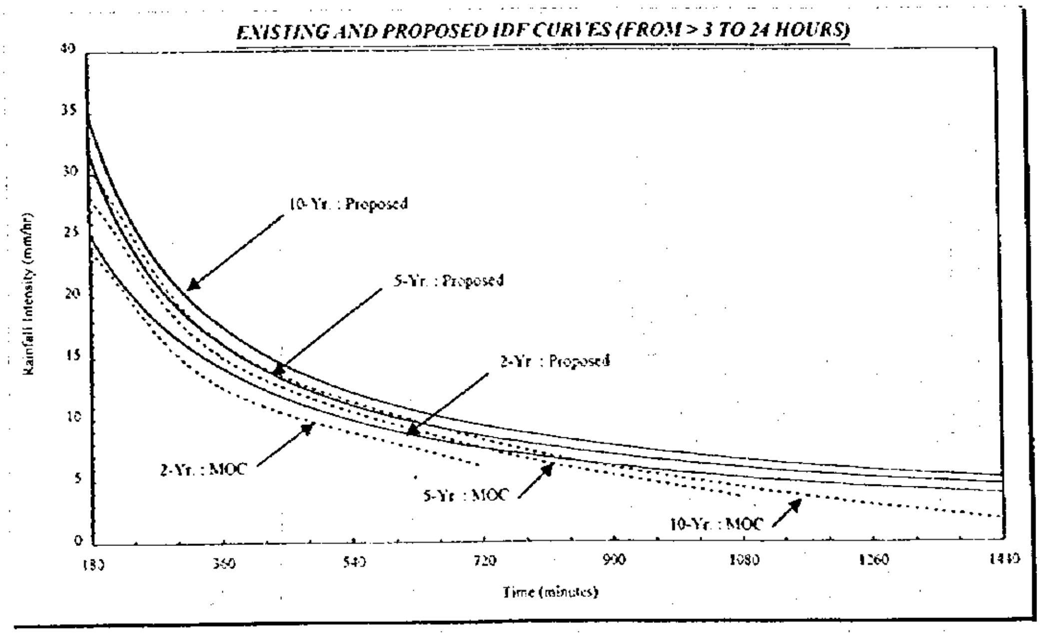
Note : Three types of eqautions have been compared to find the best fit IDF curve.
The values of the points are the calculated probable maximum rainfall intensities using Gumbel's method.

Data : 1952 - 1997

Figure C.3.7 COMPARISON AMONG THREE TYPES OF EQUATIONS FOR IDF CURVES AT TSN



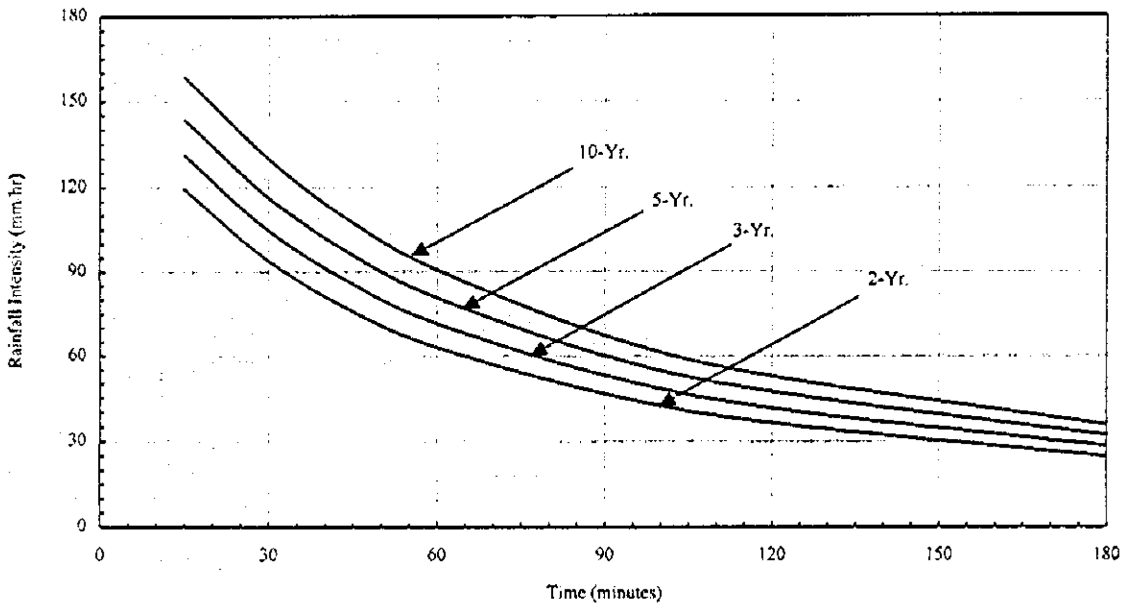
Note : Comparison has been made (for 2-Yr, 5-Yr and 10-Yr rainfall intensities) among Proposed IDF curves (1952 - 1997 data), fitted by Kimijima type equation with Existing IDF curves (1933 - 1989 data) of Hydrological Sub-Institute, HCMC (KTTV) and Existing IDF curves (1956 - 1994 data) of Asian Development Bank's Report (ADB)



Note : Comparison has been made (for 2-Yr, 5-Yr and 10-Yr rainfall intensities) between Proposed IDF curves (1952 - 1997 data), fitted by Kimijima type equation and Existing IDF curves (1953 - 1983 data) of Ministry of Construction, Hanoi (MOC)

Figure C.3.8 COMPARISON BETWEEN EXISTING AND PROPOSED IDF CURVES

PROPOSED IDF CURVES WITH EQUATIONS (UP TO 3 HOURS)



Data : 1952 - 1997

Proposed Equations of IDF Curves

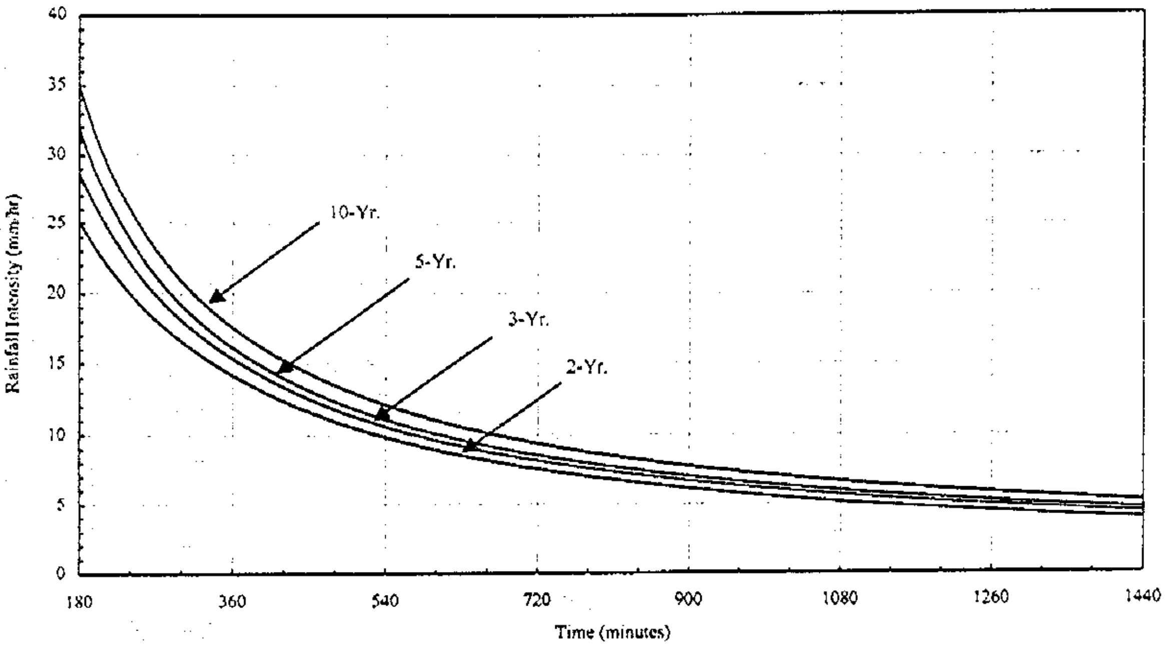
Kimijima Type : $I = \frac{b}{t^n + a}$

I = Rainfall Intensity, mm/hr
t = Duration, minutes

Return Period (Years)	Parameter b	Parameter n	Parameter a
1	3,055	1.04	24
1.5	10,633	1.15	74
2	13,567	1.18	89
3	17,439	1.20	107
5	22,294	1.22	128
10	29,125	1.25	154
20	36,410	1.27	179
25	38,836	1.28	186
30	40,861	1.28	192
50	46,733	1.29	209
70	50,683	1.30	220
100	54,976	1.31	231

Figure C.3.9 PROPOSED IDF CURVES WITH EQUATIONS AT TSN (UP TO 3 HOURS)

PROPOSED IDF CURVES WITH EQUATIONS (FROM > 3 TO 24 HOURS)



