A summary of rainfall and stream gauging stations is shown in *Table C.2.6* and *Figure C.2.1*.

In general, data on flow rate are recorded regularly twice a day in the morning and afternoon, these data are called daily data. However some stations were severely damaged by the Hurricane Mitch in 1998 and the measurement was conducted irregularly, these data are called non-daily data.

Both daily and non-daily data are not used in the calculation because they are not the actual peak flow.

The annual maximum, average and minimum flow rates of the main stations recorded are shown in *Table C.2.7* and are summarized as follows:

Table C.2.8 Average Flow Rate in the Choluteca River Basin in Tegucigalpa

Basin	Station	Flow Rate (m^3/s)		
		Maximum	Minimum	Average
Grande	Concepcion	9.96	0.072	0.895
San Jose	El Incienso	36.70	0.005	0.359
	El Aguacate	88.80	0.001	0.427
Guacerique	Quibra Montes	10.90	0.040	0.566
	Guacerique II	217.00	0.011	1.393

2.3 FREQUENCY ANALYSIS

Frequency analysis of the rainfall data was conducted to clarify its return period by using the standard Gumbel method. Theoretical background of this method is shown in the *Appendix AC.1*.

Rainfall at Toncontin station in Tegucigalpa was used as the representative rainfall in the entire basin because

- The station has a long range record of more than 50 years, and
- Hourly rainfall is available.

The average annual rainfall at Toncontin station is about 866 mm.

2.3.1 CONSIDERATION OF UNIT RAINFALL

The average annual rainfalls in the basin are different. However, during the Hurricane Mitch, although the storm period was about 3 days, the continuous rainfall was found to be about 48 hours in the entire region. The distribution of rainfall for 2 days from all stations was apparently uniform. Comparison of 1-day and 2-day rainfall is shown in the following table.

Table C.2.9 Maximum Rainfall during the Hurricane Mitch

Basin	Station	1 Day Rainfall (mm)	2 Day Rainfall (mm)
Grande	Concepcion	220.3	289.30
San Jose	Aguacate & Villa Real	236.3	275.20
Guacerique	Batallon & Quiebra Montes	215.0	232.80
Chiquito	Santa Lucia	Not Available	Not Available
Choluteca in Tegucigalpa	Toncontin	120.4	240.70

From these data, maximum 2-day rainfall at Toncontin station was used in the analysis because:

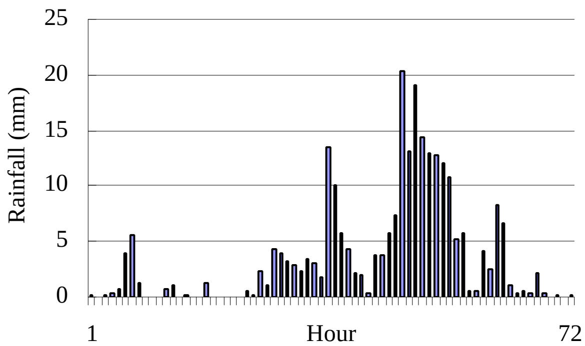
- Toncontin station has the longest data range (50 years) and is considered as the most reliable data for the analysis of up to 50-year return period,
- Maximum 1-day rainfall at Toncontin station was comparatively low. This was because the period 1 day was set for 24 hours of 1 calendar day from 0:00 to 24:00. However, peak rainfall during the Hurricane Mitch occurred at night on October 30, 1998, and continued until October 31, 1998. In this case 1-day rainfall could not cover the actual rainfall period. As a result, maximum 2-day rainfall was considered more applicable to represent the actual rainfall during the Hurricane Mitch.

2.3.2 FREQUENCY ANALYSIS OF RAINFALL

At first, the frequency analysis was conducted for the 1-day rainfall data at Toncontin station from 1951 to 1999. The maximum daily rainfall at Toncontin station is shown in *Table C.2.4.* After that, the maximum 2-day rainfall was calculated and analyzed. Maximum 1-day and 2-day rainfall, and return period at Toncontin station are shown in *Figure C.2.2*.

The hourly rainfall pattern at Toncontin station during the Hurricane Mitch had its peak at 120 mm on October 30, 1998, and the total rainfall in 72 hours was 256 mm. The rainfall pattern is as follows:

Figure C.2.3 Recorded Rainfall at Toncontin during the Hurricane Mitch



The design rainfall pattern at each return period at Toncontin station was constructed from the hourly rainfall pattern during the Hurricane Mitch. The design maximum 2-day rainfall at each return period is shown as follows:

Table C.2.10 Design Maximum 2-Day Rainfall in the Choluteca River Basin in Tegucigalpa

Return Period (Year)	Design Maximum 2-Day Rainfall (mm)
500 – 600 (Mitch)	240.70*
5	109.21
10	128.98
25	153.95
50	172.48

Note : * This is the measured data during the Hurricane Mitch, not calculated value

These design maximum rainfalls, together with the synthetic rainfall pattern, were used in the rainfall-runoff analysis for the entire river basin including the Grande, the San Jose, the

Guacerique, the Chiquito and the Choluteca river basins.

2.4 RAINFALL - RUNOFF ANALYSIS

Rainfall-runoff analysis was conducted by using a standard storage function method. Theoretical approach of this analysis is explained in *Appendix AC.1*.

Hourly rainfall data at Toncontin station during the Hurricane Mitch were used to construct the design rainfall pattern for the entire river basin. The measured data from rainfall stations from the sub-basins were not used to calculate the runoff in those basins because the recorded data were not sufficiently long.

The synthetic rainfalls were then input into the rainfall-runoff model for the calculation of runoff.

2.4.1 CALIBRATION OF THE MODEL

The storage function model was calibrated by using the actual flow at the Concepcion dam during the Hurricane Mitch with the condition as follows:

- Peak flow at the dam was 827 m^3/s,
- The storage volume was at its full capacity, thus the inflow was assumed to be same as outflow, and
- The drainage area above the dam was 139.51 km^2.

Necessary parameters in the storage function model shown in the following table were calibrated by using the above condition. These parameters were adjusted to make the simulated flow from the model had negligibly small discrepancy in comparison with the outflow at the dam.

Table C.2.11 Parameters in the Rainfall-runoff Analysis

Parameter	Value
k	17.0
p	0.3333

Note : Parameters are referred in the *Appendix AC.1*

2.4.2 RUNOFF IN THE ENTIRE BASIN

The parameters from the calibration were then used in the calculation for the entire river basin of 819.65 km^2.

By using the maximum 2-day rainfall at each return period as mentioned in the previous section, the rainfall pattern was constructed and input into the model to calculate the peak runoff in the entire basin at each return period.

Relationship of the rainfall and simulated hydrograph from the storage function method is shown in *Figure C.2.4*. Simulated hydrograph during the Hurricane Mitch is shown in the following figure. Relationship of the runoff (peak of the simulated hydrograph) and its return period is shown in *Figure C.2.5* and a summary is also shown in the following table.

Figure C.2.6 Simulated Hydrograph during the Hurricane Mitch in the Choluteca River Basin in Tegucigalpa

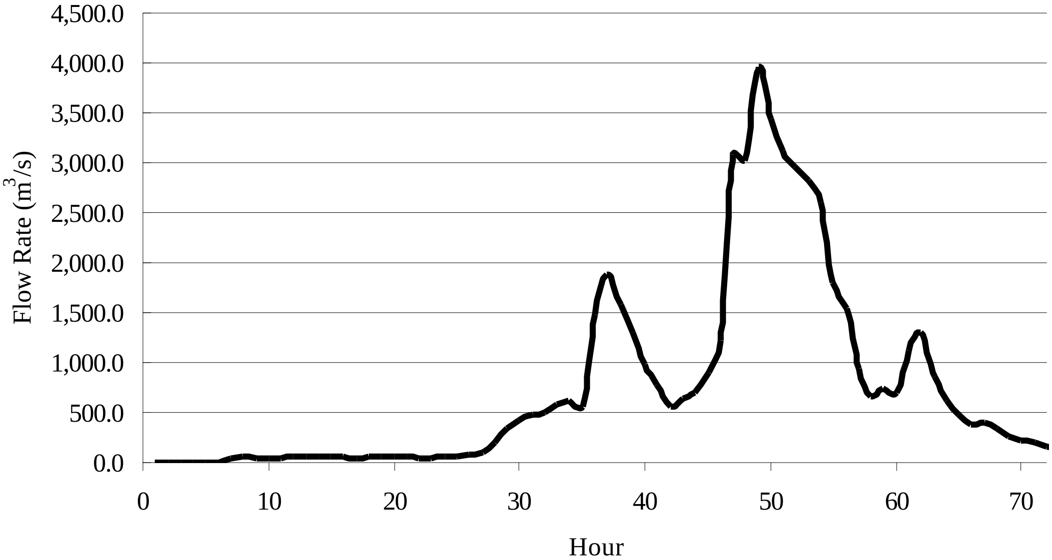


Table C.2.12 Runoff in the Choluteca River Basin in Tegucigalpa

Return Period (Year)	Runoff (m^3/s)
Mitch	3,954
5	1,508
10	1,867
25	2,328
50	2,673

2.4.3 RUNOFF IN THE SUB-BASINS

Runoff in the sub-basins were calculated from the ratio of drainage area in each basin and the total drainage area (820 km^2) based on the assumption that 2-day rainfall was uniform over the entire basin during the Hurricane Mitch. The result is shown in the following table.

Table C.2.13 Maximum Flow Rate in the Sub-basins at Each Return Period

Basin	Drainage Area (km^2)			Maximum Flow Rate (m^3/s)				
	Each	Accumulated	Mitch	5 year	10 year	15 year	25 year	50 year
Grande	258.18	258.18	1,245.46	475.03	588.08	652.47	733.27	842.00
San Jose	168.50	426.68	812.85	310.03	383.81	425.83	478.57	549.53
Guacerique	244.16	670.84	1,177.83	449.24	556.15	617.04	693.45	796.27
Chiquito	90.42	761.26	436.20	166.37	205.97	228.52	256.82	294.90
Sapo	2.97	764.23	14.35	5.47	6.77	7.52	8.45	9.70
Remaining	55.42	819.65	267.34	101.97	126.23	140.05	157.40	180.74
Choluteca (Tegucigalpa)		819.65	3,954.04	1,508.11	1,867.02	2,071.42	2,327.96	2,673.14

It should be noted that the peak flow from this calculation is based on the assumption that all peaks in the sub-basins occur at the same time. However, the actual flow in the sub-basins had a time lag of the peak from upstream to downstream, the more accurate peak flow is calculated and shown in the hydraulic simulation.

3. GRANDE RIVER BASIN

3.1 RIVER CONDITION

Grande river originates in the Yerba Buena mountains and branches into many tributaries. The river is named San Jose river after the confluence of the tributaries: Quebrada Agua Oscura and Quebrada Agua Helada. The river flows eastwards to the Concepcion dam in the midstream and takes its name after the dam.

In the eastern part of the Concepcion dam, there is a natural lake, Pescado Lake (or in Spanish "Laguna del Pescado"). This lake is the original water sources of Quebrada la Laguna, a main tributary in the basin. Quebrada la Laguna flows southwards to meet Grande river in the downstream of the dam. The river then flows down to San Jose river from the west in Tegucigalpa.

The total drainage area is 258.2 km^2 at the confluence with San Jose river as shown in *Figure C.1.1*. The sub-basin areas are as follows:

Table C.3.1 Drainage Basins of Grande River

River/Location	Basin Area (km^2)	
	Sub-basin	Total
Concepcion Dam	139.5	139.5
At the confluence with San Jose river	118.7	258.2

Source : SANAA

The Concepcion dam was constructed as a multi-purpose dam during 1970. The dam is located at the average elevation of about 1,550 m above mean sea level.

3.2 AVAILABLE DATA

3.2.1 RAINFALL

Rainfall data are available at the meteorological stations of SANAA in the basin as follows:

Table C.3.2 Rainfall Stations in the Grande River Basin

Station	Recorded Data	
	years	Range
Concepcion	28	1972 - 1999
Labrea	15	1972 - 1986

Source : SANAA

Rainfall data are recorded regularly 4 times a day at 6:00, 12:00, 18:00 and 24:00, daily rainfall is the summation of these recorded data.

The average annual rainfall at Concepcion is 920 mm. Data from Labrea was not used in the analysis because the measurement was halted for a long time. Annual rainfalls in the basin are shown in *Table C.3.3.*

3.2.2 WATER LEVEL AND FLOW RATE

Data on water level and flow rate are available at the stream gauging stations of SANAA in the basin as follows:

Table C.3.4 Stream Gauging Station in the Grande River Basin

Station	Recorded Data	
	years	Range
Non-Daily Data		
Concepcion	23	1977 - 1999

Source : SANAA

A summary of rainfall and stream gauging stations is shown in *Table C.2.6.*

In general, data on flow rate are recorded regularly twice a day in the morning and afternoon. The annual maximum, average and minimum flow rates of the station is summarized as follows:

Table C.3.5 Average Flow Rate in the Grande River Basin

Station	Flow Rate (m^3/s)		
	Maximum	Minimum	Average
Concepcion	9.96	0.072	0.895

Source : SANAA

It should be noted that the maximum flow rate shown above was the average monthly flow rate.