Data : 1952 - 1997

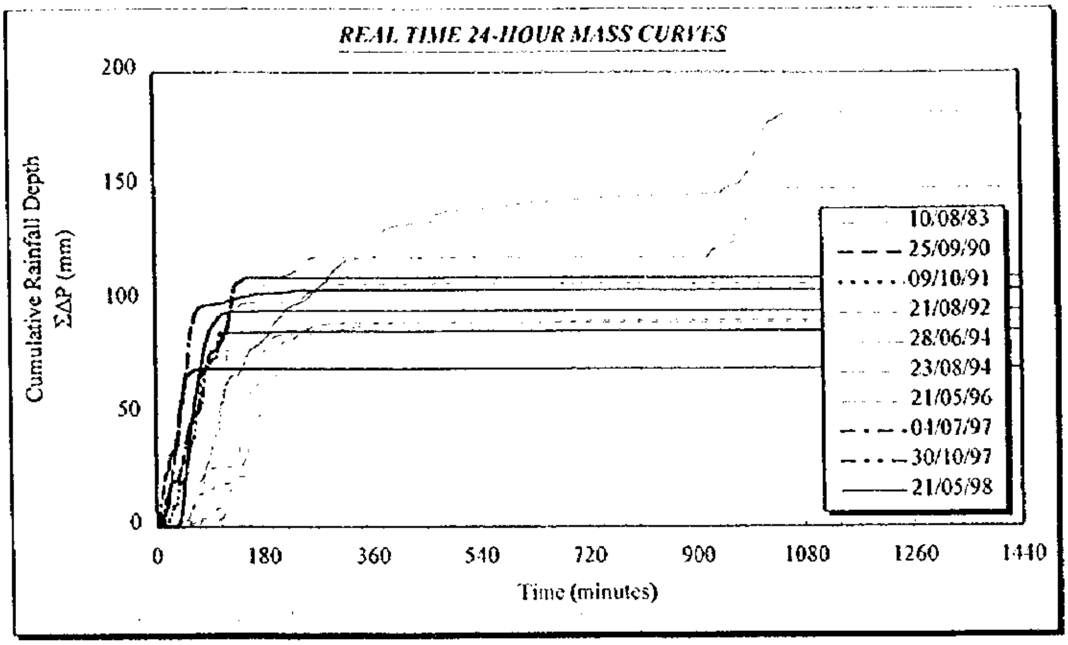
Proposed Equations of IDF Curves

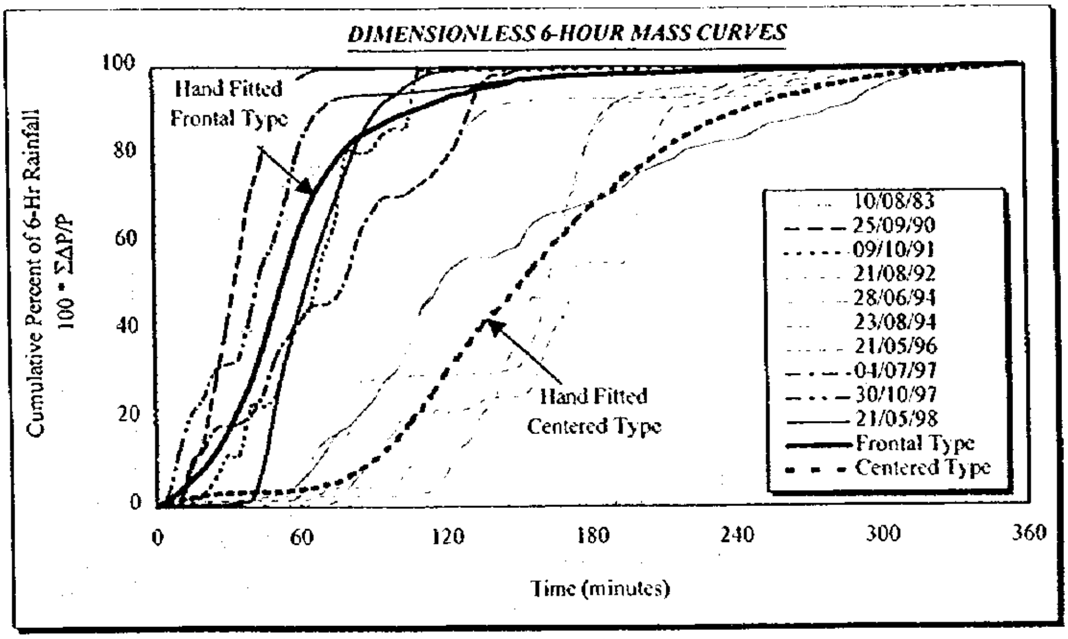
Kimijima Type : $I = \dfrac{b}{t^n + a}$

I = Rainfall Intensity, mm/hr
t = Duration, minutes

Return Period (Years)	Parameter		
	b	n	a
1	515,400	1.68	35,184
1.5	7,372	1.05	94
2	5,858	1.00	53
3	3,269	0.91	1
5	2,024	0.84	-15
10	1,669	0.80	-16
20	1,229	0.75	-17
25	1,305	0.75	-17
30	1,073	0.72	-17
50	886	0.69	-17
70	872	0.68	-16
100	875	0.68	-16

Figure C.3.10 PROPOSED IDF CURVES WITH EQUATIONS AT TSN (FROM MORE THAN 3 TO 24 HOURS)



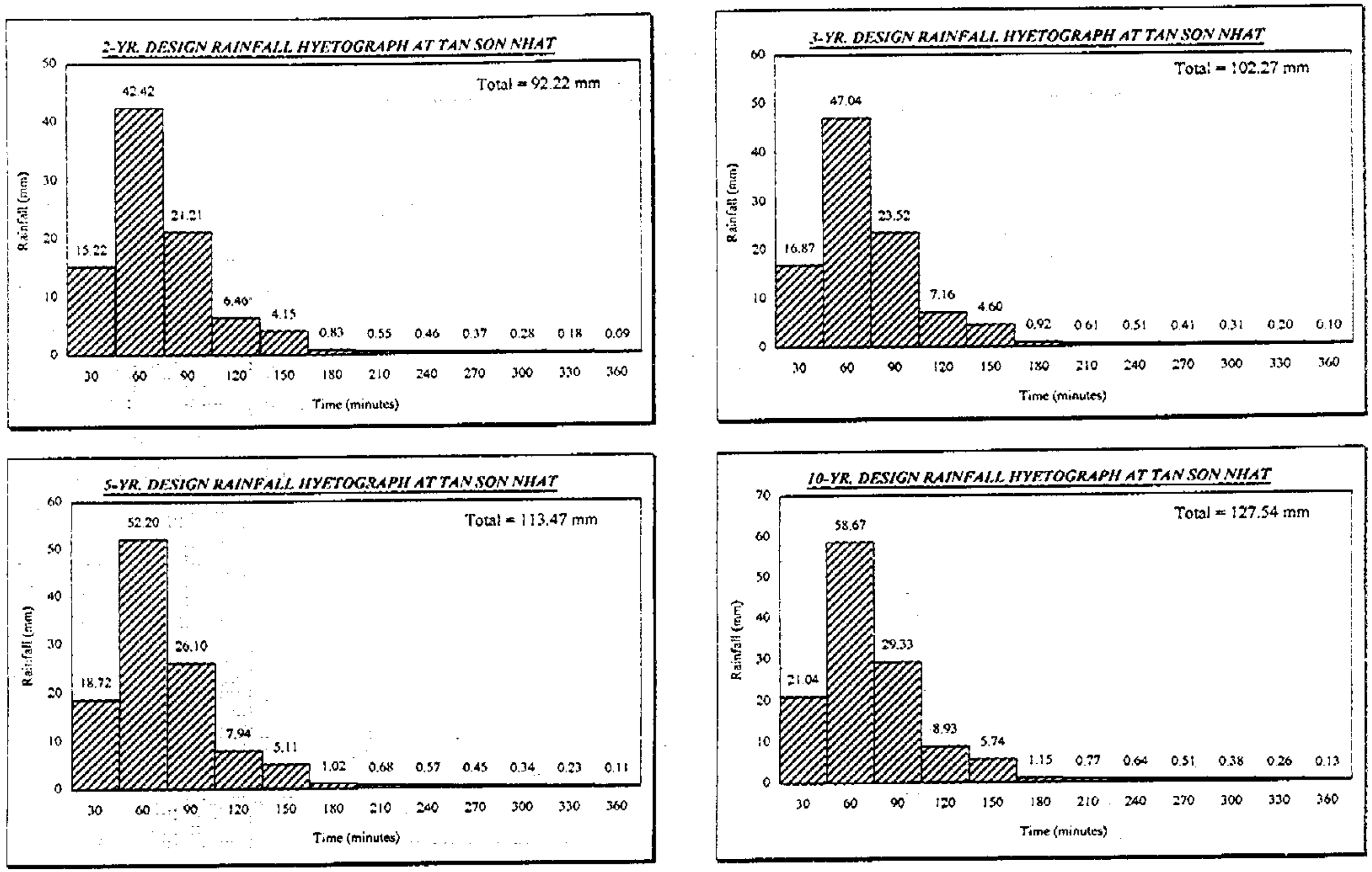


Nomenclature : P = Total rainfall depth (mm) in 6 hours
ΣΔP = Cumulative rainfall depth (mm) at time, t

Note : The ten heavy rain events have daily rainfall depths of about 100 mm to more than 100 mm with return periods varying from 5-year to 10-year.

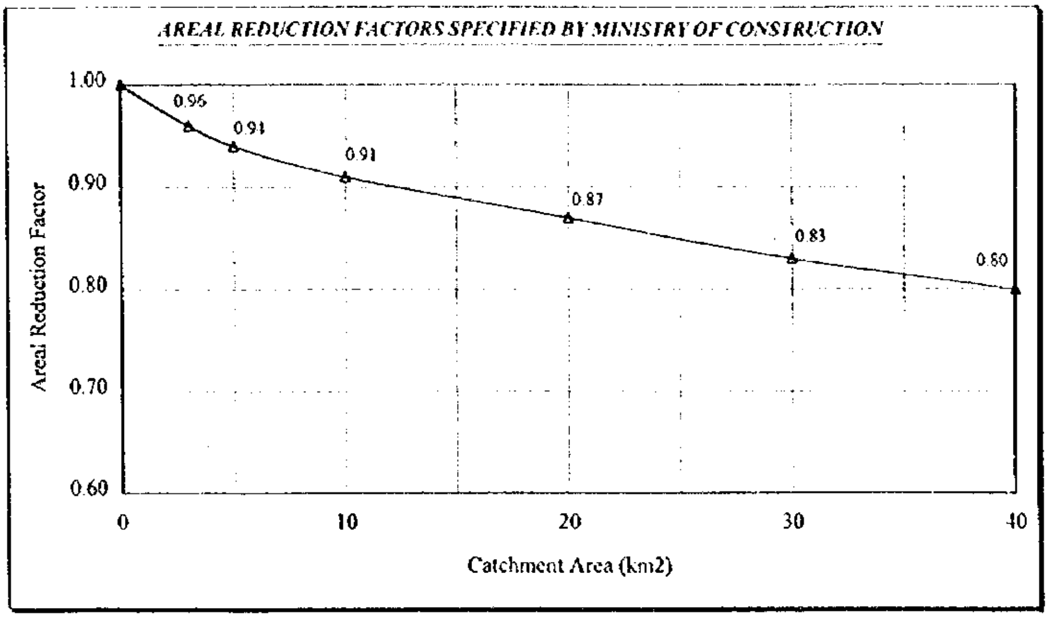
Data Source : Southern Region Hydro Meteorological Center, Ho Chi Minh City

Figure C.3.11 MASS CURVES OF TEN HEAVY RAINALL EVENTS (1983 - 1998)