3.3 FREQUENCY ANALYSIS

The analysis of maximum 1-day and 2-day rainfall was conducted using the data at Concepcion station for comparison.

The design maximum rainfalls from the analysis are shown in *Figure C.3.1* and can be summarized as follows:

Table C.3.6 Design Maximum Rainfall in the Grande River Basin

Return Period (Year)	1-Day Rainfall (mm)	2-Day Rainfall (mm)
Mitch	220	289
10	124	168
20	147	199
25	154	209
50	175	239
200	220	299

Both maximum 1-day and 2-day rainfalls were considered applicable for the analysis but maximum 2-day rainfall was selected in compatible with the other sub-basins. However, these rainfalls were not used in the analysis because the data range was not sufficiently long, and data at Toncontin station were used instead as explained in Chapter 2.

4. SAN JOSE RIVER BASIN

4.1 RIVER CONDITION

San Jose river is composed of 2 main tributaries, Sabacuante and Tatumbla river. The river takes its name after the confluence of these tributaries in Tegucigalpa.

Sabacuante river originates in the Azagualpa mountains, but with a different name, and branches into many tributaries in the upstream. The river is named after the confluence of the tributaries: Quiebradra Potrerillos and the Quebrada El Lechero in the midstream, then flows northwards and meets sevearl tributaries, Quebra Los Robles, Quebrada Guijamanil, Quebrada Santa Elena, Quebrada El Terrero, etc. The river meets its main tributary Quebrada El Aquila (sometimes called Quebrada Grande) in the downstream and flows to its end point in the Study Area at El Aguacate.

Tatumbla river originates from several tributaries in the La Loma mountain in the south-east and El Jicarito mountain in the south-west. The river is named after the confluence of the Quebrada El Chile and Chiquito river, then flows northwards and meets several tributaries, Quebrada Carrancres, Quebrada de Munuare, Quebrada La Calero. In the downstream, the river is sometimes called Las Canoas river. The river flows to its end point at the confluence with Sabacuante river in the downstream.

The drainage basin area of San Jose river is shown in *Figure C.1.1* and summarized as follows:

Table C.4.1 Drainage Basins of San Jose River

River/Location	Basin Area (km^2)	
	Sub-basin	Total
Sabacuante	-	47.5
Quebrada El Aguila	33.0	80.5
Tatumbla Upstream	64.0	144.5
Remaining	24.0	168.5
Total		168.5

Source : SANAA

4.2 AVAILABLE DATA

4.2.1 RAINFALL

Rainfall data are available at the meteorological stations of SANAA in the basin as follows:

Table C.4.2 Rainfall Stations in the San Jose River Basin

Station	Recorded Data	
	years	Range
Villa Real in Sabacunate	10	1991 - Present
El Aguacate in Sabacuante	18	1973 - 1990
El Incienso in Tatumbla	21	1970 - 1990

Source : SANAA

The average annual rainfall at Villa Real, El Aguacate and El Incienso station is 841 mm, 857 and 783 mm respectively. Annual rainfalls in the basin are shown in *Table C.4.3.*

4.2.2 WATER LEVEL AND FLOW RATE

Data on water level and flow rate are available at the stream gauging stations of SANAA in the basin as follows:

Table C.4.4 Stream Gauging Stations in the San Jose River Basin

Station	Recorded Data	
	years	Range
Daily Data		
El Aguacate in Sabacuante	21	1970 - 1990
El Incienso in Tatumbla	16	1971 - 1986
Non-Daily Data		
El Aguacate in Sabacuante	8	1993 - Present
El Incienso in Tatumbla	8	1993 - Present

A summary of the rainfall and stream gauging stations is shown in *Table C.2.6.*

The measurement was conducted at El Aguacate station continuously from 1973 to 1990 then halted in 1990. From 1993 until present, the non-daily measurement has been conducted again.

The annual maximum, average and minimum flow rates are summarized as follows:

Table C.4.5 Average Flow Rate in the San Jose River Basin

Station	Flow Rate (m^3/s)		
	Maximum	Minimum	Average
El Aguacate	88.8	0.001	0.427
El Incienso	36.7	0.005	0.359

Source : SANAA

4.3 FREQUENCY ANALYSIS

The analysis of 1-day and 2-day rainfall was conducted using the data at Villa Real and El Aguacate station for comparison.

The design maximum rainfalls from the analysis are shown in *Figure C.4.1* and can be summarized as follows:

Table C.4.6 Design Maximum Rainfall in the San Jose River Basin

Return Period (Year)	1-Day Rainfall (mm)	2-Day Rainfall (mm)
Mitch	236	275
10	161	185
20	193	219
25	203	229
50	234	262
200	295	327

The result of maximum1-day analysis showed that Mitch had its return period of about 50 - 60 years, this was much different from the Choluteca river basin. The maximum 2-day analysis showed a more compatible result.

However, these rainfalls were not used in the analysis because the data range was not sufficiently long, and data at Toncontin station were used instead as explained in Chapter 2.

5. GUACERIQUE RIVER BASIN

5.1 RIVER CONDITION

Guacerique river originates in the Rincon Dolares mountains, but with a different name, and branches into many tributaries in the upstream. The river is named after the confluence of the tributaries: Quebradra Quiscamnote and Quebrada Ocote Vuelto in the midstream, and then meets its main tributaries, Quiebra Montes and Mateo river at Mateo. The river flows eastwards to the Los Laureles dam in Los Laureles, then meets Choluteca river in Tegucigalpa.

The total drainage area is 195.0 and 244.2 km^2 at the Los Laureles dam and the confluence with Choluteca river respectively as shown in *Figure C.1.1*. The sub-basin areas are as follows:

Table C.5.1 Drainage Basins of Guacerique River

River/Location	Basin Area (km^2)	
	Sub-basin	Total
Guacerique Upstream	102.0	102.0
Quiebra Montes	23.0	125.0
Guacerique II Station	-	148.0
Mateo Bridge	-	174.0
Los Laureles Dam	-	195.0
Downstream	-	244.2

Source : SANAA

The Los Laureles dam was constructed with the main purpose as a water source for water supply system in Tegucigalpa during 1974 - 1976. The dam is located at the elevation of about 1,037 m above mean sea level, with the height of about 55 m and the storage capacity of about 12 millions m^3.

5.2 AVAILABLE DATA

5.2.1 RAINFALL

Rainfall data are available at the meteorological stations of SANAA in the basin as follows:

Table C.5.2 Rainfall Stations in the Guacerique River Basin

Station	Recorded Data	
	years	Range
Batallon	38	1963 - Present
Quiebra Montes	9	1992 - Present

Source : SANAA

Rainfall data are recorded regularly 4 times a day at 6:00, 12:00, 18:00 and 24:00, daily rainfall is the summation of these recorded data.

The average annual rainfall at Batallon station and Quiebra Montes station is 945 mm and 1,064 mm respectively. Annual rainfalls in the basin are shown in *Table C.5.3.*

5.2.2 WATER LEVEL AND FLOW RATE

Data on water level and flow rate are available at the stream gauging stations of SANAA in the basin as follows:

Table C.5.4 Stream Gauging Stations in the Guacerique River Basin

Station	Recorded Data	
	years	Range
Daily Data		
Batallon*	10	1964 - 1973
Guacerique II	15	1982 - 1996
Quiebra Montes	7	1991 - 1997
Los Laureles	2	1999 - Present
Non-Daily Data		
Guacerique II	11	1990 - Present
Quiebra Montes	11	1990 - Present

Source : SANAA

* Data at Batallon are not complete and not in a digital format

A summary of rainfall and stream gauging stations is shown in *Table C.2.6.*

In general, data on flow rate are recorded regularly twice a day in the morning and afternoon. The record at Batallon station was halted during the construction of the Los Laureles dam in 1974, then a new station, Guacerique II station, was set up again in 1982, a few years after the completion of the dam. Another station, Quiebra Montes station, was also set up in 1991. Although this station is named as Quiebra Montes, it is actually located in the upstream of Guacerique river just before the confluence of Guacerique river and Quiebra Montes river.

However Guacerique II station and Quiebra Montes station were severely damaged by the Hurricane Mitch in 1998 and the record was halted. In 1999, a new station, Los Laureles station, was set up at the Mateo bridge and has been the only station to record the flow rate in the basin since then.

There are also some non-daily recorded data at Guacerique II station and Quiebra Montes station after the Hurricane Mitch. These data are used as a reference in this study, but not for the analyses.

The annual maximum, average and minimum flow rates are summarized as follows:

Table C.5.5 Average Flow Rate in the Guacerique River Basin

Station	Flow Rate (m^3/s)		
	Maximum	Minimum	Average
Guacerique II	217.0	0.011	1.393
Quiebra Montes	10.9	0.040	0.566

Source : SANAA

It should be noted that the maximum flow rate shown above was the average monthly peak flow rate at Guacerique II station and Quiebra Montes station. The flow rate of these 2 stations did not reach the peak at the same time.

5.3 FREQUENCY ANALYSIS

The analysis of maximum 1-day and 2-day rainfall was conducted using the data at Batallon and Quiebra Montes for comparison.

The recorded rainfall range at Batallon station was apparently long, but data during the Hurricane Mitch was missing. The data range at Quiebra Montes station was not sufficiently long, but included the Hurricane Mitch. These 2 stations were combined based on the assumption that the rainfall pattern was same.

The design maximum rainfalls from the analysis are shown in *Figure C.5.1,* and can be summarized as follows:

Table C.5.6 Design Maximum Rainfall in the Guacerique River Basin

Return Period (Year)	1-Day Rainfall (mm)	2-Day Rainfall (mm)
Mitch	215	233
10	105	133
20	124	153
25	130	160
50	149	180
200	186	219

It should be noted that this analysis combined the data from Batallon and Quiebra Montes station together based on the assumption of similarity for comparison of maximum 1-day and 2-day rainfall only. The actual analysis was conducted by using the rainfall data at Toncontin station.

Both cases showed the return period of the Hurricane Mitch of more than 200 years.

However, these rainfalls were not used in the analysis because the data range was not sufficiently long, and data at Toncontin station were used instead as explained in Chapter 2.

6. CHIQUITO RIVER BASIN

6.1 RIVER CONDITION

Chiquito river originates in the San Juancito mountains. The river is named after the confluence of the tributaries: Quebrada Las Canas, Quebrada Dulce and Quebrada Canales. The river flows westwards and meets it tributay, Quebrada Las Lomas and then Choluteca river in Tegucigalpa.

The total drainage area is 90.4 km^2 at the confluence with Choluteca river as shown in *Figure C.1.1*. The sub-basin areas are as follows:

Table C.6.1 Drainage Basins of Chiquito River

River/Location	Basin Area (km^2)	
	Sub-basin	Total
Chiquito Upstream	72.4	72.4
Quebrada Las Lomas	18.0	90.4
Chiquito Downstream	-	90.4

Source : SANAA

6.2 AVAILABLE DATA

6.2.1 RAINFALL

Rainfall data are available at the meteorological stations of SANAA in the basin as follows:

Table C.6.2 Rainfall Station in the Chiquito River Basin

Station	Recorded Data	
	years	Range
Santa Lucia	15	1985 - Present

Source : SANAA

Rainfall data are recorded regularly 4 times a day at 6:00, 12:00, 18:00 and 24:00, daily rainfall is the summation of these recorded data.

The average annual rainfall at Santa Lucia station is 1,089 mm. Annual rainfalls in the basin are shown in *Table C.6.3.*

6.2.2 WATER LEVEL AND FLOW RATE

There is no stream gauging station in the basin.

6.3 FREQUENCY ANALYSIS

Rainfall data at Santa Lucia are not sufficiently long for the analysis. Therefore, the rainfall at Toncontin station is used instead.

Maximum 1-day and 2-day rainfall during the Hurricane Mitch measured from this station was 146 mm and 245 mm respectively.

7. HYDRAULIC SIMULATION

Hydraulic simulation was conducted by using a software package so called MIKE11, a one-dimensional unsteady flow program, developed by the Danish Hydraulic Institute.

A river model of Choluteca river and its tributaries was set up by using the cross sections from the river survey in April 2001.

The river survey was conducted at the distance interval of 100 m from Point A (the end point of the Study Area) over Choluteca, Chiquito, Sapo, Sabacuante, Guacerique and Grande rivers, with a total length of about 30 km (20 km along Choluteca river and 10 km along the tributaries).