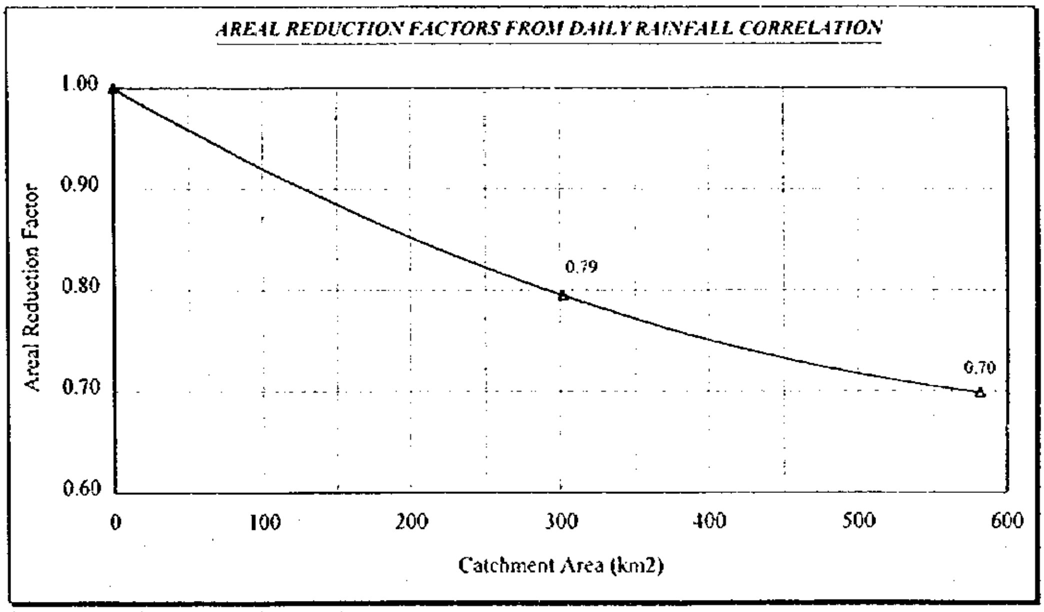


Note: The amount of rainfalls represent daily total probable maximum rainfalls as calculated from Gumbel's distribution method.
The duration (6 hours) and pattern (frontal type) of the design rainfall hyetographs have been selected based on mass curve analysis on ten heavy rain events during the period of 1983 to 1998.

Figure C.3.12 PROPOSED DESIGN RAINFALL HYETOGRAPHS AT TAN SON NHAT



Note : Ministry of Construction (MOC) only specifies the values, not the smooth line.



Note : Invesigated by the JICA Study Team using Thiessen Polygons of seven stations and daily rainfall correlations between Tan Son Nhat and other six stations based on 1994 & 1996 rainfall data.

Figure C.3.13 AREAL REDUCTION FACTORS SPECIFIED BY MOC AND CALCULATED FROM DAILY RAINFALL CORRELATIONS BY JICA

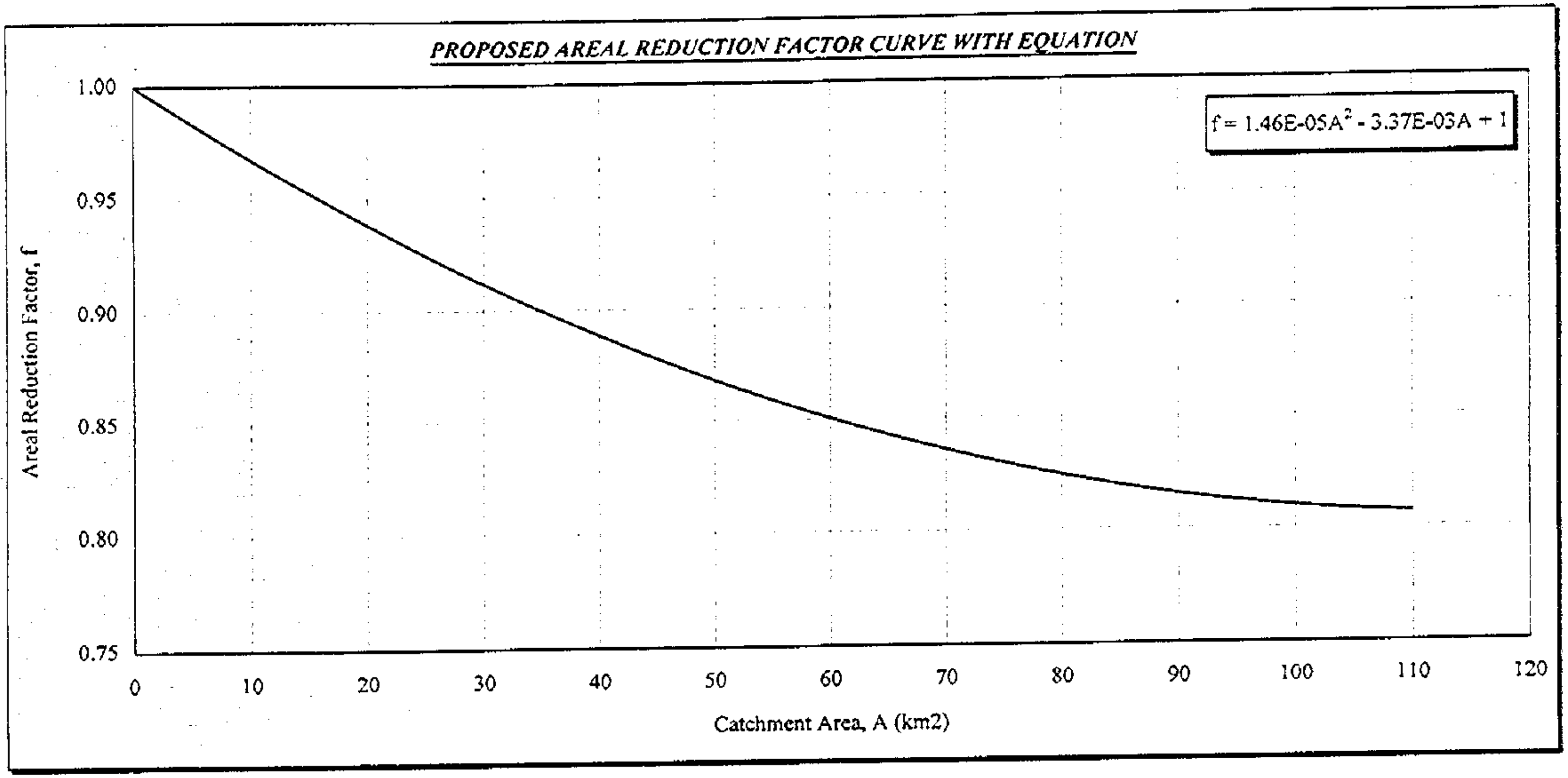
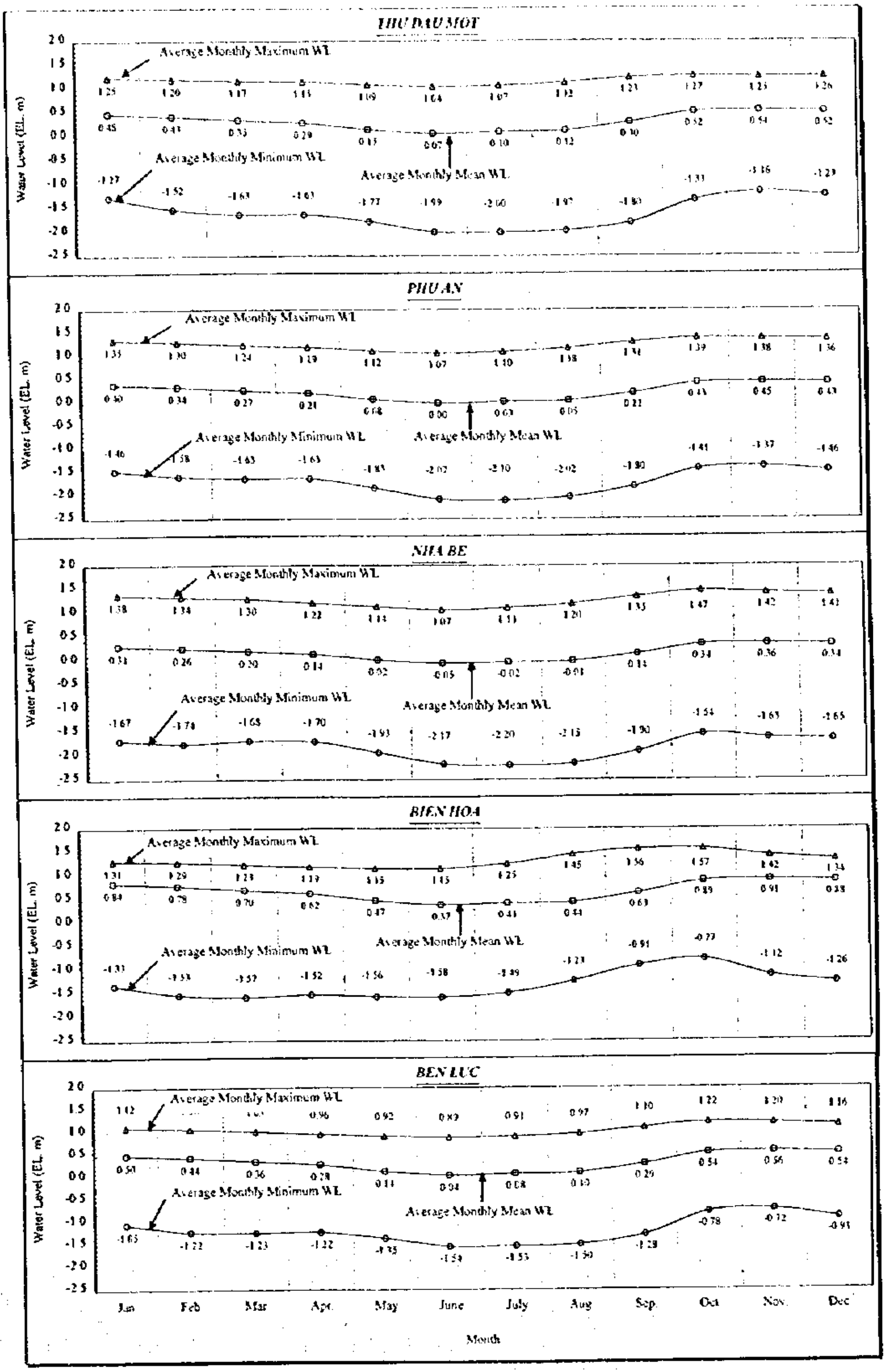
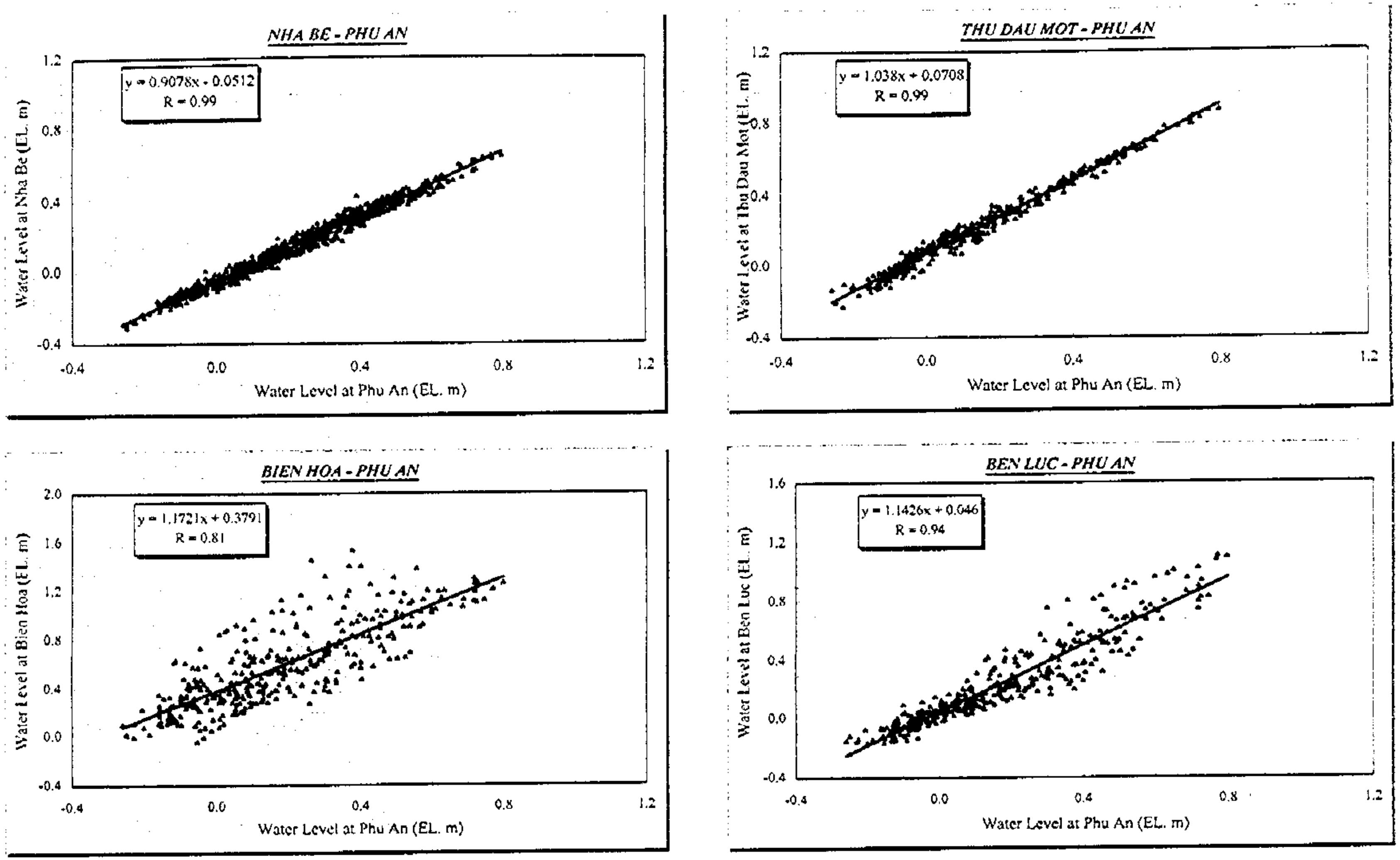