The purposes of the hydraulic simulation are:

- To clarify the effect of the proposed river improvement in the reduction of water level and flood risk area. Results from the simulation are the basic data for the preparation of the flood risk maps for the case "*without*" and "*with*" the proposed river improvement project,
- To verify the extent of impact of the dam-break at Pescado Lake during the Hurricane Mitch to the downstream,
- To verify the impact of Berinche landslide to the river flow during the Hurricane Mitch, since there was no clear evidence to confirm that the maximum water level along the river was during the peak flow or the back water effect after the landslide and
- To investigate the impact of a bus terminal to be constructed between Mallol and Carlias bridges.

7.1 SIMULATION SET-UP

A series of hydraulic simulation was done for 2 types of cross sections, the cross sections without the implementation of the proposed river improvement project (hereinafter so called "*Without Project*") and with the implementation of the proposed river improvement project (hereinafter so called "*With Project*"). These 2 types of cross sections, in combination with various boundary conditions, were used to formulate the river model as follows:

- The river "*with project*" and "*without project*",
- The river with the impact of Pescado Lake,
- The river with the impact of Berinche landslide and
- The river with and without a bus terminal to be constructed.

7.1.1 RIVER "*WITHOUT PROJECT*" AND "*WITH PROJECT*"

Simulation for each series was done for 6 cases of flow rate with different return periods: during Hurricane Mitch (500-600 year), 5 year, 10 year, 15 year, 25 year and 50 year return period.

The simulation cases can be summarized as follows:

Table C.7.1 Calculation Cases "*Without Project*" and "*With Project*"

Return Period/ Flood Scale	River Cross Section and Code Number For the case "*Without Project*"	River Cross Section and Code Number For the case "*With Project*" (MP&PP)
Mitch	Existing Section in 2001 (w/o P-Mitch)	Design Section (w P-Mitch)
5 year	Existing Section in 2001 (w/o P-05)	Design Section (w P-05)
10 year	Existing Section in 2001 (w/o P-10)	Design Section (w P-10)
15 year	Existing Section in 2001 (w/o P-15)	Design Section (w P-15)
25 year	Existing Section in 2001 (w/o P-25)	Design Section (w P-25)
50 year	Existing Section in 2001 (w/o P-50)	Design Section (w P-50)

Remarks : Calculation for the case "*With Project*" was done for 2 series: Master Plan Stage (MP) and Priority Project (PP).

(1) Existing Section in 2001

Existing sections were the cross sections from the river survey in April 2001. Since the Hurricane Mitch, the river condition has apparently changed due to the landslide, deposition, erosion, excavation, etc. This case is equivalent to the present situation without the implementation of the proposed river improvement project. The river configuration (river course and cross sections) is the present configuration after the Hurricane Mitch.

(2) Design Section

Design sections were the new cross sections proposed in the river improvement project to accommodate the flood at 15-year return period. This case is equivalent to the river condition after the proposed river improvement project is completely implemented, and the river configuration (river course and cross sections) is the design configuration.

It should be noted that the proposed river improvement project is divided 2 stages: the project is fully implemented (so called “Implementation in Master Plan Stage”) and only the priority project is implemented (so called “Implementation of the Priority Project”).

River section in the Master Plan stage is the section between C-27 to C-93.

River section in the Priority Project is the section between C-40 to C-65.

Calculation was done for both cases, the river improvement project in Master Plan stage (C-27 to C-93) and Priority Project (C-40 to C-65).

7.1.2 IMPACT OF DAM-BREAK AT PESCADO LAKE

It was reported that on October 30, 1998 before midnight (22:00 – 23:00), the dam-break occurred at Pescado Lake. The excess flood discharge flowed down to the river and resulted in the inundation in the downstream.

The extent of the impact was verified by adding the possible excess flood discharge from the dam-break to the hydrograph in the upstream end. This excess flood discharge was added to only the case “*without project*” during the Hurricane Mitch. In the case “*with project*”, Pescado Lake is assumed to be re-constructed and have no more dam-break.

This discharge was taken into consideration in the model. From references and topographic map, dimension of the lake was as follows:

Table C.7.2 Dimension of Pescado Lake

Laguna	Dimension
Surface Area	88,688 m^2
Depth	8 m
Storage Volume	709,504 m^3

Note : Surface area, measured from the topographic map
Depth, referred to Informe de Visita a la Laguna del Pescado in 1999

From the field investigation, the outlet of the lake after the dam-break had its width of about 20 m and depth of 8 m.

Flow from the lake was estimated by using the equation as follows:

where Q = flow rate, m^3/s, B = gate width, m,

H = water level, m, C = constant = 2.65

From this equation, the maximum flow rate is as follows:

$$Q_{max} = 1{,}139 \quad m^3/s$$

From this peak flow and the storage volume, it is estimated that the lake would discharge all storage by 10.4 minutes.

However, since the outflow from the lake was not constant at peak all the time and other dimensions were roughly estimated, time in the calculation was set at about 1 hour.

Calculation case is as follows:

Table C.7.3 Calculation Case for the Impact of Pescado Lake

Flood Scale	River Cross Section	Condition
Mitch	Existing Section in 2001	Discharge of Pescado Lake from dam-break was added into the hydrograph in the upstream during the Hurricane Mitch (for the case "*without project*")

7.1.3 IMPACT OF BERINCHE LANDSLIDE

During the Hurricane Mitch, it was reported that the peak flow in Tegucigalpa was at midnight of October 30, 1998, while the landslide at Berinche occurred in the morning of October 31, 1998. The landslide blocked the river and formed a small weir over the river cross section. This resulted in the backwater along river in the upstream.

There was no clear evidence to confirm that the actual maximum water level was during the peak flow at midnight of October 30, 1998, or in the morning of October 31, 1998 due to the backwater after the landslide.

The river model was set up to verify this by 2 different cases for comparison as follows:

(1) Without Landslide

The river configuration was the case "w*ithout project*". The flood scale was the flood during the Hurricane Mitch.

(2) With Landslide

The river configuration was the case "*without project*". The flood scale was the flood during the Hurricane Mitch. A temporary weir was set up at section C-48, the reportedly nearest section to the landslide.

From the high water mark survey, it was found that the mark of landslide remaining on a building on the right side of the river at Berinche was 919.50 m. This mark was considered as the lowest elevation of the landslide because the landslide formed a heap or mountain at the left side and had a gradual slope down towards the right side. Therefore, in the calculation, the weir was set up as a flat bed with the average level of 922.50 m.

Calculation cases are as follows:

Table C.7.4 Calculation Cases Without and With Berinche Landslide

Return Period/ Flood Scale	River Cross Section and Code Number For the case "Without Landslide"	River Cross Section and Code Number For the case "With Landslide"
Mitch	Existing Section in 2001 (w/o L-Mitch)	Existing Section in 2001 + Weir (w L-Mitch)

7.1.4 IMPACT OF BUS TERMINAL TO BE CONSTRUCTED

It was reported that a bus terminal would be constructed on the left bank of Choluteca river between Mallol and Carlias bridges. The impact of this terminal was investigated by 2 different cases as follows:

(1) Without Bus Terminal

The river configuration was the case *"with project"*. The flood scale was 15-year return period

(2) With Bus Terminal

The river configuration was the case *"with project"*. But this case is still divided into 2 types as follows:

- The case when the proposed improvement project is fully implemented
  (Implementation in the Master Plan stage, section C-27 – C93) and
- The case when only the priority project is implemented
  (Implementation of Priority Project, section C-40 – C-65).

The flood scale was 15-year return period.

The terminal dimension was added to the sections between those bridges (C-52, C-53, C-54, C-55 and C-56). The calculation was conducted again for comparison to verify the water increase and back water.

The dimension of the bus terminal is as follows:

- Height of terminal = 918.0 m
- Width of terminal from the left bank = 30 – 60 m

Calculation cases are as follows:

Table C.7.5 Calculation Cases Without and With Bus Terminal

Return Period/ Flood Scale	River Cross Section and Code Number For the case "Without Bus"	River Cross Section and Code Number For the case "With Bus" in M/P	River Cross Section and Code Number For the case "With Bus" in P/R
15-year	Design Section (w/o B-15)	Design Section + Bus (MP-w B-15)	Design Section + Bus (PR-w B-15)

Remarks : "M/P" = Master Plan, Implementation of section C-27 to C-93
"P/R" = Priority Project, Implementation of section C-40 to C-65

7.2 MODEL SET-UP

7.2.1 RIVER NETWORK

The river network model was set up from the river coordinates and the cross sections along the river. Basically, the cross sections were set up in 2 categories as follows:

Table C.7.6 River Network Set-Up

Categoies	Cross section Set-up
"*Witout Project*" (Cross section in 2001)	The cross sections from River Survey in 2001 were used to set up the river network with the distance interval of 100 m from Point A to the upstream of Choluteca river and its tributaries. The total distance was about 30 km.
"*With project*"	The design sections were set up based on the flow rate during flood at 15-year return period

Remarks : "*Without project*" refers to the cases without the implementation of the river improvement project,
"*With project*" refers to the cases with the implementation of the river improvement project

These 2 categories later were modified for the investigation of the impact of dam-break at Pescado Lake, landslide at Berinche and bus terminal to be constructed.

The controlled sections are shown in *Table C.7.7*. The river model is shown in *Figure C.7.1*.

7.2.2 CALCULATION PROCEDURE

Procedure of the calculation is as follows:

- Set up the river model using the cross sections for each case, flow direction, nodes and branches,
- Set up the boundary condition in the upstream using the hydrograph during the Hurricane Mitch, and in the downstream using water level during the Hurricane Mitch,
- Set up the necessary hydrodynamic parameters,
- Calculate the water level and flow rate at each section along the river,
- Calibrate the parameters in the model to make the least error between the simulated water level and observed water level from the High Water Mark Survey (as explained in the latter section),
- Set up a free boundary at the downstream end,
- Set up all inflow hydrograph for boundary condition, and
- Calculate the water level and flow rate at each section along the river,

Theoretical consideration of the model is shown in *Appendix AC.1*.

7.2.3 PARAMETERS AND BOUNDARY CONDITION

The parameters and boundary condition in the model are:

- Manning roughness, n = 0.036 – 0.038 for the river bed in accordance with the river bed material survey and calibration,
- At the upstream end, hydrographs at Grande, San Jose, Guacerique and Chiquito rivers (with the same pattern as in *Figure C.2.5*, but different magnitude) were used as the boundary condition,
- The series of flood scale were during the Hurricane Mitch (500 to 600-year), 5, 10, 15, 25 and 50-year,
- At the downstream end, free flow was set as the boundary condition,
- Time step in the calculation = 5 seconds.

7.2.4 MODEL CALIBRATION

The model was calibrated by using the data from the High Water Mark Survey conducted in 2001 by the JICA Study Team. Maximum water levels from the survey along Choluteca river and its tributaries are shown in *Table C.7.8*, some major locations are shown as follows:

Table C.7.9 Water Level during the Hurricane Mitch

Location	Water Level (m)
Mallol Bridge	927.9
Chile Bridge	921.6

7.2.5 VERIFICATION OF CROSS SECTIONS BEFORE AND AFTER THE HURRICANE MITCH

The cross sections at Berinche before and after the Hurricane Mitch were compared to verify the deposition, erosion and sedimentation in that area. The sections before the Hurricane Mitch were the sections from the topographic map in 1996, while the sections after the Hurricane were obtained from the river survey in 2001.

Comparison of these sections is shown in *Figures C.7.2* and *C.7.3.*

It is found that the change of these cross sections from 1996 to 2001 is negligibly small and will not have any effect in the simulation.

7.3 HYDRAULIC SIMULATION RESULTS

The simulation was done for several cases as explained in the previous section.

7.3.1 PEAK FLOW

Peak flow at each sub-basin can be summarized as follows:

Table C.7.10 Peak Flow in the Sub-Basins from Hydraulic Simulation

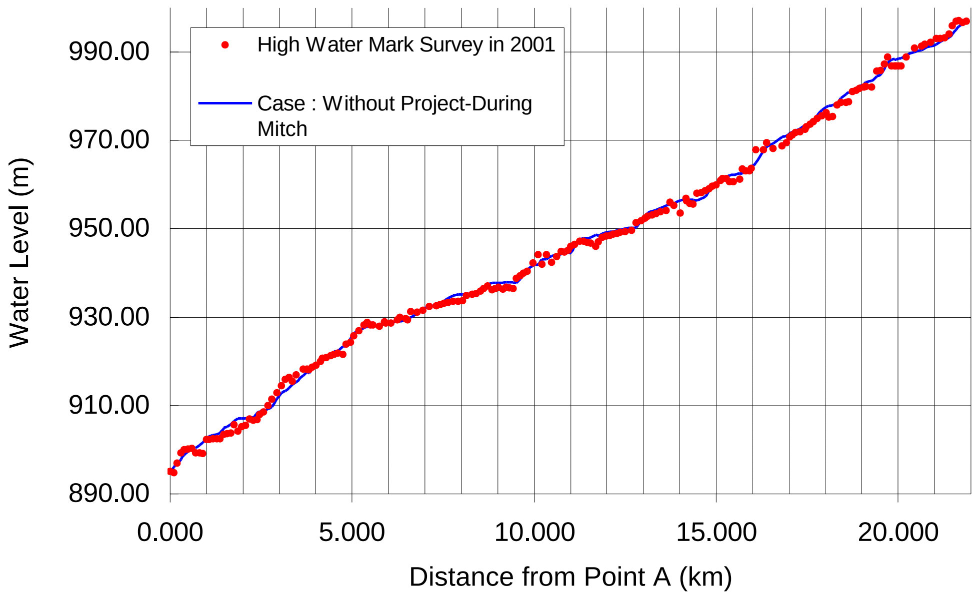
Sub-basin/Location	Peak Flow in the Sub-basins (m^3/s)					
	Mitch	5-Year	10-Year	15-Year	25-Year	50-year
Choluteca Upstream (Grande)	1,459.83	473.90	584.70	646.40	727.39	834.30
After confluence with San Jose	2,092.00	825.71	1,010.73	1,147.12	1,249.55	1,428.75
After confluence with Guacerique	3,337.57	1,318.27	1,603.87	1,700.35	1,971.80	2,261.69
Choluteca Downstream	3,878.28	1,505.80	1,823.82	1,905.58	2,231.51	2,601.52

It should be noted that these peak flows were calculated from the hydraulic simulation that peak times were taken into consideration. The peak flow after any confluence was not necessarily the summation of the peak flow of those sub-basins before the confluence.

7.3.2 CALIBRATION RESULT

The simulation result for the case without project during the Hurricane Mitch and the High Water Mark survey result are as follows:

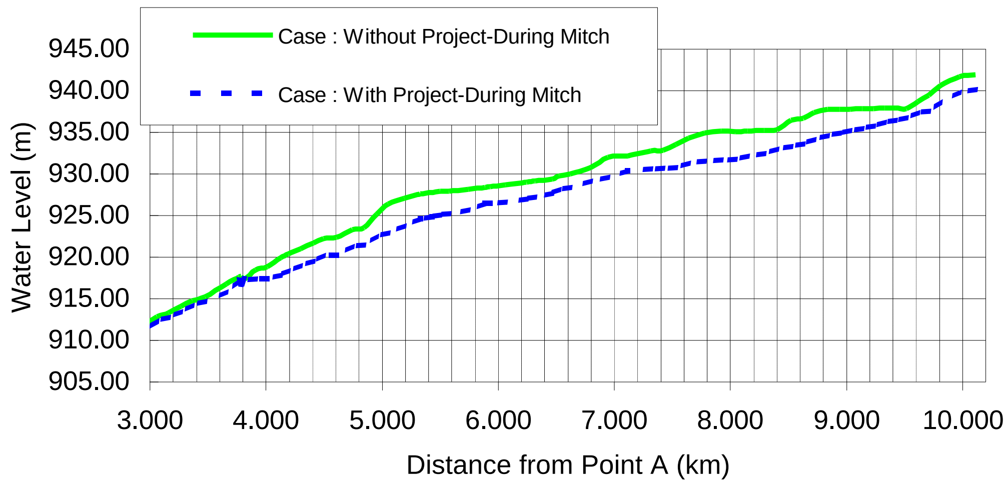
Figure C.7.4 Water level in the Choluteca River during Hurricane Mitch and from High Water Mark Survey



7.3.3 WATER LEVEL "*WITHOUT PROJECT*" AND "*WITH PROJECT*"

Water level at each section in each case from the calculation is shown in *Table C.7.11.* A summary of water level during the Hurricane Mitch in Choluteca river "*without project*" and "*with project*" is shown as follows:

Figure C.7.5 Water level in Choluteca river during Hurricane Mitch



Water level decreases apparently about 0.5 - 2.0 m in the case "*With Project*" from the case

"*Without Project*".

7.3.4 IMPACT OF DAM-BREAK AT PESCADO LAKE

The hydrograph in the upstream and downstream during the Hurricane Mitch were compared in order to check the extent of the impact of the dam-break as shown in the following figures.

The hydrograph in the upstream had 2 peaks during October, 30 – 31, 1998, the higher peak was at 23:00 on October 30, while that in the downstream had the higher peak at 2:00 on October 31. This can be interpreted that the impact of the dam-break was only in the upstream before the confluence with San Jose river.

Figure C.7.6 (1) Water Level in the Upstream
(At Section C195, Chainage 403 m)

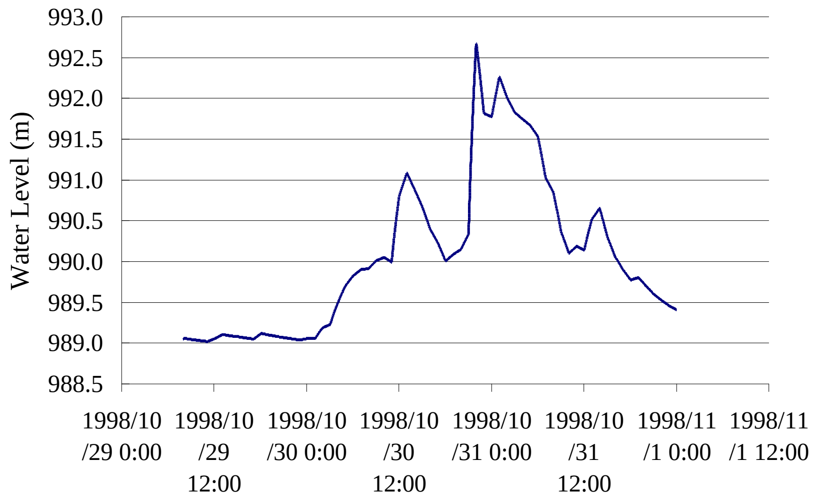
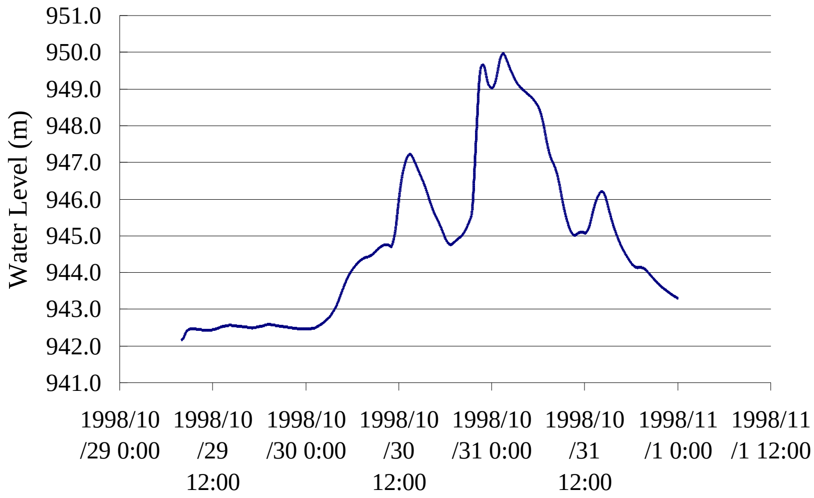


Figure C.7.6 (2) Water Level in the Downstream
(At Section C115, Chainage 7,563 m)



7.3.5 IMPACT OF LANDSLIDE AT BERINCHE

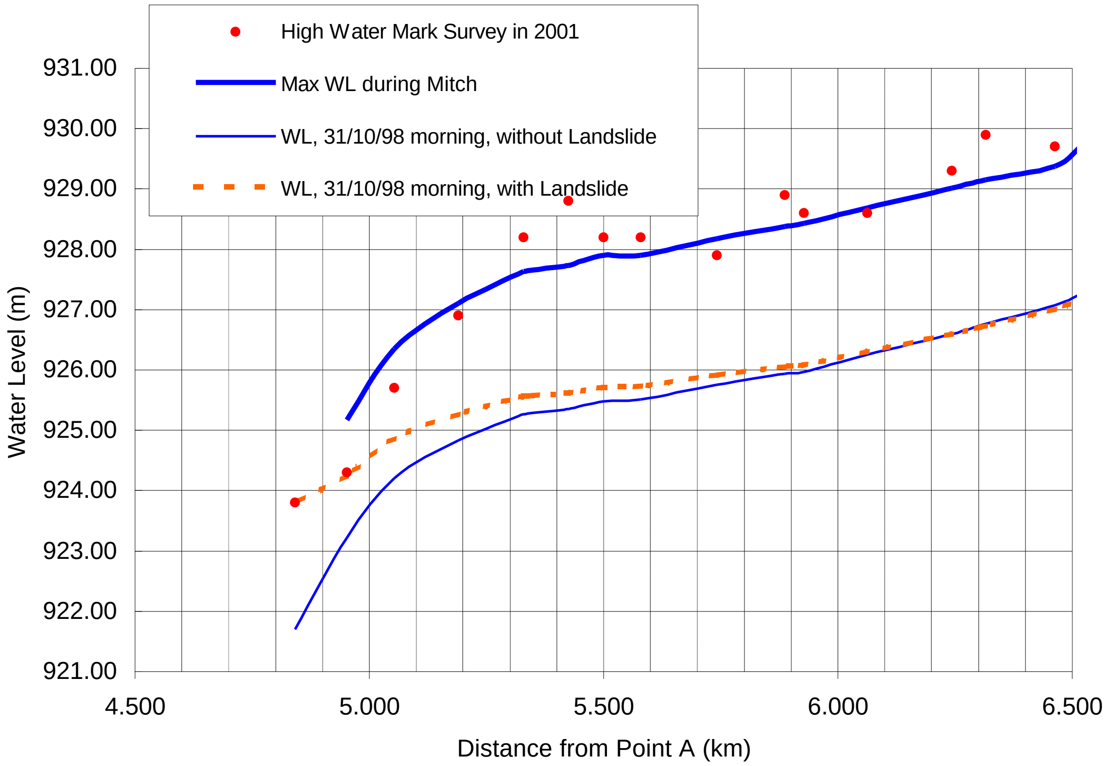
(1) Cross Section Change before and after Hurricane Mitch

Comparison of the cross sections at Berinche (C-47, C-48 and C-49) in 1996 and 2001 reveals that the cross sections have not significantly changed by erosion, deposition and sedimentation.

(2) Impact of Landslide

Peak water level during the Hurricane Mitch was compared with the water level due to backwater after the landslide in the following figure. It can be seen that backwater effect did not make the water level increase over the peak. This is because at the time of landslide, water level had become much lower than the peak.

Figure C.7.7 Water Level in Choluteca River during the Hurricane Mitch After Berinche Landslide (Oct. 31, 1998, 6:00)



7.3.6 IMPACT OF BUS TERMINAL

As shown in the following table, the bus terminal to be constructed will make the water level increase slightly in the upstream. The maximum increase is about 0.3 – 0.4 m.

Table C.7.12 Water Level Without and With Bus Terminal (15-Year Return Period)

Distance from downstream (km)	Section	Water Level in case "*with project*" (Design section)		
		Witout Bus	With Bus (Section in M/P)	With Bus (Section in P/R)
6.243	C-60	923.93	923.96	923.99
6.063	C-59	923.36	923.41	923.53
5.928	C-58	923.04	923.19	923.36
5.887	C-57	922.87	922.96	923.12
5.742	C-56	922.47	922.50	922.53
5.579	C-55	921.98	922.02	922.06
5.500	C-54	921.88	921.89	921.89
5.425	C-53	921.74	921.75	921.75
5.425	C-53	921.74	921.75	921.75
5.329	C-52	921.51	921.54	921.56

Remarks : "M/P" = Master Plan, Implementation of section C-27 to C-93
"P/R" = Priority Project, Implementation of section C-40 to C-65

8. RECOMMENDATIONS

The following items are the problems found during the Study and the recommendations.

8.1 PROBLEMS AND CONSTRAINTS

Most of the rainfall and stream gauging stations are a conventional type with manual record. The problems and constraints are:

8.1.1 RAINFALL STATIONS

- Rainfall data from rainfall stations, except Toncontin station, are not sufficiently long for the analysis,
- Rainfall data from some stations in some years are not reliable due to the manual record with human error either at site or the organization in charge,
- Rainfall data in some stations, except at Toncontin station, are recorded basically 3 times a day at 7:00, 13:00 and 18:00. This may cause an error during the torrential rain because the quantity of rain may exceed the capacity of the rain bucket, and the excess rain may overflow out of the bucket before the time of recording,
- At present, there are only 2 telemetric stations at Mateo in Guacerique river and Concepcion in Grande river. Rainfall and water level data are recorded continuously and transmitted automatically to SERNA. But they were established in 1999, the recorded data range is still short,
- It seems that the telemetric station at Concepcion has a problem of sediment clogging at its sensor and needs frequent cleaning,
- Many organizations including SERNA, SANAA and SMN are in charge in the stations. This may cause some confusion in the data management.