Figure C.3.14 PROPOSED AREAL REDUCTION FACTOR CURVE WITH EQUATION



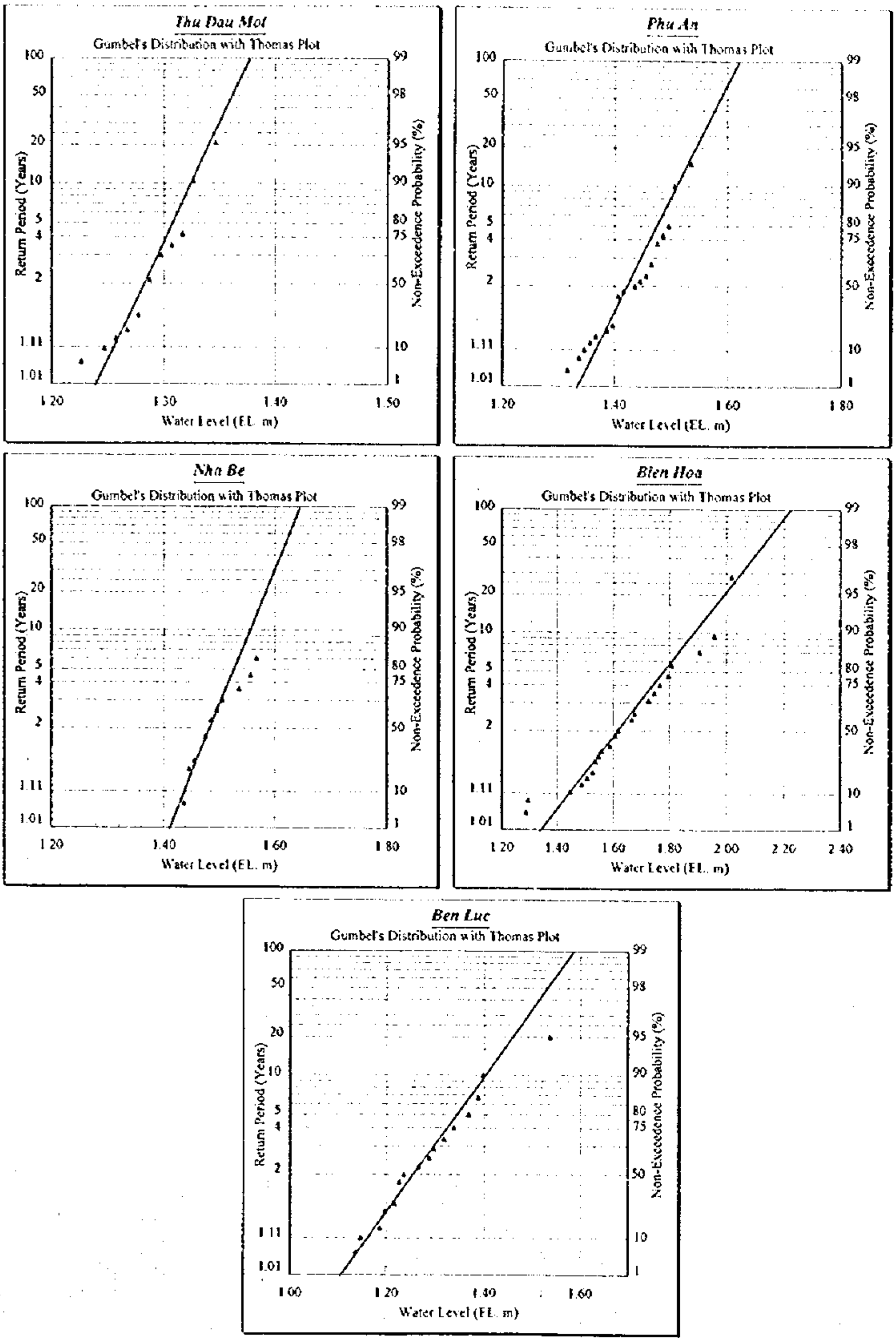
Monthly maximum and minimum water levels : Data ranges from 1960 to 1997, depending upon the station
Monthly mean water level   Data for Phua An ranges from 1993 to 1997 (hourly data) and for other stations, estimated from correlations of mean water levels

Figure C.4.1 MONTHLY MAXIMUM, MINIMUM AND MEAN WATER LEVELS



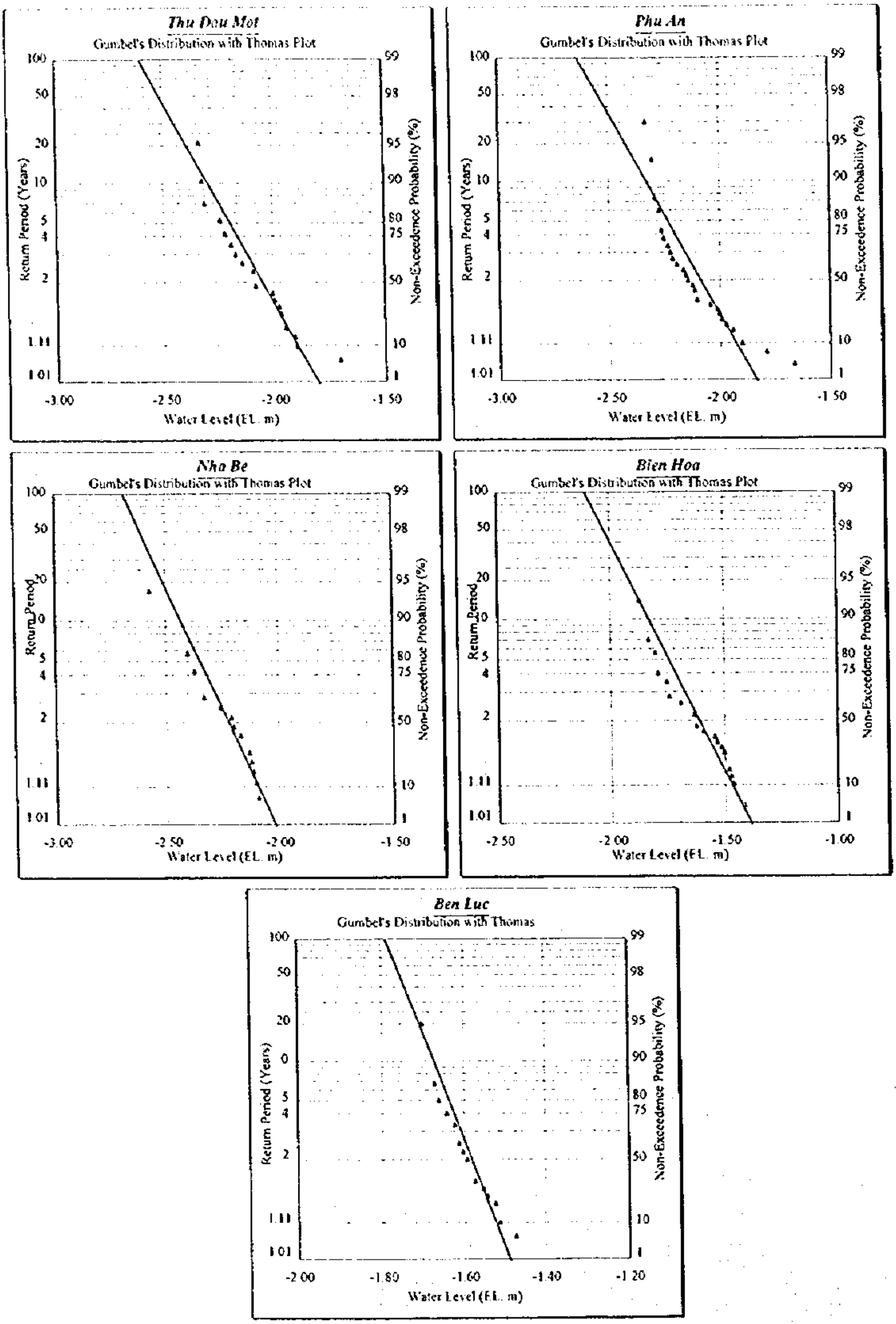
Data : Daily mean water levels for different months during the period 1990 to 1997.