8.1.2 STREAM GAUGING STATIONS

- There are only a few stream gauging stations in the basin,
- There is no any gauging station along Choluteca river in Tegucigalpa,

- Water level data are recorded twice a day (in the morning and afternoon) and every day. But at the time of recording, data do not represent the maximum or minimum flow of that day, this makes data become random,
- Sometimes water level data are missing due to the constraints on human convenience and natural phenomena,
- After the Hurricane Mitch, water level in many stations has been measured manually by using staff gauges twice a day. But these data do not represent the flow characteristics such as the maximum, minimum or average,
- Due to the manual record, some data were missing or recorded wrongly. It was found that rainfall data during the Hurricane Fify in 1974 directly obtained from the rainfall station were different from the data in the damage survey report of a government agency and
- Many institutions including SERNA and SANAA are in charge in the stations. This may cause some confusion in the data management.

Table C.2.4 Maximum and Annual Rainfall at Toncontin Station

Year	Rainfall (mm)	
	Max. Daily	Annual
1951	76.20	786
1952	61.20	1,146
1953	47.80	823
1954	54.40	1,173
1955	49.80	1,274
1956	44.20	689
1957	63.20	779
1958	78.70	972
1959	109.00	944
1960	45.50	962
1961	53.10	774
1962	93.00	1,066
1963	47.80	883
1964	69.30	893
1965	77.20	766
1966	79.20	1,047
1967	46.20	641
1968	83.30	1,025
1969	45.00	1,199
1970	65.20	1,003
1971	46.70	750
1972	34.30	453
1973	60.50	1,078
1974	68.10	861
1975	86.00	995
1976	44.50	750
1977	74.50	776
1978	57.60	731
1979	78.10	1,180
1980	62.30	996
1981	54.40	1,113
1982	49.20	718
1983	49.40	719
1984	94.40	1,084
1985	39.90	610
1986	41.00	503
1987	66.10	693
1988	82.00	1,264
1989	36.90	878
1990	73.10	675
1991	38.30	595
1992	54.10	728
1993	43.10	949
1994	75.70	564
1995	56.60	1,146
1996	73.00	889
1997	94.80	835
1998	120.40	1,180
1999	53.00	870

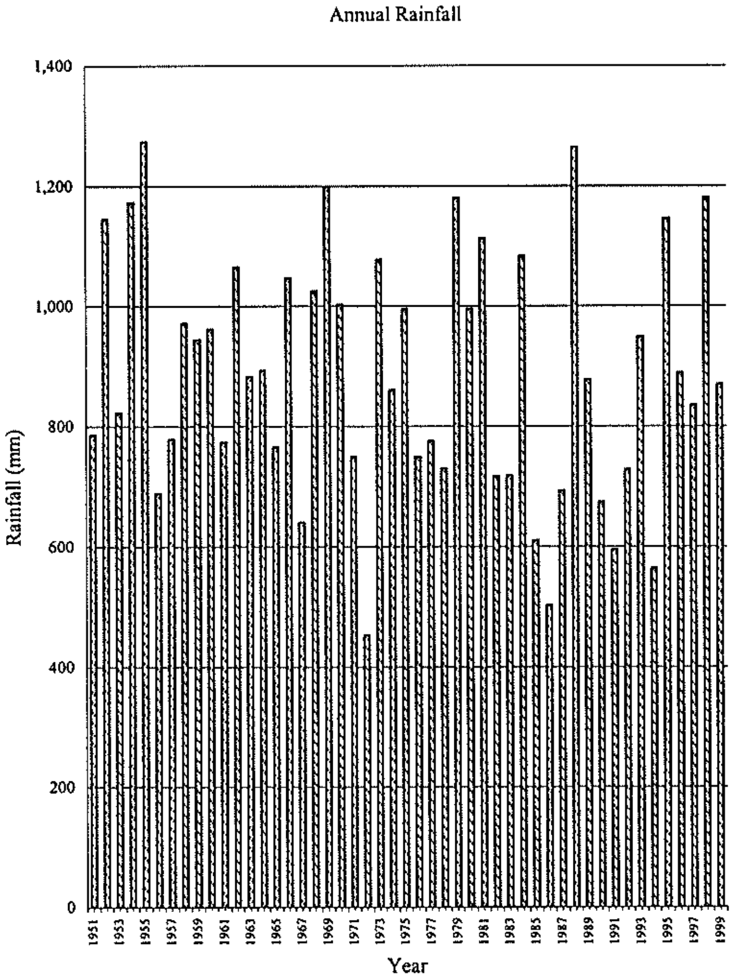


Table C.2.6 Rainfall and Stream Gauging Stations in the Hydrological Area

Rainfall and Stream Gauging Stations in the Hydrological Area

Rainfall

Basin	Rainfall Station	Type	Recorded	51 - 62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Grande	Concepcion	HMO	27											▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨		
Grande	La Brea	PV	15											▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨														
Grande	Lapaterique	PV	30								▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨		
Sabacuente	Villa Real	HMO	10																														▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Sabacuente	El Aguacate	HMO	18												▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨										
Tatumbla	El Incienso	HMO	21									▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨										
Guacerique	Batallon	HMO	38		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Guacerique	Quebra Montes	HMO	9																															▨	▨	▨	▨	▨	▨	▨	▨	▨
Chiquito	Santa Lucia	PV	15																								▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Choluteca	Toncontin	HMP	50	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

Flow Rate

Basin	Gauging Station	Type	Recorded	51 - 62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Grande	Concepcion	HP	14																░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Sabacuente	El Aguacate	HP	21									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
Sabacuente	El Aguacate	HP	8																																░	░	░	░	░	░	░	░
Tatumbla	El Incienso	HP	16										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■														
Tatumbla	El Incienso	HP	8																																░	░	░	░	░	░	░	░
Guacerique	Batallon	HP	10			■	■	■	■	■	■	■	■	■	■																											
Guacerique	Guacerique II	HP	15																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Guacerique	Guacerique II	HP	11																													░	░	░	░	░	░	░	░	░	░	░
Guacerique	Quebra Montes	HP	7																														■	■	■	■	■	■	■			
Guacerique	Quebra Montes	HP	11																													░	░	░	░	░	░	░	░	░	░	░
Guacerique	Los Laureles	LN	2																																						■	■

Remarks : Sources of data are SANAA and SERNA ▨ = daily rainfall data ■ = daily flow data ░ = non-daily flow data

HMO	=	Hidrometeorologico Ordina	=	Ordinary Hydro-meteorologic
PV	=	Pluviometrica	=	Pluviometric
HMP	=	Hidrometeorologico Princip	=	Principle Hydro-meteorologic
HP	=	Hidrometrico Principal	=	Principle Hydrometric (Water Level and Flow Rate)
LN	=	Lluvia y Niveles	=	Telemetering System

Table C.2.7 (2) Flow Rate in the San Jose River Basin (Sabacuante)

Year	Sabacuante River Basin			
	El Agucate Station			
	Flow rate (m^3/s)			Annual ($m^3/year$)
	Max	Min	Average	
1970	16.000	0.012	0.661	20,831,829
1971	15.800	0.013	0.426	13,420,647
1972	8.150	0.013	0.190	5,978,753
1973	7.330	0.011	0.428	13,505,270
1974	40.300	0.009	0.467	14,716,800
1975	7.940	0.017	0.387	12,196,591
1976	6.540	0.015	0.223	7,019,309
1977	11.900	0.005	0.224	7,050,586
1978	3.890	0.000	0.121	3,802,291
1979	25.100	0.001	0.894	28,200,096
1980	88.751	0.000	1.534	48,361,217
1981	14.330	0.017	1.346	42,438,334
1982	4.538	0.005	0.176	5,556,470
1983	2.490	0.007	0.114	3,599,326
1984	9.360	0.001	0.312	9,842,515
1985	1.440	0.000	0.069	2,171,750
1986	57.302	0.004	0.343	10,817,798
1987	1.543	0.005	0.058	1,824,975
1988	13.360	0.001	0.435	13,718,160
1989	10.697	0.094	0.481	15,176,730
1990	1.223	0.016	0.083	2,625,626
1991				
1992				
1993				
1994				
1995				
1996				
Average	16.571	0.012	0.427	13,469,289

Table C.2.7 (3) Flow Rate in the San Jose River Basin (Tatumbla)

Year	Tatumbla River Basin			
	El Incienso Station			
	Flow rate (m^3/s)			Annual ($m^3/year$)
	Max	Min	Average	
1970				
1971	11.100	0.007	0.303	9,569,280
1972	4.290	0.012	0.131	4,131,734
1973	6.830	0.007	0.346	10,897,546
1974	32.300	0.012	0.332	10,470,730
1975	7.370	0.012	0.443	13,966,743
1976	3.460	0.023	0.219	6,902,582
1977	7.440	0.033	0.183	5,755,882
1978	3.360	0.010	0.204	6,426,605
1979	8.140	0.022	0.535	16,868,486
1980	36.700	0.007	1.121	35,355,917
1981	7.020	0.014	0.498	15,704,755
1982	5.700	0.013	0.332	10,479,370
1983	5.160	0.009	0.225	7,106,974
1984	9.630	0.005	0.579	18,243,619
1985	1.160	0.006	0.071	2,230,243
1986	6.091	0.017	0.227	7,156,080
1987				
1988				
1989				
1990				
1991				
1992				
1993				
1994				
1995				
1996				
Average	9.734	0.013	0.359	11,329,159

Table C.2.7 (4) Flow Rate in the Guacerique River Basin

Year	Guacerique River Basin							
	Guacerique II Station				Quebra Montes Station			
	Flow rate (m^3/s)			Annual	Flow rate (m^3/s)			Annual
	Max	Min	Average	(m^3/year)	Max	Min	Average	(m^3/year)
1970								
1971								
1972								
1973								
1974								
1975								
1976								
1977								
1978								
1979								
1980								
1981								
1982	171.000	0.062	0.997	31,451,904				
1983	217.000	0.029	1.524	48,071,376				
1984	42.300	0.075	2.049	64,609,380				
1985	14.400	0.043	0.956	30,151,044				
1986	38.900	0.038	0.852	26,881,812				
1987	57.500	0.030	1.130	35,625,168				
1988	125.700	0.041	2.174	68,543,496				
1989	40.000	0.075	1.523	48,031,956				
1990	25.200	0.036	1.293	40,765,536				
1991	69.200	0.031	0.865	27,293,388	10.900	0.059	0.489	15,415,370
1992	72.529	0.011	0.794	25,037,627	9.270	0.040	0.436	13,754,952
1993	32.300	0.021	1.527	48,170,127	4.840	0.053	0.757	23,862,240
1994	137.000	0.048	0.754	23,783,755	4.390	0.055	0.330	10,392,545
1995	99.400	0.098	2.942	92,791,383	5.020	0.108	0.819	25,830,421
1996	39.600	0.024	1.521	47,969,510				
Average	78.802	0.044	1.393	43,945,164	6.884	0.063	0.566	17,851,106

Table C.3.3 Annual Rainfall in the Grande River Basin

Year	Rainfall (mm) at Concepcion
1972	1,014
1973	1,170
1974	913
1975	956
1976	839
1977	1,010
1978	1,131
1979	1,006
1980	1,020
1981	979
1982	675
1983	805
1984	1,003
1985	572
1986	588
1987	823
1988	1,220
1989	738
1990	680
1991	762
1992	835
1993	1,076
1994	778
1995	1,429
1996	841
1997	409
1998	1,563

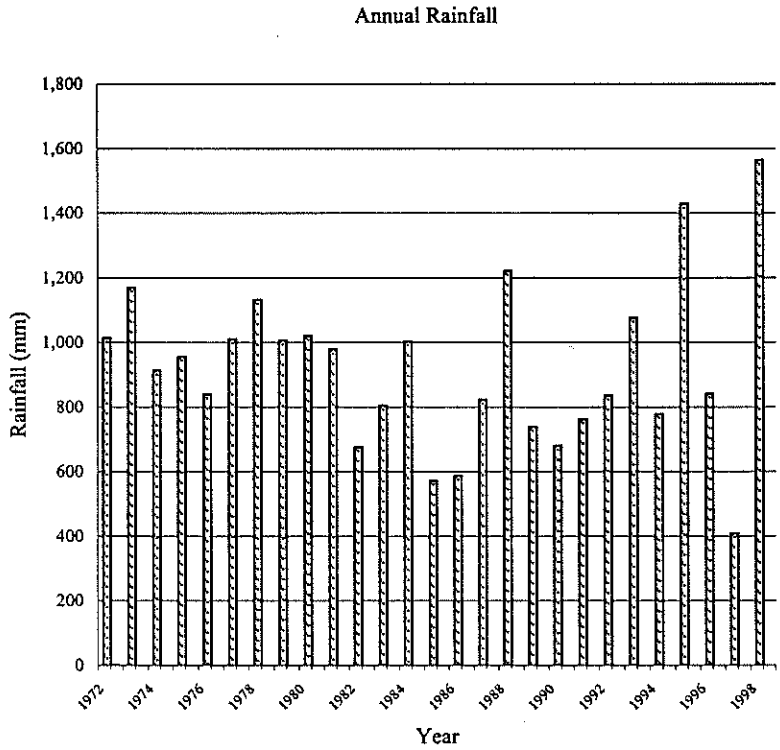


Table C.4.3 Annual Rainfall in the San Jose River Basin

Year	Rainfall (mm) at El Aguacate and Villa Real
1973	556
1974	925
1975	1,063
1976	836
1977	882
1978	839
1979	701
1980	1,353
1981	1,011
1982	643
1983	314
1984	1,377
1985	486
1986	668
1987	786
1988	1,187
1989	858
1990	655
1991	390
1992	759
1993	983
1994	725
1995	1,136
1996	956
1997	701
1998	1,206