Figure C.4.2 CORRELATIONS ON DAILY MEAN WATER LEVELS BETWEEN PHU AN AND OTHER STATIONS



Data : Thu Dau Mot => 1966-1997; Phu An => 1960-1997; Nha Be => 1977-1997; Bien Hoa => 1960-1997 and Ben Luc => 1962-199

Figure C.4.3 PROBABILITY PLOTS OF MAXIMUM WATER LEVELS



Data : Thu Dau Mot => 1966-1997; Phu An => 1960-1997; Nha Be => 1977-1997; Bien Hoa => 1960-1997 and Ben Luc => 1962-199

Figure C.4.4 PROBABILITY PLOTS OF MINIMUM WATER LEVELS

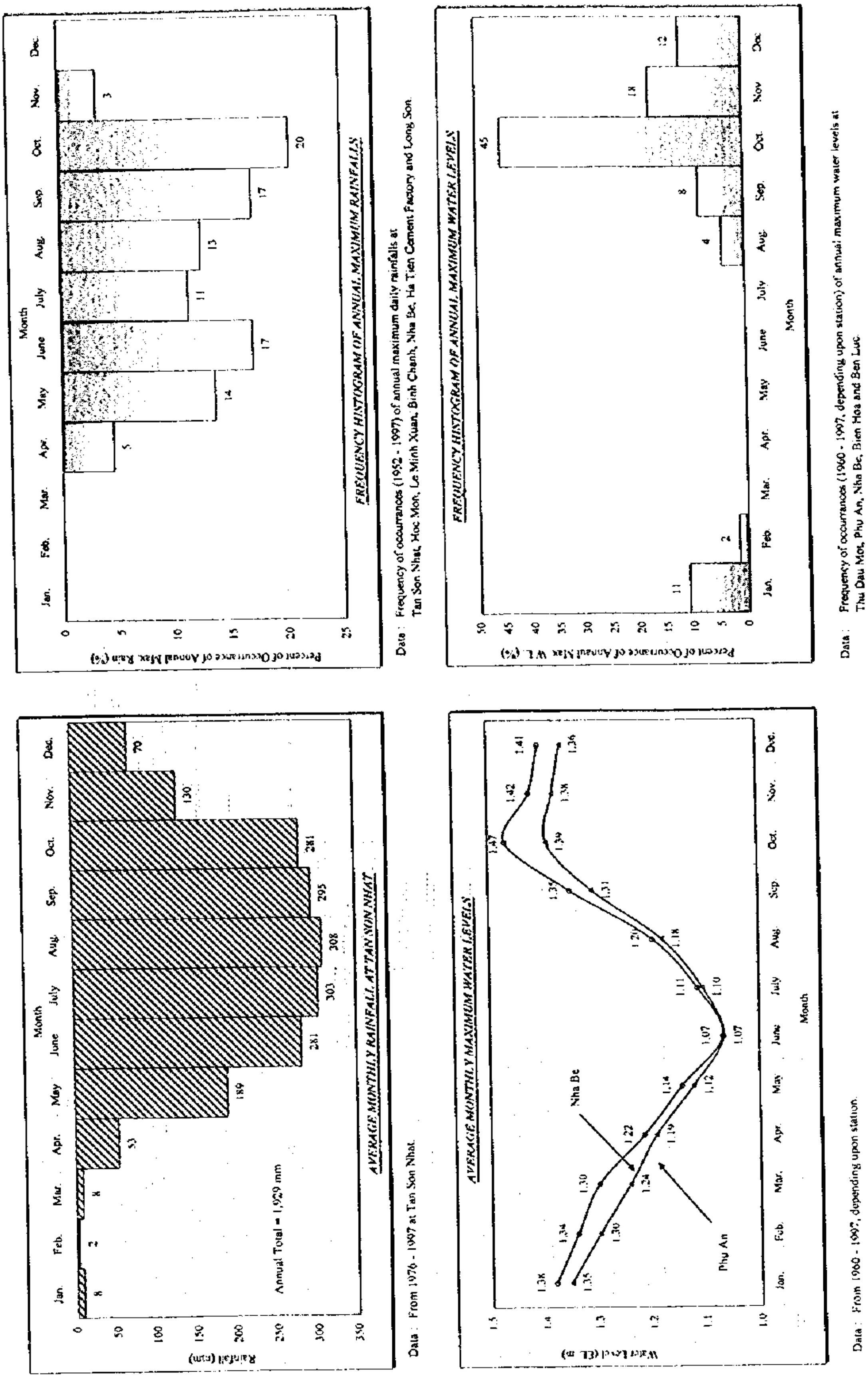
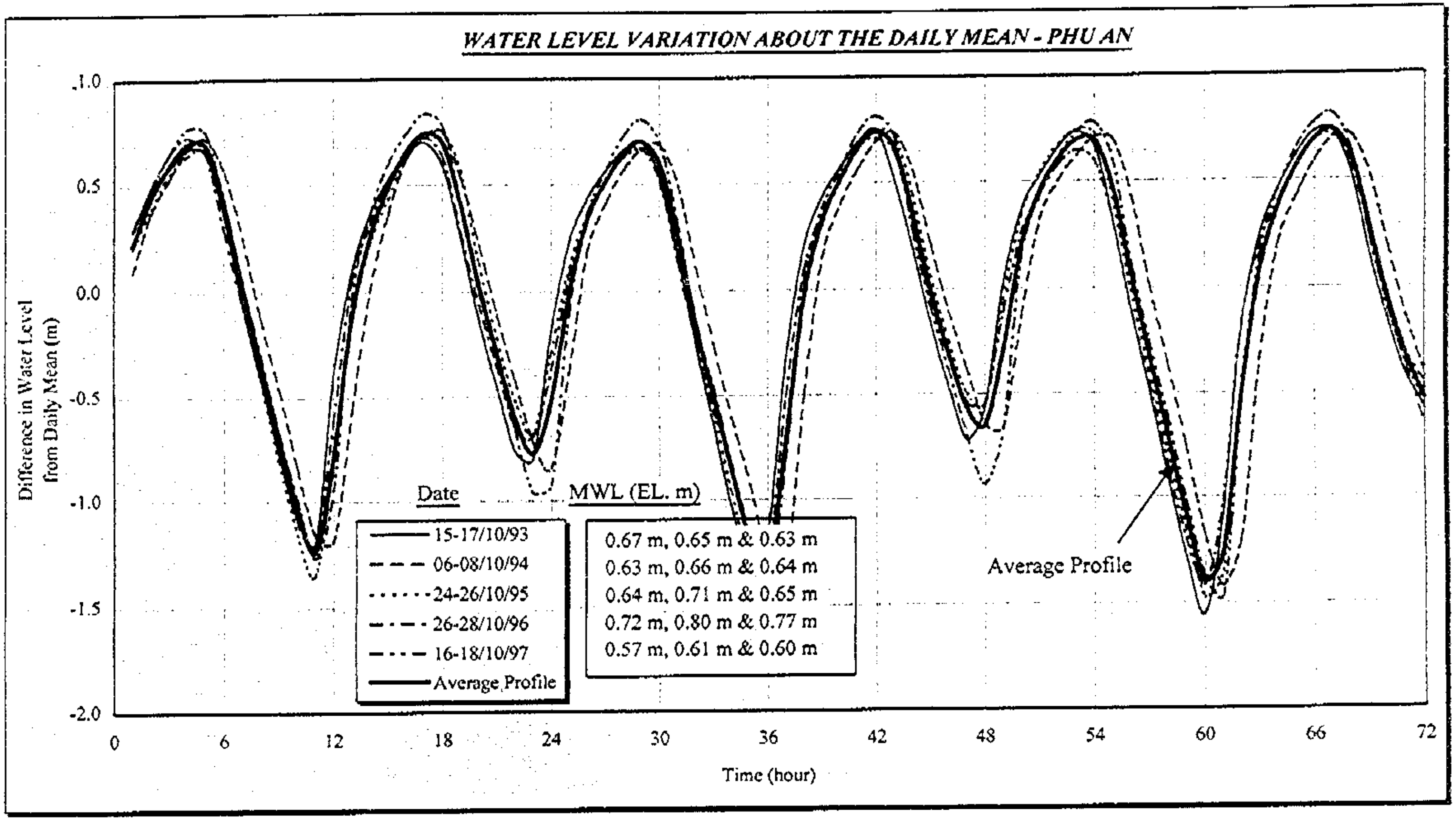
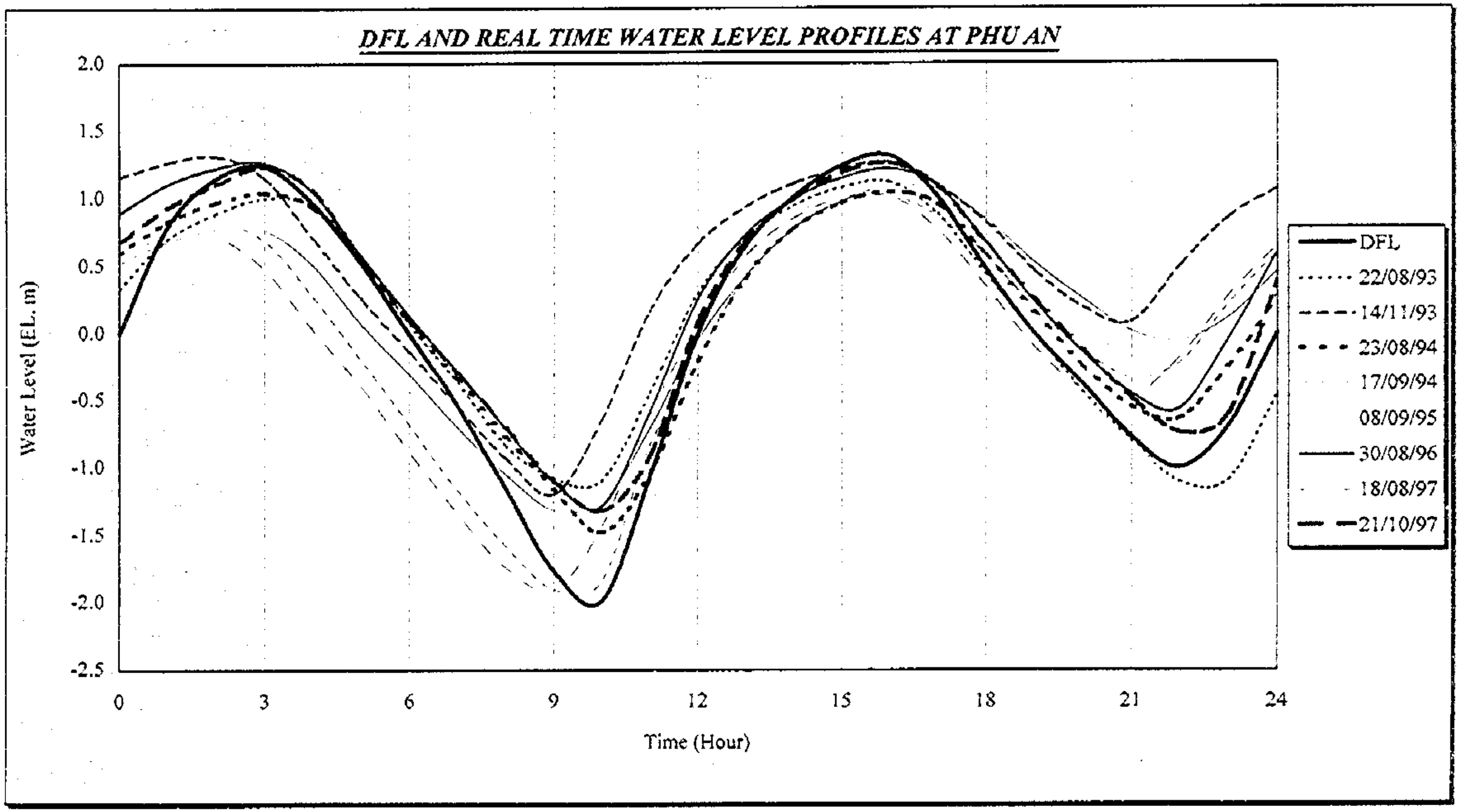