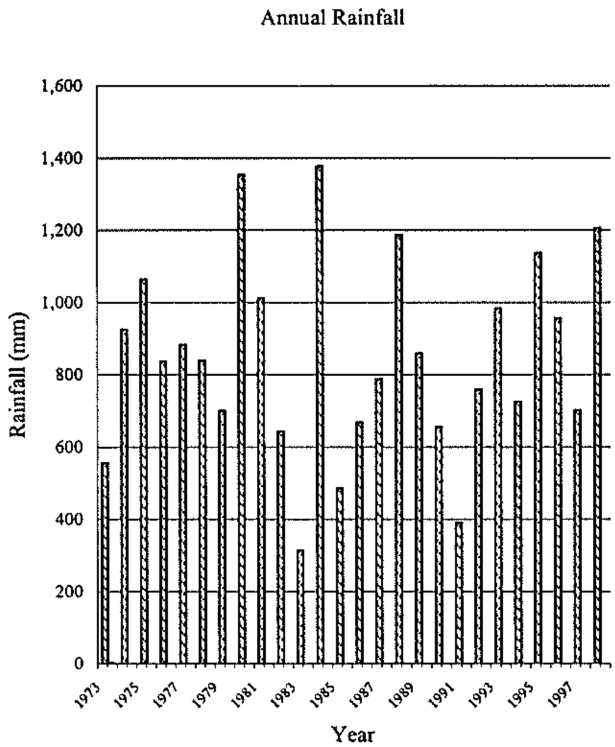


Table C.5.3 Annual Rainfall in the Guacerique River Basin

Year	Rainfall (mm) Batallon	Q Montes
1963	315.5	
1964	1,247.7	
1965	1,099.8	
1966	1,280.7	
1967	499.8	
1968	1,075.0	
1969	1,619.5	
1970	1,296.1	
1971	1,065.3	
1972	0	
1973	977.1	
1974	915.8	
1975	1,026.0	
1976	947.0	
1977	736.4	
1978	746.6	
1979	1,005.8	
1980	1,074.5	
1981	1,057.2	
1982	733.9	
1983	882.0	
1984	1,093.5	
1985	757.6	
1986	761.3	
1987	887.9	
1988	1,218.7	
1989	893.5	
1990	847.9	
1991	834.9	
1992	876.2	935.1
1993	942.7	1,056.9
1994	758.2	866.5
1995	1,272.9	1,472.2
1996	862.2	937.0
1997	782.6	970.0
1998	693.5	1,208.6

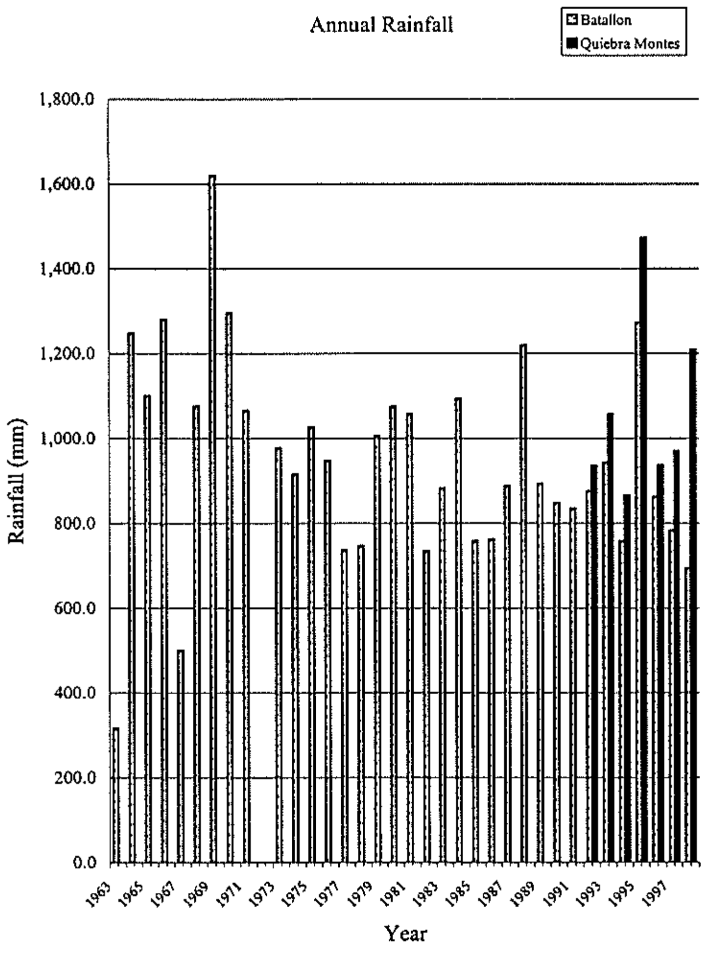


Table C.6.3 Annual Rainfall in the Chiquito River Basin

Year	Rainfall (mm) at Santa Lucia
1985	1,006
1986	880
1987	800
1988	1,493
1989	1,002
1990	1,301
1991	879
1992	879
1993	1,283
1994	1,164
1995	1,421
1996	1,056
1997	1,004
1998	1,409
1999	753

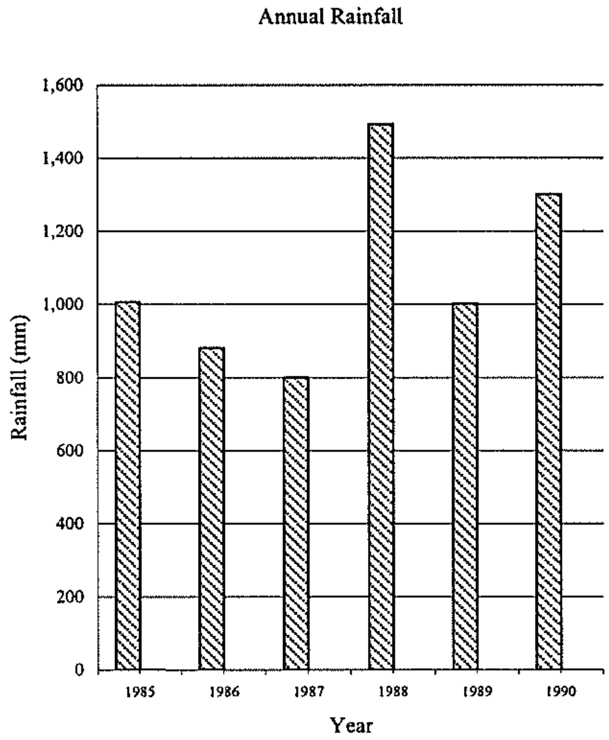


Table C.7.7 (1) Control Sections in Choluteca River

No.	CODE	x	y	Chainage (m)	Remarks
201	C-0	477,618.1	1,563,023.6	21,873.3	Downstream
200	C-1	477,621.1	1,562,922.2	21,771.9	
199	C-2	477,619.9	1,562,825.7	21,675.4	
198	C-3	477,620.1	1,562,725.9	21,575.6	
197	C-4	477,617.4	1,562,634.2	21,483.8	
196	C-5	477,607.7	1,562,535.3	21,384.4	
195	C-6	477,569.7	1,562,429.4	21,271.9	
194	C-7	477,483.5	1,562,370.4	21,167.5	
193	C-8	477,427.7	1,562,289.9	21,069.5	
192	C-9	477,391.3	1,562,202.5	20,974.9	
191	C-10	477,348.5	1,562,109.8	20,872.7	
190	C-11	477,287.3	1,562,070.9	20,800.2	
189	C-12	477,233.5	1,561,976.3	20,691.3	
188	C-13	477,183.4	1,561,892.8	20,594.0	
187	C-14	477,139.2	1,561,809.3	20,499.5	
186	C-15	477,053.2	1,561,748.6	20,394.2	
185	C-16	477,019.2	1,561,668.4	20,307.2	
184	C-17	476,998.3	1,561,573.5	20,210.0	
183	C-18	477,003.5	1,561,475.0	20,111.4	
182	C-19	477,019.8	1,561,369.3	20,004.4	
181	C-20	477,053.5	1,561,276.1	19,905.3	
180	C-21	477,119.7	1,561,201.6	19,805.7	
179	C-22	477,196.6	1,561,115.7	19,690.3	
178	C-23	477,257.7	1,561,031.1	19,586.0	
177	C-24	477,330.7	1,560,967.6	19,489.3	
176	C-25	477,399.4	1,560,948.5	19,417.9	
175	C-26	477,519.0	1,560,933.3	19,297.3	
174	C-27	477,633.3	1,560,927.4	19,182.9	
173	C-28	477,740.2	1,560,895.1	19,071.3	
172	C-29	477,748.6	1,560,764.5	18,940.4	
171	C-30	477,754.3	1,560,636.1	18,811.9	
170	C-31	477,664.2	1,560,593.4	18,712.2	
169	C-32	477,562.1	1,560,580.0	18,609.3	
168	C-33	477,463.0	1,560,567.5	18,509.4	
167	C-34	477,363.2	1,560,525.5	18,401.1	
166	C-35	477,368.2	1,560,340.5	18,216.0	
165	C-36	477,262.6	1,560,363.5	18,108.0	
164	C-37	477,270.8	1,560,350.5	18,092.5	
163	C-38	477,282.1	1,560,315.5	18,055.7	
162	C-39	477,334.0	1,560,236.7	17,961.4	
161	C-40	477,387.0	1,560,151.7	17,861.3	
160	C-41	477,455.1	1,560,062.1	17,748.7	
159	C-42	477,428.5	1,560,002.7	17,683.6	
158	C-43	477,389.9	1,559,903.5	17,577.2	
157	C-44	477,297.6	1,559,843.1	17,466.9	
156	C-45	477,261.6	1,559,762.8	17,378.9	
155	C-46	477,249.1	1,559,654.7	17,270.1	
154	C-47	477,247.6	1,559,514.3	17,129.7	
153	C-48	477,246.6	1,559,416.5	17,031.9	
152	C-49	477,246.6	1,559,306.1	16,921.4	
151	C-50	477,249.9	1,559,205.1	16,820.4	
150	C-51	477,316.2	1,559,085.4	16,683.6	
149	C-52	477,367.9	1,558,956.8	16,545.0	

Table C.7.7 (1) Control Sections in Choluteca River

No.	CODE	x	y	Chainage (m)	Remarks
148	C-53	477,463.9	1,558,949.6	16,448.7	Downstream C-53, Sapo
147	C-54	477,535.7	1,558,926.9	16,373.4	
146	C-55	477,591.7	1,558,871.0	16,294.3	
145	C-56	477,749.5	1,558,909.8	16,131.8	C-56, 57, Chiquito
144	C-57	477,613.7	1,558,858.8	15,986.8	
143	C-58	477,606.7	1,558,818.4	15,945.8	
142	C-59	477,603.7	1,558,683.5	15,810.8	
141	C-60	477,760.9	1,558,595.6	15,630.7	
140	C-61	477,725.7	1,558,531.1	15,557.2	
139	C-62	477,767.4	1,558,390.2	15,410.3	
138	C-63	477,764.5	1,558,326.8	15,346.8	
137	C-64	477,745.7	1,558,238.4	15,256.4	
136	C-65	477,753.3	1,558,061.3	15,079.1	
135	C-66	477,657.0	1,557,947.7	14,930.2	
134	C-67	477,747.2	1,557,801.3	14,758.2	Upstream of C-67, Guacerique
133	C-68	477,934.8	1,557,742.9	14,561.7	
132	C-69	477,948.9	1,557,637.3	14,455.2	
131	C-70	478,013.3	1,557,545.7	14,343.2	
130	C-71	478,009.2	1,557,436.2	14,233.7	
129	C-72	477,914.1	1,557,336.4	14,095.8	
128	C-73	477,775.5	1,557,303.9	13,953.4	
127	C-74	477,655.9	1,557,294.9	13,833.5	
126	C-75	477,576.9	1,557,220.2	13,724.8	
125	C-76	477,641.4	1,557,092.2	13,581.5	
124	C-77	477,728.6	1,557,028.5	13,473.5	
123	C-78	477,800.5	1,556,929.2	13,350.9	
122	C-79	477,858.1	1,556,844.1	13,248.2	
121	C-80	477,909.2	1,556,765.9	13,154.8	
120	C-81	477,960.3	1,556,656.9	13,034.4	
119	C-82	477,980.8	1,556,555.9	12,931.3	
118	C-83	477,989.5	1,556,468.4	12,843.4	
117	C-84	477,991.5	1,556,362.0	12,736.9	
116	C-85	477,990.1	1,556,266.0	12,640.9	
115	C-86	477,984.1	1,556,170.7	12,545.4	
114	C-87	477,982.6	1,556,076.4	12,451.2	
113	C-88	477,987.7	1,555,981.5	12,356.1	
112	C-89	477,974.6	1,555,885.4	12,259.1	
111	C-90	477,957.1	1,555,791.9	12,164.0	
110	C-91	477,881.4	1,555,729.5	12,066.0	
109	C-92	477,932.9	1,555,573.6	11,901.7	
108	C-93	477,795.1	1,555,580.0	11,763.8	
107	C-94	477,703.1	1,555,520.1	11,654.1	
106	C-95	477,603.0	1,555,582.6	11,536.0	
105	C-96	477,469.4	1,555,622.3	11,396.6	
104	C-97	477,483.9	1,555,772.9	11,245.3	
103	C-98	477,364.7	1,555,792.7	11,124.4	
102	C-99	477,288.9	1,555,753.2	11,039.0	
101	C-100	477,220.5	1,555,673.9	10,934.2	
100	C-101	477,211.0	1,555,612.8	10,872.4	
99	C-102	477,155.3	1,555,504.2	10,750.3	
98	C-103	477,227.1	1,555,390.3	10,615.7	
97	C-104	477,300.7	1,555,329.8	10,520.4	
96	C-105	477,383.9	1,555,266.9	10,416.1	

Table C.7.7 (1) Control Sections in Choluteca River

No.	CODE	x	y	Chainage (m)	Remarks
95	C-106	477,466.4	1,555,207.6	10,314.5	
94	C-107	477,604.1	1,555,173.7	10,172.6	
93	C-108	477,648.3	1,555,133.2	10,112.7	
92	C-109	477,761.1	1,555,129.5	9,999.9	
91	C-110	477,848.3	1,555,082.2	9,900.7	
90	C-111	477,955.9	1,555,100.3	9,791.5	
89	C-112	478,040.1	1,555,085.6	9,706.1	
88	C-113	478,150.7	1,555,069.8	9,594.3	
87	C-114	478,229.6	1,555,031.6	9,506.6	
86	C-115	478,364.7	1,555,026.4	9,371.5	
85	C-116	478,490.3	1,554,913.8	9,202.8	
84	C-117	478,428.5	1,554,804.8	9,077.4	
83	C-118	478,388.4	1,554,662.4	8,929.5	
82	C-119	478,323.1	1,554,573.0	8,818.9	
81	C-120	478,267.0	1,554,612.8	8,750.0	
80	C-121	478,223.2	1,554,504.1	8,632.8	
79	C-122	478,121.9	1,554,453.5	8,519.6	
78	C-123	478,118.7	1,554,342.0	8,408.1	
77	C-124	477,972.7	1,554,288.1	8,252.4	
76	C-125	477,902.2	1,554,205.0	8,143.4	
75	C-126	477,834.9	1,554,128.5	8,041.5	
74	C-127	477,661.1	1,554,167.9	7,863.3	
73	C-128	477,640.8	1,554,009.8	7,703.9	
72	C-129	477,648.0	1,553,980.7	7,673.9	
71	C-130	477,640.6	1,553,906.5	7,599.3	
70	C-131	477,704.2	1,553,829.1	7,499.2	
69	C-132	477,787.3	1,553,764.2	7,393.7	
68	C-133	477,822.0	1,553,662.0	7,285.8	
67	C-134	477,897.3	1,553,585.0	7,178.1	
66	C-135	477,911.7	1,553,480.9	7,073.0	
65	C-136	477,914.1	1,553,378.3	6,970.5	
64	C-137	477,888.8	1,553,276.1	6,865.1	
63	C-138	477,790.3	1,553,231.1	6,756.8	
62	C-139	477,820.5	1,553,182.1	6,699.2	
61	C-140	477,768.7	1,553,091.7	6,595.0	
60	C-141	477,862.0	1,553,060.4	6,496.6	
59	C-142	477,939.2	1,553,008.8	6,403.7	
58	C-143	478,008.1	1,552,844.7	6,225.7	
57	C-144	478,078.4	1,552,814.7	6,149.3	
56	C-145	478,034.9	1,552,733.4	6,057.0	
55	C-146	477,990.2	1,552,647.2	5,960.0	
54	C-147	477,945.9	1,552,606.5	5,899.8	
53	C-148	477,824.4	1,552,617.7	5,777.9	
52	C-149	477,644.8	1,552,709.9	5,575.9	
51	C-150	477,560.0	1,552,711.8	5,491.1	
50	C-151	477,477.9	1,552,865.6	5,316.8	
49	C-152	477,589.7	1,552,632.7	5,058.5	
48	C-153	477,482.6	1,552,595.2	4,945.0	
47	C-154	477,413.3	1,552,541.6	4,857.4	
46	C-155	477,400.3	1,552,472.9	4,787.5	
45	C-156	477,375.1	1,552,379.4	4,690.6	
44	C-157	477,366.1	1,552,260.0	4,570.9	
43	C-158	477,391.5	1,552,116.7	4,425.4	

Table C.7.7 (1) Control Sections in Choluteca River

No.	CODE	x	y	Chainage (m)	Remarks
42	C-159	477,374.3	1,552,104.3	4,404.2	
41	C-160	477,416.7	1,552,000.6	4,292.2	
40	C-161	477,457.9	1,551,916.3	4,198.4	
39	C-162	477,511.8	1,551,825.3	4,092.6	
38	C-163	477,540.3	1,551,705.3	3,969.3	
37	C-164	477,540.7	1,551,588.7	3,852.7	
36	C-165	477,547.5	1,551,515.8	3,779.5	
35	C-166	477,569.6	1,551,413.5	3,674.8	
34	C-167	477,666.3	1,551,349.2	3,558.6	
33	C-168	477,653.8	1,551,244.7	3,453.4	
32	C-169	477,606.9	1,551,113.3	3,313.8	
31	C-170	477,551.5	1,551,065.8	3,240.8	
30	C-171	477,448.5	1,551,086.9	3,135.8	
29	C-172	477,349.5	1,551,111.6	3,033.7	
28	C-173	477,298.8	1,551,023.7	2,932.3	
27	C-174	477,295.2	1,550,913.3	2,821.7	
26	C-175	477,282.2	1,550,883.1	2,789.0	
25	C-176	477,312.4	1,550,873.5	2,757.3	
24	C-177	477,346.2	1,550,730.0	2,609.8	
23	C-178	477,484.8	1,550,737.1	2,471.0	
22	C-179	477,602.0	1,550,707.5	2,350.1	
21	C-180	477,570.0	1,550,613.2	2,250.5	
20	C-181	477,584.8	1,550,523.1	2,159.2	
19	C-182	477,493.8	1,550,562.3	2,060.2	
18	C-183	477,451.0	1,550,490.9	1,977.0	
17	C-184	477,432.0	1,550,455.0	1,936.4	
16	C-185	477,407.1	1,550,389.8	1,866.6	
15	C-186	477,479.8	1,550,366.9	1,790.4	
14	C-187	477,528.1	1,550,243.9	1,658.2	
13	C-188	477,611.8	1,550,026.7	1,425.4	
12	C-189	477,443.1	1,549,945.2	1,238.2	
11	C-190	477,351.5	1,549,934.0	1,145.9	
10	C-191	477,281.6	1,549,788.4	984.3	
9	C-192	477,391.1	1,549,678.7	829.3	
8	C-193	477,486.6	1,549,617.4	715.8	
7	C-194	477,560.7	1,549,539.6	608.4	
6	C-195	477,639.5	1,549,435.7	478.0	
5	C-196	477,665.2	1,549,347.3	385.9	
4	C-197	477,668.0	1,549,251.4	289.9	
3	C-198	477,614.4	1,549,202.7	217.5	
2	C-199	477,511.5	1,549,169.9	109.6	
1	C-200	477,401.9	1,549,171.9	0.0	Upstream

Table C.7.7 (2) Control Sections in Chiquito River

No.	CODE	x	y	Chainage (m)	Remarks
52	CH-0	477,824.0	1,558,940.7	5,653.5	Downstream
51	CH-1	477,920.2	1,558,853.9	5,523.9	
50	CH-2	477,929.5	1,558,795.7	5,464.9	
49	CH-3	478,067.3	1,558,821.1	5,324.8	
48	CH-4	478,081.3	1,558,846.9	5,295.4	
47	CH-5	478,128.4	1,558,863.5	5,245.4	
46	CH-6	478,195.6	1,558,868.7	5,178.0	
45	CH-7	478,216.2	1,558,835.2	5,138.7	
44	CH-8	478,328.4	1,558,809.4	5,023.6	
43	CH-9	478,547.2	1,558,827.5	4,804.0	
42	CH-10	478,364.5	1,558,891.5	4,610.4	
41	CH-11	478,485.2	1,558,972.4	4,465.1	
40	CH-12	478,590.6	1,559,011.6	4,352.6	
39	CH-13	478,616.2	1,559,134.5	4,227.1	
38	CH-14	478,691.6	1,559,197.0	4,129.2	
37	CH-15	478,755.7	1,559,187.5	4,064.4	
36	CH-16	478,785.6	1,559,044.1	3,917.9	
35	CH-17	478,921.7	1,559,068.6	3,779.6	
34	CH-18	478,941.6	1,559,146.0	3,699.7	
33	CH-19	479,059.2	1,559,177.1	3,578.1	
32	CH-20	479,134.1	1,559,155.5	3,500.1	
31	CH-21	479,230.0	1,559,114.6	3,395.9	
30	CH-22	479,320.0	1,559,142.7	3,301.6	
29	CH-23	479,396.0	1,559,076.8	3,200.9	
28	CH-24	479,505.8	1,559,110.8	3,086.0	
27	CH-25	479,511.2	1,559,174.1	3,022.5	
26	CH-26	479,586.2	1,559,229.5	2,929.2	
25	CH-27	479,657.4	1,559,330.5	2,805.7	
24	CH-28	479,709.4	1,559,402.3	2,717.0	
23	CH-29	479,730.1	1,559,480.5	2,636.0	
22	CH-30	479,768.8	1,559,598.6	2,511.8	
21	CH-31	479,890.3	1,559,589.8	2,390.0	
20	CH-32	479,977.6	1,559,568.8	2,300.2	
19	CH-33	480,012.1	1,559,458.0	2,184.2	
18	CH-34	480,071.2	1,559,514.5	2,102.4	
17	CH-35	480,137.4	1,559,484.6	2,029.8	
16	CH-36	480,204.7	1,559,468.2	1,960.5	
15	CH-37	480,306.3	1,559,411.7	1,844.3	
14	CH-38	480,373.9	1,559,374.7	1,767.3	
13	CH-39	480,534.8	1,559,336.2	1,601.8	
12	CH-40	480,592.3	1,559,341.3	1,544.1	
11	CH-41	480,687.5	1,559,367.2	1,445.4	
10	CH-42	480,792.5	1,559,377.8	1,339.9	
9	CH-43	480,921.4	1,559,340.2	1,205.6	
8	CH-44	480,882.1	1,559,182.0	1,042.6	
7	CH-45	480,922.7	1,559,074.3	927.5	
6	CH-46	480,999.7	1,559,038.9	842.8	
5	CH-47	481,118.5	1,559,188.6	651.7	
4	CH-48	481,120.5	1,558,989.1	452.2	
3	CH-49	481,179.7	1,558,885.6	332.9	
2	CH-50	481,300.9	1,558,839.7	203.3	
1	CH-51	481,460.2	1,558,966.0	0.0	Upstream