Figure C.4.5 MONTHLY RAINFALL AND MAXIMUM WATER LEVELS AND FREQUENCY HISTOGRAMS



Data : The dates correspond to maximum water levels in October for the recent five years.

Figure C.4.6 VARIATION IN WATER LEVEL ABOUT THE DAILY MEAN AT PHU AN



Note: The real time water level profiles have been selected from the months of August to November during the period 1993 to 1997.
The maximum water levels of the profiles are close to the maximum value of Design Flood Level.

Figure C.4.7 COMPARISON OF 24-HOUR DFL WITH REAL TIME WATER LEVEL PROFILES AT PHU AN

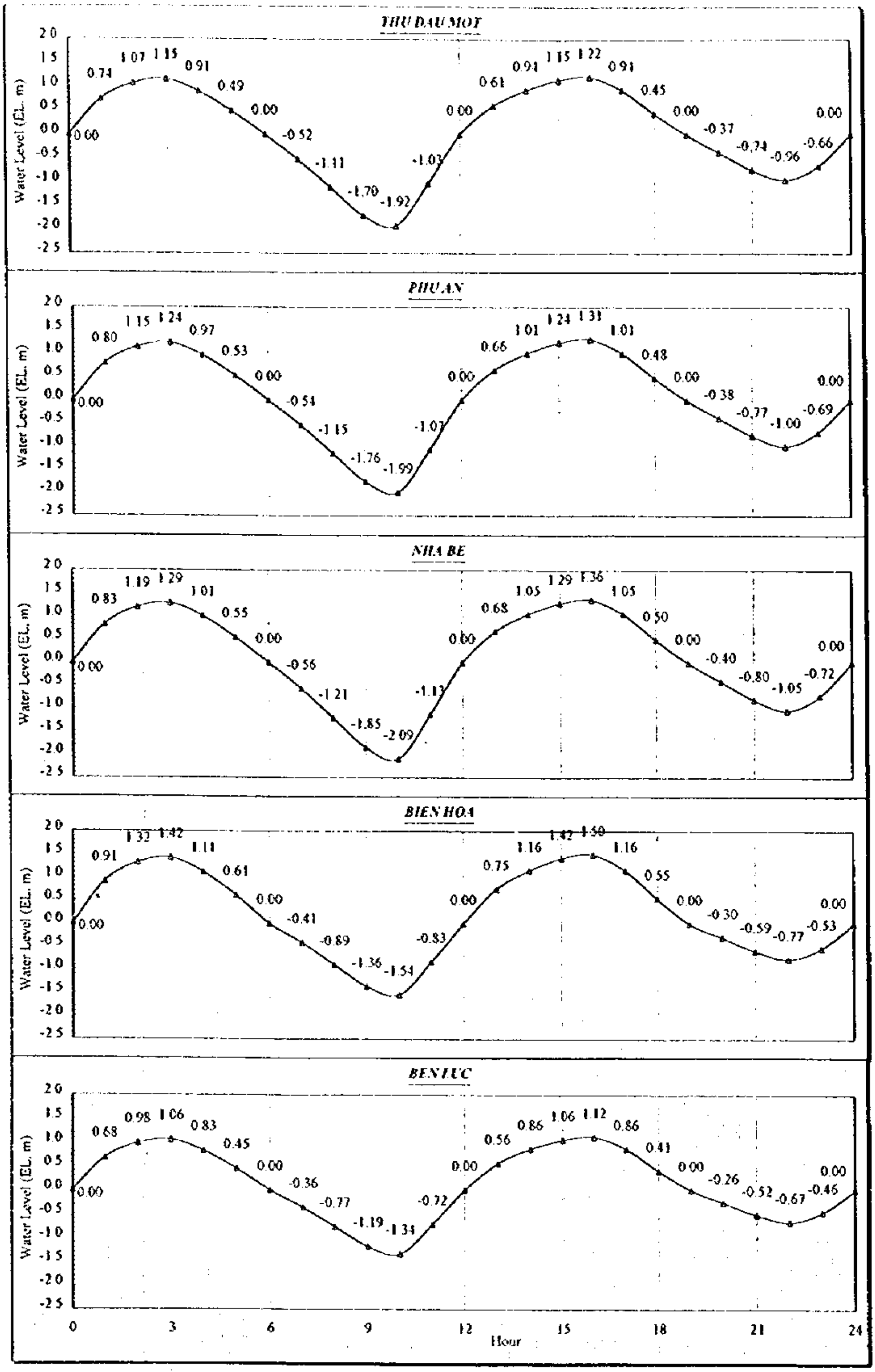


Figure C.4.8 24-HOUR DESIGN FLOOD LEVEL (DFL) BY STATION

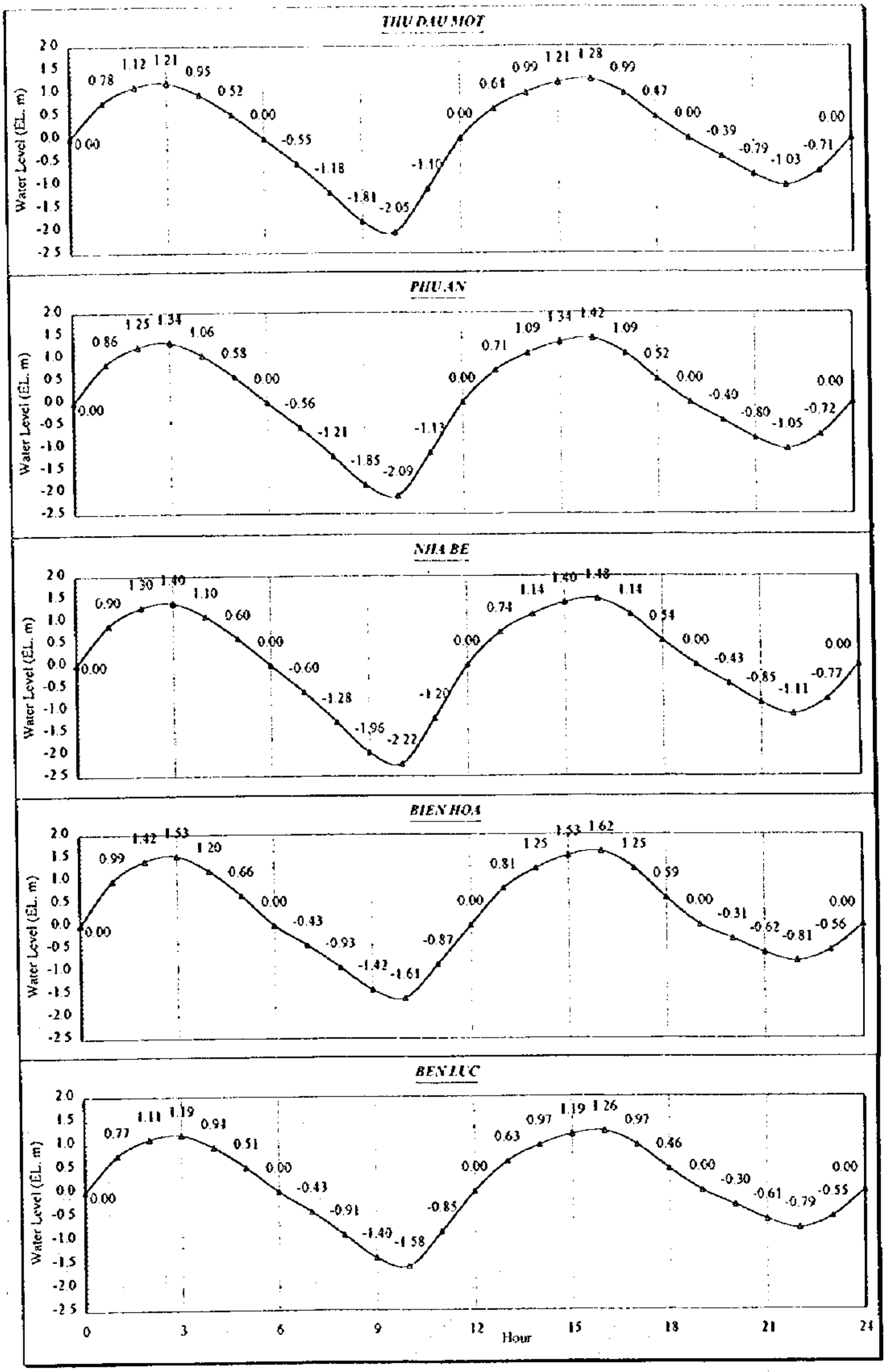


Figure C.4.9 2-YEAR WATER LEVEL PROFILE BY STATION

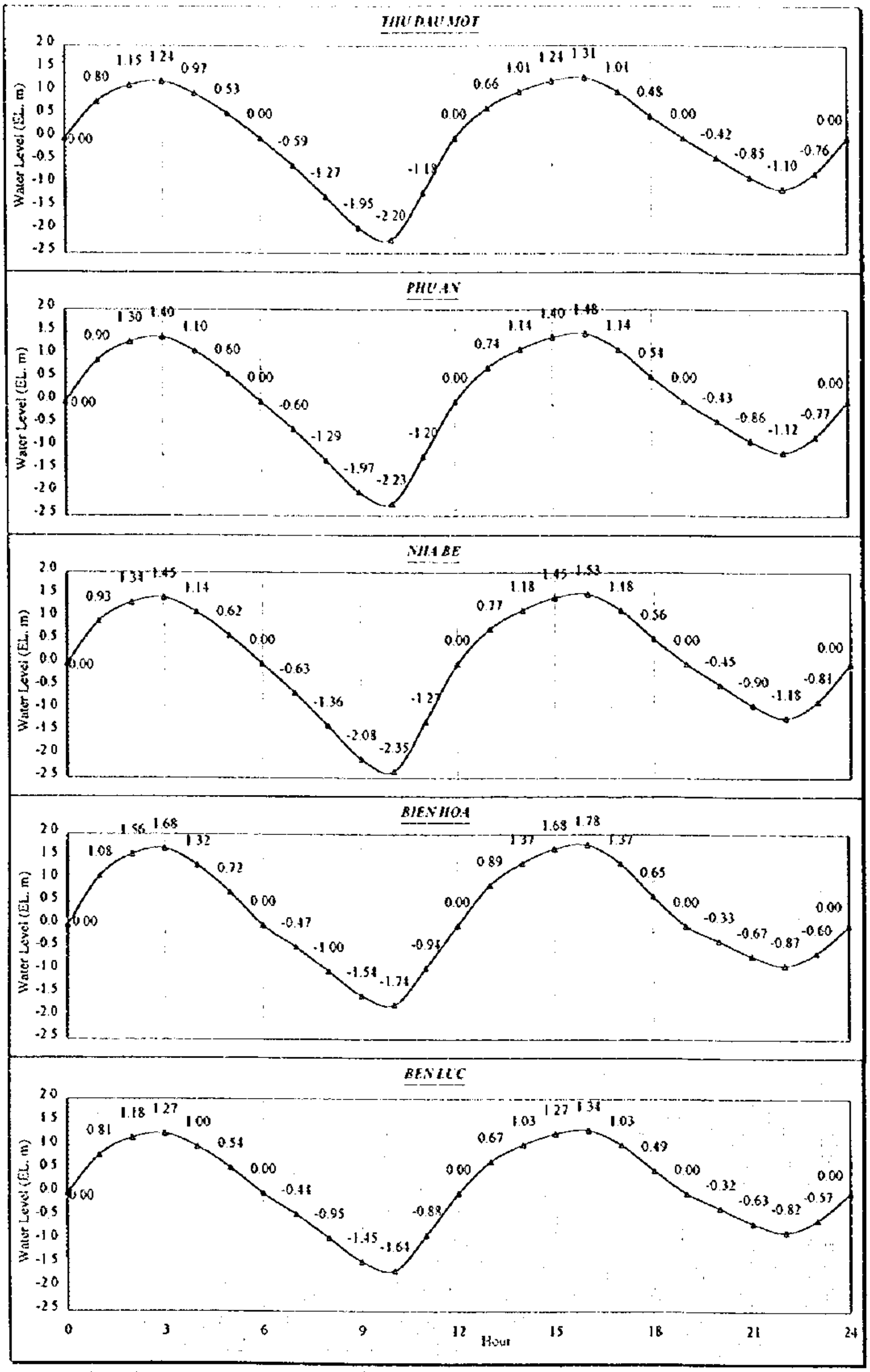


Figure C.4.10 5-YEAR WATER LEVEL PROFILE BY STATION

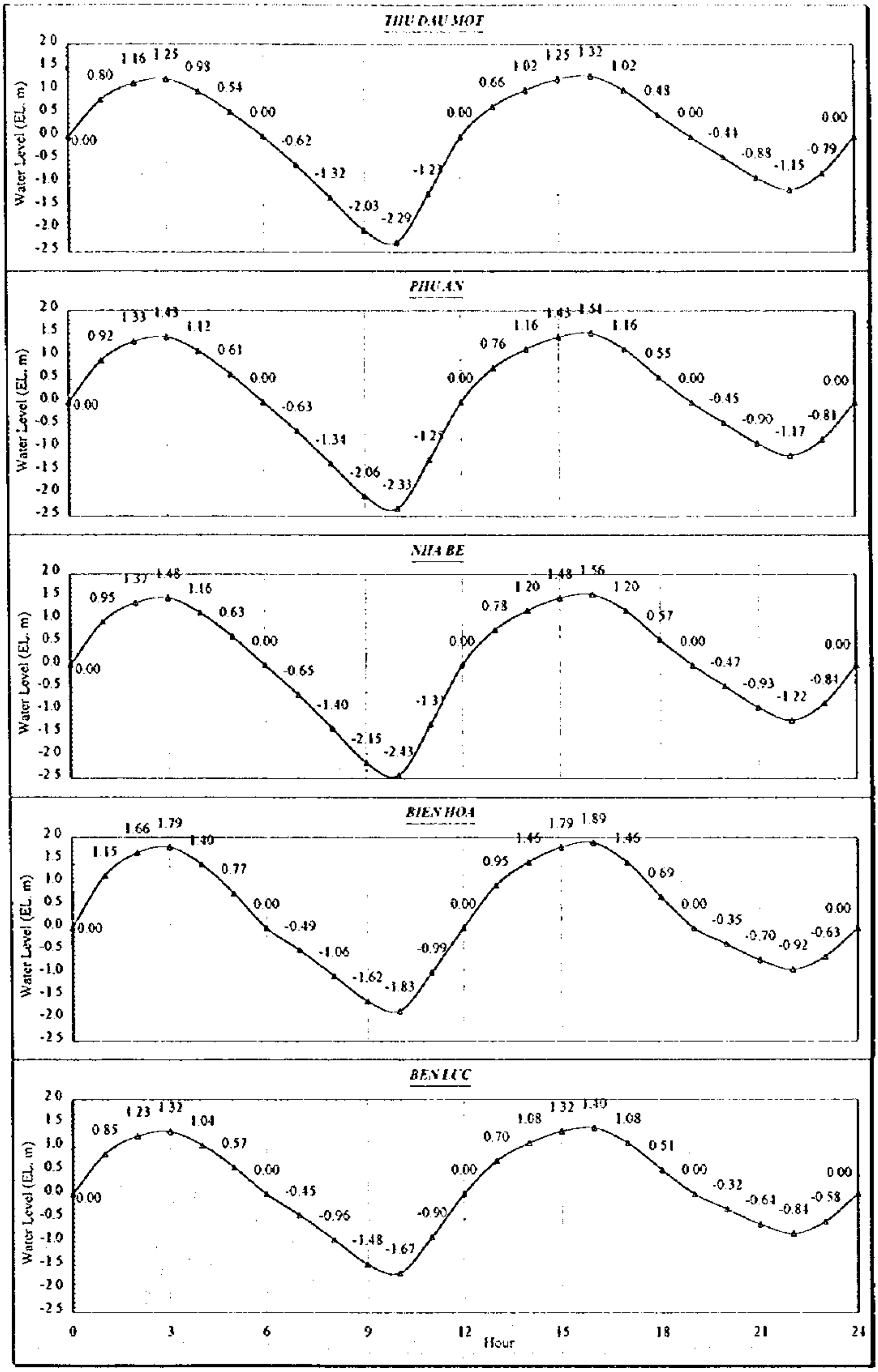
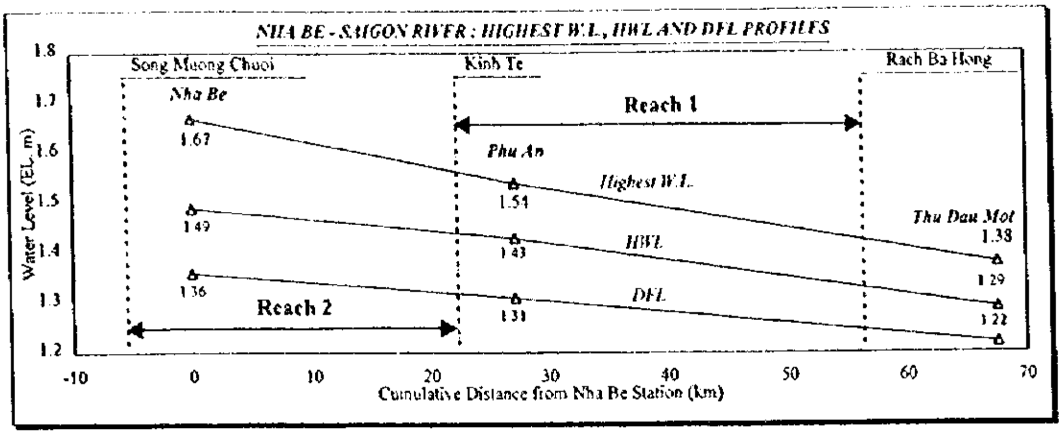
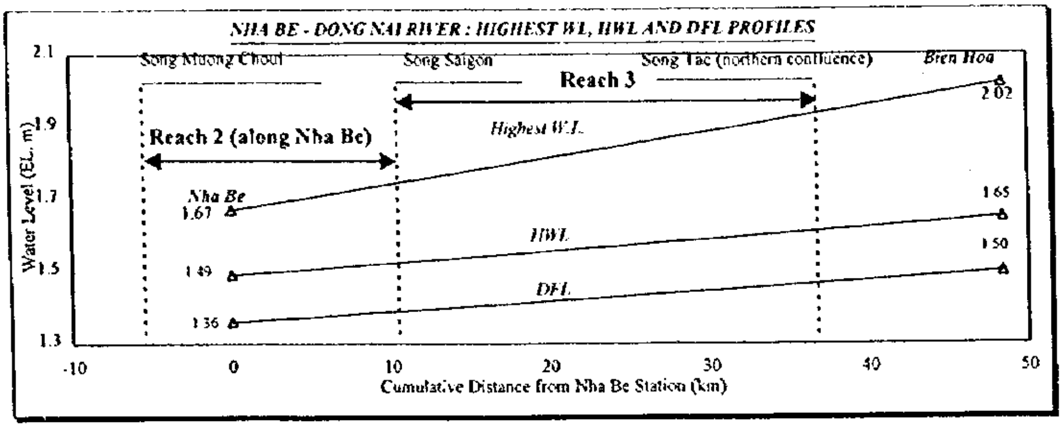