Table C.7.7 (3) Control Sections in Sapo River

No.	CODE	x	y	Chainage (m)	Remarks
32	S-0	477,427.8	1,559,035.8	3,400.6	Downstream
31	S-1	477,150.8	1,558,811.3	3,044.1	
30	S-2	477,075.2	1,558,787.2	2,964.7	
29	S-3	476,962.3	1,558,865.2	2,827.5	
28	S-4	477,003.8	1,558,790.6	2,742.1	
27	S-5	476,948.6	1,558,704.6	2,639.9	
26	S-6	476,860.6	1,558,691.9	2,551.1	
25	S-6-1	476,787.9	1,558,651.3	2,467.8	
24	S-7	476,733.3	1,558,621.4	2,405.5	
23	S-8	476,775.0	1,558,568.2	2,338.0	
22	S-9	476,654.6	1,558,533.2	2,212.6	
21	S-10	476,526.1	1,558,540.6	2,083.9	
20	S-11	476,464.8	1,558,539.8	2,022.6	
19	S-12	476,348.7	1,558,532.2	1,906.2	
18	S-13	476,229.7	1,558,542.9	1,786.8	
17	S-14	476,139.1	1,558,562.3	1,694.1	
16	S-15	476,047.2	1,558,589.8	1,598.2	
15	S-16	475,996.6	1,558,628.5	1,534.5	
14	S-17	475,967.4	1,558,693.4	1,463.3	
13	S-18	475,953.5	1,558,771.3	1,384.2	
12	S-19	475,914.9	1,558,905.3	1,244.8	
11	S-20	475,845.6	1,558,967.1	1,151.9	
10	S-21	475,786.2	1,558,985.0	1,089.8	
9	S-22	475,717.5	1,558,974.6	1,020.3	
8	S-23	475,714.0	1,558,976.7	1,016.3	
7	S-24	475,789.8	1,558,996.0	938.1	
6	S-25	475,716.4	1,559,136.0	780.0	
5	S-26	475,713.4	1,559,232.6	683.3	
4	S-27	475,665.3	1,559,305.0	596.4	
3	ST-1	475,648.7	1,558,945.6	236.7	
2	ST-2	475,541.6	1,558,915.4	125.5	
1	ST-3	475,433.9	1,558,851.0	0.0	Upstream

Table C.7.7 (4) Control Sections in Guacerique River

No.	CODE	x	y	Chainage (m)	Remarks
31	G-0	477,797.8	1,557,790.8	3,175.5	Downstream
30	G-1	477,746.1	1,557,670.3	3,044.4	
29	G-2	477,639.5	1,557,634.3	2,931.8	
28	G-3	477,588.2	1,557,555.2	2,837.6	
27	G-4	477,475.9	1,557,511.1	2,716.9	
26	G-5	477,400.9	1,557,412.8	2,593.3	
25	G-6	477,312.5	1,557,297.9	2,448.3	
24	G-7	477,314.8	1,557,157.0	2,307.3	
23	G-8	477,348.3	1,557,055.9	2,200.9	
22	G-9	477,261.7	1,556,995.7	2,095.4	
21	G-10	477,209.9	1,556,943.1	2,021.7	
20	G-11	477,209.7	1,556,829.1	1,907.6	
19	G-12	477,164.8	1,556,740.2	1,808.1	
18	G-13	477,064.7	1,556,734.1	1,707.7	
17	G-14	476,978.8	1,556,788.9	1,605.9	
16	G-15	476,969.9	1,556,891.2	1,503.2	
15	G-16	476,965.9	1,556,990.9	1,403.4	
14	G-17	476,937.3	1,557,089.2	1,301.0	
13	G-18	476,884.9	1,557,175.1	1,200.4	
12	G-19	476,799.7	1,557,226.8	1,100.7	
11	G-20	476,708.0	1,557,270.7	999.1	
10	G-21	476,628.7	1,557,203.1	894.8	
9	G-22	476,573.7	1,557,118.0	793.5	
8	G-23	476,493.0	1,557,052.7	689.8	
7	G-24	476,426.1	1,556,989.3	597.6	
6	G-25	476,325.8	1,556,950.9	490.2	
5	G-26	476,227.3	1,556,929.3	389.3	
4	G-27	476,147.9	1,556,867.2	288.5	
3	G-28	476,056.5	1,556,863.2	197.0	
2	G-29	475,957.8	1,556,862.0	98.4	
1	G-30	475,861.0	1,556,879.4	0	upstream

Table C.7.8 High Water Mark Survey Results

Section	River/Chainage	High Water Mark (m)
C-200	CHOLUTECA 0.000	996.90
C-199	CHOLUTECA 0.110	996.70
C-198	CHOLUTECA 0.218	997.10
C-197	CHOLUTECA 0.290	997.00
C-196	CHOLUTECA 0.386	995.90
C-195	CHOLUTECA 0.478	994.00
C-194	CHOLUTECA 0.608	993.20
C-193	CHOLUTECA 0.716	993.10
C-192	CHOLUTECA 0.829	993.00
C-191	CHOLUTECA 0.984	992.20
C-190	CHOLUTECA 1.146	991.70
C-189	CHOLUTECA 1.238	991.30
C-188	CHOLUTECA 1.425	990.90
C-187	CHOLUTECA 1.658	988.90
C-186	CHOLUTECA 1.790	986.90
C-185	CHOLUTECA 1.867	986.90
C-184	CHOLUTECA 1.936	986.90
C-183	CHOLUTECA 1.977	986.80
C-182	CHOLUTECA 2.060	986.80
C-181	CHOLUTECA 2.159	988.80
C-180	CHOLUTECA 2.251	987.30
C-179	CHOLUTECA 2.350	985.80
C-178	CHOLUTECA 2.471	985.70
C-177	CHOLUTECA 2.610	982.10
C-176	CHOLUTECA 2.757	982.20
C-175	CHOLUTECA 2.789	982.20
C-174	CHOLUTECA 2.822	982.10
C-173	CHOLUTECA 2.932	981.80
C-172	CHOLUTECA 3.034	981.40
C-171	CHOLUTECA 3.136	981.10
C-170	CHOLUTECA 3.241	978.70
C-169	CHOLUTECA 3.314	978.60
C-168	CHOLUTECA 3.453	978.60
C-167	CHOLUTECA 3.559	978.00
C-166	CHOLUTECA 3.675	975.40
C-165	CHOLUTECA 3.780	975.30
C-164	CHOLUTECA 3.853	976.20
C-163	CHOLUTECA 3.969	975.60
C-162	CHOLUTECA 4.093	974.90
C-161	CHOLUTECA 4.198	974.30
C-160	CHOLUTECA 4.292	973.70
C-159	CHOLUTECA 4.404	973.10
C-158	CHOLUTECA 4.425	972.50
C-157	CHOLUTECA 4.571	971.90
C-156	CHOLUTECA 4.691	971.80
C-155	CHOLUTECA 4.787	971.20
C-154	CHOLUTECA 4.857	970.70
C-153	CHOLUTECA 4.945	969.40
C-152	CHOLUTECA 5.059	968.70
C-151	CHOLUTECA 5.317	968.20
C-150	CHOLUTECA 5.487	969.40
C-149	CHOLUTECA 5.581	967.90
C-148	CHOLUTECA 5.783	967.90
C-147	CHOLUTECA 5.905	963.70
C-146	CHOLUTECA 5.965	963.10
C-145	CHOLUTECA 6.062	963.10

Table C.7.8 High Water Mark Survey Results

Section	River/Chainage	High Water Mark (m)
C-144	CHOLUTECA 6.155	963.50
C-143	CHOLUTECA 6.231	961.20
C-142	CHOLUTECA 6.409	960.70
C-141	CHOLUTECA 6.502	960.60
C-140	CHOLUTECA 6.600	961.30
C-139	CHOLUTECA 6.705	961.30
C-138	CHOLUTECA 6.762	960.90
C-137	CHOLUTECA 6.870	959.90
C-136	CHOLUTECA 6.976	959.60
C-135	CHOLUTECA 7.078	959.10
C-134	CHOLUTECA 7.183	958.60
C-133	CHOLUTECA 7.291	958.10
C-132	CHOLUTECA 7.399	958.00
C-131	CHOLUTECA 7.505	955.50
C-130	CHOLUTECA 7.605	955.70
C-129	CHOLUTECA 7.679	956.30
C-128	CHOLUTECA 7.709	956.90
C-127	CHOLUTECA 7.869	953.50
C-126	CHOLUTECA 8.047	955.30
C-125	CHOLUTECA 8.149	956.00
C-124	CHOLUTECA 8.258	954.10
C-123	CHOLUTECA 8.413	953.80
C-122	CHOLUTECA 8.525	953.40
C-121	CHOLUTECA 8.638	953.10
C-120	CHOLUTECA 8.755	952.80
C-119	CHOLUTECA 8.824	952.40
C-118	CHOLUTECA 8.935	951.80
C-117	CHOLUTECA 9.083	951.40
C-116	CHOLUTECA 9.208	949.70
C-115	CHOLUTECA 9.377	949.40
C-114	CHOLUTECA 9.512	949.20
C-113	CHOLUTECA 9.600	948.90
C-112	CHOLUTECA 9.711	948.70
C-111	CHOLUTECA 9.797	948.50
C-110	CHOLUTECA 9.906	948.30
C-109	CHOLUTECA 10.005	948.10
C-108	CHOLUTECA 10.118	947.00
C-107	CHOLUTECA 10.178	946.00
C-106	CHOLUTECA 10.320	946.70
C-105	CHOLUTECA 10.421	946.90
C-104	CHOLUTECA 10.526	947.10
C-103	CHOLUTECA 10.621	947.20
C-102	CHOLUTECA 10.756	946.40
C-101	CHOLUTECA 10.878	946.00
C-100	CHOLUTECA 10.940	945.20
C-99	CHOLUTECA 11.044	944.70
C-98	CHOLUTECA 11.130	944.90
C-97	CHOLUTECA 11.251	943.70
C-96	CHOLUTECA 11.402	942.40
C-95	CHOLUTECA 11.541	944.10
C-94	CHOLUTECA 11.659	942.00
C-93	CHOLUTECA 11.769	944.20
C-92	CHOLUTECA 11.907	942.30
C-91	CHOLUTECA 12.071	940.40
C-90	CHOLUTECA 12.169	939.90
C-89	CHOLUTECA 12.264	939.30

Table C.7.8 High Water Mark Survey Results

Section	River/Chainage		High Water Mark (m)
C-88	CHOLUTECA	12.361	938.80
C-87	CHOLUTECA	12.457	936.40
C-86	CHOLUTECA	12.551	936.60
C-85	CHOLUTECA	12.646	936.80
C-84	CHOLUTECA	12.742	936.30
C-83	CHOLUTECA	12.849	936.80
C-82	CHOLUTECA	12.937	936.40
C-81	CHOLUTECA	13.040	936.10
C-80	CHOLUTECA	13.160	937.00
C-79	CHOLUTECA	13.254	936.50
C-78	CHOLUTECA	13.356	935.90
C-77	CHOLUTECA	13.479	935.30
C-76	CHOLUTECA	13.587	935.10
C-75	CHOLUTECA	13.730	934.90
C-74	CHOLUTECA	13.839	933.70
C-73	CHOLUTECA	13.959	933.50
C-72	CHOLUTECA	14.101	933.50
C-71	CHOLUTECA	14.239	933.30
C-70	CHOLUTECA	14.349	933.10
C-69	CHOLUTECA	14.461	932.90
C-68	CHOLUTECA	14.567	932.60
C-67	CHOLUTECA	14.764	932.40
C-66	CHOLUTECA	14.936	931.50
C-65	CHOLUTECA	15.084	931.10
C-64	CHOLUTECA	15.262	931.20
C-63	CHOLUTECA	15.352	929.40
C-62	CHOLUTECA	15.416	929.70
C-61	CHOLUTECA	15.563	929.90
C-60	CHOLUTECA	15.636	929.30
C-59	CHOLUTECA	15.816	928.60
C-58	CHOLUTECA	15.951	928.60
C-57	CHOLUTECA	15.992	928.90
C-56	CHOLUTECA	16.137	927.90
C-55	CHOLUTECA	16.300	928.20
C-54	CHOLUTECA	16.379	928.20
C-53	CHOLUTECA	16.454	928.80
C-52	CHOLUTECA	16.550	928.20
C-51	CHOLUTECA	16.689	926.90
C-50	CHOLUTECA	16.826	925.70
C-49	CHOLUTECA	16.927	924.30
C-48	CHOLUTECA	17.037	923.80
C-47	CHOLUTECA	17.135	921.50
C-46	CHOLUTECA	17.275	921.90
C-45	CHOLUTECA	17.384	921.60
C-44	CHOLUTECA	17.472	921.20
C-43	CHOLUTECA	17.583	920.90
C-42	CHOLUTECA	17.689	920.70
C-41	CHOLUTECA	17.754	919.90
C-40	CHOLUTECA	17.867	919.10
C-39	CHOLUTECA	17.967	918.60
C-38	CHOLUTECA	18.061	918.10
C-37	CHOLUTECA	18.098	918.10
C-36	CHOLUTECA	18.113	918.20
C-35	CHOLUTECA	18.221	918.20
C-34	CHOLUTECA	18.406	916.90
C-33	CHOLUTECA	18.515	915.50