Figure C.4.11 10-YEAR WATER LEVEL PROFILE BY STATION





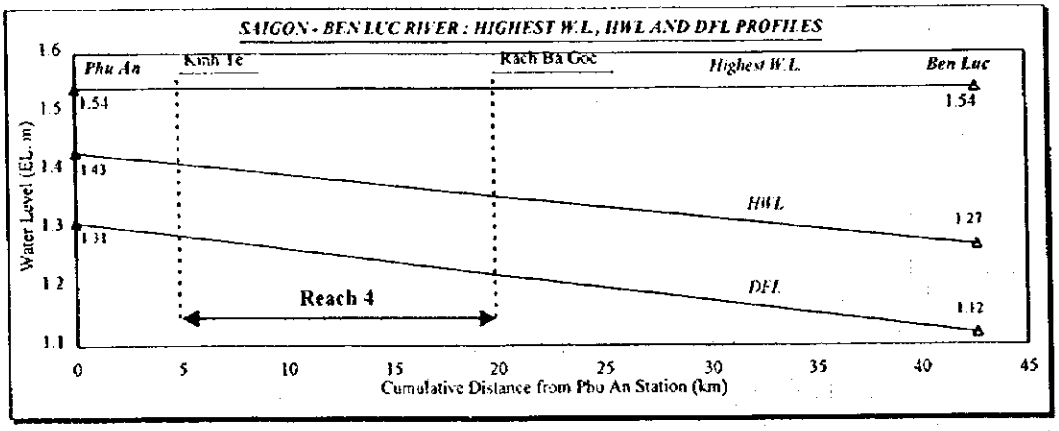
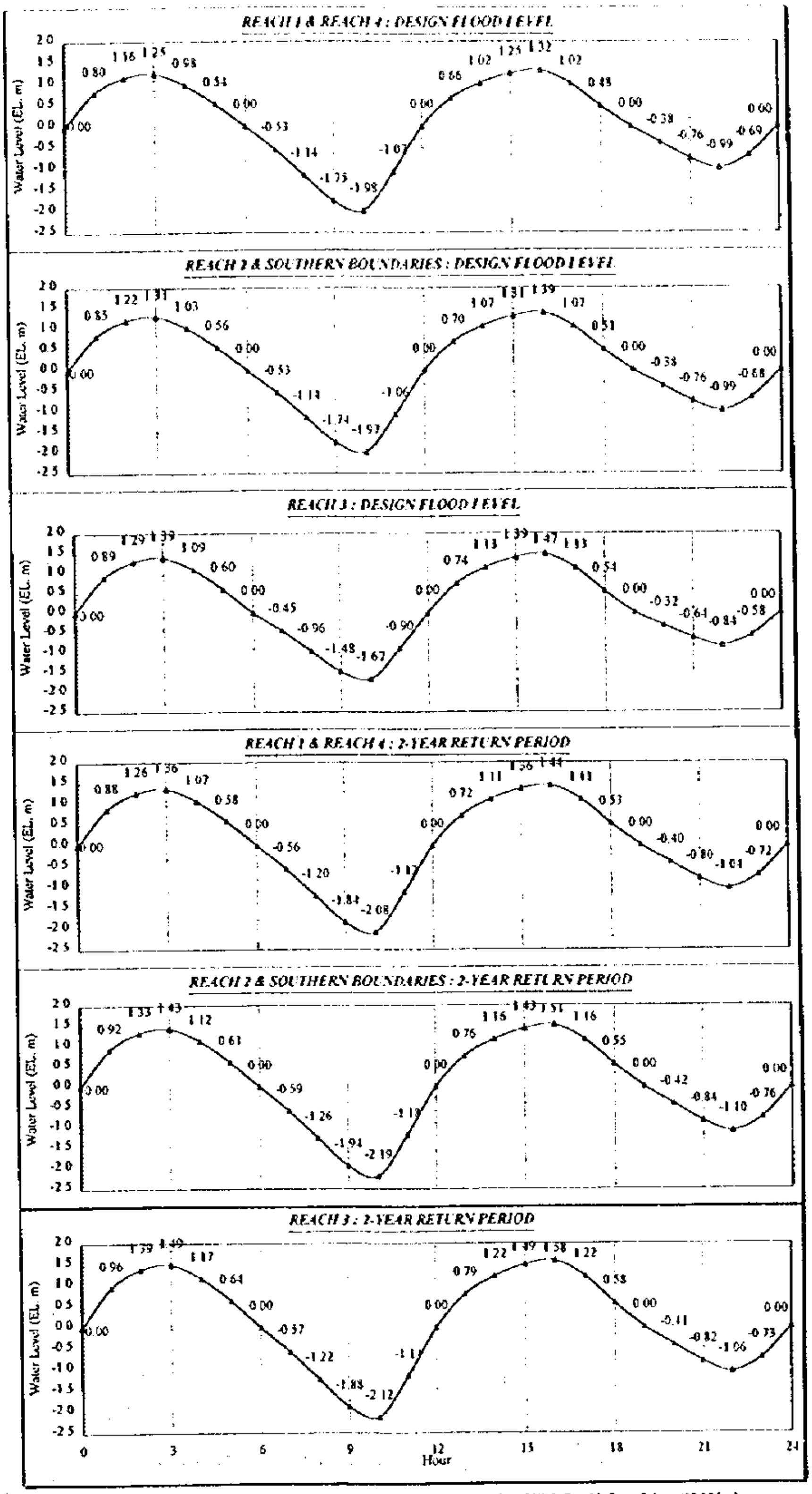
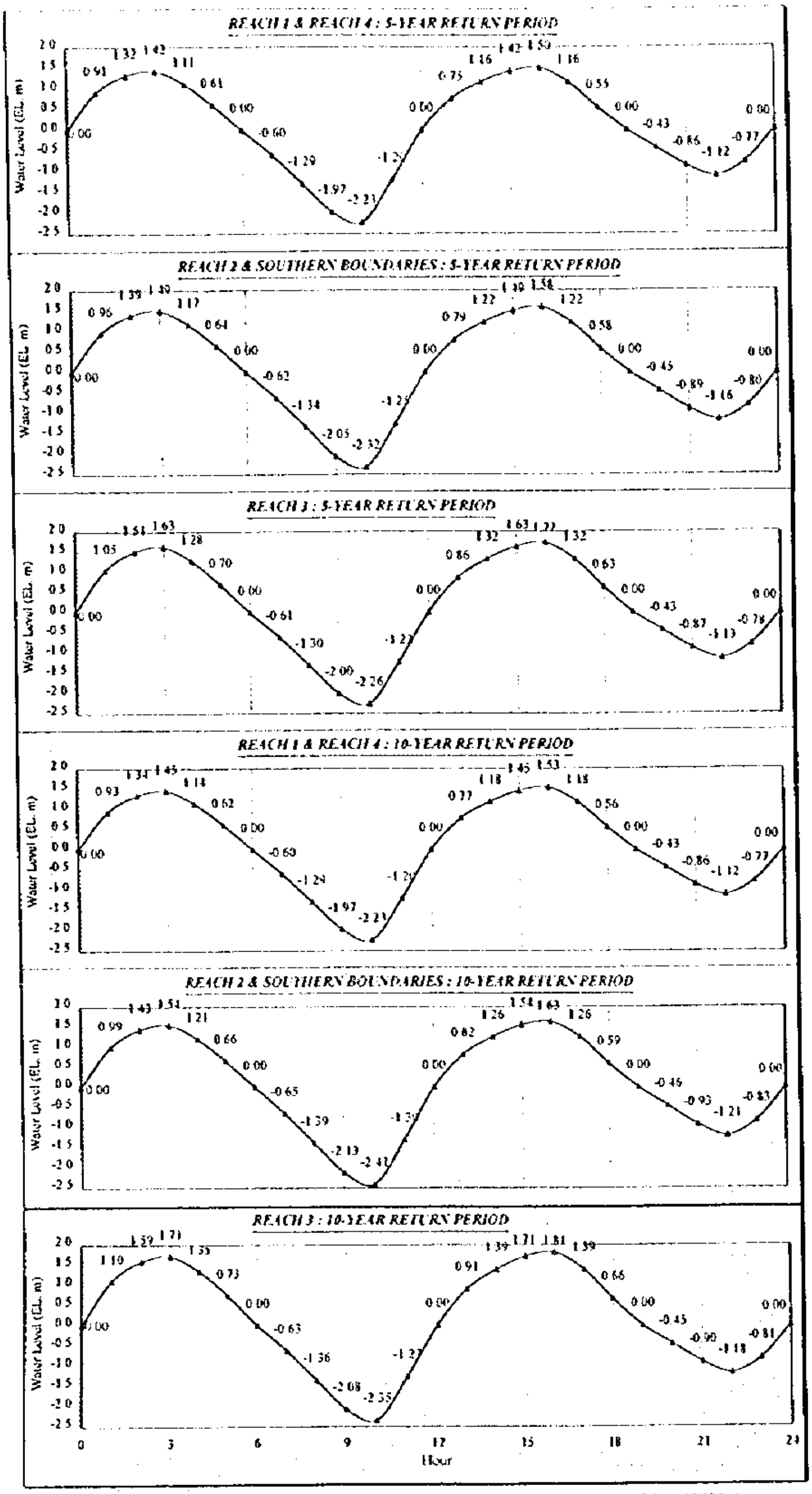


Figure C.4.12 LONGITUDINAL WATER LEVEL PROFILES



Reach 1 : From confluence point of Rach Ba Hong with Song Saigon to confluence point of Kinh Te with Song Saigon (33 97 km)
Reach 2 : From confluence point of KinhTe with Song Saigon to confluence point of Song Muong Chaoi with Song Nha Be (27 83 km)
Reach 3 : From confluence point of Song Saigon with Song Nha Be to (northern) confluence point of Song Tac with Song Dong Nai (26 33 km)
Reach 4 : From confluence point of Kinh Te with Song Saigon to confluence point of Rach Ba Goc with Song Ben Luc (15 65 km)
Southern Boundaries : The southern boundaries of Rach Can Giuoc and Rach Ba Lao flowing towards the south

Figure C.4.13 24-HOUR WATER LEVEL PROFILE BY REACH (1/2)



Reach 1 : From confluence point of Rach Ba Hong with Song Saigon to confluence point of Kinh Te with Song Saigon (33 97 km)
Reach 2 : From confluence point of KinhTe with Song Saigon to confluence point of Song Muong Chuoi with Song Nha Be (27 83 km)
Reach 3 : From confluence point of Song Saigon with Song Nha Be to (northern) confluence point of Song Tac with Song Dong Nai (26 33 km)
Reach 4 : From confluence point of Kinh Te with Song Saigon to confluence point of Rach Ba Goc with Song Ben Luc (35 65 km)
Southern Boundaries : The southern boundaries of Rach Can Giuoc and Rach Ba Lao flowing towards the south.

Figure C.4.13 24-HOUR WATER LEVEL PROFILE BY REACH (2/2)